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**Indoor air —**

**Part 9:**

**Determination of the emission of  
volatile organic compounds from  
samples of building products and  
furnishing — Emission test chamber  
method**

**ISO/CEN PARALLEL PROCESSING**

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CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
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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 document 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)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 264, *Air quality*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16000-9:2006), which has been technically revised.

The main change is as follows: detailed information about cut edge has been added.

A list of all parts in the ISO 16000 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

The objectives of the determination of volatile organic compounds (VOCs) emitted from building products using emission test chambers in conjunction with the standardised sampling, storage of samples and preparation of test specimens are:

- to provide manufacturers, builders and end users with emission data useful for the evaluation of the impact of building products on the indoor air quality;
- to promote the development of improved products.

The method can in principle be used for most building products used indoors.

Sampling, transport and storage of materials to be tested, and preparation of test specimens are described in ISO 16000-11. Air sampling and analytical methods for the determination of VOCs are specified in ISO 16000-6 and ISO 16017-1.

A general description of an emission test chamber is given in [Annex C](#).

For the determination of formaldehyde emissions from wood-based panels, refer to EN 717-1<sup>[1]</sup>. The measurement procedure for formaldehyde is described in ISO 16000-3<sup>[2]</sup>.

The determination of the emission rates of cut edges is described in [Annex D](#).



## Indoor air —

### Part 9:

# Determination of the emission of volatile organic compounds from samples of building products and furnishing — Emission test chamber method

## 1 Scope

This document specifies a general laboratory test method for the determination of the area specific emission rate of volatile organic compounds (VOCs) from samples of newly produced building products or furnishing under defined climate conditions. The method can also, in principle, be applied to samples of aged products. The emission data obtained can be used to calculate concentrations in a model room (see [Table B.1](#)).

This document is applicable to various emission test chambers used for the determination of the emission of VOCs from building products or furnishing.

This document is also applicable to samples of wood-based panels and other building products, in order to determine the emission rate of formaldehyde.

NOTE In principle, this document can be applied to the study of any gas phase emissions from samples of building products and furnishing.

## 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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 16000-6, *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 16000-11, *Indoor air — Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

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*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology 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**  
**air change rate**  
ratio of the volume of clean air brought into the emission test chamber per hour and the free emission test chamber volume measured in identical units

**3.2**  
**air flow rate**  
air volume entering into the emission test chamber per time

**3.3**  
**air velocity**  
air speed over the surface of the *test specimen* (3.13)

**3.4**  
**area specific air flow rate**  
ratio between the supply *air flow rate* (3.2) and the area of the *test specimen* (3.13)

**3.5**  
**building product**  
product produced for incorporation in a permanent manner in construction works

**3.6**  
**emission test chamber**  
enclosure with controlled operational parameters for the determination of *VOCs* (3.15) emitted from *samples* (3.10) of *building products* (3.2)

Note 1 to entry: The chamber size depends upon the required application but should at minimum be 20 l.

**3.7**  
**emission test chamber concentration**  
concentration of a specific *volatile organic compound* (3.15),  $VOC_x$ , (or group of volatile organic compounds) measured in the emission test chamber outlet

**3.8**  
**product loading factor**  
ratio of exposed surface area of the *test specimen* (3.13) and the free emission test chamber volume

**3.9**  
**recovery**  
measured mass of a *target volatile organic compound* (3.12) in the air leaving the emission test chamber during a given time period divided by the mass of target volatile organic compound added to the emission test chamber in the same time period

Note 1 to entry: Recovery is expressed as a percentage.

Note 2 to entry: The recovery provides information about the performance of the entire method.

**3.10**  
**sample**  
part or piece of a *building product* (3.2) or furnishing product that is representative of the production

**3.11**  
**specific emission rate**  
 $E_A$   
product specific rate describing the mass of a *volatile organic compound* (3.15) emitted from a unit area of a *test specimen* (3.13) per time at a given time from the start of the test

Note 1 to entry: Several other specific emission rates can be defined according to different requirements, e.g. length specific emission rate,  $E_l$ , mass specific emission rate,  $E_m$ , volume specific emission rate,  $E_v$ , and unit specific emission rate,  $E_u$ .



Note 2 to entry: The term "area specific emission rate" is sometimes used in parallel with the term "emission factor".

### 3.12

#### target volatile organic compound

specific *VOC* (3.15) identified as a target chemical in a standard or specification

### 3.13

#### test specimen

part of the *sample* (3.10) specially prepared for emission testing in an emission test chamber in order to simulate the emission behaviour of the material or product that is tested

### 3.14

#### total volatile organic compound

##### TVOC

sum of the concentrations of identified and unidentified *VOCs* (3.15) eluting between and including *n*-hexane and *n*-hexadecane

Note 1 to entry: For quantification of the identified compounds, their individual response is used. The areas of the unidentified peaks are converted on molecular mass basis to concentrations using the toluene response factor<sup>[3]</sup>.

Note 2 to entry: Due to practical reasons to be taken into account for test chambers, this definition differs slightly from that defined in ISO 16000-6:2021, where TVOC are related to the sampling medium Tenax TA<sup>®1)</sup> on which the TVOC are adsorbed.

### 3.15

#### volatile organic compound

##### VOC

organic compound that is emitted from the *test specimen* (3.13) 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 16000-6:2021.

Note 2 to entry: The emission test method described in this document is optimum for the range of compounds specified by the definition of *total volatile organic compounds (TVOC)* (3.14).

## 4 Symbols and abbreviated terms

### 4.1 Symbols

$\rho_x$	mass concentration of a $VOC_x$ in the emission test chamber	$\mu\text{g}/\text{m}^3$
$L$	product loading factor	$\text{m}^2/\text{m}^3$
$n$	air change rate	$\text{h}^{-1}$
$q$	area specific air flow rate ( $= n/L$ )	$\text{m}^3/(\text{m}^2 \cdot \text{h})$
$E_A$	area specific emission rate	$\mu\text{g}/(\text{m}^2 \cdot \text{h})$
$t$	time after start of the test	h or d

1) Tenax TA<sup>®</sup> is the trade name of a product manufactured by Supelco, Inc. This information is given for the convenience of users of this part of ISO 16000 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

## 4.2 Abbreviated terms

RH	relative humidity
QAPP	quality assurance project plan
QA/QC	quality assurance and quality control
TVOC	total volatile organic compound
VOC	volatile organic compound
VOC <sub>x</sub>	individual VOC

## 5 Principle

The principle of the test is to determine the area specific emission rate of VOCs emitted from samples of building products. The test is performed in an emission test chamber at constant temperature, relative air humidity, and area specific air flow rate. The air in the emission test chamber is fully mixed (see [9.6](#)), and measurements of the VOC concentration in the air at the outlet are representative of the emission test chamber air concentrations.

Area specific emission rates at a given time  $t$  are calculated from the emission test chamber air concentrations and the area specific air flow rate  $q$  (see [Clause 13](#)).

With knowledge of the concentration in the air, the air flow through the emission test chamber and the surface area of the test specimen, the area specific emission rates of VOCs from the test specimen can be determined.

## 6 Emission test chamber system

### 6.1 General

A facility designed and operated to determine area specific emission rates for VOCs emitted from samples of building products shall contain the following: emission test chamber, clean air generation and humidification system, air mixing system, monitoring and control systems to ensure that the test is carried out according to specified conditions<sup>[4],[5]</sup>.

General specifications and requirements that apply to all types of emission test chambers included in this document are given in [6.2](#) to [6.6](#).

Quality assurance and quality control activities shall be carried out as described in [Annex A](#).

A general description of an emission test chamber is given in [Annex C](#) and [Figure C.1](#).

### 6.2 Emission test chamber materials

The emission test chamber and the parts of the sampling system coming in contact with the emitted VOCs are normally made of surface-treated (polished) stainless steel or glass.

Other materials may be used for mixing devices, e.g. fans, and for sealing materials. These shall be low emitting and low adsorbing and shall be tested in the test chamber as part of the overall background test to confirm that they do not contribute to the emission test chamber background concentration or low VOC recoveries (see [6.6](#)).

### 6.3 Air supply and mixing facilities

The emission test chamber shall have facilities (e.g. electronic mass flow controller) capable of continuously controlling the air flow rate at a fixed value with an accuracy of  $\pm 5\%$ .

The emission test chamber shall be designed to ensure proper mixing of the emission test chamber air. The requirements are given in [9.6](#).

NOTE Fans, multi-port inlet and outlet diffusers, perforated floors and baffle plates are used to obtain adequate mixing.

### 6.4 Air tightness

The emission test chamber shall be airtight in order to avoid uncontrolled air exchange with external air.

The emission test chamber shall be operated slightly above atmospheric pressure to avoid influence from the laboratory atmosphere.

The emission test chamber is considered sufficiently airtight if at least one of the following requirements is fulfilled:

- the air leakage is less than 0,5 % of the chamber volume per minute at an overpressure of 1 000 Pa;
- the air leakage is less than 5 % of the supply airflow rate.

### 6.5 Air sampling devices

The outlet air (at the emission test chamber outlet) shall be used for sampling, although separate sampling ports in the emission test chamber can be used, provided that the air sampled is equivalent to the outlet air.

The sampler manifold should enter directly to the outlet air stream. If a duct shall be used, it shall be as short as possible and maintained at the same temperature as the emission test chamber.

The total sampling flows shall not exceed 80 % of the air flow rate into the chamber to avoid negative pressure.

A multiport sampling manifold can be used to provide flexibility for duplicate air sampling. A mixing chamber between the emission test chamber and the manifold or between the air inlet and the emission test chamber can be included to permit addition and mixing of internal standard gases with the emission test chamber air stream.

The exhaust from the emission test chamber should be ducted into a fume hood, ensuring that any chemicals emitted from the test material are isolated from the laboratory environment.

### 6.6 Recovery and sink effects

The recovery of a target VOC can be determined using a VOC source of known specific emission rate in the emission test chamber. The concentrations generated shall be of similar magnitude to those expected during the emission tests of building products.

Recovery tests shall be performed in the test chamber using toluene and *n*-dodecane. Chamber concentrations shall be determined at 72 h after start of the test (i.e. first mandatory measurement, see [12.3](#)). The mean recovery shall be greater than 80 % for toluene and *n*-dodecane. The results of recovery test shall be reported (concentration expected versus concentration measured).

For more information see [Annex A](#).

NOTE 1 Low recovery of hygroscopic VOCs can occur in humidified air.

NOTE 2 Sink effects, leaks or poor calibration can cause difficulties to meet the minimum requirements. Sink and adsorption characteristics are very much dependent on the type of compound emitted. Additional recovery tests using target VOCs with different molecular weight and polarity can be used to increase understanding of these effects.

## 7 Apparatus

The equipment necessary for carrying out an emission test are listed below.

- 7.1 **Clean air supply**, e.g. pressurised purified air or synthetic air in gas cylinders.
- 7.2 **Emission test chamber system.**
- 7.3 **Humidification system.**
- 7.4 **Air humidity, temperature and air velocity monitoring systems.**
- 7.5 **Air flow meters.**
- 7.6 **Cleaning agent for the emission test chamber walls or equipment for thermal treatment.**
- 7.7 **Equipment for measurement of air mixing.**
- 7.8 **Facilities for recovery testing.**

## 8 Test conditions

### 8.1 Temperature and relative air humidity

Test specimens shall be tested at temperature and relative humidity 23 °C, 50 % RH in the supply air during the emission test in accordance with ISO 554. The tolerances are  $\pm 1$  °C and  $\pm 5$  % RH.

For test specimens with applications under other climatic conditions, alternative temperature and air humidity conditions may be used, preferably as specified in ISO 554.

NOTE Initial variance can be observed in the emission test chamber climate after opening the emission test chamber door and loading a test specimen. Wet test specimens lead to increased humidity over hours or days.

### 8.2 Supply air quality and background concentration

Supply air shall not contain any VOCs at levels greater than the emission test chamber background requirements.

Background concentrations shall be low enough not to interfere with the emission determinations beyond quality assurance limits.

The TVOC background concentration shall be lower than  $20 \mu\text{g}/\text{m}^3$ . The background concentration of any single target VOC shall be lower than  $2 \mu\text{g}/\text{m}^3$ .

The water used for humidification shall not contain interfering VOCs.

### 8.3 Air velocity

The air velocity near the surface of the test specimen shall be in the range 0,1 m/s to 0,3 m/s (see [9.5](#)).

NOTE 1 An averaging time of 1 min is appropriate for air velocity measurements.

NOTE 2 The air velocity can be important for evaporative controlled emissions, e.g. from some liquid products. This depends on the substrate.

## 8.4 Area specific air flow rate and air change rate

The emission test chamber concentration depends on the area specific air flow rate that is selected as a parameter in designing the emission test conditions.

## 9 Verification of the test conditions

### 9.1 General

All control measures shall be traceable to a reference standard mixture according to the quality assurance and quality control schemes (see [Annex A](#)). Temperature, relative air humidity and air flow rate shall be monitored and recorded continuously with sufficient accuracy.

### 9.2 Temperature and relative air humidity control systems

Control of temperature can be made by either placing the emission test chamber within a location controlled to the required temperature or by maintaining the temperature within the emission test chamber. In the latter case, the emission test chamber walls shall be insulated effectively to avoid condensation of moisture on the interior walls of the emission test chamber.

Control of relative air humidity should be made by external humidity control of the clean air supply.

NOTE If internal humidity control of the air is provided by the emission test chamber, precautions shall be taken when testing hygroscopic or wet test specimens. Condensation can happen or droplets of water can be deposited.

Temperature and relative air humidity shall be measured independently of the systems for controlling the temperature and air humidity.

### 9.3 Air change rate in the emission test chamber

The air change rate shall be regularly checked with a minimum frequency of every 12 months, either by using a calibrated gas meter or the tracer gas procedure as referred to [6.4](#). The air change rate shall not vary by more than  $\pm 3$  % of the set value.

If the test is carried out on the outlet with a gas volume meter/flow meter that is not permanently installed, one should be aware that the back pressure introduced by the instrument can lower the flow rate through the emission test chamber.

### 9.4 Emission test chamber air tightness

The emission test chamber air tightness shall be checked regularly, either by pressure drop measurements or by comparison of simultaneous measurement of flow rates at the inlet and the outlet ports; or by measuring tracer gas dilution, see [6.4](#).

### 9.5 Air velocity in the emission test chamber

The air velocity in the emission test chamber shall be measured in at least one position; over the centre of the test specimen, at a distance of 10 mm from the exposed surface of the test specimen. If the size and configuration of the test specimen obstructs the air flow, additional measurement points shall be selected.

NOTE Adequate equipment for air velocity measurements are hot wire or film anemometers calibrated in the range of 0,1 m/s to 0,5 m/s.

## 9.6 Efficiency of the internal emission test chamber air mixing

Tests to determine the efficiency of the air mixing shall be conducted with test specimens or the inert substrate of the test specimens located in the test chamber.

One approach to determine whether the test chamber air is adequately mixed is to blend a tracer gas with the inlet air at constant concentration and flow, and measure the concentration in the chamber outlet over time. The chamber concentration versus time plot is then compared to the theoretical curve for a completely mixed chamber. A procedure would be to adjust the theoretical curve by least square fit to the measured data using the chamber volume as a variable. One can then compare the actual chamber volume to the "apparent" chamber volume based on the curve fit<sup>[6]</sup>. Internal chamber air should be properly mixed and should comply with or within 10 % of the theoretical perfectly mixed model.

## 10 Test specimens

Studies of the emission of VOCs from products in emission test chambers require proper handling of the product prior to testing.

Follow the procedures for test specimen preparation as specified in ISO 16000-11.

NOTE If the test specimen preparation of the product to be tested is not covered by ISO 16000-11, other standards and/or test methods can also be used as a reference.

## 11 Emission test chamber preparation

The emission test chamber shall be cleaned in order to fulfil the requirements of [8.2](#). Cleaning can be done by flushing with clean air or washing the inner surfaces of the emission test chamber with an alkaline detergent followed by two separate rinsings with freshly distilled water. The emission test chamber is then dried and purged at test conditions. The emission test chamber can also be cleaned by elevating the temperature and flush with clean air. Cleaning is done until the background level is met.

## 12 Test method

### 12.1 Background concentrations

An air sample of the emission test chamber background is taken before the start of a new emission test, to quantify any background contribution of VOCs from the empty emission test chamber.

Background concentrations shall meet the requirements in [8.2](#).

### 12.2 Test specimen location in the emission test chamber

The test specimen shall be positioned in the centre of the emission test chamber to ensure that the air flow is evenly distributed over the emitting surface of the test specimen.

### 12.3 Time for measurements of test chamber air concentration

The concentration measurements shall be carried out at predefined sampling times. Depending on the objective of the test, it can be appropriate to sample the air at additional times. Air sampling duration for concentration measurements depends on the analytical methods to be used and they shall be documented.

If not otherwise specified, duplicate air samples shall be taken at least at 72 h and at 28 d after the start of the test. When air sampling is carried out prior to 7 d from the start of the test, a tolerance of  $\pm 1$  h for the selected time is acceptable. When air sampling is carried out after 7 d from the start of the test, a

tolerance of  $\pm 6$  h for the selected time is acceptable. The reported sampling time shall be the mid-point of the sampling period.

After termination of the emission test, the emission test chamber shall be cleaned according to [Clause 11](#).

Emission test duration is determined by the purpose of the test. The test specimen shall remain in the test chamber during the whole testing period to provide comparable test results, if not specified otherwise.

NOTE 1 Necessary pre-conditioning (drying or curing time) of the test specimen may be carried out outside the test chamber before testing according to the objective of the test.

NOTE 2 If decay studies are required, air samples may be taken after 1, 3, 7, 14, 28 and 56 days, or longer, after the start of the test.

### 13 Calculation of area specific emission rates and expression of results

At a given test condition,  $\rho_x$  depends on the area specific emission rate of the test specimen and the air flow rate through the emission test chamber. For individual VOCs, the compounds found both in the material and in the background shall be subtracted compound by compound. For TVOC, the measured background shall be subtracted. The relation between  $\rho_x$ , the area specific emission rate  $E_A$  and the area specific air flow rate  $q$  of the emission test chamber can be expressed as:

$$\rho_x = E_A \cdot (L/n) = E_A / q \text{ at time } t \quad (1)$$

[Formula \(1\)](#) shows that the area specific air flow rate  $q$  equals the  $n/L$  ratio. For a given product tested under given emission test chamber conditions, the concentration of  $\text{VOC}_x$  depends on the area specific air flow rate.

The measured concentration  $\rho_x$  of a VOC in the outlet air from the emission test chamber shall be converted to an area specific emission rate  $E_A$ .  $\rho_x$  is the mean concentration of a  $\text{VOC}_x$  calculated from duplicate air samples as described in [12.3](#):

$$E_A = \rho_x \cdot q \text{ at time } t \quad (2)$$

The result shall be related to the time of the emission measurement after placing the test specimen in the emission test chamber and may be reported quantitatively as the area specific emission rate, of individual VOCs and/or TVOC according to the objective of the test.

The sum of emitted compounds, TVOC, should be regarded only as a factor specific to the product studied and only to be used for comparison of products with similar target VOC profiles.

NOTE For certain purposes, area specific emission rates can be calculated from time concentration profiles, or by means of various mathematical models, e.g. first-order decay from concentration time data. This and other models are referred to in References [\[6\]](#) and [\[7\]](#).

### 14 Performance characteristics

Performance characteristics of this test method, when used in conjunction with ISO 16000-6, shall be in accordance with ISO 16000-6 and ISO 16017-1.

## 15 Test report

The test report shall include the following information:

- a) test laboratory:
  - 1) name and address of the laboratory;
  - 2) name of the responsible person;
  - 3) description of the equipment and methods used (test chamber, clean air system, environmental control, sample collection, analytical instrumentation, standard generation and calibration);
- b) sample description:
  - 1) type of product (and brand name if appropriate);
  - 2) sample selection process (e.g. random);
  - 3) product history (date of production, date of sampling, date of sending, date of arrival to the test laboratory, storage conditions and transportation conditions if the conditions of ISO 16000-11 are not met);
- c) test specimen preparation
  - 1) date, and time of unpacking and test specimens preparation (hour, day, month and year);
  - 2) method of preparation, including thickness and substrate, including for liquid products the substrate, the mass of sample applied per unit area, and/or wet-film thickness and the product density, the amount per unit area, and/or the thickness;
- d) experimental conditions and procedures:
  - 1) date of the test and International standard used;
  - 2) chamber conditions (temperature, relative air humidity, air change rate, air velocity);
  - 3) test specimen area and loading factor;
  - 4) sampling of emitted VOCs (adsorbent used, volume sampled, sampling duration and times after introduction into the chamber);
  - 5) any deviations from the procedure or any unusual features observed;
- e) data analysis:

describe the method used to derive specific emission rates from measured chamber concentrations (specify mathematical models or equations used);
- f) results:

specific emission rates shall be reported for each test specimen, for individual VOCs and/or TVOC, at the times of air sampling;
- g) quality assurance / quality control:
  - 1) background chamber concentrations of target compounds;
  - 2) recovery data of toluene and *n*-dodecane (to evaluate sinks);
  - 3) results of duplicate sampling/analysis;
  - 4) quality of the environmental variables (temperature, relative air humidity, air change rate, air velocity).



## Annex A (normative)

### System for quality assurance and quality control

#### A.1 General

Small chamber testing of organic emissions from indoor materials/products may be conducted within the framework of a quality assurance project plan (QAPP). The QAPP may contain a project description, data quality objectives/acceptance criteria, QA/QC approaches/activities, and QA/QC audits.

#### A.2 Project description

A brief description can include what materials are to be tested; how the testing is to be conducted; and who is responsible for various project activities. The project experimental design may contain the necessary information for this portion of the QAPP.

#### A.3 Data quality objectives/Acceptance criteria

This clause of the QAPP specifies the precision, accuracy, and completeness desired for each parameter being measured.

#### A.4 QA/QC approaches/activities

The types of QA/QC activities<sup>[6]</sup> that can be specified in the QAPP include establishment of a system of records/notebooks to ensure proper operation of equipment and recording of data, such as:

- a) sample log to record receipt, storage, and disposition of materials;
- b) GC standards preparation log to document preparation of all organic compound substances;
- c) permeation tube log to record weight loss data for all permeation tubes;
- d) calibration logs to contain environmental systems calibration data;
- e) instrument maintenance logs to document maintenance and repairs of all equipment;
- f) materials testing logs in which to record all pertinent information for each test, including sample details, sample ID number, and GC run ID number;
- g) sorbent tubes conditioning/desorption log detailing thermal clean-up and QC validation of sorbent tubes;
- h) separate electronic log to document location and content of electronically stored data;
- i) manuals governing operation of all equipment used by the project.

QC activities are carried out by project staff in a routine, consistent manner to provide necessary feedback in operation of all measurement systems. Such activities can include:

- routine maintenance and calibration of systems;
- daily recording of GC calibration accuracy and precision (i.e. control charting);
- timely monitoring of percent recovery of the internal standard that was added to all samples;

- collection and analysis of duplicate samples;
- QC checking of organic collection sorbent tubes;
- periodic analysis of audit gases supplied by an independent source.

#### **A.5 QA/QC audits**

Finally, the QA/QC program can include periodic audits by qualified quality personnel to evaluate compliance with QAPP protocols.

## Annex B (informative)

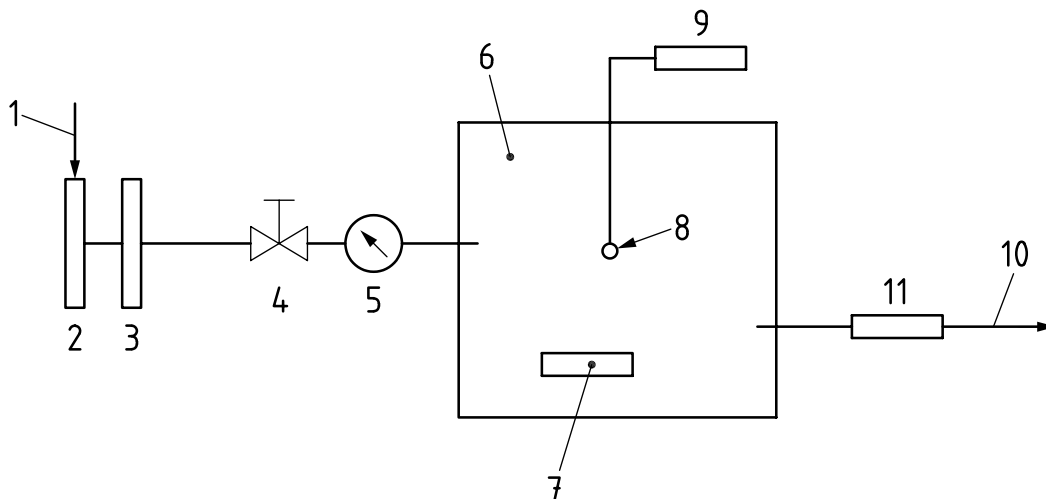
### Examples of loading factors for a model room

**Table B.1 — Examples of loading factors for a model room**

Model room <sup>a</sup>	Loading factor m <sup>2</sup> /m <sup>3</sup>
30 m <sup>3</sup> , $n = 0,5 \text{ h}^{-1}$ :	
Floor or ceiling area = 12 m <sup>2</sup>	0,4
Wall area = 31,4 m <sup>2</sup>	1,0
Small surfaces	0,05
— door = 1,6 m <sup>2</sup>	
— window = 2 m <sup>2</sup>	
— heating system = individual	
Very small surfaces (sealants, fillers, putty) = 0,2 m <sup>2</sup>	0,007
<sup>a</sup> See EN 16516[8].	

## Annex C (informative)

### General description of an emission test chamber



**Key**

- 1 air inlet
- 2 air filter
- 3 air conditioning system unit
- 4 air flow regulator
- 5 air flow meter
- 6 test chamber
- 7 device to circulate air and control of air velocity
- 8 temperature, air humidity, and air velocity sensors
- 9 monitoring system for temperature and air humidity
- 10 exhaust outlet
- 11 manifold for air sampling

**Figure C.1 — General description of an emission test chamber**

## **Annex D**

### **(informative)**

### **Determination of the emission rates of seams and cut edges**

This annex describes the effect of sealed seams and edges on the emission of VOCs that include formaldehyde from composite wood products, especially of the materials on which its surface is coated. Testing materials with no exposed seams and cut edges underestimate the emission from the test specimen. Due to this, it is likely that test specimens will be labelled inappropriately, and the emission may not reflect the emission in real installation. Therefore, the ratio of exposed seams and cut edges to the top surface area shall reported.

References [9] to [13] provide more information on determining the emission rates of seams and cut edges.

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