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**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**

*Air intérieur —*

*Partie 11: Dosage de l'émission de composés organiques volatils de  
produits de construction et d'objets d'équipement — Échantillonnage,  
conservation des échantillons et préparation d'échantillons pour essai*



Reference number  
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 16000-11 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 264, *Air quality*, in collaboration with Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 16000 consists of the following parts, under the general title *Indoor air*:

- *Part 1: General aspects of sampling strategy*
- *Part 2: Sampling strategy for formaldehyde*
- *Part 3: Determination of formaldehyde and other carbonyl compounds — Active sampling method*
- *Part 4: Determination of formaldehyde — Diffusive sampling method*
- *Part 5: Measurement strategy for volatile organic compounds (VOCs)*
- *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*
- *Part 7: Sampling strategy for determination of airborne asbestos fibre concentrations*
- *Part 8: Determination of local mean ages of air in buildings for characterizing ventilation conditions*
- *Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*
- *Part 10: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test cell method*
- *Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

The following parts are under preparation:

- *Part 12: Sampling strategy for polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzo-furans (PCDFs) and polychlorinated biphenyls (PCBs)*

- *Part 13: Determination of total (gas and particle-phase) polychlorinated dioxin-like biphenyls and polychlorinated dibenzo-p-dioxins/dibenzofurans — Collection on sorbent-backed filters with high-resolution gas chromatographic/mass spectrometric analysis*
- *Part 14: Sampling strategy for nitrogen dioxide (NO<sub>2</sub>)*
- *Part 15: Measurement of nitrogen dioxide (NO<sub>2</sub>)*
- *Part 16: Detection and enumeration of moulds — Sampling of moulds by filtration*
- *Part 17: Detection and enumeration of moulds — Culture-based method*

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## Introduction

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 has objectives such as:

- 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.

## 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

## 1 Scope

Studies of the emission of volatile organic compounds from unused building products or furnishing in test chambers or cells require proper handling of the product prior to testing, and during the testing period.

This part of ISO 16000 defines three types of building products or furnishing: solid, liquid and combined. For each type, specifications are given for the sampling procedures, transport conditions, storage, and substrate used that can affect emissions of volatile organic compounds. For individual products, the preparation of a test specimen for each type is prescribed.

**NOTE** Depending on the non-homogeneity of the product, it can be necessary to make measurements on different test specimens to determine the specific emission rate.

## 2 Normative references

The following referenced documents are indispensable for the application 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 1937, *Test method for hydraulic setting floor smoothing and/or levelling compounds — Standard mixing procedures*

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 16000-10, *Indoor air — Part 10: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test cell method*

EN 13892-1, *Methods of test for screed materials — Part 1: Sampling, making and curing specimens for test*

ISO 3251:1993, *Paints and varnishes — Determination of non-volatile matter of paints, varnishes and binders for paints and varnishes*

ISO 2811-1, *Paints and varnishes — Determination of density — Part 1: Pycnometer method*

ISO 2811-2, *Paints and varnishes — Determination of density — Part 2: Immersed body (plummet) method*

ISO 2811-3, *Paints and varnishes — Determination of density — Part 3: Oscillation method*

ISO 3233, *Paints and varnishes — Determination of percentage volume of non-volatile matter by measuring the density of a dried coating*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16000-9 and ISO 16000-10, and the following apply.

**3.1 solid product**  
(building product or furnishing) resilient or rigid product whose properties meet user-specifications directly without a transition phase, e.g. curing or drying

EXAMPLE 1 Examples of resilient products are several insulation products, flexible flooring and wall coverings.

EXAMPLE 2 Examples of rigid products are tiles, parquets, laminated floorings, wall construction products, such as chip- and gypsum boards, wood panels, ceiling materials, acoustic panels, and doors etc.

**3.2 liquid product**  
(building product or furnishing) product whose properties meet the user-specifications after a transition phase, e.g. curing or drying

EXAMPLE Examples of liquid products are paints, varnishes, oils, waxes, levelling compounds, plasters, mortars, concrete, adhesives, sealants, caulks, putties, and surface coatings.

NOTE 1 Liquid products can have a wide range of viscosity and are supplied to the user in containers, such as cans, tubes, bottles, and sacks and are applied on the site.

NOTE 2 Some liquid products need the addition of water before they can be applied.

**3.3 combined product**  
(building product or furnishing) combined product formed on-site by the combination of more than one solid or liquid product

EXAMPLE Examples are glued applications such as floor and wall coverings that are fixed on the site on surfaces using adhesives.

NOTE When liquid products as paints, oils and waxes are spread on an absorbing surface such as wood and gypsum board etc, the systems are considered to be combined.

### 4 Sampling the product and transport and storage of sample

#### 4.1 Sampling of the product to be tested

Product samples collected at the point of manufacture shall be taken as soon as possible after the normal manufacturing process. Product samples can also be collected from retail stores.

#### 4.2 Sample packaging and transport

Samples shall be thoroughly protected from chemical contamination or any physical exposure, e.g. heat, light and humidity.

For solid products, this can usually be achieved by wrapping each specimen separately in aluminium foil and in a polyethylene bag or alternatively, in aluminised packaging lined with polyethylene or clear polyvinyl fluoride film. Liquid products shall be shipped in unopened cans, tubes, etc.

NOTE Transportation of collected samples can affect the emission characteristics of the product. The possible effects of temperature and humidity are of particular concern.



### 4.3 Sample description

The sample shall be labelled with the details of the type of product, week of manufacture (if known) and/or any identification numbers, e.g. batch numbers (see also Clause 15 in ISO 16000-9 and ISO 16000-10).

### 4.4 Storage of the sample prior to starting the testing

In many cases, it can be necessary to store the sample in the laboratory before starting the test. The sample shall be kept in its package, see 4.2, and stored at normal indoor conditions during any period of storage.

Storage may affect the emission properties due to ageing of the sample. It is recommended to minimise the storage time of the sample prior to preparation of the test specimen.

## 5 Preparation of test specimens

The preparation of test specimens of different product classes are prescribed in the annexes. The period of time between the unpacking and preparation of the test specimen shall be as short as possible and shall be recorded. After the completion of the test specimen, it shall immediately be put in the conditioned storage in accordance with 12.3 of ISO 16000-9 and ISO 16000-10, or in the emission test chamber, or in the emission test cell. This time shall be regarded as the starting time of the emission test, i.e.  $t = t_0$ .

## Annex A (normative)

### Solid products — Procedure for sampling and test specimen preparation

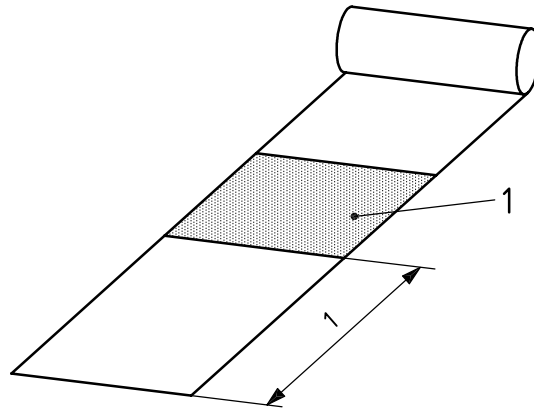
#### A.1 General

This method covers only unused products.

#### A.2 Sampling

##### A.2.1 Selection of samples from rolls (see Figure A.1)

Dimensions in metres



#### Key

1 sample

**Figure A.1 — Procedure for sampling of solid products from rolls**

Discard one meter, or at least the outer layer, of the roll to take the sample.

The sample shall have an area appropriate to the test chamber or cell.

After taking the sample, it is rolled across the direction of the production roll, secured with staples, wrapped in aluminium foil, and placed in an unprinted, airtight polyethylene bag and sealed. Each bag shall contain only one sample.

Not more than 1 h shall elapse from the time of taking the sample to packing it. The packed samples shall be sent to the testing laboratory with the shortest possible delay.

##### A.2.2 Selection of samples of rigid products

Send an unopened standard package of the product to the testing laboratory.

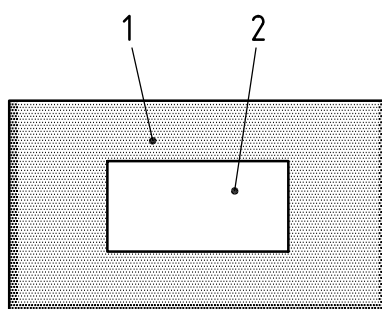
Boards are transported in the normal manufacturer's delivery package unless the delivery package is large and impractical to handle. Then a sample may be taken from the middle of the board for more convenient transportation. In the latter case the sample is packed according to 4.2.

Tiles, laminated parquets and other products assembled from pieces are transported to the laboratory for emission testing in the original package.

### A.3 Preparation of test specimens

#### A.3.1 Samples from rolls (see Figure A.2)

Unpack the sample and select an appropriate area of the product from the middle, if possible at least 50 cm from the edge of the short side, and take a test specimen.



#### Key

- 1 sample
- 2 test specimen

**Figure A.2 — Preparation of test specimens from rolls**

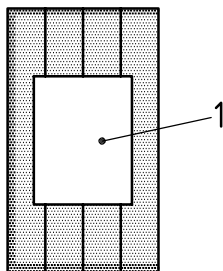
The underside of the test specimen shall be secured to an inert substrate (glass or stainless steel) in order to determine exclusively the emission of the upper surface. Alternatively, place the test specimens back-to-back. Seal the edges with aluminium foil or frames.

**NOTE** For some products, depending on the nature of the exposure to indoor air during use, the emission from the lower surfaces may also be of interest.

#### A.3.2 Samples of rigid products (see Figures A.3 and A.4)

Tiles and panels, etc. are taken from the middle of the package and assembled side by side.

If the surface to be tested is composed of several pieces as, e.g. laminated parquets or flooring tiles, the joints in the test piece shall be proportionally distributed over the surface of the test specimen, i.e. the proportion of joint length to tile area shall be the same in the test specimen as in the finished floor. No glue is used in the joints. As an example, when parquet/laminate flooring is to be tested, at least two panels are taken from the middle of the package and the tongue and the groove are pushed together without using an adhesive.

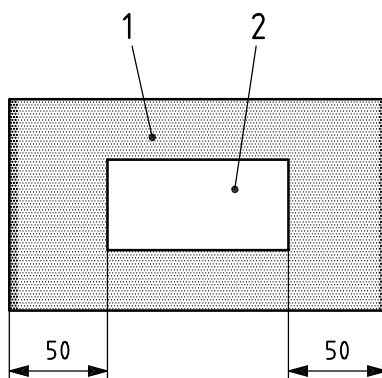


**Key**

- 1 test specimen

**Figure A.3 — Preparation of test specimens from joint rigid products**

Dimensions in centimetres



**Key**

- 1 sample
- 2 test specimen

**Figure A.4 — Preparation of test specimens from entire rigid products (e.g. boards)**

Unpack the sample and select an appropriate area of the product from the middle, if possible at least 50 cm from the edge of the short side, and take a test specimen.

Secure the underside of the test specimen to a sheet of glass or stainless steel, or place the test specimens back-to-back. Seal the edges with aluminium foil or frames.

NOTE For some products, depending on the nature of the exposure to indoor air during use, the emission from the lower surfaces may also be of interest.

## Annex B (normative)

### Liquid products — Procedure for sampling and test specimen preparation

#### B.1 Life cycle of liquid products

After its application, a liquid product enters a life cycle which is normally comprised of three stages.

- a) The liquid product undergoes a physical transformation from the liquid state to the solid state. This takes place by evaporation of volatile components (water or organic solvents). In some cases the transition is achieved by a chemical reaction.
- b) The final properties are obtained either by a physical process or by a chemical one.
- c) When the product has reached its final properties, the specific emission rates are expected to be considerably lower than during the curing, setting, or reaction periods as described in stages a) and b).

#### B.2 Test specimen preparation

Since the solid content of liquid products differs widely depending on the type of binder, and use, appearance and formulation, it is essential, in order to obtain comparative results, that tests are undertaken using a reproducible method of application that is appropriate for the product type.

##### B.2.1 Paints, varnishes, and impregnating primers

###### B.2.1.1 Classification of a paint product

The product shall be classified by the dry film thickness recommended by the manufacturer. The emission test shall then be performed at the specified dry thickness as given for the class in Table B.1.

**Table B.1 — Classes for dry film thickness**

Class	Manufacturer's recommended mean dry film thickness $\delta_m$	Dry film thickness chosen for testing $\delta_c$
minimal	$< 5 \mu\text{m}$	$5 \mu\text{m}$
low	$5 - 20 \mu\text{m}$	$15 \mu\text{m}$
medium	$20 - 60 \mu\text{m}$	$40 \mu\text{m}$
high	$> 60 \mu\text{m}$	$60 \mu\text{m}$
NOTE	The information in Table B.1 has been taken from EN 927-1:1996 [1].	

The recommended usage amount of paint is given by the manufacturer in square meters per litre wet product. The resulting dry film thickness is then calculated according to:

$$\delta_m = (\phi / S) 10 \quad (\text{B.1})$$

where

$\delta_m$  is the dry film thickness following recommendations of the manufacturer, in micrometres,  $\mu\text{m}$ ;

$\phi$  is the solid content of the product, expressed as a volume fraction in percent, (given by the manufacturer);

$S$  is the recommended spreading rate of the product, in square meters per litre of wet product.

The film thickness class in which the product is tested shall be given in the test report.

NOTE 1 In most cases, painting is carried out as multi-layer systems of various paints of different function. The simplest form of system painting (excluding simple repainting) consists of a primer and a top coat. Other more complicated systems include floor paints for concrete which are built up by a primer, a clear varnish with decorative flakes, and then 1 to 2 layers of clear varnishes on top. Another example is stains for interior walls consisting of a primer, a thin layer of stain, and then 1 to 2 layers of clear varnish on top.

NOTE 2 Depending on the objective of the test, a paint can be tested separately or in a paint system. Paint systems are tested as combined products (Annex C).

For certain purposes, e.g. assessment of health effects, the paint or varnish can be used as for a combined product (Annex C). In this case, more realistic substrates, such as wood based panels, gypsum board or flooring materials, should be used. The use of such substrates will, in most cases, give a different specific emission rate as compared with glass, stainless steel or polyester.

NOTE 3 Penetrating wood stains, oils, and waxes may be tested as combined products (Annex C), i.e. on substrates other than the ones given below.

### B.2.1.2 Preparation of the test specimen

The product shall be applied on a substrate of glass, or stainless steel or a polyester sheet of sufficient rigidity (minimum 150  $\mu\text{m}$ ). Apply the product to the substrate using suitable equipment to acquire an even thickness of the applied product. Examples are brushes, spray pistols, rollers, applicators, and drawdown bars.

The amount of wet product applied to a certain area to receive a specified dry film thickness is calculated according to:

$$m = (\delta_c \cdot A \cdot \rho) / (\phi \cdot 100) \quad (\text{B.2})$$

where

$m$  is the amount of wet product to be applied, in grams;

$\delta_c$  is the dry film thickness chosen for testing, in micrometres, according to Table B.1;

$A$  is the painted area, in square centimetres;

$\rho$  is the density of wet product, in grams per cubic centimetre, (given by the manufacturer);

$\phi$  is the solid content of the product, expressed as a volume fraction in percent, (given by the manufacturer).

To assess that the correct amount of paint is added to the test substrate, the substrate shall be weighed before and after application of the product. The actual amount applied shall not differ from the calculated value  $m$  by more than  $\pm 15\%$ .

Density can also be measured in accordance with ISO 2811. Solid content as a volume fraction can also be measured in accordance with ISO 3233, or calculated from the solid content as a mass fraction as measured in accordance with ISO 3251.

### B.2.2 Adhesives

Mix the sample uniformly. Transfer the sample in an excess of minimum 20 % by weight in relation to the desired final weight onto a pre-weighted plate of glass or stainless steel and spread it with a notched spatula/trowel in such a way that the sample is uniformly structured across the whole area. Weigh the plate again and record the weight of the specimen. The specimen shall weigh  $(300 \pm 50) \text{ g/m}^2$ .

The preparation shall not take more than 5 min.

For flooring adhesives, a type B1 spatula (held at  $60^\circ$  angle in one stroke) can be used (see Reference [2]).

For the emission cell it is important to have a smooth surface to ensure the defined testing conditions e.g. air tightness, airflow, and cell volume. A roller or an applicator can be used to prepare the test specimen.

In some cases it is also important to protect the emission cell from contamination. A specimen holder may be used to avoid contact between the emission cell surfaces and the adhesive.

NOTE An example of a full test method for adhesives, levelling compounds, synthetic resin flooring and plasters is given in Reference [2].

### B.2.3 Levelling compounds, synthetic resin flooring and plasters

Mix the material according to EN 1937 or EN 13892-1. Place a 3-mm thick and uniform layer of the mixture on glass or on stainless steel. Use a border made of glass or stainless steel for low-viscosity levelling compounds. Alternatively an inert mould with a defined size according to the test chamber can be used. High-viscosity products can be drawn off over a template of 3-mm thickness with a flat spatula.

### B.2.4 Screed materials other than B 2.3; and concrete

Mix the material and fill the moulds according to EN 13892-1. The moulds shall be made of emission-free material having an appropriate size according to the test chamber and a depth of  $50 \pm 1$  mm. Make sure that the moulds are level, and fill each up to the rim.

Some materials, e.g. concrete, may settle during the first hours with some water forming on the surface. In such a case, the surface is finished with a steel tool after the bleeding water has evaporated.

### B.2.5 Sealants and fillers

Test specimens shall be prepared in a profile in an inert material with a depth of 3 mm and a width of 10 mm. The length of the test specimen depends on the test chamber/cell. Specific emission rates shall be reported in  $\mu\text{g/m}\cdot\text{h}$ .

### B.2.6 Putty

Place a 2-mm thick and uniform layer of putty on glass or stainless steel. Use a spatula or any other putty device. Use a border made of glass or stainless steel for low-viscosity products. Alternatively an inert mould with a defined size according to the test chamber can be used.

## Annex C (informative)

### Combined products

#### C.1 General

A combination of products can result in emissions, which are different from the sum of that emitted by the components. The total amount and type of VOCs as well as the emission profile over time may be influenced by the interaction of the components. Since there is a wide variety of possible combinations, it is not possible to make a standard for how such testing should be performed. Therefore this annex only contains a general principle for such testing, a description of how a standard concrete can be made and a reference to an example of an industry standard for testing of combined products.

EXAMPLE Examples of combined products are:

- flooring glued with an adhesive to a concrete substrate;
- interior wall covering built up by a board, e.g. gypsum or wood based board, glass fibre, plastic or paper covering, adhesives, and paints (primer and top coat);
- penetrating oil or stain applied to wood.

#### C.2 Principle

The testing of combinations should be done by way of comparison of a **test specimen** with a **reference specimen**. The latter consists of a known combination of well-defined components. In the test specimen, normally only one component is changed as compared to the reference specimen, either by replacement of one material, e.g. the adhesive, or by adding a new component, e.g. a levelling compound. The reference specimen and the test specimen should be treated in the same way, as far as possible.

The testing starts with the preparation of a test specimen and a reference specimen. The emissions from the reference specimens and the test specimens are measured and compared. The test should continue for a sufficient time to detect long-term effects on emissions if this is appropriate for the purpose of the test. The comparison is done with regard to TVOC and individual VOC emissions, especially those that do not appear when testing the materials alone. Such new emissions indicate that the combination has started an emitting process, e.g. an alkali attack on the adhesive or the plasticizer in PVC.

If long-term effects on emissions are to be studied, the general conditions for the specimens should be selected that would enable the chemical reactions to occur that produce this emission. Using conditions that give a high moisture level in the system often does this. An example where testing of combinations are important, is when surface coatings or layers are applied to a recently cast concrete. In such cases, a standard concrete, as specified below, could be used in the reference specimens. It should also be used in the test specimen, unless it is a certain concrete that is under test.

#### C.3 Example of a reference concrete specimen

The composition of the concrete should be the same as the one that is used for testing cement according to EN 196-1 [3], i.e. 1 part cement, 3 parts standard sand and 0,5 parts water. The cement should preferably be ordinary portland cement.



The concrete is mixed and compacted according to EN 13892-1. The mould should be of emission-free material and the depth should be  $(100 \pm 1)$  mm. The other dimensions of the mould are selected to fit the emission testing procedure.

Allow the concrete to stand uncovered for about three hours in the climate chamber, so that it can start to set and any separated water evaporates. Then scrape the surface with a steel scraper towards the edge of the mould to produce a smooth, even surface. If any part of the surface is below the line of the edge, fill it with some of the scraped-off concrete. Finish by cleaning the edge of the mould and weighing the specimen.

Store the specimens for 14 days in  $23 \text{ °C} \pm 2 \text{ °C}$  and  $50 \% \pm 5 \% \text{ RH}$ . Then weigh the specimens again to control the drying, and apply the surface coating or layer. This drying time is expected to create a moist and aggressive substrate.

#### **C.4 Example of a test procedure**

An example of a full test method for combined products is given in Reference [4].

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