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Indoor air —

Part 11: Determination of the emission of volatile organic compounds from samples of 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 d'échantillons de produits de construction et d'objets d'équipement — Échantillonnage, conservation des échantillons et préparation des éprouvettes d'essais

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Foreword

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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 16000-11:2006), which has been technically revised.

The main changes are as follows:

— detailed descriptions for the preparation of samples of liquid products like paints, varnishes and impregnating primers have been added;

— the wet layer thickness instead of the dry film thickness for preparing liquid samples have been recommended;

— sample preparation instructions have been added to determine the cut edge emissions.

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.

Introduction

The determination of volatile organic compounds (VOCs) emitted from building products and furnishing 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.

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

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

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.

Indoor air —

Part 11: Determination of the emission of volatile organic compounds from samples of building products and furnishing — Sampling, storage of samples and preparation of test specimens

1 Scope

This document specifies the sampling procedures, transport conditions, storage and substrate used that can affect emissions of volatile organic compounds for three types of building products or furnishing: solid, liquid and combined. For individual products, the preparation of a test specimen for each type is specified.

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 16000-9:2024, *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 1937, *Test method for hydraulic setting floor smoothing and/or levelling compounds — Standard mixing procedures*

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

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
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.

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 to entry: 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 to entry: Some liquid products need the addition of water before they can be applied.

3.3
combined product
<building product or furnishing> product formed on-site by the combination of more than one *solid product* (3.1) or *liquid product* (3.2)

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

Note 1 to entry: When liquid products as paints, oils and waxes are spread on an absorbing surface such as wood and gypsum board, 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. The dates of sample manufacture and sample collection shall be recorded. Product samples can also be collected from retail stores.

NOTE An example of a sampling report is given in EN 16516[1].

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.

The product shall arrive in the laboratory within 14 days of sampling. If it takes longer than this, the time shall be recorded in the test report.

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, such as the batch numbers, as specified in ISO 16000-9:2024, Clause 15 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 can affect the emission properties due to ageing of the sample. It is recommended to minimize the storage time of the sample prior to preparation of the test specimen.

Testing shall begin within eight weeks of sampling provided that the sample remains in the specified packaging while stored at the laboratory. Wet-applied products that are shipped in a sealed container (e.g. can, cartridge) shall be tested within four months of sampling.

5 Preparation of test specimens

The dimensions of the test specimen depend on the selected test scenario and chamber size.

The preparation of test specimens of different product classes is prescribed in Annexes A, B and C. 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 be treated in accordance with ISO 16000-9.

NOTE 1 Some products (e.g. paint products) can require preconditioning prior to placing into a test chamber or emission cell.

NOTE 2 This document does not cover all types of construction materials and furnishings. Additional test methods for products are described in References [9], [10], [11] and [12].

The preparation of test specimens for the determination of emissions from cut edges is described in Annex D.

Annex A
(informative)

Solid products — Procedure for sampling and test specimen preparation

A.1 General

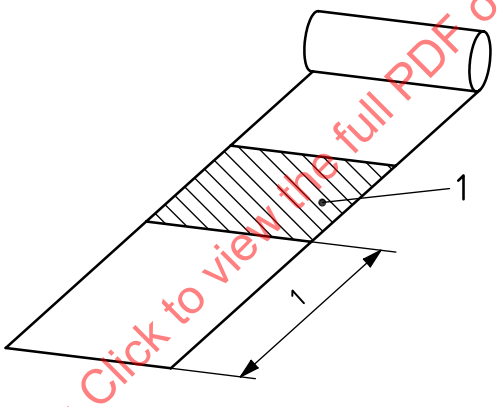
This method covers only unused products.

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 metre, 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 or sales unit of the product to the testing laboratory.

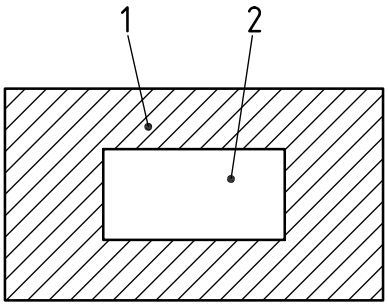
Boards are transported in the normal manufacturer's delivery package unless the delivery package is large and impractical to handle. Then a sample may be taken from the middle of the board for more convenient transportation. In the latter case, the sample is packed according to 4.2.

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

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. See Figure A.2.



Key

1 sample

2 test specimen

Figure A.2 — Preparation of test specimens from rolls

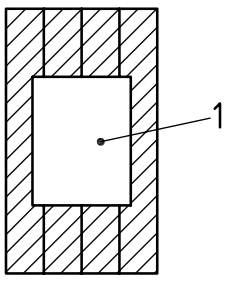
The underside of the test specimen shall be secured to an inert substrate (glass, stainless steel or aluminium foil) in order to determine exclusively the emission of the upper surface. Alternatively, place the test specimens back-to-back. Seal the edges with low-emitting aluminium tape or frames.

NOTE For some products, depending on the nature of the exposure to indoor air during use, the emission from the cut edge and/or the back side can also be of interest.

A.3.2 Samples of products with joints

Tiles and planks, 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, such as 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 or 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. See Figure A.3.



Key

1 test specimen

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

Unpack the sample and select an appropriate area of the product from the middle and take a test specimen.

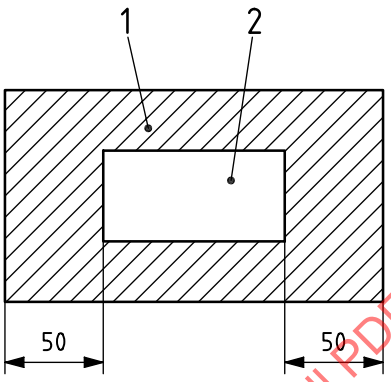
Secure the underside of the test specimen to an inert substrate (glass, stainless steel or aluminium foil), or place the test specimens back-to-back. Seal the edges with low-emitting aluminium tape or frames.

NOTE For some products, depending on the nature of the exposure to indoor air during use, the emission from the cut edge and/or the lower surfaces can also be of interest.

A.3.3 Samples of boards

Boards, etc. are taken from the middle of the package. 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. See Figure A.4.

Dimensions in centimetres



Key

1 sample

2 test specimen

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

Secure the underside of the test specimen to an inert substrate (glass, stainless steel or aluminium foil), or place the test specimens back-to-back. Seal the edges with low-emitting aluminium tape or frames.

NOTE For some products, depending on the nature of the exposure to indoor air during use, the emission from the cut edge and/or the lower surfaces can also be of interest.

Annex B
(informative)

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 comprising 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

B.2.1 General

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 be undertaken using a reproducible method of application that is appropriate for the product type.

B.2.2 Paints, varnishes and impregnating primers

B.2.2.1 General

The product shall be tested with the application amount specified by the manufacturer or technical data sheet. If applicable, the product can 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.

NOTE EN 16402[2] specifies minimum application amounts.

B.2.2.2 Preparation of the test specimen

The product shall be tested with the application amount specified by the manufacturer or technical data sheet in g/m^2. If the amount in the technical data sheet are given as a coverage rate in m^2/l, the amount of wet product applied to a certain area to receive a specified coverage is calculated according to Formula (B.1):

$$m = (\rho \times A) / (\vartheta \times 1\,000) \quad \text{(B.1)}$$

where

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

ρ is the density of wet product, in kg/l;

A is the painted area, in m^2;

ϑ is the coverage, in m^2/l, (given by the manufacturer).

The product shall be applied on a substrate of glass, stainless steel, or a polyester sheet of sufficient rigidity (minimum 150 µm). 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.

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. Applied amount shall be documented in the test report in g/m^2.

Density can also be measured according to ISO 2811-1[4], ISO 2811-2[5] and ISO 2811-3[6].

B.2.2.3 Classification by the dry film thickness and preparation of the test specimen

Table B.1 — Classes for dry film thickness

Class	Manufacturer's recommended mean dry film thickness δ_m µm	Dry film thickness chosen for testing Δ_c µm
minimal	< 5	5
low	5 to 20	15
medium	20 to 60	40
high	> 60	60
NOTE This information is taken from EN 927-1:1996[3].		

The recommended usage amount of paint is given by the manufacturer in square meters per litre of wet product. The resulting dry film thickness is then calculated according to Formula (B.2):

$$\delta_m = (\phi / S)10 \quad \text{(B.2)}$$

where

δ_m is the dry film thickness following recommendations of the manufacturer, in µm;

ϕ 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 (see Annex C).

For certain purposes, e.g. assessment of health effects, the paint or varnish can be used as for a combined product (see 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.

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

The product shall be applied on a substrate of glass, or stainless steel or a polyester sheet of sufficient rigidity (minimum 150 µm). 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 Formula (B.3):

$$m = (\delta_c \cdot A \cdot \rho) / (\phi \cdot 100) \quad \text{(B.3)}$$

where

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

δ_c is the dry film thickness chosen for testing, in µm, according to Table B.1;

A is the painted area, in cm^2;

ρ is the density of wet product, in g/cm^3 (given by the manufacturer);

ϕ 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 ± 15 %.

Density can also be measured according to ISO 2811-1[4], ISO 2811-2[5] and ISO 2811-3[6]. Solid content as a volume fraction can also be measured in accordance with ISO 3233-1[7], or calculated from the solid content as a mass fraction as measured in accordance with ISO 3251[8].

B.2.3 Adhesives

The product shall be tested using the application method and amount specified by the manufacturer or technical data sheet in g/m^2.

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 or trowel or another tool in such a way that the sample is uniformly structured across the whole area as required or recommended by the manufacturer or the technical datasheet. Weigh the plate again and record the weight of the applied specimen. Applied amount shall be documented in the test report in g/m^2.

The preparation shall not take more than 5 min.

For harmonized comparison of different products, a consistent application amount of (300 ± 10) g/m^2 for all adhesives can be used. For flooring adhesives with an application amount of 300 g/m^2, a type B1 spatula (held at 60° angle in one stroke) can be used (see Reference [9]).

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 [9].

B.2.4 Levelling compounds, screeds, plasters, tile grouts and cast concrete

Mix the material in accordance with EN 1937 or EN 13892-1. Place a uniform layer of the mixture on glass or stainless steel using wet layer thickness specified by the manufacturer or technical data sheet (see Table B.2). Use a border made of glass or stainless steel for low-viscosity products. Alternatively, an inert, emission-free mould with a defined size according to the test chamber can be used. Make sure that the moulds are level, and fill each up to the rim. High-viscosity products can be drawn off over a template of the desired thickness with a flat spatula.

Table B.2 — Test specimen wet layer thicknesses for levelling compounds, screeds, plasters, tile grouts and cast concrete

Product type	Application thickness specified by the manufacturer	Test specimen wet layer thickness[a]
Plasters Renders Levelling compounds Screeds Fillers Mortars	Min ≤ 3 mm, max ≤ 30 mm	3 mm
	Min > 3 mm, max ≤ 30 mm	Minimum application thickness specified in manufacturer's technical instructions
	30 mm < max < 50 mm	Maximum application thickness specified in manufacturer's technical instructions
	Max ≥ 50 mm	50 mm
Tile grouts	—	3 mm
Concrete	—	According to manufacturer's technical instructions, minimum 50 mm

[a] Alternatively, the wet applied thickness can be calculated into an application amount in g/m² by using the wet density as specified by the manufacturer. Then the laboratory can use this application amount, which shall be reported in the test report additional to the required wet layer thickness.

The test specimen preparation and wet layer thickness selected for testing shall be reported in the test report.

For tests with a wet layer thickness of more than 3 mm, it is likely that the relative humidity in the test chamber is higher than 50 % ± 5 % during air sampling. If this is the case, either the wet layer thickness or the duration of the test should be considered.

For harmonized comparison of different products, a consistent application thickness of 3 mm for all levelling compounds and tile grouts can be used.

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 Resin flooring

The product shall be tested using the application amount specified by the manufacturer or technical data sheet in g/m². Mix the components as specified by the manufacturer or technical data sheet.

The sample shall be applied on a substrate of glass or stainless steel. Use a border made of glass or stainless steel for low-viscosity products. Alternatively, an inert, emission-free mould or petri dishes with defined size according to the test chamber can be used. Apply the product to the substrate using suitable equipment to acquire an even thickness of the applied product. To assess that the correct amount is added to the test substrate, the substrate shall be weighed before and after application of the product. Applied amount shall be documented in the test report in g/m².

In case the resin flooring consists of multiple layers, these shall be applied accordingly. The drying period between layers shall be as specified by the manufacturer or technical data sheet. Drying between two layers shall take place in a well-ventilated room at room temperature.

B.2.6 Joint sealants, joint fillers and putties

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 or cell.

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 volatile organic compounds (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, 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 ± 1) mm. The other dimensions of the mould are selected to fit the emission testing procedure.