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Interior air of road vehicles —

Part 5:

Screening method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Static chamber method

Air intérieur des véhicules routiers —

Partie 5: Méthode de criblage pour la détermination des émissions de composés organiques volatils des parties et matériaux intérieurs des véhicules — Méthode de la chambre statique

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Foreword

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

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

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

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air.*

ISO 12219 consists of the following parts, under the general title *Interior air of road vehicles*:

- *Part 1: Whole vehicle test chamber — Specification and method for the determination of volatile organic compounds in cabin interiors*
- *Part 2: Screening method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Bag method*
- *Part 3 Screening method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Micro-scale chamber method*
- *Part 4: Method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Small chamber method*
- *Part 5: Screening method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Static chamber method*

Introduction

Volatile organic compounds (VOCs) are widely used in industry and may be emitted by many everyday products and materials. They have attracted attention in recent years because of their impact on indoor air quality. After homes and workplaces, people spend a lot of time in their vehicles. Therefore there is a need for comprehensive and reliable information about the types of organic compounds in the interior air of vehicles and also their concentrations. As part of measures to achieve acceptable indoor air quality it is important to determine the material emissions of interior parts and to reduce them, if necessary, to an acceptable level.

Measuring VOCs from vehicle interior trim components can be performed in several ways and the approach selected depends upon the desired outcome and the material type. Complete assembly-based measurements[1,5] provide total emission results only, but cannot provide VOCs emission of each constituent component. Rapid screening methods obtain VOCs emission data for cut components.[2,3,6,7] Therefore, VOCs emission data for constituent unit component of car interior trim is required for reducing VOCs level in vehicles.

This part of ISO 12219 outlines a method of measuring the types and levels of chemicals emitted by unit component-based car interior trim using a static chamber method based on the principles of static headspace. Static chamber methods can provide diffusion data from unit components of vehicle interior trim without emission from cutting planes. It can be used to verify the correlation between a material-based method and an assembly-based method. Adjunctively, the static headspace chamber method is simply modified to the dynamic headspace mode to obtain complementary information by connecting of a supply of air for comparison.

Each measurement method such as bag[2] / micro-scale chamber[3] / small-chamber[1] sampling offers a complementary approach.

ISO 16000-3, ISO 16000-5, ISO 16000-6, ISO 16000-9, ISO 16000-10, ISO 16000-11, ISO 16000-24, and ISO 16000-25 also focus on VOC and formaldehyde measurements. ISO 16017-1 and ISO 16017-2 focus on VOC measurements.

Interior air of road vehicles —

Part 5:
Screening method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Static chamber method

1 Scope

This part of ISO 12219 specifies a chamber based, static headspace type method for measuring volatile organic compounds (VOCs), formaldehyde and other carbonyl compounds which may diffuse from vehicle interior unit components into the cabin air. The chamber emission test is intended to provide characteristic emission of unit component to car interior of assembly level emission. It also specifies the emission test chamber, preparation of the test specimen, connection of the vapour sampling devices and test conditions. This method is valid for new car interior unit components intended for vehicles, and can also be used for car interior unit components disassembled from assembly of car interior trim or used cars. A set of multi-unit components could be applicable according to the test purpose.

A dynamic mode operation of emission chamber could be applied if corroborative information of the unit component emission between this method and small chamber method (ISO 12219-4:2013) is desired.

The specified analytical procedure for VOCs (ISO 16000-6) is valid for the determination of VOCs ranging in concentration from sub-µg/m^3 to several mg/m^3. The method is applicable to the measurement of non-polar and slightly polar VOCs ranging in volatility from n-C_6 to n-C_{16}. Some very volatile compounds (VVOC) and semi-volatile organic compounds (SVOC) can also be analysed (see informative Annex D of ISO 16000-6:2011).

This part of ISO 12219 is complementary to existing standards and provides third party test laboratories and manufacturing industry with an approach for:

- comparing emissions from various unit components (sub-assemblies) with VOC emissions from related complete assemblies measured in other tests,
- evaluating and categorising specific unit components by their VOC emission data,
- comparing and correlating emission from unit components with VOC emission data obtained in other tests for the various materials used to make the unit component,
- evaluating prototype, “low-emission” unit components during development.

NOTE 1 All volatile carbonyls except formaldehyde can be analysed by ISO 16000-6:2011 incorporating informative Annex D.

NOTE 2 The dynamic mode operation is described in the informative Annex D of this part of ISO 12219.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12219-4:2013, *Interior air of road vehicles — Part 4: Method for the determination of the emissions of volatile organic compounds from vehicle interior parts and materials — Small chamber method*

ISO 16000-3:2011, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method*

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

3 Terms and definitions

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

3.1
emission test chamber

enclosure ranging in size from 10 l to 500 l excluding buffer bag volume that permits the testing of vapour-phase organic emissions from various types of vehicle interior trim unit components under atmospheric pressure, and which is equipped with mixing fan for homogeneous mixing in the entire chamber and buffer bag

Note 1 to entry: Adapted from ISO 16000-9:2006, definition 3.6.

Note 2 to entry: See Annex A for a description of the test chamber.

Note 3 to entry: The size of the buffer bag connection port shall be large enough for homogeneous mixing between the bag and test chamber.

3.2
buffer bag

low-emitting, impermeable and low-sorption plastic bag having a large enough mouth for proper connection to the test chamber and a capacity higher than the expansion volume that is due to heating of the emission test chamber

3.3
test concentration

concentration of a specific volatile organic compounds, VOC_X, (or group of volatile organic compounds), formaldehyde and other carbonyl compounds collected from an emission test chamber outlet which has been heated for a specified period of time with unit component test sample in it

Note 1 to entry: Adapted from ISO 16000-9:2006, definition 3.7 emission test chamber concentration.

3.4
background concentration

concentration of a specific volatile organic compounds, VOC_X, (or group of volatile organic compounds), formaldehyde and other carbonyl compounds collected from an emission test chamber outlet which has been heated for a specified period of time without any test sample

Note 1 to entry: Adapted from ISO 12219-4:2013, definition 3.6.

3.5
unit component value

total mass of each target compound, (VOC or carbonyl) or TVOC emitted from unit component under the prescribed test conditions

3.6
recovery rate

ratio of the total amount of VOC, formaldehyde and other carbonyl compounds collected from an emission test chamber to the known total amount of VOC, formaldehyde and other carbonyl compounds supplied to the emission test chamber in the same time period[4]

Note 1 to entry: Adapted from ISO 16000-9:2006, definition 3.9, recovery.

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

3.7
unit component
basic manufacturing unit of car trim interior part at the part manufacturing factory, and components before assembling the assembly of car interior trim or disassembled components in the assembly of car interior trim

3.8
volatile organic compound
VOC
organic compounds that are emitted from the unit components and all those detected in the chamber air

Note 1 to entry: For a detailed definition see ISO 16000-6.

3.9
total volatile organic compound
TVOC
sum of organic compounds eluting between and including *n*-hexane and *n*-hexadecane

Note 1 to entry: For a detailed definition see ISO 16000-6.

4 Principle

The principle of the test is to assess the emission rate of VOCs and carbonyls from unit components under conditions of fixed temperature and no external air flow. It is a static headspace type method. The sample is incubated in an emission test chamber containing clean air for a selected period at fixed temperature. During the incubation, the air between the chamber inside and buffer bag is mixed thoroughly with a mixing fan. The gas inside the test chamber is then sampled and analysed, after equilibrium has been reached or at time, *t*, to determine the vapour-phase masses/concentrations of VOCs and carbonyls. These data are used to characterize the car trim unit component in terms of their relative emission rates.

5 Instrument and reagent

5.1 General

A test bed to determine VOCs and carbonyls emissions consists of the following required elements:

- a suitable emission test chamber to contain the test specimen of unit component;
- a regulated, pressurized supply of clean air for cleaning and checking airtightness;
- a non-emitting, temperature-controlled incubation chamber;
- low-emitting, low-sorptive plastic buffer bag with large diameter connection port;
- a non-emitting cover of buffer bag connection port;
- flow controlled pumps, to draw the air from the test chamber through the sampling devices;
- an inert, non-emitting flow meter to control the flow of air supplied to the test chamber;
- vapour sampling trains incorporating the sampling devices specified in ISO 16000-6 and ISO 16000-3 and associated analytical apparatus;
- pressure and humidity control and regulation apparatus.

An example of a static test chamber is shown schematically in Annex A.

5.2 Test chamber

The test chamber is an airtight container with the volume of 10 l to 500 l, excluding the volume of the buffer bag. A typical standard test chamber size has a volume of 125 l ± 5 l. It shall be equipped with a connection port for air supply for cleaning and airtightness checking, connection port for sampling and large diameter port for buffer bag, and stir fan for mixing inside chamber and buffer bag. A stand is installed inside to set off the unit component without touching the test chamber walls. The buffer bag port should be blocked by non-emitting cover when the incubation chamber is cleaned at a high temperature.

5.2.1 Materials

The chamber material shall be an inert, non-emitting and non-adsorbing material, such as surface treated (polished) or inert coated stainless steel or deactivated glass. The sealing materials used for sealing the lid of test chamber, shall be low emitting and low sorption and shall not contribute significantly to the background concentration.

5.2.2 Airtightness

The test chamber, equipped with the buffer bag, shall be sealed securely so that the air leakage is less than 0,5 % of the test chamber volume per minute during a period of 30 min or less than 5 % of air supply flow rate at 1 000 Pa of excess pressure.

5.2.3 Cleaning

The test chamber should be freed of all particles or similar remains of the components with mechanical purification methods. Remove any o-rings or gaskets and clean the test chamber components using an alkaline detergent, followed by two separate rinses with distilled water or by using an appropriate solvent and thoroughly dried.

Alternatively, the emission test chamber can be heated for cleaning. At this moment, the buffer bag is removed and the buffer connection port should be blocked by a non-emitting cover. The empty emission test chamber should be baked at a temperature of 180 °C up to 230 °C in an incubation chamber or appropriate heating oven.

If the test chamber has an inert coating, care shall be taken not to damage the coating during cleaning (e.g. by using abrasive cleaners and/or high pH).

5.3 Clean air

Clean air is used for maintaining excess pressure when checking airtightness of the test chamber, and exchanging the test chamber air during cleaning. VOC, formaldehyde and other carbonyl compound concentrations in the clean air shall be as low as possible so that they do not adversely affect the test results.

5.4 Buffer bag

The bag has a large mouth for connection with the chamber. The capacity is large enough to contain the desired sampling volume and expansion volume of the emission test chamber when it is heated in the test procedure. The buffer bag is low emitting, impermeable, flexible and low-sorptive plastic. It shall not contribute significantly to background VOC concentration. A new plastic bag should be used in each emission test.

5.5 Non-emitting cover

A buffer connection port shall be covered with a non-emitting cover when the test chamber is cleaned by heat and is operated by a dynamic mode described in Annex D. The material of the cover is generally identical to that of the buffer bag connection port.

5.6 Vapour sampling devices

Tubes packed with sorbents (such as Tenax[1] TA®) are used for sampling vapour-phase organics ranging in volatility from *n*-hexane to *n*-hexadecane in ISO 16000-6:2011. Note that alternative sorbents or sorbent combinations may be required for monitoring compounds over a wider volatility range. See ISO 16017-1 or informative Annex D of ISO 16000-6:2011 for more details.

DNPH cartridges as described in ISO 16000-3 are used for the collecting and analysis of formaldehyde and other carbonyl compounds.

6 Unit component sample preparation

6.1 General

When determining volatile organic emissions, the conditions the unit component was exposed to before the test can have a considerable effect on the results, especially in quantitative tests. Therefore, it is necessary to standardize the history and preparation procedure for the unit component.

NOTE If the emission results of the unit component attempt to be harmonized with the small chamber method (ISO 12219-4:2013), the sample preparation for the unit component could follow the sample preparation procedure (ISO 12219-4:2013, Clause 8 and 9.3.1).

6.2 History of the unit component

The components need to be checked at their delivery condition when used for tests in which the emissions from a new part are to be measured.

Possibly, the adsorption of substances from the environment not in the original component also should be expected. Therefore, the history of the component before conducting the test should be documented as completely as possible.

If it is prepared by dismantling the assembly to a unit component, then the original assembly and this procedure should be documented.

6.3 Packaging, transport and storage of the unit component

The unit component shall be thoroughly protected from chemical contamination or any physical exposure, e.g. heat, light and humidity, until the start of the test.

During temporary storage and transport the component shall be kept in its packaging and a temperature of 23 °C should not be exceeded during any period.

For a unit component of car interior trim, this can usually be achieved by wrapping each unit component separately in aluminium foil and in a polyethylene bag or alternatively, in aluminised packaging lined with polyethylene or clear polyvinyl fluoride film.

The component shall be labelled with the details of the type of product, date of manufacture (if known) and/or any identification numbers or batch numbers.

Storage may affect the emission properties due to aging of the component. It is recommended to minimize the storage time of the sample prior to testing.

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[1] Tenax TA® is the trade name of a product manufactured by Supelco, Inc. This information is given for the convenience of users of this International Standard 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

6.4 Preparation of unit component specimens

Car interior components selected for emissions testing shall be manufactured, packaged and handled in the usual way for component used in manufacture. They shall not be stored for more than two weeks before the start of emissions testing, and shall be tested within three months after manufacture. The test specimen of unit components shall not be modified by extra treatment such as cutting. The test specimen is prepared using the unit component before assembling but can, in principle, be prepared as a unit component by dismantling the assembled car interior trim.

7 Verification of test conditions

7.1 Test temperature

Heating temperatures shall be monitored and recorded. The emission test chamber shall be uniformly heated in the incubation chamber at 65 °C ± 2 °C.

The accuracy of the instrument used to measure the temperature throughout the test period shall be ± 0,5 °C.

7.2 Recovery

The recovery of organic vapours can be determined by introducing a known mass of one or more specific target volatile organic compounds into the chamber on a suitable substrate and by sampling the total mass of vapour recovered from the small chamber exhaust. Examples of compounds commonly used for recovery tests include: toluene, *n*-dodecane and surrogate polar compounds such as ethyl hexanol. The addition of a known mass of a compound into the small chamber can be performed via a syringe injected on a substrate or with a known mass of the compound in the supply air. The substrate has to be put in the middle of the small chamber. Contact with the walls of the chamber should be avoided. A set of several substrates shall be arranged in such a way that an air flow through the circulation is achieved from all sides in the best way possible. Attention should be paid to a reasonable product loading factor. The small chamber has to be closed/locked immediately after inserting the compound on the substrate.

The tests of analytic recovery with dynamic mode shall be carried out under normal test conditions, e.g. normal time, 65 °C, and an exchange rate of 0,4 times per hour.

If a standard solution is used to check recovery, it is recommended, where practicable, to use a very volatile solvent that will not be retained by the sorbent sampling device. Methanol is a good example of a solvent that is not quantitatively retained by many common sorbents including Tenax TA®. This will minimize subsequent analytical interference.

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

NOTE 2 Sink effects, leaks or poor calibration can cause difficulties with achieving the desired recovery. 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.

7.3 Clean air

Clean air supplied to the test chamber for excess pressure and for cleaning shall be pure and dry, and at satisfactory background levels (see 7.4).

7.4 Background concentration levels

Clean air shall not contain VOCs and carbonyls at levels greater than 50 µg/m^3 as TVOC, and 5 µg/m^3 as any single target VOC and target carbonyl.

Background concentrations of the emission test chamber, equipped with buffer bag, shall be evaluated with each emission test at 65 °C. Background concentrations shall be low enough not to interfere with the analysis. Background concentration of TVOC shall be no greater than 10 % of the respective measured value. The background concentration of any target individual VOC and carbonyls shall be below 10 % of the same target compounds measured.

The background concentration of formaldehyde shall be below 0,1 µg/cartridge in DNPH cartridge itself.

7.5 Airtightness

Airtightness of the test chamber is checked at an excess pressure of 1 000 Pa by measuring the pressure drop during a period of 30 min. Airtightness shall be lower than 0,5 % of the test chamber volume per minute during a period of 30 min. The sensitivity of the pressure transducer should be smaller than 100 Pa with an accuracy of ± 5 %. The average value of leak rate, n_L(l/min), is calculated using Formula (1):

$$n_L = 1000 \frac{\Delta p \times V_T}{t \times p_{30}} \qquad (1)$$

where

n_L is the specific leak rate, in ml min^{-1};

Δp is the pressure drop during measuring period of 30 minutes, in Pa;

p_{30} is the pressure after 30 minutes, in Pa;

V_T is the volume of test chamber, in litres;

t is the period of time of the leak rate determination, in minutes.

7.5.1 Alternative procedure

The tightness of the test chamber is determined by measuring the difference in air flow rate between the inlet air and the outlet air when the pressure of test chamber is maintained at 1 000 Pa of excess pressure. The leakage shall be less than 5 % of the inlet air flow.

NOTE The period of pressure drop could be shortened by using a high resolution pressure transducer in the airtight test.

8 Standard test procedure

This test method could be applicable to the static mode test. The static mode test simulates the test conditions of the whole test chamber method (ISO 12219-1:2012).

8.1 General

The standard test procedure of static mode is divided into six parts:

a) Cleaning of the emission test chamber;

b) Preconditioning of the chamber;

c) Checking airtightness of the emission test chamber;

d) Background measurement of the emission test chamber;

e) Conditioning of the unit component;

f) Sampling.

The test temperature for conditioning is 65 °C. The test and blank sample concentrations of VOC and carbonyls are determined by selecting the appropriate sampling media (see 5.6).

8.2 Cleaning

The emission test chamber shall be cleaned before the start of a unit component emission test. The background concentrations should be below the values regulated in 7.4.

The test chamber should be freed of all particles or similar remains of the components with mechanical purification methods. Remove any o-rings or gaskets and clean the test chamber components using an alkaline detergent, followed by two separate rinsing with distilled water or by using an appropriate solvent and dry thoroughly.

Alternatively, the emission test chamber can be heated for cleaning without a buffer bag. The empty emission test chamber, the buffer bag connection port should be blocked by non-emitting cover, could be baked to a temperature of 180 °C up to 230 °C.

If the test chamber has an inert coating, care shall be taken not to damage the coating during cleaning (e.g. by using abrasive cleaners and/or high pH).

The cover of buffer connection port should be the same material as the door of the emission test chamber. The airtightness of the test chamber shall be met according to 5.2.2 when the cover is installed at 65 °C.

8.3 Test

8.3.1 Cleaning — Phase 1

The emission test chamber is cleaned by heating to 180 °C or up to 230 °C, if possible overnight. The buffer connection port should be blocked by a non-emitting cover.

8.3.2 Preconditioning — Phase 2

The test chamber shall be conditioned at a temperature of 65 °C ± 2 °C. Then the cover of a buffer bag connection port should be replaced by a buffer bag.

8.3.3 Airtightness checking — Phase 3

Install a buffer bag on the buffer bag connection port. After that, close the outlet port and the chamber is pressurized by clean air at 1000 Pa of excess pressure. Then the air supply is stopped and the measured pressure drop during a period of 30 min is recorded.

The air leakage shall be less than 0,5 % of the test chamber volume per minute or less than 5 % of supply air flow rate at 1 000 Pa of excess pressure (see 5.2.2). If the airtightness of the test chamber is not satisfied, the buffer bag shall be reinstalled and rechecked for airtightness.

8.3.4 Measuring background concentrations — Phase 4

Emission test chamber background levels shall be checked before each emission test, to quantify any background contribution of vapour-phase organic compounds from the air, buffer bag and emission test chamber apparatus itself.

Background concentrations shall meet the requirements in 7.4.

8.3.5 Inserting the unit component — Phase 5

The unit component shall be put on a stand in the middle of the test chamber. Contact with the walls of the chamber should be avoided. Ensure that the unit component does not move during the entire duration of the test. A set of several unit components could be tested together according to the test purpose.

After inserting the unit component, the test chamber shall be closed immediately.

8.3.6 Conditioning and air sampling — Phase 6

The test shall be started immediately after closing the test chamber. The test procedure of the individual test phases are summarized in Table 1.

From the time that the unit component is placed in the chamber, 4 h shall be allowed for the conditioning of the unit component.

Table 1 — Test procedure by phase

Phases	**Time** h:min	**Temperature** °C	**Air exchange** 1/h	**Procedure**
1		Max. 230	Max.	**Pre-heat the chamber**
2		65	Max.	**Set temperature to 65 °C and equilibrate at 65 °C**
3		65	—	**Install the buffer bag and then check airtightness**
4	0:00	65	—	**Measure the background concentration for 30 min**
5	0:30	65	—	**Insert sample and condition the sample at 65 °C for 4 h**
6	**4:30**	**65**	—	**Start air sampling**

NOTE Earlier sampling times can be applied if more volatile compounds are of interest.

8.4 Vapour sample collection

At the end of the conditioning period, the sampling train is connected to the sampling device and pump to the tubing from the test chamber.

Vapour sampling shall start at the end of this conditioning time by opening the valve on the sampling train tubing and switching on the sampling pump. VOCs should be sampled following guidance given in ISO 16000-6 and using typical pump flow rates of 50 ml/min to 100 ml/min. Formaldehyde and carbonyls should be sampled following guidance given in ISO 16000-3 and using typical pump flow rates of 500 ml/min to 1 000 ml/min.

Vapour sampling volumes for VOCs and carbonyl compounds depend on the analytical methods to be used and buffer bag volume. Each vapour sample shall be taken using an appropriate volume for duplicate samples.

Once the vapour sampling step is complete, remove the sampling device or devices from the sampling train(s) and seal immediately. See ISO 16000-6 or ISO 16000-3 for details.

8.5 Sealing the vapour sampling devices after vapour sample collection

Sample tubes shall be disconnected from the sampling train at the end of vapour sampling, resealed using appropriate caps and fittings (ISO 16000-6 and ISO 16000–3) and the duration of sampling immediately recorded. Sample tubes shall be stored carefully before analysis following guidance given in the relevant standard.

8.6 Sample analysis

Analyse the vapour sampling devices according to ISO 16000-3 (formaldehyde and carbonyls) or ISO 16000-6 (VOCs) in order to determine the mass of each target compound retained by the vapour sampling tubes. Analyte vapour concentrations can be determined from the respective masses if required.

9 Calculation of unit component values

Determine the unit component value of gas emission from a unit component in the static mode using Formula (2):

$$W_m = (\gamma_s - \gamma_b) \times V_s \tag{2}$$

where

γ_s is the test concentration, in µg m^{-3};

γ_b is the background concentration, in µg m^{-3};

V_s is the emission test chamber volume plus the buffer bag volume, in m^3;

W_m is the unit component value, in µg.

The concentration of VOCs and carbonyl compounds in air are calculated as described in ISO 16000-6:2011, Clause 11, or ISO 16000-3:2011, Clause 10, using the correction for 23 °C and 101,3 kPa.

10 Test report

The following is a guide to the details required in a test report if the static chamber results are to be used for evaluation of emissions in absolute terms. A simpler report is acceptable if this test is carried out for routine, in-house quality control purposes:

a) test laboratory:

- laboratory details (if appropriate),
- name of the responsible person,
- reference to this part of ISO 12219, i.e. ISO 12219-5:2014,
- reference to the appropriate in-house protocol or detailed description of the equipment and methods used.

b) sample description:

- type and batch number of product (and brand name, if appropriate),
- sample selection process (e.g. random, disassemble of assembly),
- product history (e.g. date of production or date of arrival at the test laboratory, if appropriate),
- description of packaging, if appropriate;

c) test sample preparation:

- date and time of unpacking and test specimen preparation,

  - method of preparation;

d) experimental conditions and procedures:

  - test mode (static mode or dynamic mode),
  - chamber conditions (temperature, buffer bag, volume of gas introduced, humidity (if appropriate),
  - airtightness of test chamber,
  - describe how the test unit component was set within the test chamber, e.g. sample position, using stand tool,
  - sampling of emitted compounds (adsorbent used, volume sampled, sampling duration and times after introduction into the test chamber),
  - analytical conditions used (i.e. thermal desorption parameters, GC column selected, GC-MS conditions, HPLC etc.);

e) data analysis:

  - describe the method used to calculate the unit component value and vapour concentration data;

f) results:

  - the unit component value shall be reported for each test specimen, for individual VOCs and/or TVOC (if required), at the times of gas sampling;

g) quality assurance / quality control:

  - emission test chamber background concentrations of target volatile organic compounds,
  - recovery data for toluene (to evaluate the overall performance),
  - results of duplicate sampling/analysis,
  - quality of the environmental variables [e.g. temperature, air or gas selected, humidity (if appropriate)].

11 Quality assurance/quality control (QA/QC)

An appropriate level of quality control shall be employed following ISO 16000-3 and ISO 16000-6 including the following:

- Background samples are prepared according to 8.3.4.
- The background level is acceptable if artefact peaks are below 500 µg/m^3 (as TVOC) or no greater than 10 % of the typical areas of the analytes of interest.
- Desorption efficiency of VOCs/carbonyls should be checked according to ISO 16000-3 and ISO 16000-6.
- The collection efficiency can be controlled by using back-up tubes or taking samples of different sampling volumes less than the safe sampling volume.
- Repeatability of the air sampling and analytical method shall be determined. A relative standard deviation ≤ 15 % (16000-3 and ISO 16000-6) from the duplicate measurements should be reached.

NOTE The repeatability of the emission test can be influenced by the inhomogeneity of the material being tested.

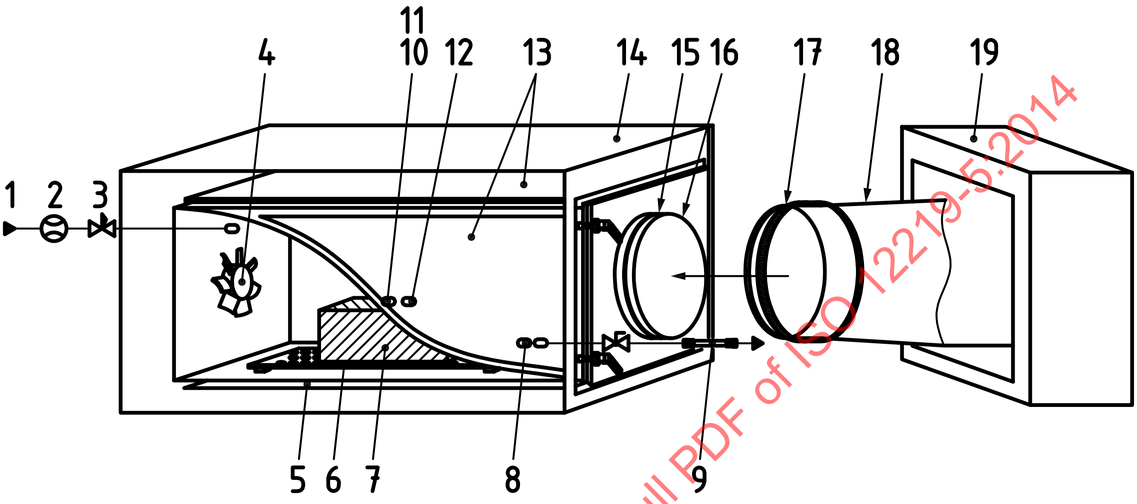
- Documentation illustrating traceable calibrations for temperature, humidity, and flow measurements.
- Documentation illustrating traceable calibrations for temperature and flow measurements.

12 Safety measures

It is the responsibility of the user of this part of ISO 12219 to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. National regulations for precautions shall be followed.

Annex A
(informative)

General description of the static test chamber



Key

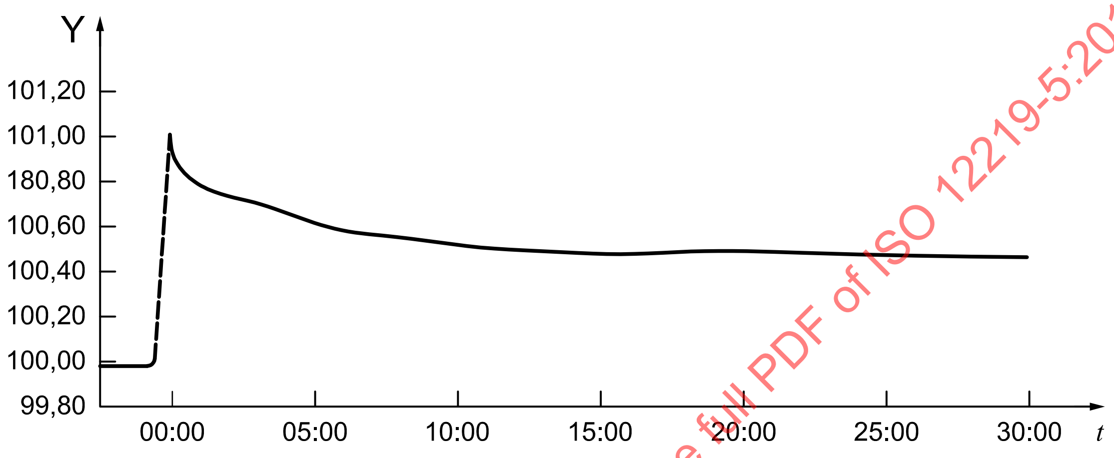
1	air supply port	11	humidity sensor
2	flow meter	12	pressure sensor
3	on/off valve	13	heater
4	mixing fan	14	incubation chamber
5	emission test chamber	15	O-ring
6	stand for sample	16	buffer bag connection port
7	test sample (unit component)	17	joint band
8	sampling port	18	buffer bag
9	sampling media	19	outer chamber door
10	temperature sensor		

Figure A.1 — General description of the static test chamber

Annex B
(informative)

Example of airtightness test and temperature stability of entire phases

EXAMPLE An example of the airtightness test is shown in Figure B.1.



Key

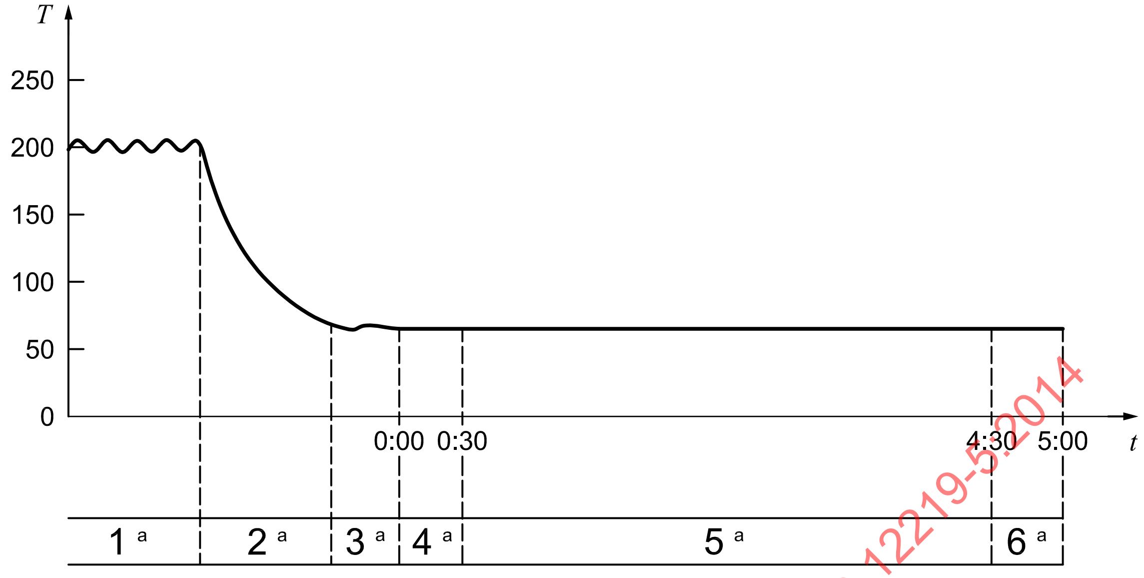
t time in minutes

Y pressure in kPa

Figure B.1 — Trend of pressure change during an airtightness test

The airtightness of the test chamber can be derived from the pressure drop during a time period of 30 min at an excess pressure of 1 000 Pa. The average value of leak rate, n_L (l/min), is calculated using Formula (B.1):

$$n_L = 1000 \frac{520\ \text{Pa} \times 125\ \text{l}}{30\ \text{min} \times 100470\ \text{Pa}} = 22\ \text{ml/min} \tag{B.1}$$



Key

t time in minutes

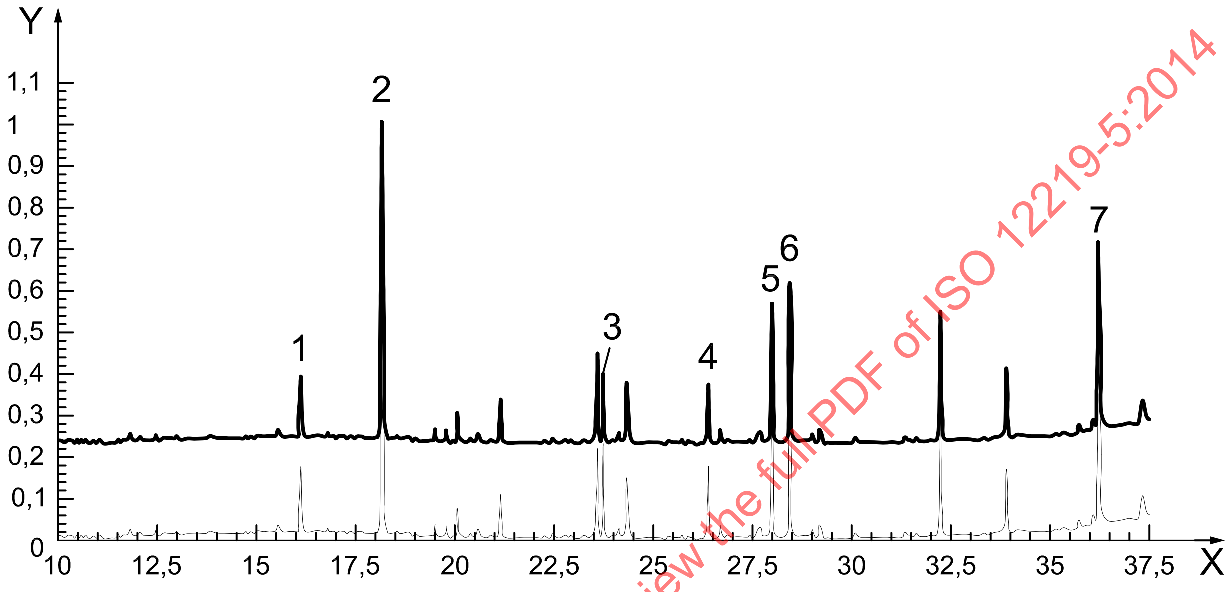
Y pressure in °C

a number of the individual test phase

Figure B.2 — Variation and stability of temperature during whole phases

Annex C
(informative)

Comparison of VOCs concentration between the buffer bag inside and the static chamber inside



Key

X	time in minutes	Upper line	buffer bag inside
Y	signal in arbitrary units	Lower line	static chamber inside

Figure C.1 — Comparison of total ion chromatogram of VOCs emitted from console between the inside of buffer bag (upper) and the inside of static camber (lower)

Table C.1 — Concentrations of typical VOCs in the buffer bag and in the static chamber

No.	RT min	Compound	CAS no.	Concentration ug/m^3	
				Buffer bag	Chamber
1	16,2	Toluene	108–88–3	239	279
2	18,2	Hexamethyl cyclotrisiloxane	541–05–9	1,256	1,259
3	23,7	1,1-Oxybis-2-propanol	110–98–5	306	451
4	26,4	2-Ethyl hexanoic acid	149–57–5	315	434
5	28,0	Decamethyl cyclopentasiloxane	541–02–6	571	569
6	28,5	2-(2-Butoxyethoxy)-ethanol	112–34–5	650	878
7	36,2	Butylated hydroxytoluene	128–37–0	830	1,173

Annex D
(informative)

A dynamic mode operation

D.1 Introduction

This annex describes procedures for a dynamic headspace type method for measuring volatile organic compounds (VOCs), formaldehyde and other carbonyl compounds which may diffuse from vehicle interior unit components into the cabin air. A dynamic mode operation of an emission chamber could provide corroborative information between the method in this part of ISO 12219 and the small chamber method (ISO 12219-4:2013).

D.2 Principle

The dynamic mode operation assesses the emission rate of VOCs and carbonyls from unit component under condition of fixed temperature, humidity and air exchange. The principle of the dynamic mode operation is identical to the small chamber method (ISO 12219-4:2013).

D.3 Apparatus

D.3.1 Non-emitting cover of buffer bag connection port

When the test chamber is operated in a dynamic mode operation, a buffer bag is eliminated and then the buffer connection port shall be sealed by a non-emitting cover. The buffer bag port shall be sealed securely to satisfy airtightness conditions described in 7.5.

D.3.2 Clean air supply

The air supply system shall be a satisfied air exchange rate of 0,4 per hour under the test condition with accuracy of ± 5 %. The purity of clean air shall fulfil the requirements of air supply according to ISO 12219-4:2013.

D.4 Test procedure

The standard test procedure of a dynamic operation mode has six parts described in 8.3. In phase 3, an installation of buffer bag procedure is skipped but a checking of the airtightness of the test chamber is required in the dynamic operation mode also.

Table D.1 — Test procedure by phase in dynamic mode operation

Phases	Time h:min	Temperature °C	Air exchange 1/h	Procedure
1		Max. 230	Max.	**Pre-heat the chamber**
2		65	Max.	**Set temperature to 65 °C and equilibrate at 65 °C**
3		65	—	**Check airtightness**
4	0:00	65	0,40	**Measure the background concentration for 30 min**
5	0:30	65	0,40	**Insert sample and condition the sample at 65 °C for 4 h**
6	**4:30**	**65**	**0,4**	**Start air sampling**

As described in Table D.1, an air exchange flow supply is from phase 4 through 6 with conditions specified in D.3.2. Other procedures of background measurement, sample installation and air sampling are identical to the static mode operation described in 8.3.

D.5 Calculation of emission rate

Area or mass-specific emission rates (q_A or q_m) can be derived from dynamic mode operation chamber air concentrations using the calculation method in ISO 12219-4:2013, Clause 10.

Determine the area-specific emission rate of gas emission from a unit component in the dynamic mode using Formula (D.1) below:

$$\gamma_x = q_A \times \left(\frac{L_A}{n} \right) = \frac{q_A}{q} \tag{D.1}$$

where

γ_x is the measured concentration, in µg m^{-3};

q_A is the area-specific emission rate, in µg m^{-2} h^{-1};

q is the area-specific air flow rate, in m^3 m^{-2} h^{-1};

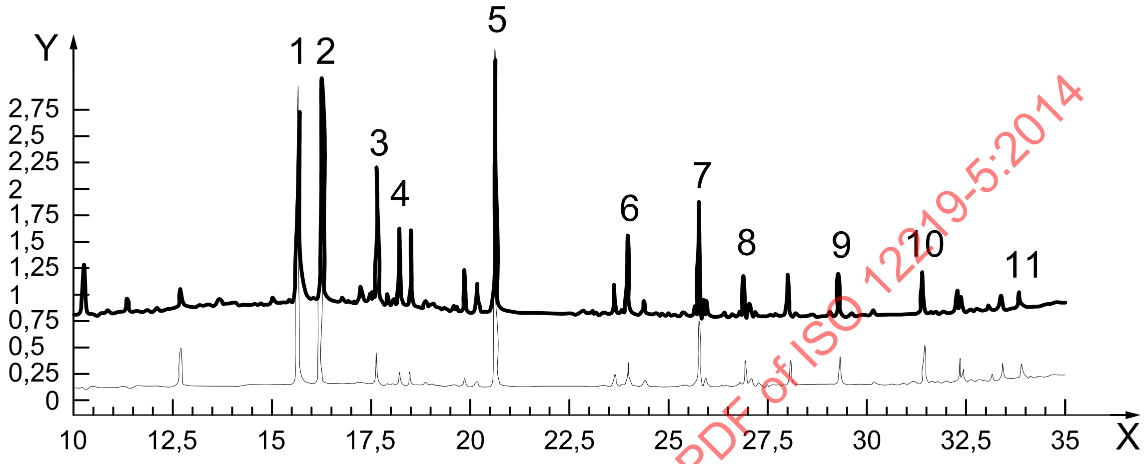
n is the air exchange rate, in h^{-1};

L_A is the loading factor, in m^2 m^{-3}.

The concentration of VOCs and carbonyl compounds in air are calculated as described in ISO 16000-6:2011, Clause 11, or ISO 16000-3:2011, Clause 10, using the correction for 23 °C and 101,3 kPa.

Annex E
(informative)

Comparison of the static mode and the dynamic mode operation



Key

X time in minutes

Y signal in arbitrary units

Upper line static mode operation

Lower line dynamic mode operation

Figure E.1 — Comparison of total ion chromatogram of VOCs emitted from console between the static mode operation (upper) and the dynamic mode operation (lower)

Table E.1 — The ratio of concentration of typical VOCs between the static mode and the dynamic mode after 4 h at 65 °C

No.	RT min	Compound	Area ratio (Static mode/ Dynamic mode)	CAS no.
1	15,7	N,N-Dimethyl formamide	1.0	68–12–02
2	16,3	Toluene	8.5	108–88–3
3	17,6	Octane	4.0	111–65–9
4	18,2	4-Hydroxy-4-methyl-2-pentamone	6.1	123–42–2
5	20,6	2-Butoxy ethanol	1.7	111–76–2
6	23,9	Decane	2.9	124–18–5
7	25,7	4,5-Dimethyl nonane	1.7	17302–23–7
8	26,9	3,7-Dimethyl decane	1.6	17312–54–8
9	29,3	Dodecane	1.4	112–40–3
10	31,4	5-(2-methylpropyl) nonane	1.0	62185–53–9
11	33,8	Tetradecane	1.2	1120–36–1