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Indoor air —

Part 44: Test method for measuring perceived indoor air quality for use in testing the performance of gas phase air cleaners

Air intérieur —

Partie 44: Méthode d'essai pour mesurer la qualité de l'air intérieur perçue à utiliser pour tester les performances des épurateurs d'air en phase gazeuse

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Foreword

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

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

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This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

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.

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Introduction

There is an increased interest in the development of air cleaners removing gaseous pollutants. Such air cleaners are also called air purifiers. They have been marketed for reducing concentrations of gaseous pollutants using different removal principles including among others physical and physicochemical sorption or oxidation (mineralization).

The performance of gas phase air cleaners can be evaluated by their removal efficiency defined by the ratio of concentration of pollutants downstream and upstream an air cleaner in the case of single pass efficiency. Removal efficiency can also be obtained by determining the change of concentration in a room where an air cleaner is in operation. Removal efficiency is consequently used to calculate clean air delivery rate i.e. the equivalent airflow delivered by an air cleaner that does not contain pollutants that were removed by an air cleaner (unpolluted air).

The removal efficiency is usually determined using a single pollutant or a mixture of up to a few pollutants thus not capturing the entire spectrum of pollutants present. For this purpose, sensory assessment of air quality made by human subjects can be made. The ratings of air quality as perceived by people are not normally used (seldom) to assess the removal efficiency of air cleaners although, based on them, ventilation requirements prescribed by standards in many parts of the world have been determined. Because measurements of chemical compounds will seldom capture all pollutants and because no models exist to describe how they will be perceived by building occupants, examining the effect of the air quality of an air cleaner as perceived by humans [so-called perceived air quality (PAQ)] seems relevant and should be considered as a supplementary method to chemical measurements.

There are different methods used to determine PAQ. The two most frequently used are the assessments of odour intensity of the air and acceptability of air quality; the latter can be used to determine the percentage of dissatisfied people. The measurements are made by human subjects (sensory panels) who use their olfactory sense to determine PAQ. Specially trained subjects (so-called trained panels) and untrained subjects (so-called untrained panels) can be used.

Historically, when ventilation requirements were determined in the 1930s by Yaglou and his colleagues, odour intensity was used to determine PAQ based on which ventilation requirements were prescribed. Yaglou's results were subsequently used in standards and handbooks in many parts of the world have been fundamentally based on his work. In the later research in the 1980s among others by Fanger and his colleagues, the ratings of acceptability were used to describe PAQ and ventilation requirements prescribed in the standards were subsequently revised.

Considering the above, there is a need for a standard to assess the performance of gas phase air cleaners based on sensory ratings of air quality so that it can be compatible with the current ventilation standards. This document describes a test method that can be used to evaluate the performance of air cleaners that primarily remove gaseous pollutants from the air based on the ratings of PAQ.

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Indoor air —

Part 44:
Test method for measuring perceived indoor air quality for use in testing the performance of gas phase air cleaners

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1 Scope

This document specifies a laboratory test method for measuring perceived air quality using human subjects that can be used for assessing the performance of air cleaners removing gas-phase pollutants. The method describes the performance of gas-phase air cleaners with respect to removal of pollutants that can be sensed by human subjects.

The method has a reference to sensory tests specified in ISO 16000-28.

Air cleaners removing particles and aerosols (mechanical or electronic filters) can also remove pollutants responsible for sensory response. The method described in this document does not apply to testing of these air cleaners.

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

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

ISO 16000-9, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

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

ISO 16000-28, *Indoor air — Part 28: Determination of odour emissions from building products using test chambers*

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

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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3.1
acceptability
parameter used to describe indoor air quality as it is perceived by people

Note 1 to entry: Acceptability describes overall perception of the quality of air indoors taking into account intensity and hedonic character.

Note 2 to entry: Acceptability can be assessed with the dichotomous or continuous visual-analogue scale; the latter is frequently used. The end points are clearly acceptable and clearly unacceptable.

3.2
air cleaner
apparatus that reduces concentration of indoor pollutants using active or passive method

Note 1 to entry: An air cleaner in this document is understood as an electrically-powered device that is basically built of components having the ability to capture gas-phase pollutants and a fan drawing the air through it.

Note 2 to entry: An air cleaner is the device that can be installed either in a room or in a duct, or both.

3.3
odour intensity
parameter used to describe the intensity of odour caused by indoor pollutants as it is perceived by people

Note 1 to entry: Odour intensity is assessed using a continuous scale having end points "no odour" and "overpowering odour" and four intermediate equally distanced levels: "slight odour", "moderate odour", "strong odour" and "very strong odour".

Note 2 to entry: Odour intensity can also be measured using other methods than described in Note 1 to entry. ISO 16000-28 provides a method using the perceived intensity with the unit pi. The method presented in Note 1 to entry and pi method are well correlated.

3.4
panel
group of people (assessors or subjects) performing sensory evaluation of *air quality* (3.6)

3.5
panel member
member of a *panel* (3.4) performing sensory evaluation of *air quality* (3.6)

3.6
perceived air quality
parameter used to describe the quality of indoor air as perceived by people and evaluated in terms of either *acceptability* (3.1) or *odour intensity* (3.3), or *both*

4 Principle

The aim of this document is to describe the method for measuring the perceived air quality indoors when gas-phase air cleaner(s) is(are) in operation. The perceived air quality is determined using subjective evaluations of either acceptability or odour intensity, or both. The air assessed by a panel is presented via a sniffing device (a funnel). The perceived air quality is used to determine the removal efficiency of an air cleaner(s). If the equivalent measurement accuracy can be guaranteed, the alternative method can be used where panel members directly enter the test chamber to perform sensory evaluations. Follow the method specified in Annex C.

The assessments are made in a test chamber having a general room volume size. The test method consists of two steps:

a) a sensory test without air cleaner(s), and

b) a sensory test with an air cleaner(s).

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Before performing a sensory test using the described method, it must be documented that no compounds are present in the air that are toxic, carcinogenic or harmful to people performing sensory evaluations at the inhalation doses (concentration and exposure time) received during testing. Fulfilling this requirement will comply with general requirements set by the ethical committees worldwide.

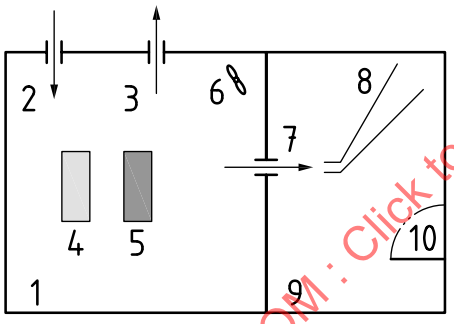
5 Apparatus, materials and sensory panel

5.1 Test chamber. A space large enough to room air cleaner, pollution sources and people - volunteer(s) staying inside for the purpose of emitting pollutants (a source of human bioeffluents) (see Figure 1) should be used as a test chamber. The room shall guarantee the same conditions as the test chamber specified in ISO 16000-9.

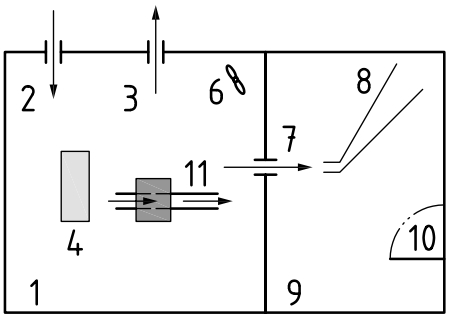
Test room shall have a suitable environmental control system to maintain a constant temperature and humidity, and provide ventilation with outdoor (unpolluted) air.

The room shall be kept clean and be characterized as low–polluting, i.e. the emissions of pollutants inside the room should be kept as low as possible to ensure proper background reference. The removal capacity of the test chamber for gaseous pollutants through e.g. adsorption should be sufficiently low not to compete with an air cleaner being tested.

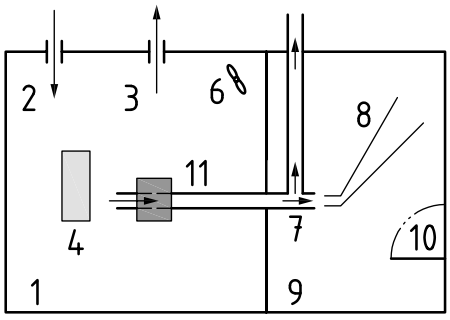
The test chamber shall be equipped with a fan ensuring that the air is well mixed within the entire volume thus complying with relevant specifications and requirements of ISO 16000-9. The mixing of the air shall be documented. No air shall be allowed to circulate from the air exhaust to air supply terminals.



a) Test room for a standalone air cleaner



b) Test room for a duct air cleaner



c) Test room for a duct air cleaner (single-pass condition)

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Key

1	test chamber	7	tube or duct
2	clean and temperature/humidity conditioned air supply inlet	8	sniffing device, complying with relevant specifications and requirements of ISO 16000-28
3	exhaust outlet	9	front/anterior space in which human panel enter
4	emission source	10	doors where panel enters
5	an air cleaner	11	in duct air cleaner
6	mixing fan		

Figure 1 — Schematic diagram of a test room

5.2 Anterior space. Front/anterior space in which human panel enter shall guarantee the same temperature, relative humidity and background concentration conditions as the test chamber.

5.3 Temperature and humidity. Temperature in the chamber shall be maintained at 23 °C (±1 °C). Relative humidity in the chamber shall be maintained at 50 % (±10 %).

5.4 Air flow meter shall be installed at the inlet or the outlet of the test chamber to measure and monitor the air flow rate to or air exchange rate in the test chamber. Air flow meter should also be installed to measure the air flow rate from sniffing device. Air flow rate shall be regularly recorded.

5.5 Odour emission source(s) shall be building material(s) or product(s), permeation tube(s), and/or human volunteer(s) that steadily and constantly emit gaseous pollutants. They shall be placed/installed in the test chamber. Odour emission source(s) that result at least in the moderate odour intensity is desirable under the Step 1 test condition specified in 8.1.2.

5.6 Air cleaner. A stand-alone air cleaner shall be placed and operated in the test chamber. The in-duct air cleaners shall be installed in the duct with fan and then placed in the test chamber. When testing under single-pass conditions, the sniffing device should be installed in the duct after passing through the in-duct air cleaner.

5.7 Air sampling devices. Sampling devices used to sample the inlet and outlet air of the test chamber shall comply with the specifications of ISO 16000-3 and ISO 16000-6, respectively. When the air is sampled from the inlet, it shall be ensured that the supply air flow rate remains constant.

5.8 Analytical instrument. For determination of carbonyl compounds and volatile organic compounds (VOCs), a high-performance liquid chromatograph (HPLC) and/or a gas chromatograph (GC) shall be used as specified in ISO 16000-3, ISO 16000-6, and ISO 16017-1. Alternative devices with an equal or better accuracy can be used.

5.9 Sensory panel. The panel selection shall comply with the specifications of ISO 16000-28.

6 Test conditions

6.1 General

These test conditions apply at atmospheric pressure conditions. Temperature, relative humidity, background pollution levels, and air flows apply both for the test and anterior space.

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6.2 Temperature and relative humidity

The temperature in the test chamber should be set to 23 °C (±1 °C), and relative humidity to 50 % (±10 %) when the tests are carried out. The actual temperature and humidity during any test shall be monitored and recorded and included in the test report. The measurements shall follow the protocol described in ISO 16000-9.

For air cleaners that have applications under specific climatic conditions varying significantly from the indicated set points, alternative temperature and air humidity conditions may be used, preferably as specified in ISO 554. These alternative conditions shall be monitored and recorded and included in the test report.

When it is important to examine whether the performance of an air cleaner depends on the changing levels of air temperature and relative humidity, the tests shall be extended to other temperatures and relative humidities than those indicated in this subclause.

6.3 Supply air quality and background concentration

The background concentration of pollutants in the air supplied to the test chamber shall be as low as not to interfere with the testing procedure. The same requirement applies to the background level (with no additional pollution sources) in the test chamber. The levels carbonyl and VOCs in the background shall be determined prior to the tests. It is recommended that the total VOC concentration in the test room is lower than 20 µg/m^3, while the concentration of each carbonyl compound and VOC lower than 2 µg/m^3 as specified in ISO 16000-9. Water used for humidification shall be purified and shall not to contain VOCs that can affect the testing procedure.

6.4 Air change rate

The air change rate should be kept constant at two levels of 0,50/h (±0,03/h) or 2,0/h (±0,12/h) in order to control odour concentration level in test chamber. The air change rate shall be regularly checked as specified in ISO 16000-9. Airflow meter shall be installed at the inlet or the outlet of the test chamber to perform measurements of the air flow rate or air change rate in the test chamber. Airflow meter should also be installed to measure the air flow rate from sniffing device. Airflow rate shall be monitored and recorded regularly.

The airflow rate at the sniffing device presenting the air to a panel member in anterior chamber and extracted from the space where air cleaner is tested shall be between 0,6 l/s to 1 l/s; it shall be constant for the duration of each test session as specified in ISO 16000-28. The air flow shall be regularly measured and reported. The system delivering the air for sensory assessments shall not be contaminated. An example of air flow condition is given in Annex B.

When the capped sniffing device is uncapped, the pressure in the test chamber can change and the flow rate will also change. Airflow rate from test chamber outlet and from niffing device shall be monitored and recorded regularly.

6.5 Panel members

The panel selection and assessment procedure of the acceptability and perceived intensity test shall comply with the specifications of ISO 16000-28. A minimum panel size is 15 untrained members as specified in ISO 16000-28. A panel of 25 members is needed to achieve the 90 % confidence interval, and to achieve the 95 % confidence interval, a panel of 30 to 40 members is needed.

6.6 Anterior space condition

Anterior chamber should be ventilated to keep the background concentration low enough not to interfere with the test. The temperature and relative humidity should be the same as in the test chamber. The changes in temperature and humidity during the test period should be monitored and recorded.

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7 Preparation

7.1 Preparation of the odour emission source(s)

The building materials, products and human volunteers shall be used as odour emission sources. Multiple permeation tubes can also be used as an alternative method to create odour emission sources.

The building material(s) used as the odour emission source(s) shall be typical materials and building products for indoor use; the emission should be constant.

Human volunteer(s) used as the odour emission sources should ensure constant emission during the test and between tests.

Carbonyl compounds and VOCs from odour emission sources shall be documented by performing the measurements described in ISO 16000-3, ISO 16000-6 and ISO 16000-9.

7.2 Preparation of air cleaner(s)

The type of operating mode of air cleaner shall be determined before the test. The free-standing and in-duct air cleaner(s) can be examined.

The airflow of air supplied by air cleaner shall be specified. It should be expressed as an equivalent air change rate in relation to the test chamber volume.

The test of air cleaner shall be conducted under at least two airflow rates through the air cleaner, most likely typical (recommended) and either the lowest (night mode) or the highest (boost); it is advised to examine all three airflows. The equivalent air change rate described above should not exceed 10 times the airflow rate of the test chamber. The equivalent air flow rate of air cleaner (s) shall be checked during the test.

8 Test method

8.1 Test chamber method

8.1.1 General

Prior to testing, the test chamber shall be ventilated for one day. Then the background pollution levels shall be determined. The air from the test chamber shall be sampled via tube or duct between the test chamber and the anterior space (see Figure 1), or directly in the test chamber. Carbonyl compounds and VOC concentrations shall be measured as described in ISO 16000-3 and ISO 16000-6.

The test of an air cleaner shall commence afterwards and shall be carried out in the following order.

8.1.2 Step 1: Measuring the perceived air quality without operating air cleaner(s)

Before the measurements, the test chamber with or without odour emission source(s) shall be ventilated for at least three times the nominal time constant, which is a time scale defined by test chamber volume and ventilation air flow rate; this is done to ensure that steady-state condition is obtained.

NOTE Nominal time constant corresponds to 2 h for 0,5/h air change rate condition, and 0,5 h for 2,0/h air change rate condition.

Under the condition of evaluation via sniffing device in the anterior chamber, sniffing device shall be capped until the panel member is ready to assess.

The panel member shall enter the front/anterior space one by one and assess quality of air presented via sniffing device immediately upon arriving at the measuring point where sniffing device is located. The measurement shall be made after taking one sniff of the air. Only one measurement shall be made at

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a time, either acceptability or perceived odour intensity, the order of measurements shall be balanced. If one sniff is not enough, the panel member shall leave anterior space and re-enter after 3 min to repeat the measurement.

The measurements shall be recorded by a pen on a paper questionnaire or on a tablet with the digital questionnaire. Then, the panel member leaves the anterior chamber. For the same panel member there shall be 3 min between assessments.

The panel members shall make assessments four times, twice for acceptability and twice for perceived odour intensity.

Parallel to the sensory measurements, carbonyl compounds and VOC concentrations in test chamber should be measured as described in ISO 16000-3, ISO 16000-6 and ISO 16000-9.

8.1.3 Step 2: Measuring the perceived air quality with operating air cleaner(s)

Before the measurements, the test chamber with air cleaner(s) in operation shall be ventilated for at least three times the nominal time constant, which is a time scale defined by test chamber volume and ventilation air flow rate; this is done to ensure that steady-state condition is obtained.

Operation of the air cleaner (s) may change the temperature and humidity in the test chamber and the changes in temperature and humidity during the test period should be monitored.

The assessment procedure of perceived air quality is the same as that described in 8.1.2. The same applies to measurements of carbonyl compounds and VOCs.

8.1.4 Determination of perceived air quality

8.1.4.1 General

Perceived air quality is assessed by determining acceptability of air quality and its odour intensity.

8.1.4.2 Acceptability

Acceptability of air quality is assessed using continuous scale (Figure 2). To create the context, it shall be assessed in the following context. “Imagine you are exposed to this air environment in your daily life. How do you assess this air quality?”

The acceptability of the air quality by indicating a position along the line between the end points –1 “clearly unacceptable” to +1 “clearly acceptable”. The numbers are not shown to panel members and are only used for coding of their votes.

The score is determined by imposing a scale in steps of 0,05 on the line and reading the value next to the assessment marking (see Figure 2).

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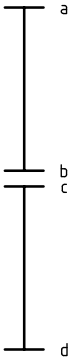

Key

a	clearly acceptable	c	just unacceptable
b	just acceptable	d	clearly unacceptable

Figure 2 — Acceptability scale

8.1.4.3 Perceived odour intensity

Perceived odour intensity is assessed using continuous category scale (see Figure 3) marked with six labels describing intensity of the perception:

— 0: no odour,

— 1: slight odour,

— 2: moderate odour,

— 3: strong odour,

— 4: very strong odour,

— 5: overpowering odour.

The numbers are not shown to panel members and are used only to record their votes.

The panel members evaluate the odour intensity by indicating a position along the line between the end points 0 “no odour” to 5 “overpowering odour”; the vote can be made anywhere on the scale.

The odour intensity score is determined by imposing a scale in steps of 0,1 on the line and reading the value next to the assessment marking.

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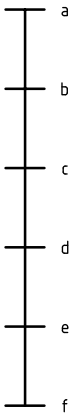

Key

a	no odour	d	strong odour
b	slight odour	e	very strong odour
c	moderate odour	f	overpowering odour

Figure 3 — Perceived odour intensity with category scale

NOTE Odour intensity can be measured using different scales. Perceived intensity (unit pi) using a comparative scale defined by ISO 16000-28 is determined by comparing the intensity of the sample with difference intensities of the reference substance (acetone) and is assessed using trained panel.

8.1.5 Instructions

Prior to the measurements, the panel member receives short instruction on measurements and shall practice assessments at least four times.

9 Efficiency

Average acceptability score and average perceived odour intensity score are determined by calculating arithmetic mean, standard deviation and 95 % confidence interval.

Performance of air cleaner is evaluated relative score ratio from the results obtained in Step 1 and those in Step 2.

10 Test report

The test report shall include at least the following information:

a) test laboratory:
   1) name and address of the test laboratory;
   2) name of the responsible person;

b) test chamber and material description:
   1) specifications of test chamber;
   2) air change rate;
   3) specifications of air cleaning products (e.g. type and performance of air purifier, equivalent air change rate);

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4) type of building material used as odour emission source (and brand name, if appropriate), sample selection process (e.g. random), and product history (date of production, batch number, date of arrival at the test laboratory, date and time of unpacking, date and time of preparation of test specimen, etc.);

5) human volunteer used as bio-effluent emission source;

c) information about panel leader, panel size;

d) test results:

1) acceptability;

i) arithmetic mean of the acceptability assessments;

ii) uncertainty (confidence interval);

2) perceived odour intensity;

i) arithmetic mean of the perceived odour intensity assessments;

ii) uncertainty (confidence interval);

e) test conditions:

1) test chamber conditions (e.g. temperature, relative humidity, air change rate, carbonyl compounds and VOCs concentrations);

2) sensory test procedures;

f) quality control/quality assurance (details are as specified in Annex A):

1) background concentration of carbonyl compounds and VOCs;

2) number of measurements;

3) accuracy of temperature, relative humidity and air change rate;

g) the International Standard used (i.e. ISO 16000-44:202X);

h) the method used (if the standard includes several);

i) any deviations from the procedure;

j) any unusual features observed;

k) the date of the test.

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Annex A
(informative)

System for quality assurance and quality control

A.1 General

Testing for evaluating the perceived air quality shall be conducted within the framework of a quality assurance project plan (QAPP). The QAPP shall contain a project description, data quality objectives and acceptance criteria, quality assurance and quality control (QA/QC) approaches and activities, as well as QA/QC audits. In particular, air sampling and analytical methods to determine VOCs are described in ISO 16000-6 and ISO 16017-1. Sampling, transport and storage of materials to be tested and preparation of test specimens are specified in ISO 16000-11. The QA/QC procedures shall be conducted in accordance with the requirements of ISO 16000-3, ISO 16000-6, ISO 16000-11 and ISO 16017-1.

A.2 Project description

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

A.3 QA/QC approaches and activities

The types of QA/QC activity that can be specified in the QAPP include establishment of a system of records or notebooks to ensure proper operation of equipment and recording of data, such as:

a) sample log to record receipt, storage, and disposal of materials;

b) GC standards preparation log to document preparation of all organic compound substances;

c) permeation tube log to record mass loss data for all permeation tubes;

d) calibration logs to contain environmental systems calibration data;

e) instrument maintenance logs to document maintenance and repairs of all equipment;

f) materials testing logs in which to record all pertinent information for each test, including sample details, sample identification (ID) number and GC run ID number;

g) sorbent tube clean-up and desorption log, detailing thermal clean-up and QC validation of sorbent tubes and solvent extraction log;

h) separate electronic log to document location and content of electronically stored data;

i) manuals governing operation of all equipment used by the project.

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

a) routine maintenance and calibration of systems;

b) daily recording of GC calibration accuracy and precision (i.e. control charting);

c) timely monitoring of the percentage recovery of the internal standard that was added to all samples;

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d) collection and analysis of duplicate samples;

e) QC checking of organic collection sorbent tubes;

f) periodic analysis of audit gases supplied by an independent source.

A.4 QA/QC audits

Finally, the QA/QC programme shall include periodic audits by QA personnel to evaluate compliance with QAPP protocols.

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Annex B
(informative)

Examples of Test conditions for test chamber and air purifier

B.1 Minimum test chamber size

Minimum test chamber volume and maximum air flow rate of air purifier that satisfies the requirements described in Clause 6 are specified in Table B.1.

Table B.1 — Minimum test chamber size

Air flow rate from sniffing device l/s	Air change rate of the test chamber h^{-1}	Minimum test chamber volume[a] m^3	Maximum air flow rate of air purifier[b] m^3/h
0,6	0,5	4,3	21,6
1,0	0,5	7,2	36,0

[a] Conditions for the air flow rate from sniffing device and air change rate of test chamber to be identical.

[b] 10 times the air changer rate of the test chamber.

B.2 Possible conditions for test chamber size and air purifier performance

Other possible conditions for test chamber size and maximum air flow rate of air purifier that satisfies the requirements described in Clause 6 are specified in Table B.2.

Table B.2 — Possible conditions for test chamber size and air purifier performance

Air flow rate from sniffing device l/s	Air change rate of the test chamber h^{-1}	Test chamber volume m^3	Maximum air flow rate of air purifier [a] m^3/h
0,6	2,0	4,3	86,4
1,0	2,0	7,2	144,0
0,6 to 1,0	0,5	24,0	120,0
0,6 to 1,0	2,0	24,0	480,0

[a] 10 times the air changer rate of the test chamber.

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