
Indoor air —

Part 9:

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

Air intérieur —

Partie 9: Dosage de l'émission de composés organiques volatils de produits de construction et d'objets d'équipement — Méthode de la chambre d'essai d'émission



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Foreword

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

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

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16000-9 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 264, *Air quality*, in collaboration with Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

- *Part 1: General aspects of sampling strategy*
- *Part 2: Sampling strategy for formaldehyde*
- *Part 3: Determination of formaldehyde and other carbonyl compounds — Active sampling method*
- *Part 4: Determination of formaldehyde — Diffusive sampling method*
- *Part 5: Measurement strategy for volatile organic compounds (VOCs)*
- *Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID*
- *Part 7: Sampling strategy for determination of airborne asbestos fibre concentrations*
- *Part 8: Determination of local mean ages of air in buildings for characterizing ventilation conditions*
- *Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*
- *Part 10: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test cell method*
- *Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

The following parts are under preparation:

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

- *Part 13: Determination of total (gas and particle-phase) polychlorinated dioxin-like biphenyls and polychlorinated dibenzo-p-dioxins/dibenzofurans — Collection on sorbent-backed filters with high-resolution gas chromatographic/mass spectrometric analysis*
- *Part 14: Sampling strategy for nitrogen dioxide (NO₂)*
- *Part 15: Measurement of nitrogen dioxide (NO₂)*
- *Part 16: Detection and enumeration of moulds — Sampling of moulds by filtration*
- *Part 17: Detection and enumeration of moulds — Culture-based method*

This corrected version of ISO 16000-9:2006 incorporates the following corrections:

- in Clause 2, on page 1, 2006 has been added after ISO 16000-11;
- in 3.11, on page 2, the symbols in Note 1 have been corrected;
- in Clause 10, on page 8, ISO 16000-11:2005 has been replaced by ISO 16000-11:2006.

Introduction

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

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

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

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Indoor air —

Part 9:

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

1 Scope

This part of ISO 16000 specifies a general laboratory test method for determination of the area specific emission rate of volatile organic compounds (VOCs) from newly produced building products or furnishing under defined climate conditions. The method can also, in principle, be applied to aged products. The emission data obtained can be used to calculate concentrations in a model room.

This part of ISO 16000 applies to various emission test chambers used for determination of the emission of volatile organic compounds from building products or furnishing.

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

A general description of an emission test chamber is given in Annex C of this part of ISO 16000.

For the determination of formaldehyde emissions from wood-based panels, refer to EN 717-1:2004 ^[12]. However, ISO 16000-9 is also applicable to wood-based panels and other building products, in order to determine the emission rate of formaldehyde. The measurement procedure for formaldehyde is described in ISO 16000-3 ^[1].

2 Normative references

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

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 16000-6:2004, *Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA[®] sorbent, thermal desorption and gas chromatography using MS/FID*

ISO 16000-11:2006, *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*

3 Terms and definitions

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

3.1

air change rate

ratio of the volume of clean air brought into the emission test chamber per hour and the free emission test chamber volume measured in identical units

3.2

air flow rate

air volume entering into the emission test chamber per time

3.3

air velocity

air speed over the surface of the test specimen

3.4

area specific air flow rate

ratio between the supply air flow rate and the area of the test specimen

3.5

building product

product produced for incorporation in a permanent manner in construction works

3.6

emission test chamber

enclosure with controlled operational parameters for the determination of volatile organic compounds emitted from building products

3.7

emission test chamber concentration

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

3.8

product loading factor

ratio of exposed surface area of the test specimen and the free emission test chamber volume

3.9

recovery

measured mass of a target volatile organic compound in the air leaving the emission test chamber during a given time period divided by the mass of target volatile organic compound added to the emission test chamber in the same time period, expressed in percent

NOTE The recovery provides information about the performance of the entire method.

3.10

sample

part or piece of a building product that is representative of the production

3.11

specific emission rate

q_m
product specific rate describing the mass of a volatile organic compound emitted from a product per time at a given time from the start of the test

NOTE 1 Area specific emission rate, q_A , is used in this part of ISO 16000. Several other specific emission rates can be defined according to different requirements, e.g. length specific emission rate, q_l , volume specific emission rate, q_V , and unit specific emission rate, q_U .

NOTE 2 The term "area specific emission rate" is sometimes used in parallel with the term "emission factor".

3.12

target volatile organic compound

product specific volatile organic compound

3.13

test specimen

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

3.14

total volatile organic compound

TVOC

sum of the concentrations of identified and unidentified volatile organic compounds eluting between and including *n*-hexane and *n*-hexadecane.

NOTE 1 For quantification of the identified compounds, their individual response is used. The areas of the unidentified peaks are converted on molecular mass basis to concentrations using the toluene response factor [2].

NOTE 2 Due to practical reasons to be taken into account for test chambers, this definition differs slightly from that defined in ISO 16000-6:2004. In ISO 16000-6, TVOC are related to the sampling medium Tenax TA^{®1)} on which the TVOC are adsorbed.

3.15

volatile organic compound

VOC

organic compound that is emitted from the test specimen and all those detected in the chamber outlet air

NOTE 1 Due to practical reasons to be taken into account for test chambers, this definition differs from that defined in ISO 16000-6:2004. In ISO 16000-6, the definition is based on the boiling point range (50 °C to 100 °C) to (240 °C to 260 °C).

NOTE 2 The emission test method described in this part of ISO 16000 is optimum for the range of compounds specified by the definition of total volatile organic compounds (TVOC).

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 part of ISO 16000 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4 Symbols and abbreviated terms

The symbol and the abbreviated terms used in this part of ISO 16000 are given below.

Symbol	Meaning	Unit
ρ_x	mass concentration of a VOC _x in the emission test chamber	micrograms per cubic metre
L	product loading factor	square metres per cubic metre
n	air change rate	changes per hour
q	area specific air flow rate ($= n/L$)	cubic metres per square metre and hour
q_A	area specific emission rate	micrograms per square metre and hour
q_l	length specific emission rate	micrograms per metre and hour
q_m	mass specific emission rate	micrograms per gram and hour
q_V	volume specific emission rate	micrograms per cubic metre and hour
q_u	unit specific emission rate	micrograms per unit and hour
t	time after start of the test	hours or days

5 Principle

The principle of the test is to determine the area specific emission rate of VOCs emitted from building products. The test is performed in an emission test chamber at constant temperature, relative air humidity, and area specific air flow rate. The air in the emission test chamber is fully mixed (see 9.7), and measurements of the VOC concentration in the air at the outlet are representative of the emission test chamber air concentrations.

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

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

6 Emission test chamber system

6.1 General

A facility designed and operated to determine area specific emission rates for VOCs emitted from building products shall contain the following: emission test chamber, clean air generation and humidification system, air mixing system, monitoring and control systems to ensure that the test is carried out according to specified conditions [3], [4].

General specifications and requirements that apply to all types of emission test chambers included in this part of the standard are given in 6.2 to 6.6 below.

Quality assurance / quality control activities shall be carried out as described in Annex A.

A general description of an emission test chamber is given in Annex C.

6.2 Emission test chamber materials

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

Other materials may be used for mixing devices, e.g. fans, and for sealing materials. These shall be low emitting and low adsorbing and shall be tested in the test chamber to confirm that they do not contribute to the emission test chamber background concentration.

6.3 Air supply and mixing facilities

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

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

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

6.4 Air tightness

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

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

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

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

6.5 Air sampling devices

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

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

The sum of sampling air flows should be smaller than 80 % of the inlet air flow to the emission test chamber to avoid underpressure.

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

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

6.6 Recovery and sink effects

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

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

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

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

7 Apparatus

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

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

8 Test conditions

8.1 Temperature and relative air humidity

Products for use in Europe shall be tested at temperature and relative air humidity 23 °C, 50 % RH during the emission test (ISO 554). The tolerances are ± 2 °C and ± 5 % RH.

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

Initial variance can be observed in the emission test chamber climate after opening the emission test chamber door and loading a test specimen. These variances should be recorded.

8.2 Supply air quality and background concentration

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

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

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

NOTE For large scale chambers (larger $\geq 20 \text{ m}^3$), the respective numbers may be in practice in the range of 50 $\mu\text{g}/\text{m}^3$ and 5 $\mu\text{g}/\text{m}^3$.

The water used for humidification shall not contain interfering VOCs.

8.3 Air velocity

The air velocity near the surface of the test specimen shall be in the range 0,1 m/s to 0,3 m/s.

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

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

8.4 Area specific air flow rate and air change rate

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

EXAMPLE Examples of area specific air flow rates are given in Annex B.

9 Verification of the test conditions

9.1 General

All control measures shall be traceable to a certified standard according to the quality assurance and quality control schemes (Annex A of this part of ISO 16000).

9.2 Temperature and relative air humidity control systems

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

Control of relative air humidity can be made by various systems of either external humidity control of the clean air supply or internal humidity control of the air in the emission test chamber. In the latter case, precautions shall be taken to avoid condensation or spray of water in the emission test chamber.

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

9.3 Test conditions in the emission test chamber

Temperature, relative air humidity and air flow rate shall be monitored and recorded continuously with instruments meeting the following accuracy:

- temperature $\pm 1,0$ °C
- relative air humidity ± 3 % RH
- air flow rate ± 3 %

Air velocity shall be measured at the start and at the end of the emission test, with an accuracy of $\pm 0,1$ m/s.

9.4 Air change rate in the emission test chamber

The air change rate shall be regularly checked with a minimum frequency of every 12 months, either by using a calibrated gas meter or the tracer gas procedure as referred to in Annex D. The air change rate shall not vary by more than ± 3 % of the set value.

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

9.5 Emission test chamber air tightness

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

9.6 Air velocity in the emission test chamber

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

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

9.7 Efficiency of the internal emission test chamber air mixing

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

One approach for determining if the test chamber air is adequately mixed is to blend a tracer gas with the inlet air at constant concentration and flow, and measure the concentration in the chamber outlet over time. The chamber concentration vs. time plot is then compared to the theoretical curve for a completely mixed chamber. A procedure would be to adjust the theoretical curve by least square fit to the measured data using the chamber volume as a variable. One can then compare the actual chamber volume to the "apparent" chamber volume based on the curve fit^[5]. Internal chamber air should be properly mixed and should comply with or within 10 % of the theoretical perfectly mixed model.

10 Test specimens

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

Follow the procedures for test specimen preparation as specified in Annex A (for solid products) and in Annex B (for liquid products) of ISO 16000-11:2006.

11 Emission test chamber preparation

The emission test chamber shall be cleaned in order to fulfil the requirements of 8.2. Cleaning can be done by washing the inner surfaces of the emission test chamber with an alkaline detergent followed by two separate rinsings with freshly distilled water. The emission test chamber is then dried and purged at test conditions. The emission test chamber can also be cleaned by thermal desorption^[6].

12 Test method

12.1 Background concentrations

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

Background concentrations shall meet the requirements in 8.2.

12.2 Test specimen location in the emission test chamber

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

12.3 Time for measurements of test chamber air concentration

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

Duplicate air samples shall be taken at (72 ± 2) h and at (28 ± 2) days after the start of the test.

After termination of the emission test, the emission test chamber shall be cleaned according to Clause 11.

Emission test duration is determined by the purpose of the test. For periods when the test specimen is not in the chamber, it shall be stored at an average temperature of 23 °C and a relative air humidity of 50 % RH. During this storage, the aging process of the test specimen shall be similar to that occurring in the test chamber. Any contamination by other stored test specimens has to be avoided. The test specimen shall then be re-introduced into the test chamber at least 72 h prior to air sampling. Each removal of the test specimen has to be documented in the test protocol.

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

Background concentrations of VOCs should be sufficiently controlled in order to avoid contamination of test specimens.

NOTE 2 To minimize contamination of test specimens, well ventilated shelves or storage cabinets can be used.

13 Calculation of area specific emission rates and expression of results

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

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

Equation (1) shows that the area specific air flow rate, q , equals the n/L ratio. For a given product tested under given emission test chamber conditions, the concentration of VOC_x depends on the area specific air flow rate.

The measured concentration, ρ_x , of a VOC in the outlet air from the emission test chamber shall be converted to an area specific emission rate, q_A . ρ_x is the mean concentration of a VOC_x calculated from duplicate air samples as described in 12.3.

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

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

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

NOTE For certain purposes, area specific emission rates can be calculated from time concentration profiles, or by means of various mathematical models, e.g. first-order decay from concentration time data. This and other models are referred to in References [7] and [8].

14 Performance characteristics

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

15 Test report

The test report shall include the following information:

- a) test laboratory:
 - 1) name and address of the laboratory;
 - 2) name of the responsible person;
 - 3) description of the equipment and methods used (test chamber, clean air system, environmental control, sample collection, analytical instrumentation, standard generation and calibration);
- b) sample description:
 - 1) type of product (and brand name if appropriate);
 - 2) sample selection process (e.g. random);
 - 3) product history (date of production, date of arrival to the test laboratory);
- c) test specimen preparation
 - 1) date and time of unpacking and test specimens preparation (hour, day, month and year);
 - 2) method of preparation, including thickness and substrate, including for liquid products the substrate, the amount per unit area, and/or the thickness;
- d) experimental conditions and procedures:
 - 1) chamber conditions (temperature, relative air humidity, air change rate, air velocity);
 - 2) test specimen area and loading ratio;
 - 3) sampling of emitted VOCs (adsorbent used, volume sampled, sampling duration and times after introduction into the chamber);
- e) data analysis:

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

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

Annex A

(normative)

System for quality assurance / quality control

A.1 General

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

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 should contain the necessary information for this portion of the QAPP.

A.3 Data quality objectives/Acceptance criteria

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

A.4 QA/QC Approaches/Activities ^[9]

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

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