

Emission Classification of Building Materials: Protocol for Chemical and Sensory Testing of Building Materials



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The Building Information Foundation RTS, Finland

Finnish Society of Indoor Air and Climate, Finland

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FOREWORD

The Classification of Indoor Climate, Construction, and Finishing Materials was published in 1995 by (FiSIAQ 1995). A new updated version “**Classification of Indoor Climate 2000**” has been published. The classification consists of three parts, **Target values, Design Guidance and Product Requirements**. The Product Requirements is intended to enhance the development and use of low-emitting materials through “*The Emission Classification of Building Materials*“ and clean air-handling equipment through “*The Emission Classification of Air Handling Components*”.

The part “*The Emission Classification of Building Materials*“ of “**The Product Requirements**” is manifested in restricting the total amount of the emissions, eliminating of volatile carcinogens, and minimising the emission of formaldehyde and ammonia, the excess of which has been shown to have caused indoor air quality complaints. It has also been proven, that all pollutants causing deteriorated indoor air quality and irritation cannot be detected by routine, cost effective chemical test methods. Therefore building “*The Emission Classification of Building Materials*“ consists in addition to the chemical emission testing, also of testing the acceptability of the product in sensory terms as this is often how the consumer assesses the quality of the materials.

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1. Definitions, symbols and units

The following definitions, symbols and units are used in this testing protocol:

ageing of the material, controlled ageing, i.e. conditioning of the material at specified climatic conditions.

air exchange rate, ACH [h^{-1}], ratio of the volume of clean air brought into the emission test chamber hourly and the free emission test chamber volume.

air flow rate, [$\text{m}^3 \text{h}^{-1}$], air volume entering into the emission test chamber per unit time.

air velocity, [m s^{-1}], air speed over the surface of the test specimen.

area specific air flow rate, q [$\text{m}^3 \text{h}^{-1}$], ratio between the supply air flow rate and the area of the test specimen.

building material, material produced for incorporation in a permanent manner in construction works, equivalent for building product

building product, product produced for incorporation in a permanent manner in construction works, equivalent for building material

conditioning, synonym to ageing of the test specimen prepared from the material or product sample in the test cell or a special clean space with controlled climate conditions.

emission test chamber enclosure with controlled operational parameters for the determination of volatile compounds emitted from building products.

emission test chamber concentration, C_x , [$\mu\text{g m}^{-3}$], concentration of a specific volatile compound, (or group of volatile organic compounds) measured in the emission test chamber outlet or sampling port.

product loading factor, L , [$\text{m}^2 \text{m}^{-3}$], ratio of exposed surface area of the test specimen and the free emission test chamber volume.

Recovery, percent of 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.

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

sample, part or piece of a building product or material, which is representative of the production.

sample storage, storing the material or product sample before test specimen preparation.

specific emission rate of a VOC, (SE_{VOC}), [$\mu\text{g m}^{-2} \text{h}^{-1}$], product specific emission rate describing the mass of a volatile compound emitted from a material or product at the age of 28 days [t_{28}].

NOTE: Area specific emission rate, SE_a , is used in this testing protocol and in the CEN ENV 13419, Parts 1 and 2. Several other specific emission rates can be defined according to different requirements, e.g. length specific emission rate, SE_l , volume specific emission rate, SE_v , and unit specific emission rate, SE_u .

testing age, the testing age of the material t_{28} , is 28 days. For cleaning agents and conditioners the testing age is t_3 , three days. The age is calculated from the start of the testing at t_0 when the test specimen is prepared and immediately placed into the testing chamber or conditioning space.

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

TVOC, total volatile organic compounds [$\mu\text{g m}^{-3}$], the total amount of volatile organic compounds in the test chamber air determined as detector response (FID or MS) in toluene equivalents eluting between, and including $C_6 - C_{16}$ (n-hexane and n-hexadecane) when sampled on Tenax TA or Tenax GR adsorbent and analysed with a gas chromatograph using a nonpolar or slightly polar capillary column.

TVOC-emission value, SE_{TVOC} , [$\mu\text{g m}^{-2} \text{h}^{-1}$], value calculated from the chamber concentration of TVOC [$\mu\text{g m}^{-3}$].

NOTE:

This testing protocol consists in several chapters of informative text Times New Roman and *the normative text in Italics*.

2. Introduction

When the Classification of Finishing Materials was established in 1995 there existed no comprehensive method for the complete procedure of emission testing except the testing protocol developed for the /JOULE II+ Database project/. This testing protocol had been established by a working group from research establishments, who had former experience in working with material emission testing and the impact of material emissions on indoor air quality. The Joule Database testing protocol and documents in Table 1 have been consulted in drafting the testing protocol for the Classification of Finishing Materials.

Table 1. Reference material for the testing protocol.

Subject	Reference
Chamber operation and testing	(ECA 1997a), ECA (1991), Nordtest (1990), Nordtest (1998a), Nordtest (1998b),
Experience on performing emission measurements	ECA (1993), ECA (1995)
Specimen preparation	ECA (1995)
Sampling of materials and test specimen preparation	Swedish Trade Standard (1992)
Choice and use of adsorbents	NKB (1995), Nordtest (1990)
VOCs, TVOC-value, evaluation of emissions	(ECA 1997b) (ECA 1997a)

Today the chamber techniques are determined by standards:

CEN prEN 13419 Building products - Determination of the emission of volatile organic compounds - Part 1: Emission test chamber method

CEN prEN 13419 Building products - Determination of the emission of volatile organic compounds - Part 2: Emission test cell method

CEN prEN 13419 Building products - Determination of the emission of volatile organic compounds - Part 3: Procedure for sampling, storage and preparation of test specimens

These standards are considered the primary reference documents of emission testing for the classification, unless no other requirement or instruction is given in this testing protocol.

The chemical testing methods of formaldehyde and VOCs from material emission test chambers and indoor air are given in ISO 16000-3:2001 and /ISO 16000-6:2004.

There also exist specific chamber techniques, e.g. Nordtest has a FLEC based method /Nordtest 1998a/ for on-site measurements and a “Climpaq” chamber method for sensory measurements /Nordtest 1998b/. The “Climpaq” type chamber can also be used for chemical measurements if it fulfils the chamber requirements of chemical testing.

The proper understanding and use of the chamber techniques, material sampling and test specimen preparation is crucial of obtaining reliable results. The best proof of quality of the testing laboratory is that the laboratory has accreditation for the test methods involved in the classification procedure or at least has validated the quality e.g. through inter-laboratory comparisons. Such inter-laboratory comparison tests have been carried out by JRC, ISPRA in connection with the European Concerted Action programme /ECA 1993/ and /ECA1995/. The first test /ECA 1993/ contained a method for determination of the sink effect of test chambers and a comparison of emission determination from a solid sample, PVC flooring material and a rapidly decaying source, floor wax. The second interlaboratory comparison /ECA 1995/ consisted of validation of an emission measurement of paint which included the validation of the application of the paint on an inert surface, emission testing

in test chamber with controlled air velocity over the specimen surface and a separate validation of the chemical measurement. Lately an interlaboratory comparison of chamber measurements has been performed in Scandinavia /Nordtest / and one by /GEV /, Germany. These reports should be consulted in each laboratory as a part of the quality assurance program.

From error calculation and previous experience it is likely that results of the chemical measurements will be reproducible as follows:

- ±10% on the same specimen by the same laboratory
- ±20% across specimens within a laboratory
- ±30% across laboratories

NOTE: It has, however, been shown in several interlaboratory comparisons /ECA 1993/, /ECA 1995/, /Nordtest 1999/, /GEV/, that the inhomogeneity of the test specimen can cause unexpectedly big variation in the emission test results. Polar compounds behave unpredictably at the relative humidity defined in the CEN-standards and this testing protocol because of interaction between chamber walls.

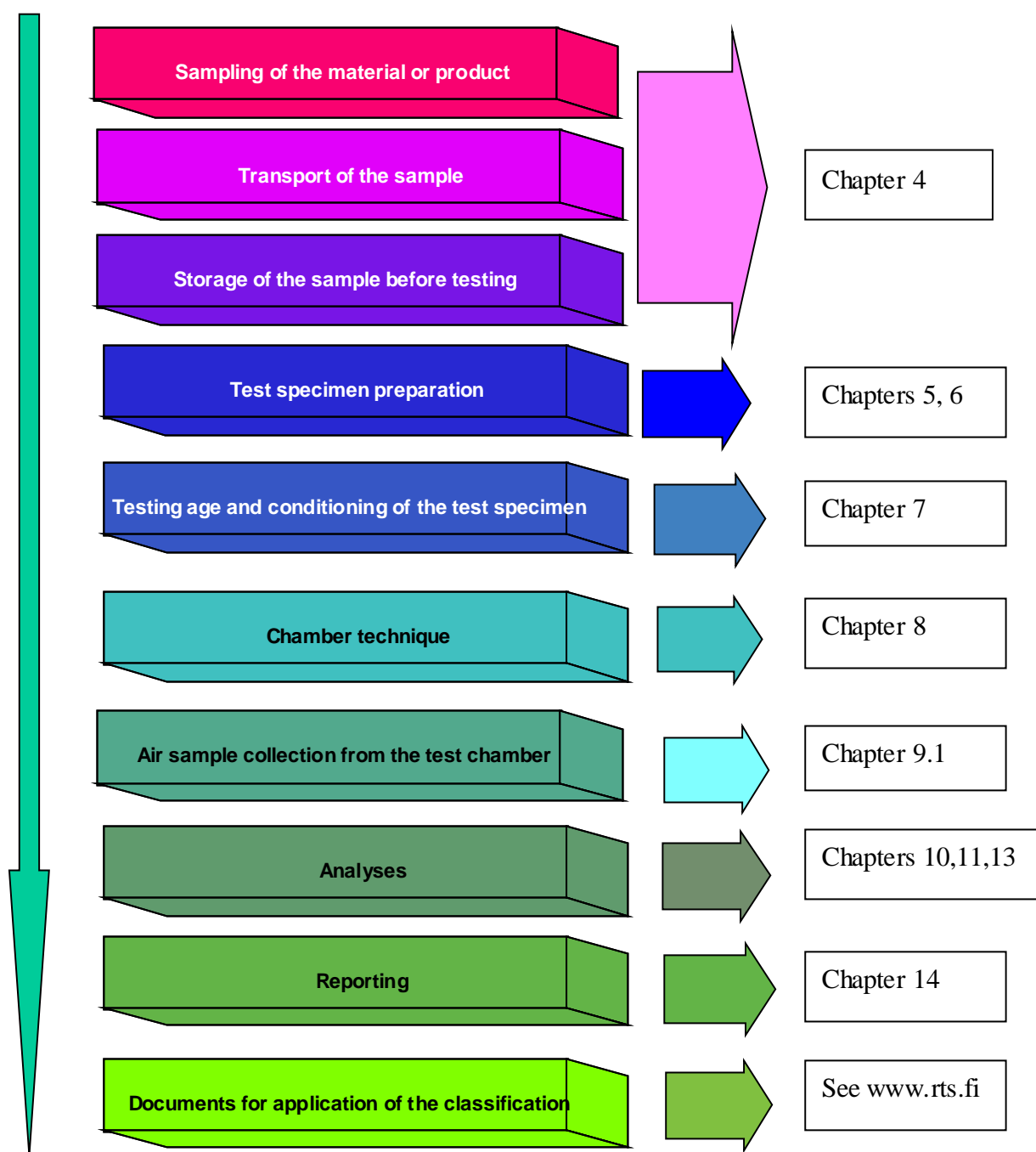
3. Scope

Materials emission mechanisms are complicated and therefore in a testing procedure many assumptions and compromises must be done and defined in the testing protocol in order to ensure the repeatability and comparability of test results. The most important examples of these are the time dependence of the emissions and the effect of substrate material when applying liquid products on different substrates.

The material classification and the emission testing procedure is worked out in a way, so that single material producers can prove the quality of their products. By obtaining a classification for marketing the products directly to customers for home use, or a single product classification can be used in supplying the product to other manufacturers to be used in composite materials combined of several single products. The composite material producer can his turn let the product be tested and classified as composite material.

The main goal of this testing protocol is to ensure comparable, reproducible and reliable emissions test results by different laboratories with proven quality to be used in applying for classification of building materials.

The essential phases of the testing procedure are illustrated in the following flow chart:



The testing protocol covers the testing procedure for the following products:

- Resilient products
- Rigid products
- Liquid products
- Combined materials and building components
- Structures

The testing protocol can also be applied in testing of products other than those described in this testing protocol by mutual agreement of the building product manufacturer and the Building Information Foundation RTS /www.rts.fi/.

4. Sample collection, packaging and storage before testing

4.1. General

The selection of the sample to be tested is essential for obtaining a representative and as homogenous building product sample as possible. The material emission rate is time dependent so that the emission rate decays as a function of time, the decay speed being dependant on material properties and properties of the emitting pollutants. It is therefore important to define the product sampling procedure beginning from taking the product sample from the manufacturer or producer, packaging of the sample, transportation of the sample to storing of the sample in laboratory before starting the emission measurement procedure.

4.2 Selection and packaging of the building product sample

Product samples shall be taken as soon as possible after the normal manufacturing process. Selection of the material or product sample to be tested takes place directly after the production line in the factory. See 4.3 NOTE

NOTE1: If possible the sample shall be taken and packed within 1 h from the normal manufacturing process.

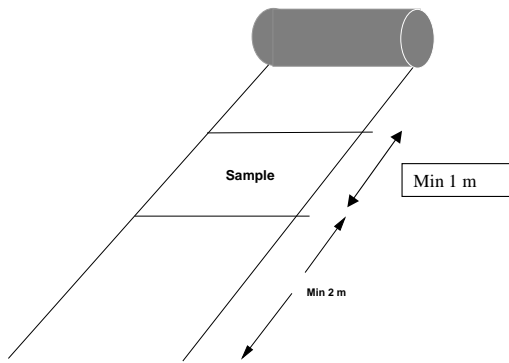
NOTE2: The packed samples shall be sent to the testing laboratory with the shortest possible delay.

NOTE 3. The production date shall be given

It is essential, that the sampled product is homogenous and representative of the production. The sample to be tested shall be packaged in a way so that no essential off gassing of the emissions or contamination occur during the transportation of the sample from factory to the testing laboratory.

4.2.1 Resilient materials

Resilient, soft materials consist commonly of floor coverings and wall coverings. All products delivered to the purchaser packed in a roll can be sampled according to this method. For the homogeneity the product sample to be tested should not be taken from the end or sides of the roll.



A sample of full width is taken from the production line from a position at least 2 m into the roll. The size of the material sample taken from the roll is determined by the size of the test chamber and loading factor (see Clause 8.3).

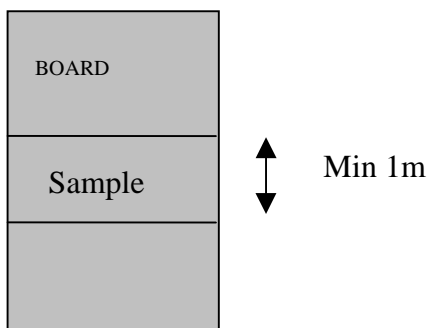
NOTE 1: For the size of the chamber, consult the testing laboratory

After taking the sample it is rolled tightly and wrapped in a tight and inert wrapping e.g. aluminium foil and placed in a polyethylene bag.

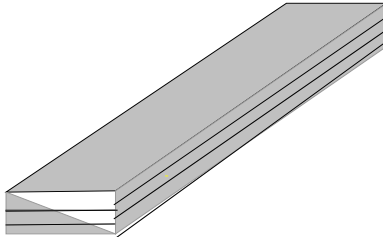
NOTE 2: There is sometimes a need to take the sample from a factory packed customer delivery package.

4.2.2 Rigid products

Materials sold or delivered to the purchasers in hard packages are considered to be rigid materials. Examples of rigid materials are tiles, parquets, laminated floorings, wall construction materials such as chip- and gypsum boards, wood panels, ceiling materials, acoustic panels. See also 4.2.4, Combined materials and structural parts. e.g. doors etc.



Boards are transported in normal manufacturer's delivery packages or in case the original delivery package is unnecessarily big, a sample may be taken from the middle of the board for more convenient transportation. In the latter case the sample is then packed in a tight, inert wrapping of aluminium foil and placed in a polyethylene bag.



Tiles, laminated parquets and other materials assembled from pieces are transported to the laboratory for emission testing in the original package or in case the original delivery package is unnecessarily big, a sample may be taken from the middle of the board for more convenient transportation. In the latter case the sample is then packed in a tight, inert wrapping of aluminium foil and placed in a polyethylene bag.

4.2.3 Liquid products

Liquid samples are products that are supplied to the user in cans, delivered or applied in liquid state. They are supplied to the customer to be applied on site, e.g. in a building or they are supplied to another manufacturer to be used as a component in further building material production (see 4.2.4 Combined materials and building components). Examples of liquid products are e.g. paints, varnishes, oils, and waxes, adhesives, levelling agents and screeds. Concrete is also considered to be a liquid product as it is applied as a viscous product and is undergoing a curing reaction.

Samples of liquid products are delivered to the testing laboratory in original unopened cans or other customer delivery way. Solid materials due to be brought to liquid state at the building site, are delivered to the testing laboratory in their normal delivery packages.

4.2.4 Combined materials and building components

Combined materials are building products that consist of more than one single material. As an example, when a liquid material sample as paint, oil or a wax is applied on an absorbing surface as wood, gypsum etc., the product is considered to become a combined material.

Building components such as doors and windows are examples of combined products consisting of a variety of different materials facing the indoor space.

Products that are applied or assembled on site are delivered to the testing laboratory separately.

Pre-manufactured, combined materials or products, e.g. factory delivered painted, varnished or glued products or building parts as doors and windows, are delivered in their original customer packages or wrapped in air tight inert wrapping.

4.2.5 Structures

When single or combined building materials or products are fixed intimately together to form a structure of a building, they become a system, the emissions of which depend on the chemical and physical interactions between the components and additionally on the humidity present in the structure. The emissions from structures are not the same as those of the single materials.

The emission behaviour of structures can only be mutually compared in test chambers. The real emission behaviour of structures and their impact on indoor air quality can only be tested in complete buildings using a micro-cell /Nordtest 1998a/.

When testing model structures in the laboratory, the products used in the structure shall be sampled as described in 4.2.1. - 4.2.4.

NOTE 1: Structures in real buildings are massive and building specific because they are exposed to the influence of humidity in a way, which is difficult to simulate in small chamber testing. If there is a need to test structures for classification purposes, the Building Information Foundation RTS shall be contacted (www.rts.fi).

4.3 Sample transportation and storage

The sample shall be immediately transported to the testing laboratory under ambient conditions that do not substantially and for a prolonged time differ from the testing conditions regarding especially the temperature (freezing or overheating).

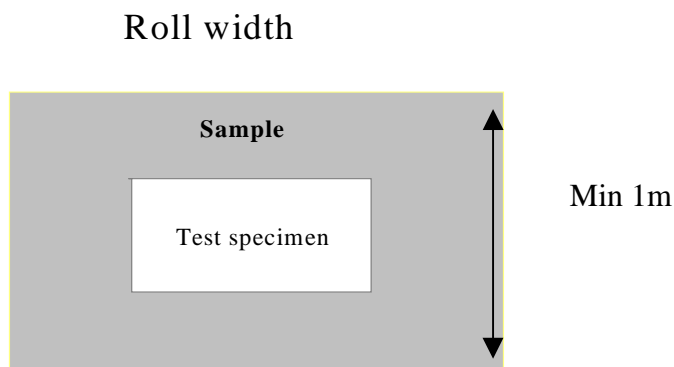
The arrival date of the sample to the testing laboratory shall be reported.

NOTE: If the testing procedure of the sample, which is starting with the four week ageing (clause 7), can not be started immediately after sample arrival to the testing laboratory, the material sample to be tested is stored in the testing laboratory at ambient conditions in the original delivery package if inert and air tight, or the sample is immediately after receiving rewrapped by the testing laboratory personnel in an airtight inert wrapping. The samples are stored for a maximum of three weeks unopened before starting the testing procedure. See 4.2.

5. Test specimen selection from the product sample

It is important, that the test specimen is chosen from the material or product sample to be tested in such a way, that it is as representative of the production as possible and homogenous.

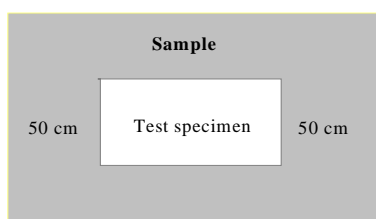
5.1 Resilient materials



Resilient material: The test specimen is taken symmetrically from the middle of the material sample collected from factory or store.

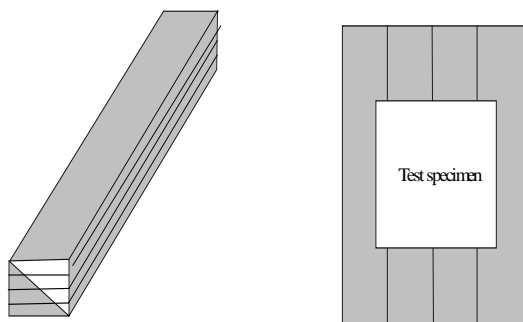
5.2 Rigid materials

5.2.1 Boards



Test specimen from boards is selected excluding a (minimum) 50-cm wide strip at both ends of the board.

5.2.2 Materials consisting of pieces



If the surface to be tested is composed of several pieces as e.g. laminated parquets, the joints in the test specimen shall be symmetrically distributed over the surface of the test specimen. No glue is used in the seams. As an example when parquet/laminate flooring is to be tested, at least two panels are taken from the middle of the package and the tongue and the groove are pushed together without using an adhesive.

5.2.3. Building components

Doors and windows are examples of building components.

It is recommended that building components are tested as such if possible. In other cases the Building Information Foundation RTS shall be contacted (www.rts.fi).

6. Test specimen preparation

The product samples to be tested are cut into an appropriate size to satisfy the requirements of the chamber-loading factor and analytical requirements. See 8.3.

6.1 Resilient and rigid materials

The preparation of the test specimen shall be done without delay after unwrapping the product sample from the storage package in order to prevent excessive ageing the sample in uncontrolled conditions before starting conditioning of the sample.

All exposed cut edges and the reverse sides of building materials are sealed. The backside and the edges of the test specimen are sealed with an aluminium foil using a low emission aluminium tape. A “double” sided specimen can also be prepared, where the backs of two identical specimens are inserted against each other and the cutting edges taped tightly with aluminium tape.

NOTE: See 6.3 Combined materials and products NOTE

6.2 Liquid products

When preparing the test specimen preparation of liquid products the specific curing reactions pay an essential role in the emission behaviour of the product. Therefore the life cycle of liquid products should be understood. After its application a liquid product enters a life cycle, which is normally comprised of three stages:

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

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

6 2.1 Paints, varnishes, primers, cleaning agents and conditioners

6 2.1.1 Classification of the product

The product shall be classified by the dry film thickness recommended by the supplier. The emission test shall then be performed at the specified dry thickness as given for the class in table 2.

Table 2 Classes for dry film thickness, as given in EN 927-1:1996.

Class	Supplier's mean thickness, T_s	Dry film thickness for testing, T_t
minimal	< 5 μm	5 μm
low	5 – 20 μm	15 μm
medium	20 – 60 μm	40 μm
high	> 60 μm	> 60 μm

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

$$T_s = (V / S) \times 10$$

*Where T_s = dry film thickness following recommendations of the supplier, in μm
 V = solid content of the paint in per cent per volume, given by the manufacturer
 S = recommended amount of product in square meters per litre wet product*

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

NOTE 1: The emission testing age of cleaning agents and conditioners is three days.

NOTE 2: For further information concerning cleaning agents and conditioners contact the Building Information Foundation RTS (www.rts.fi).

6 2.1.2 Preparation of the test specimen

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

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

$$P = (T_t \times A \times \delta) / (V \times 100)$$

Where P = the amount of wet product to be applied, in grams

T_t = dry film thickness for testing, in µm, according to table 1

A = painted area in square centimetres

δ = density of wet product in g/cm³ (given by the manufacturer)

V = solid content of the product in volume-% (given by the manufacturer)

The substrate shall be weighed before and after application of the product.

6. 2.2 Adhesives

The product shall be applied on glass or stainless steel.

Mechanically stir the sample until it is homogeneous. Transfer the sample in an excess of minimum 20 % by weight onto a weighed base plate and spread it with a notched spatula B1 completely and uniformly.

Weigh the base plate again and adjust the adhesive weight to 300 ± 50 g/m² by adding more or by removing parts of the sample. The surface shall be structured homogeneously on the whole plate. All this handling shall not take more than 3 minutes.

NOTE: If the test specimen preparation is not successful in the required time, a new one shall be prepared.

6.2.3 Levelling compounds, synthetic resin flooring and plasters

Mix the material according to EN 1937 or EN 13892-1. Place a 3mm thick and uniform layer of the mixture on glass or on stainless steel. Use a border made of glass or stainless steel for low-viscosity levelling compounds. Alternatively an inert mould with a defined size

according to the test chamber can be used. High-viscosity products can be drawn off over a template of 3 mm thickness with a flat spatula.

6.2.4 Screed materials other than 6 2.3 and concrete

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

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

6.2.5 Sealants and fillers

Test specimens shall be prepared in a profile in an inert material with a depth of 3 mm and a width of 10 mm. The length of the test specimen depends on the test chamber/cell (See 8.3 NOTE1). Specific emission rates shall be reported in $\mu\text{g}/\text{m}^2 \cdot \text{h}$.

6.2.6 Sealant foams

On site foamed sealants consist of prepolymer and curing agents packed in a pressurised container. The final product is formed during curing reactions activated by e.g. the humidity of air (polyurethane foams). As the curing is affected by an external component, the emission characteristics depend on penetration of this external reactant the penetration being a function of the film thickness.

*Test specimens of foam sealants are prepared into an U-profile with a height of 40 mm and with of min 15 mm. As example aluminium U-profile 40*20*2*2 mm ($h*b*s*t$) may be used. The length of the test specimen depends on the test chamber/cell (See 8.3).*

6 2.7 Putty

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

6.3 Combined materials and products

Test specimens of combined materials, which are finalised on site, are prepared in the testing laboratory according to the instructions given by the producers of the components. The amount of the liquid product used is determined and reported as described in 6.2.

Premanufactured combined materials or products are tested as delivered from the factory. In cases where the product is too large for inserting into the test chamber, it is cut to representative pieces and the cutting edges are sealed.

If the structure of the product is such, that it consists for a major part of two or more material surfaces, which are exposed to indoor air, or emissions from inner layers are ventilating into indoor air, the surfaces shall be left unsealed. The emissions are calculated according to the area of the single emitting surface i.e. the area facing indoor air.

NOTE: e.g. porous materials, acoustic panels, textile carpets, self-supporting block parquets, or freely floating floors.

6.4 Building components

6.4.1. Doors and windows

In windows and doors the emitting surface is usually the supporting structure e.g. the frame, which is the subject for testing of doors and windows.

NOTE 1: If the doorframe is not included in the normal customer delivery, it is adequate to test the door only.

NOTE 2: “The Classification of Indoor Climate 2000” states, that uncoated brick, stone, ceramic tile, glass and metal surfaces as well as board and log surfaces made of native untreated wood may be used freely, and are therefore not subject for emission testing.

External doors and windows are tested as such with the glass or other material mentioned in NOTE installed. Only the side of the building part e.g. a window or out door facing the indoor space is tested and the rest of the test specimen is covered. The emissions are calculated according to the area of emitting surface facing the indoor air, i.e. the frame and casement area facing the room air. The area of the inert material is omitted from the area calculation.

With internal doors all sides are tested as uncovered and the emission is calculated for the whole emitting area.

6.4.2. Testing of structures in laboratory

Complicated diffusion processes take place and affect the emission from structures assembled of different components. The emission from a structure is not the simple sum of emissions of the single materials of which the structure is assembled. Emissions of structures can be tested in laboratory using test chambers only for comparison purposes but the real emissions and their impact on indoor air quality can only be measured in real buildings.

A test structure for studying the emission behaviour is prepared for chamber testing simulating as much as possible the real structures of a building where the materials to be investigated are going to be used. In assembling the structure, the instructions in chapters 5.1 – 5.2 shall be followed when possible. The edges and the back of the structure are

sealed with impermeable, inert and non-emitting material e.g. aluminium foil, which is adhered to the structure with a non emitting aluminium tape.

NOTE 1: If the dimensions of the structure exceed the loading factor of the chamber, the product shall be tested as such and shall not be cut into small pieces.

NOTE 2: In sensory testing the loading factor can be smaller than required rather than cutting the product or the test product shall be tested in larger chamber

NOTE 3: Check the emission of the aluminium tape and use as little of tape as possible.

NOTE 4: For further information, contact the Building Information Foundation RTS (www.rts.fi).

7 Ageing of the test specimen under controlled conditions

Emissions decrease as a function of time. The rate of decrease depends on the physical and chemical structure of the material to be tested and the temperature relative humidity and air movement in the surrounding microenvironment.

7.1 Testing age

The testing age of the material is four weeks.

NOTE: The testing age of cleaning agents and conditioners is three days.

Counting of the age of the material begins at the moment t_0 when the test specimen is prepared from the product sample according to clause 6. The test specimen is placed in the test chamber for conditioning or into a separate conditioning room immediately after preparation (see Clause 9).

NOTE: The test specimen shall prepared and the testing period started at the latest three weeks after the sample has been obtained from the manufacturer and stored as described in clause 4.3.

7.2 Ageing conditions of the test specimen

The ageing of the test specimen is done under controlled conditions. Conditioning of the specimen during the test period, if not done in the test chamber, shall be done in an acclimatised clean space operated according to the following parameters:

<i>Temperature, T [°C]</i>	<i>23 ± 2</i>
<i>Relative humidity, RH [%]</i>	<i>50 ± 5</i>
<i>Air velocity, v [m/s]</i>	<i>< 0,3</i>

NOTE: The air exchange rate shall be adequate in order to prevent intercontamination of the test specimens.

If the sample has been conditioned outside the test chamber, it shall be placed into the chamber in appropriate time before the actual time point of testing, i.e. before starting the air sampling from the test chamber, in order to allow the chemical equilibrium to settle in the chamber. The time to reach this equilibrium depends on the sink properties of the chamber and of the sample, and the characteristics of the emitting compounds. In the first Inter-laboratory Comparison (ECA 1993) it was in many cases shown to be at least two days.

If the test specimen is conditioned outside the test chamber, it shall be placed in the chamber for at least three days before the measurements.

8. Chamber techniques

8.1 Design of chambers

The basic documents, which shall be used as reference for this testing protocol, when possible, are:

CEN prEN 13419 building products - Determination of the emission of volatile organic compounds - Part 1: Emission test chamber method.

and

CEN prEN 13419 Building products - Determination of the emission of volatile organic compounds - Part 2: Emission test cell method.

NOTE 1: CEN prEN 13419 Part 2: Emission test cell method is applicable only when the test specimen emission is measured from non-porous smooth single material surface, or with other types of materials the sub unit shall be used.

Emission testing in small chambers is also described in the ECA Guideline /ECA1991/, Nordtest Method /Nordtest 1990/ and ECA /ECA1997/.

NOTE 2. These guidelines or methods shall only be used as descriptive information. The method given in this testing protocol overrules anything given in the above references when it differs from these.

There also exist special chamber constructions, e.g. the CLIMPAQ /Nordtest 1998b/, which is originally designed for sensory measurements. It can also be used in chemical

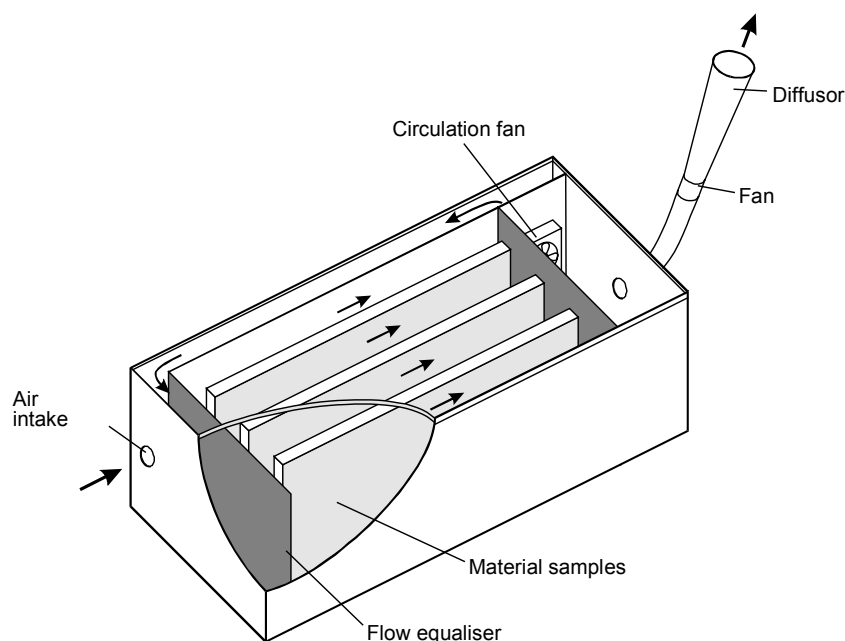
emission measurements if equipped with controlled air exchange apparatus and operated so that it fulfils the same requirements as the chemical test chambers.

The construction and operation of test chamber shall be such that the conditions of measurement can be controlled and the quantity of pollutants measured. The chamber shall be constructed and maintained to satisfy the following criteria:

- *Chamber walls are made of low emitting and low adsorbing materials; polished stainless steel or glass is recommended as chamber wall material.*
- *Exposed surfaces of caulks and adhesives should be as small as possible and ideally neither emit nor adsorb VOCs. Teflon covered sealants are preferred.*
- *The average recovery of toluene and n-dodecane shall be better than 80%*
- *The air in the chamber must be effectively mixed*
- *Clean air shall be supplied to the chamber so that the air exchange rate is better than $\pm 3\%$ of the set value.*
- *The chamber shall be tight. In chemical test chambers the air flow leakage shall be less than 0.1 % of the chamber volume per minute at an overpressure of 1000 Pa*
or
- *The air leakage shall be less than 1% of the supply air rate. In a sensory testing chamber the air leakage shall not exceed 10% of the supply air rate.*

In sensory testing the test chamber outlet air is delivered to the panellists through a diffuser at an airflow rate of 0.9 l/s. This ensures that the subject inhales air only from the test chamber and not from the surroundings. The opening angle of the diffuser should not be more than 8° because at this angle the surrounding air will not yet be sucked into the diffuser at the outlet.

Example of a sensory testing chamber is shown below:



8.2 Cleaning and Preparation

In order to ensure that the measured emissions come from the materials being tested and not the chamber itself, the chamber must be cleaned and checked for cleanliness.

Chambers are cleaned by wiping with e.g. ethanol followed by scrubbing the inner surfaces with an alkaline detergent, rinsing with tap water, final rinse with deionised water and then dried in air. Sometimes it may be necessary to use a stronger solvent or heat in cleaning the chamber. The background emission of the chamber is monitored before loading the sample by running the empty chamber including supporting devices under the test conditions and taking chemical samples by the same method as will be used in the test.

The requirement to the background concentration is that the concentration of TVOC < 20 µg/m³ and the concentration of single VOC < 2 µg/m³. At this stage any supporting materials, which will be used, shall be in the chamber.

The mean acceptability vote of the empty sensory test chamber shall be at least 0.5.

8.3 Material loading

The emission test chamber concentration depends on the area specific airflow rate, which is selected as a parameter in designing the emission test conditions. In many European countries the minimum floor area of a room is 7 m², the room height 2,4 – 2,5 m and the air exchange rate is 0,5 h⁻¹. This is considered to be a model room.

The relationship between the airflow rate, test specimen area, loading factor and air change rate is:

$$q = \frac{Q}{A} = \frac{n}{L}$$

where

q = area specific airflow rate	[m ³ h ⁻¹ m ⁻²]
Q = airflow rate	[m ³ h ⁻¹]
A = area of surface	[m ²]
n = air exchange rate	[h ⁻¹]
L = loading factor	[m ² m ⁻³]

The above calculation result to loading factors and area specific airflow rates given in the following table 3:

Table 3 Examples of area specific airflow rates (in a model room)

Model room ^{a)} Area of surfaces, A	Loading factor L [m ² m ⁻³]	Area specific air flow rate, $\frac{q}{m^3/(m^2 \cdot h)}$ or n/L
17,4 m ³ , n = 0,5 h ⁻¹ a):		
Floor / ceiling area = 7 m ² a)	0.42	1,3
Wall area = 24 m ² a)	1.41	0,4
Sealant area = 0,2 m ² a)	0.012	44
(Jointing mortar)	0.012	44
Window frames, area 0,2 m ² b)	0.12	4.2
Door area = 2 m ² b)		

a) /Danish Standard/INF 90./

b) /Nordtest 1990/

NOTE 1: If the concentrations in the chamber air do not reach the detection limit of the analytical method, the chamber loading factor can be increased keeping the set air exchange rate constant. (See: 6.2.5 Sealants and fillers)

NOTE 2: *In sensory testing, the requirements of the air flow rate of 0.9 l/s shall be taken into account in planning the test specimen area in the sensory testing chamber /Nordtest 1998 b/.*

When the supply airflow rate in the CLIMPAQ is kept at 0.9 l/s to enable sensory testing /Nordtest 1998b/, the specimen areas required for different types of materials are as shown in Table 4. As an air exchange rate of 1 h⁻¹ would result in too much material in the CLIMPAQ in the case of testing wall material, an air exchange rate of 2 h⁻¹ has been chosen for the example.

Table 4 The specimen areas required for different types of materials

Material type	Model room	CLIMPAQ			
	air exchange rate of 2 h ⁻¹				
	Area specific flow rate q=nL [m ³ *h ⁻¹ *m ⁻²]	Supply air flow rate, Q, [l*s ⁻¹]	Area of test specimens A=A _{ts} *x [m ²]	Number x	Test specimen Dimensions l*h [m*m]
Floor/ceiling	4.76	0.9	0.68	6	0.57*0.2
Wall	1.42	0.9	2.28	16	0.71*0.20
Door	16.7	0.9	0.19	2	0.48*0.20
Sealants	167	0.9	0.019	3	0.63*0.01
Window frames	167	0.9	0.019	3	0.63*0.01

NOTE 3: Using a bigger sensory testing chamber a lower air exchange rate can be chosen.

where n= air exchange rate [h⁻¹],
and L= loading factor [m²/m³]

NOTE 4: In sensory testing the area specific flow rate q shall not be changed.

8.4 Chamber operation

For the purpose of producing comparable and usable data for the database, standard values for the chamber operating parameters have been chosen as given in the following table 5:

Table 5 Environmental conditions for test.

<i>parameter</i>	<i>controlled value</i>
<i>temperature</i>	23°C ±2°
<i>relative humidity</i>	50% ± 5%
<i>air velocity near the specimen</i>	≈ 0.1-0.3 m/s
<i>Air exchange rate, chemical testing</i>	±3%
<i>Air exchange rate, sensory testing</i>	±10%

The temperature can be maintained by placing the entire chamber in a temperature-controlled room, or temperature controlled test chamber. The relative humidity of the air supplied to the chamber is maintained using deionised water. Temperature and humidity sensors should be located inside the chamber at least 50mm from the inside wall and mid-way between the air inlet and outlet ports. The air speed over the specimen is attained by directing the air into the chamber over the specimen surface, or by a small fan. The air speed is measured 1 cm above the specimen. In practice it may be difficult to obtain a uniform air velocity over the entire specimen. In such cases it is recommended to perform the measurement of air velocity in the middle of the specimen. A heated sphere anemometer (e.g. Dantech 54R10) is suitable for measuring air speeds of the order 0.1 m/s.

9. Emission testing

The test specimen prepared according to section 6 is placed in the chamber. The test specimen should be positioned in the test chamber so that the emitting surface is parallel to the direction of the airflow (in particular if a fan is installed) and in such a way that the airflow is evenly distributed over the emitting surface.

The materials are tested at the age of:

$$t_{28d} = 28 \text{ days} \pm 2 \text{ days}$$

The cleaning agents and conditioners are tested at the age of:

$$t_3 = 3 \text{ days} \pm 2 \text{ hours}$$

NOTE 1: For information concerning cleaning agents and conditioners contact the Building Information Foundation RTS (www.rts.fi).

NOTE 2: If the material, or product is conditioned in a separate conditioning space outside the testing chamber, it shall be transferred to the testing chamber at least two days before the testing time t_{28} or t_3 (See clause 7).

9.1 Air sampling from test chamber

The exhaust flow, or a special sampling outlet, is used as the sampling port. In sensory testing there is requirement for the air exhaust rate from the diffuser cone of a special design described in 8.1. The sampling system shall be inert and at the same temperature as the test chamber. Sampling techniques and times must be appropriate to the concentrations of compounds in the chamber air stream and the measurement equipment range.

10. Chemical measurements

Chemical measurements include the determination of the TVOC-value, single VOC-, formaldehyde- and ammonia emissions from the materials.

10.1 TVOC

The TVOC value is defined to be the integrated detector response value in toluene equivalents of compounds eluting between and including C6 to C16as given in ISO 16000-6:2004.

NOTE: If any compounds are detected outside this range, they shall be quantified (toluene equivalents, e.g.) and reported.

10.1.1 VOCs sampling technique

The VOC determination method should be valid for the measurement of VOCs in a concentration range of at least 2 µg/m³ to 1 mg/m³. The upper limit of the measurement method is set by the composition of the sampled gas, sampling conditions, and the dynamic range of the analytical system. The lower limit of detection (and quantification) depends on the blank levels of analyte on the sorbent tube, and on the performance capability of the analytical system.

The essential points in VOC sampling are:

- *Use Tenax TA or Tenax GR 60/80 mesh absorbent preferably at least 200 mg per tube*
- *Condition newly prepared tubes 280-300°C, at least 2 hours, 20-100ml/min inert gas*
- *Store sealed tubes at ambient room temperature*
- *Recondition tubes before use at 260-280°C for 5 minutes*
- *Use sampling flow rate 50-100 ml/min (±3%)*
- *Sampling volume 1-5 litres*
- *Store exposed tubes in an emission free container at ambient room temperature*
- *Analyse the samples within 4 weeks*

The Tenax tube analysis follows the pattern:

- *thermal desorption at a temperature of 250 - 280°C*
- *desorption time 4 - 20 minutes*
- *suitable non-polar or weakly polar capillary column GC to separate individual VOCs*
- *gas chromatograph equipped with FID or MSD*

At least three parallel or subsequent samples shall be taken from the chamber air to determine the VOC concentration.

10.1.2 VOC analysis

VOCs are thermally desorbed from the sampling tubes. A suitable non-polar or weakly polar capillary column and operating conditions are selected to separate the individual VOCs. The detectors most often used for VOC analysis are the flame ionisation detector (FID), and the mass selective detector (MSD). The overall sensitivity of the analytical system for, e.g., toluene should be at the level of 1 - 5 ng using GC-FID (signal to noise 5:1).

TVOC is calculated from the GC-FID chromatogram or GC-MSD total ion chromatogram converting the total area of the chromatogram from n-hexane to n-hexadecane into equivalents of toluene.

Appropriate analytical methods or MSD is used to identify the individual compounds. The concentration of a single identified compound is determined either from the GC-FID chromatogram or GC-MSD total ion chromatogram using toluene response factor. With GC-MSD also SIM-technique can be used to analyse the compounds given in Appendix A

The analytical system is calibrated using loaded samples prepared either by injecting aliquots of standard solution into clean sorbent tubes or sampling from controlled standard atmospheres. At least a three-point calibration must be made to determine the linearity and response factor.

10.2 Determination of formaldehyde and other aldehydes

Formaldehyde can be determined by EN 717-1 or formaldehyde together with other aldehydes with DNPH-method using high performance liquid chromatography (HPLC) according to ISO 16000-3:2001.

In ISO 16000-3:2001 aldehydes are sampled onto cartridges containing silica gel coated with 2,4-dinitrophenylhydrazine (DNPH). Carbonyl compounds form stable derivatives with the DNPH reagent. The DNPH derivatives are analysed using high performance liquid chromatography (HPLC) and ultraviolet absorption. The method is suitable for determination of formaldehyde and other aldehydes in the concentration range of 1 µg/m³ to 1 mg/m³.

The essential points in aldehyde sampling are:

- *Use pre-coated DNPH silica gel cartridges containing at least 350 mg of silica gel with a minimum DNPH loading of 0,29 % mass fraction*
- *Use sampling flow rate 0,5 - 1,2 l/min (±3%)*
- *Safe sampling volumes must be evaluated on the basis of the expected concentration of aldehydes in the chamber air. Sample size should not exceed 75 % of the DNPH mass loading of the cartridge (100 - 200 µg as HCHO)*
- *Refrigerate the exposed sample cartridges until analysis*
- *Analyse the samples within 30 days*

The aldehyde analysis follows the pattern:

- *sample desorption with acetonitrile*
- *analysis of DNPH derivatives with HPLC*
- *column: C18 reverse phase*
- *mobile phase: acetonitrile/water*
- *detector: ultraviolet, at 360 nm*

In addition to formaldehyde at least following carbonyl compounds can be determined by optimising chromatographic conditions:

acetaldehyde, benzaldehyde, propionaldehyde, butyraldehyde, crotonaldehyde, valeraldehyde, isovaleraldehyde, 2,5-dimethylbenzaldehyde, o-tolualdehyde, m-tolualdehyde, p-tolualdehyde, hexanal and acetone.

10.2.1 Aldehyde analysis

Aldehydes sampled onto DNPH coated sampling cartridge, are desorbed by passing e.g. 5 ml of acetonitrile through the cartridge. The sample is analysed using high performance liquid chromatograph equipped with C18 reverse phase column and ultraviolet detector at 360 nm. As mobile phase acetonitrile/water is used. Formaldehyde and other carbonyl compounds in the sample are identified and quantified by comparison of their retention times and peak heights or peak areas with those of standard solutions.

Standard solutions of known concentration are prepared as follows:

- *DNPH is purified by multiple recrystallisations in UV-grade acetonitrile*
- *An approximately saturated solution of DNPH in HCl (2 mol/l) is prepared*
- *Add molar excess of carbonyl compound into the solution*
- *Filter the DNPH derivative precipitate, wash it and let it dry*
- *Check the purity of the derivative by melting point determination or HPLC analysis*
- *Prepare standard stock solution of the DNPH derivative by dissolving accurately weighed amounts in acetonitrile*
- *Prepare a working standard mix from the standard stock solution*

At least five-point calibration shall be used. Using the UV detector, a linear response range of approximately 0,05 µg/ml to 20 µg/ml should be achieved for 25 µl injection volumes.

10.3. Determination of ammonia

Ammonia is sampled from chamber air by absorbing it in dilute sulphuric acid using impinger technique. The samples are analysed with ammonia specific electrode or spectrophotometrically. The method is suitable for determination of ammonia in the concentration range of 5 µg/m³ to several mg/m³.

The essential points in ammonia sampling are:

- *Use dilute (0,005 mol/l) sulphuric acid*
- *Use sampling flow rate 1 - 4 l/min (±3%) depending on the impinger construction*
- *Use sampling volumes of 100 litres of chamber air per each 10 ml absorption solution*
- *Analyse the samples within two weeks*

10.3.1. Ammonia analysis

10.3.1.1 Ion specific electrode

The ammonia dissolved in the acidic sampling solution is analysed using ammonia specific electrode. The ammonia electrode responds to the partial pressure of dissolved ammonia

gas. Ammonia gas is released at the analysis stage by adding sodium hydroxide into the sample (pH >11) just before measurement.

- *Prepare calibration solutions, use e.g. ammonium chloride standards or nitrogen equivalent standards*
- *Calibrate the analytical instrument using at least three point calibration*
- *Analyse the samples*
- *Plot calibration curve using semilogarithmic scale*
- *Determine the amount of analyte in the samples*
- *Calculate the amount of ammonia in the chamber air*

Volatile amines interfere with ammonia electrode measurements.

10.3.1.2 Spectrophotometric

Analysis is made according to SFS 3032.

11. Calculation of specific emission rate, SER

The specific emission rate, SER is calculated from the measured chamber concentrations C by the following equation (steady state condition).

$$\text{SER} = [C] \times n \times V_c / A = [C] \times n / L \quad [\text{mg}/(\text{m}^2 \times \text{h})]$$

where

$[C]$ =	mean value of the measured chamber concentrations of a single compound $[\text{mg}/\text{m}^3]$
n =	air exchange rate $[\text{h}^{-1}]$
V_c =	chamber volume $[\text{m}^3]$
A =	emitting surface area of test specimen $[\text{m}^2]$
L =	loading factor $[\text{m}^2/\text{m}^3]$.

12. Quality assurance

The testing laboratory shall have an accreditation on the emission measurement techniques described in this testing protocol, or its testing procedure shall be validated by other means, e.g. interlaboratory comparison with a certificate of an acceptable performance. The technical board gives acceptance of the testing laboratories.

13. Sensory testing of building materials

Sensory testing of material emissions is a complementary method to chemical testing in detection of emissions as the sensitivity of human nose is in many cases better than instrumental methods. Moreover it is one of the methods with which consumers experiences the quality of materials. The purpose of the sensory testing of building materials is to enhance the development and use of building materials with low odour emissions in order to improve indoor air quality.

A sensory panel assesses the odour emissions of a building material and the results, together with the results of chemical measurements, determine the classification of the building material. *The acceptability of the empty test chamber shall fulfil the requirement for the acceptability of 0.8 before the sensory tests are commenced (see 8.2). The acceptability of the testing room air shall fulfil the requirement for the acceptability of 0.5 before the sensory test can be accepted.* The empty chamber acceptability is determined as a blind analysis with the same panel used in the determination of the sample.

13.1 Overview of the test procedure

Sensory characterisation of material emissions is carried out using a two-phase sensory test. The sensory assessments are commenced with a naïve sensory panel of at least five members. If the mean acceptability vote of the panel falls outside a certain range determined in chapter 13.4, no further sensory testing is needed and the building material belongs either to emission class M1 or M3.

If the mean acceptability vote of the panel falls within this certain range, the sensory test shall be repeated with at least ten more naïve subjects in order to reach a higher accuracy of the evaluation determining the sensory emission class. In this case, the mean acceptability vote is calculated using the values given by all fifteen evaluators each giving two votes. Thus the acceptability calculation is based on 30 evaluations of which the arithmetic mean is calculated.

13.2 Sensory assessment with an untrained panel

13.2.1 Instructions for the panel

The panel assesses the acceptability of the air exhausted from the test chamber. The members of the untrained panel will be instructed to

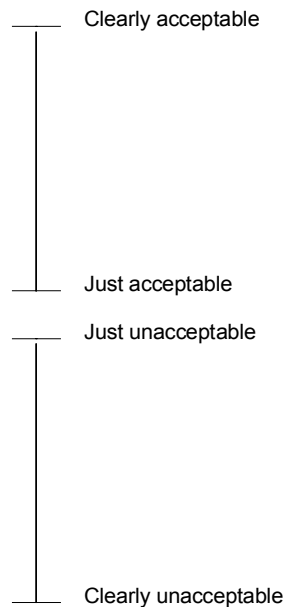
- *refrain from eating garlic on the day before sensory assessments*
- *take a shower in the morning of the assessment day and refrain from using strong-smelling cosmetic products*
- *wear odourless clothes (no leather jackets etc.)*
- *abstain from drinking coffee and smoking between sensory assessments and an hour before they begin*

*The subjects shall be carefully instructed in how to use the evaluation form so that it is filled in correctly (see **Appendix**). Figure 2 shows that the form has continuous acceptability scales for the marking of the evaluation of the air sample. The subject shall first decide whether the air sample is acceptable or unacceptable and then rate the degree of acceptability. No marks are allowed between just acceptable and just unacceptable.*

Imagine that you during your daily work would be exposed to the air from the test chamber?

How acceptable is the air quality?

Please mark on the scale and notice the distinction between acceptable and unacceptable:



Continuous acceptability scale slightly modified from /Gunnarsen and Fanger 1992/.

The evaluation form (see APPENDIX) also includes a column with odour descriptions. The subject is asked to choose the characteristics which best describe the odour of the air sample. This information is valuable for the tracing of the source of odour if there are some problems with the test arrangements and for the controlling of the performance of the sensory panel.

13.2.2 Sensory evaluation procedure

The sensory evaluation is commenced assessing the background acceptability of the empty test chamber (see 8.2) including the test specimen supports. When the required acceptability of minimum 0.5 is reached, the test specimen is placed into the chamber.

NOTE: The acceptability of the room air quality where the sensory evaluation is performed, shall fulfil the same acceptability requirement 0.5 as the test chamber.

The test specimens are placed in the chamber so that their emitting surface is parallel to the direction of the airflow, which shall be evenly distributed over the emitting surface (see 8.1). The test specimens shall be conditioned for two days in the test chamber before performing the sensory evaluation (see 7.2).

First, the subjects will be asked to assess the immediate perception of the air of the test room. The subject must tick either the box marked acceptable or the box marked unacceptable in the upper right-hand corner of the evaluation form. If 20 % or more of the subjects consider the air of the test room unacceptable, the subsequent sensory measurements shall be rejected and repeated when the acceptability of test room is reached.

Next, the subject shall wait in the test room for at least two minutes before the first evaluation. The air exhausted from the test chamber will be delivered to the subjects through a diffuser at an airflow rate of 0.9 l/s. The subjects will be asked to place their nose slightly inside the diffuser, and after waiting for a moment, to make two or three inhalations before making the assessment. The result is ticked on the left side evaluation colons of the evaluation form in APPENDIX. This assessing procedure is repeated after a two-minute pause and the result is ticked on the right hand column in APPENDIX.

Panel members are asked to mark their evaluation of the acceptability of the air sample on the continuous acceptability scale immediately after each exposure. Note that the same evaluation form is used for the assessment of both the test room air and the air exhausted from the test chamber. This is because the sensory panel is not allowed to know what it is assessing. Only two subjects may be in the test room at a time. The members of the panel shall not discuss their evaluations with each other during the sensory measurements.

13.2.3 Size of the panel

The sensory testing may be commenced with a panel of five naive subjects. If the panel acceptability vote of this falls between -0.4 and $+0.4$ (see 13.3 and 13.4) a second round of sensory testing with a panel of at least ten more members shall be done within one day.

13.3 Calculation of acceptability

Each scale will be divided into nine equal segments. Each segment is numbered so that clearly acceptable is given the numerical value $+1$ and just acceptable is given the value $+0.1$. Correspondingly, clearly unacceptable is given the value -1 and just unacceptable is given the value -0.1 . The accuracy of the values is 0.05.

Because the subjects assess the air sample twice, with a panel of five members ten numerical values are obtained from the sensory measurements. The arithmetical mean of the values is calculated, and the mean acceptability vote is presented with an accuracy of one decimal and compared to the emission classes of building materials. If the result of the five-member panel does not fall between -0.4 and $+0.4$, the evaluation shall be repeated with at least ten more members resulting altogether to thirty numerical evaluation values of which the arithmetical mean is calculated. The acceptability vote of the supply air is calculated in the same way. If the value of the test room air is ≥ 0.5 , the results of the sensory measurements are acceptable. If the value is < 0.5 , the odour source of the test room shall be removed, and the sensory measurements shall be repeated within one day.

14. Reporting of results

The test report shall include the following:

Request: (Company)

Order: (Person, date)

Assignment: Emission measurements for the emission classification of building materials

Product/Test specimen

Product type	
Product name	
Production date (by the manufacturer)	
Sending date (by the manufacturer)	
Description of packaging and transport	
Product received at the testing laboratory, date	
Test specimen preparation/Deviation from protocol	
Test period started, date	
Conditions during ageing [C°] [RH%]	
Emission sampling, date	

Chamber technique (example):

TVOC, VOC, formaldehyde, ammonia	Chamber Volume	Air change rate	Temperature °C	RH %	test specimen area or loading factor
Sample 1					
Sample 2					
...					

Sensory evaluation	Chamber Volume	Supply air flow-rate	Temperature °C	RH %	test specimen area or loading factor
Sample 1					
Sample 2					
...					

Emission sampling and analytical methods

	Standard or own validated method	Adsorbent / Absorbent	Sampling volume [l]	Quantification / Analysis method	Detection limit of the method used
VOC*	ISO 16000-6:2004				
Formaldehyde*	EN 717-1 or <u>ISO 16000-3:2001</u>				
Ammonia					
Sensory evaluation	The number of the evaluators				

* Report if deviation from standard

Results: Specific emission rates, SER

	TVOC	Formaldehyde	Ammonia	Carcinogens between C ₆ -C ₁₆ SER > 0,002 mg/(m ² h)	Sensory evaluation
	mg/(m ² h) as toluene equivalents between C ₆ -C ₁₆	mg/(m ² h)	mg/(m ² h)	mg/(m ² h) as toluene equivalents or MS quantification	Average of acceptability
Sample 1					
Sample 2					
...					

Single VOCs C₆-C₁₆ the emission of which exceed 0,005 mg/(m² h) as toluene equivalent

RT	Compound	CAS	Sample 1	Sample 2	Sample ...
		TVOC			
		Identified			
		Identification-%			

Single VOCs outside the frame C₆-C₁₆ the emission of which exceed 0,005 mg/(m² h) as toluene equivalent (example)

RT	Compound	CAS	Sample 1	Sample 2	Sample ...

Measurement uncertainty

Give the uncertainty of the testing procedure including all steps from material or product sampling to final results.

SER_{TVOC} ±...%

SER_{NH3} ±...%

SER_{Formaldehyde} ±...%

References

Appendices Chromatogram

References

ECA (1991), European Concerted Action "Indoor Air Quality and Its Impact on Man". Guideline for the Characterisation of Volatile Organic Compounds Emitted from Indoor Materials and Products Using Small Chambers. Report No 8 (EUR 13593 EN). Luxembourg: Office for Official Publications of the European Communities.

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Appendix A (informative)

Examples of compounds detected in indoor air and from building products in test chambers

Examples of compounds detected in indoor air and emitting from building products in test chambers.

Chemical compound	CAS No.	Boiling Point [°C]
AROMATIC HYDROCARBONS		
Benzene	71-43-2	80
Toluene	108-88-3	111
Ethylbenzene	100-41-4	136
m/p-Xylene	108-38-3/106-42-3	139/138
o-Xylene	95-47-6	144
Isopropylbenzene	98-82-8	152
1-Propenylbenzene	637-50-3	175
n-Propylbenzene	103-65-1	159
1,2,4-Trimethylbenzene	95-63-6	169
1,3,5-Trimethylbenzene	108-67-8	165
1,2,3-Trimethylbenzene	526-73-8	176
1,2,4,5-Tetramethylbenzene	95-93-2	197
1-Methyl-2-propylbenzene	1074-17-5	
1-Methyl-3-propylbenzene	1074-43-7	175
n-Butylbenzene	104-51-8	183
1,3-Diisopropyl benzene	99-62-7	203
1,4-Diisopropyl benzene	100-18-5	203
2-Phenyl octane	777-22-0	123
5-Phenyl decane	4537-11-5	
5-Phenyl undecane	4537-15-9	
Ethylbenzene	536-74-3	
o-Methylstyrene	611-15-4	171
m/p-Methylstyrene	100-80-1/622-97-9	168/169
a-Methylstyrene	98-83-9	165
2-Ethyltoluene	611-14-3	165
Styrene	100-42-5	145
Naphthalene	91-20-3	218
4-Phenylcyclohexene	4994-16-5	251 ^{a)}
^{a)} value of 1-phenylcyclohexene		
ALIPHATIC HYDROCARBONS		
n-C ₆ to n-C ₁₆		
n-Hexane	110-54-3	69
2-Methylhexane	591-76-4	90
3-Methylhexane	589-34-4	92
n-Heptane	142-82-5	98
n-Octane	111-65-9	125

Chemical compound	CAS No.	Boiling Point [°C]
n-Nonane	111-84-2	151
2-Methyloctane	3221-61-2	143
3-Methyloctane	2216-33-3	143
2-Methylnonane	871-83-0	167
3,5-Dimethyloctane	15869-93-9	159
n-Decane	124-18-5	174
2,4,6-Trimethyloctane	62016-37-9	
4-Methyldecane	2847-72-5	189
n-Undecane	1120-21-4	196
Isododecane	31807-55-3	216
4,5-Diethylnonane		
2,2,4,6,6-Pentamethylheptane	13475-82-6	178
n-Dodecane	112-40-3	216
n-Tridecane	629-50-5	235
n-Tetradecane	629-59-4	254
n-Pentadecane	629-62-9	271
n-Hexadecane	544-76-3	287
2-Methylpentane	107-83-5	60 ^{c)}
3-Methylpentane	96-14-0	63 ^{c)}
1-Octene	111-66-0	121
1-Decene	872-05-9	171
CYCLOALKANES		
Methylcyclopentane	96-37-7	72
Cyclohexane	110-82-7	81
1,4-Dimethylcyclohexane	589-90-2	124
1-Methyl-4-methylethylcyclohexane (cis/trans)	6069-98-3 / 1678-82-6	
Methylcyclohexane	108-87-2	101
TERPENES		
3-Carene	13466-78-9	167
α -Pinene	80-56-8	156
Camphene	79-92-5	158
β -Pinene	18172-67-3	164
Longifolene	475-20-7	254
α -Cedrene	469-61-4	262
Turpentine	8006-64-2	
β -Caryophyllene	87-44-5	129
Limonene	138-86-3	176
ALCOHOLS		
1-Propanol	71-23-8	97
2-Propanol	67-63-0	82
2-Methyl-2-propanol	75-65-0	82

Chemical compound	CAS No.	Boiling Point [°C]
2-Methyl-1-propanol	78-83-1	108
1-Butanol	71-36-3	118
1-Pentanol	71-41-0	137
1-Hexanol	111-27-3	158
Cyclohexanol	108-93-0	161
1-Octanol	111-87-5	194
2-Ethyl-1-hexanol	104-76-7	182
Phenol	108-95-2	182
Texanol® (2,2,4-trimethyl-1,3-pentanediol) isobutyrate	25265-77-4	244
BHT (2,6-di-tert-butyl-4-methyl phenol)	128-37-0	265
GLYCOLS/GLYCOLETERS		
Propylene glycol	57-55-6	189
Dimethoxymethane	109-87-5	42 ^{c)}
Dimethoxyethane	110-71-4	85
Diethylenglycol-n-monobutyl-ether; 2-(2-butoxyethoxy)-ethanol	112-34-5	230
2-Methoxyethanol	109-86-4	125
2-Ethoxyethanol	110-80-5	135
2-Butoxyethanol	111-76-2	171
1-Methoxy-2-propanol	107-98-2	118
2-Butoxyethoxyethanol	112-34-5	231
2-Phenoxyethanol	122-99-6	245
3-Phenyl-1-propanol	6180-61-6	
ALDEHYDES		
Acetaldehyde	75-07-0	21 ^{c)}
Propanal	123-38-6	49 ^{c)}
Butanal	123-72-8	76
Pentanal	110-62-3	103
Hexanal	66-25-1	129
Heptanal	111-71-7	153
2-Ethyl-hexanal	123-05-7	163
Decanal	112-31-2	208
2-Pentenal	1576-87-0	115-125
2-Heptenal(cis/trans)	57266-86-1/18829-55-5	90 to 91 at 50 mm Hg
2-Nonenal	2463-53-8	100 to 102 at 16 mm Hg
2-Decenal	2497-25-8	
2-Undecenal	1337-83-3	
Octanal	124-13-0	171
2-Butenal	123-73-9	104
2-Furancarboxaldehyde	98-01-1	162

Chemical compound	CAS No.	Boiling Point [°C]
Nonanal	124-19-6	190
Benzaldehyde	100-52-7	179
KETONES		
Acetone	67-64-1	56 ^{c)}
2-Butanone	78-93-3	80
3-Methyl-2-butanone	563-80-4	95
4-methyl-2-pentanone	108-10-1	117
Cyclopentanone	120-92-3	130
2-Methylcyclohexanone	583-60-8	163
Methylethylketone	78-93-3	80
Methylisobutylketone	108-10-1	118
2-Methylcyclopentanone	1120-72-5	139
Cyclohexanone	108-94-1	155
Acetophenone	98-86-2	202
HALOCARBONS		
Dichloromethane	75-09-2	40 ^{c)}
Carbon tetrachloride	56-23-5	76
1,2-Dichloroethane	107-06-2	84
Trichloroethene	79-01-6	87
Tetrachloroethene	127-18-4	121
1,1,1-Trichloroethane	71-55-6	74
1,4-Dichlorobenzene	106-46-7	173
ACIDS		
Acetic acid	64-19-7	118
Propanoic acid	79-09-4	141
Isobutyric acid	79-31-2	153
Butyric acid	107-92-6	163
2,2-Dimethylpropanoic acid	75-98-9	164
Pentanoic acid	109-52-4	186
Heptanoic acid	111-14-8	223
Octanoic acid	124-07-2	240
Hexadecanoic acid	57-10-3	350
Hexanoic acid	142-62-1	202
ESTERS		
Vinyl acetate	108-05-4	72 ^{c)}
Butyl formate	592-84-7	107
Isobutyl acetate	110-19-0	118
Ethyl acetate	141-78-6	77
Propyl acetate	109-60-4	102
Butyl acetate	123-86-4	126
Isopropyl acetate	108-21-4	90
2-Methoxyethyl acetate	110-49-6	145

Chemical compound	CAS No.	Boiling Point [°C]
2-Ethoxyethyl acetate	111-15-9	156
2-Ethylhexyl acetate	103-09-3	198
Linalool acetate	115-95-7	220
Methacrylic acid methyl ester	80-62-6	100
TXIB (2,2,4-Trimethylpentanediol diisobutyrate)	6846-50-0	
PHTHALATES		
Dimethyl phthalate	131-11-3	284
Dibutyl phthalate	84-74-2	340
Alkyl phthalates		
OTHER		
1,4-Dioxane	123-91-1	101
1-Methyl-2-pyrrolidinone	872-50-4	202
Caprolactam	105-60-2	267
Indene	95-13-6	182
2-Pentylfuran	3777-69-3	>120
THF (Tetrahydrofuran)	109-99-9	67 ^{c)}
<p>c) compounds with boiling point below °C (C₆) are not retained quantitatively by Tenax TA.</p> <p>NOTE 1 Safe sampling volumes for organic vapours are given in Annex B.</p> <p>NOTE 2 When analysing VOCs eluting before n-hexane complementary sorbents given in ISO 16017:2000 can be used.</p>		