The Building Information Foundation RTS sr

M1 emission classification of building materials: Protocol for chemical and sensory testing of building materials

Version 18.6.2024
Replaces version 15.11.2017

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This testing protocol was approved for publication by the principal committee Indoor environment (PT 41) on 28 March 2024. This document was published and implemented on 18 June 2024.

1 Emission classification of building materials

The Emission classification of building materials, commonly referred as the M1 emission classification, is part of a larger voluntary system, Classification of indoor environment (Sisäilmastoluokitus) [1] published by the Finnish Society of Indoor Air and Climate (Sisäilmayhdistys ry). The Classification of indoor environment was first introduced in 1995 and it has since been updated several times, 2018 version being the latest. The Classification of indoor environment is intended to be used by the construction and building design sector and in associated contracting, as well as by the building material industry, when designing and building healthier and more comfortable buildings.

The voluntary Emission classification is owned by non-profit organisation The Building Information Foundation RTS sr (Rakennustietosäätiö RTS sr) and the classification is operated by RTS's subsidiary Rakennustieto Oy. The Emission classification as well as the whole Classification of indoor environment is overseen by principal committee Indoor environment (PT 41) appointed by RTS. The multidiscipline committee consists of professionals representing research, industry, and public sector. Classification decisions are done by an impartial classification committee.

Emission classification and its requirements for building products are meant to enhance the development and use of low-emitting materials so that better indoor air quality can be achieved. While the limit values of the Emission classification are based on science and research, they are not health-based and should not be used to evaluate health hazards. For more information about the Emission classification, please see the Emission classification's website [2].

Contact details for the Emission classification:

Rakennustieto Oy
Malminkatu 16 A
00100 Helsinki, FINLAND
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2 Scope, criteria, and process of the Emission classification

The Emission classification can be applied for building materials, fixtures, non-upholstered furniture, and upholstered office chairs. Emission classification includes requirements for:

- total volatile organic compound (TVOC) emission
- emissions of volatile CMR compounds (category Carc. 1A and Carc. 1B) [3]
- emissions of volatile organic compounds on the EU-LCI list [4]
- formaldehyde emission
- ammonia emission
- acceptability of odour

Full list of the emission class criteria can be found on the Emission classification's website [2]. If a product does not meet the criteria of emission class M1, also emission class M2 is available.

The requirements of emission testing procedure for the Emission classification are presented in this testing protocol. This testing protocol is based on standards EN 16516, ISO 16000-9, and ISO 16000-11. Only emission tests performed according to this testing protocol in an approved testing laboratory are accepted when applying for the Emission classification. List of approved testing laboratories is published on the Emission classification's website [2].

No product is allowed to be marketed as M1- or M2-classified if it has not been tested according to this testing protocol, accepted to the emission class M1 or M2 by the classification committee, and has a valid certificate issued by Rakennustieto. Summary of the application process is illustrated in Figure 1. For more information on how to apply for the Emission classification, please see the Emission classification's website [2].

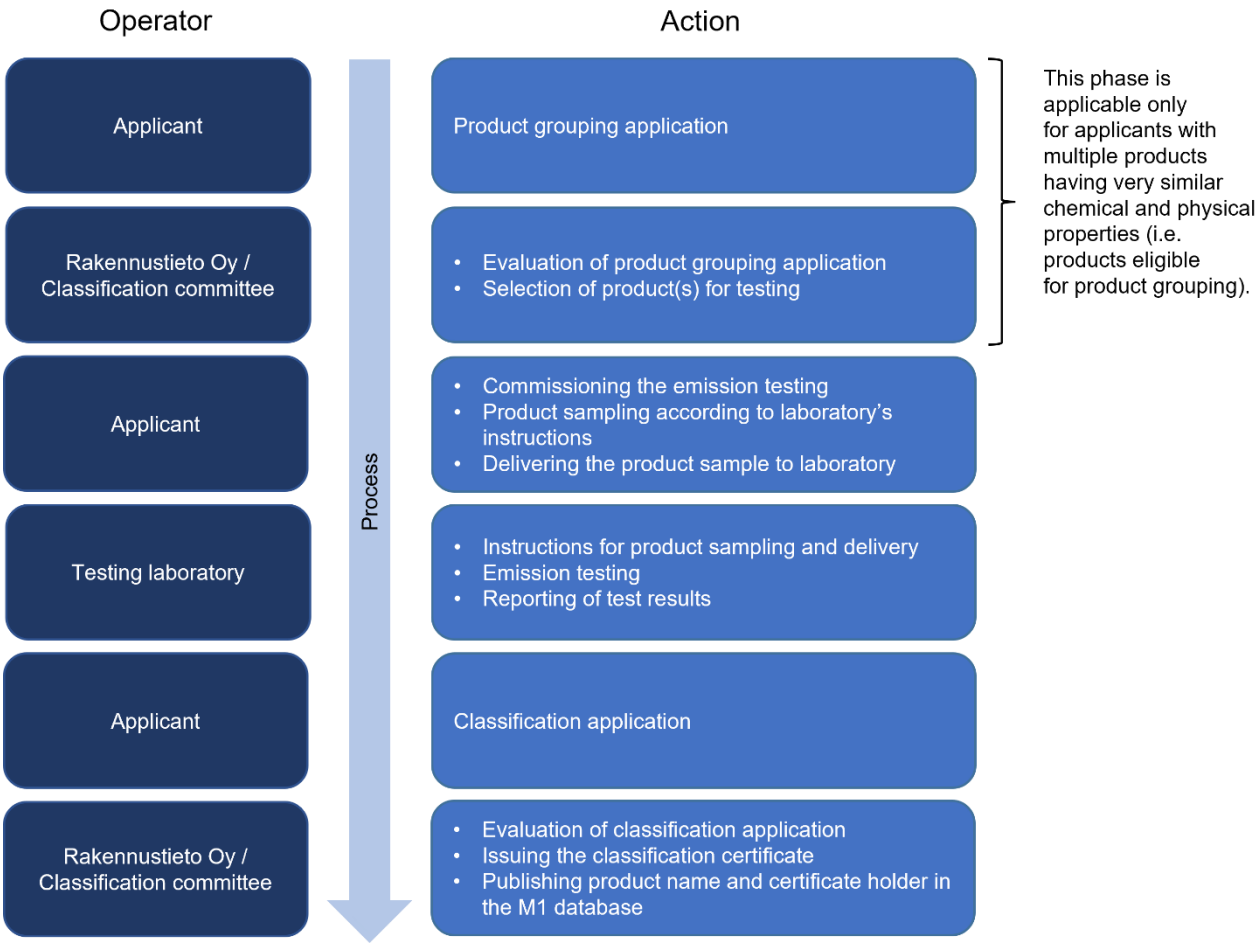


Figure 1. Summary of the Emission classification process. For more details of the process, see Emission classification's website [2].

Product grouping of chemically and physically similar products is possible in the Emission classification system. Product groups are formed prior to testing by the classification committee based on the proposal submitted by the company applying for the classification. When evaluating the product group, the committee decides

which product(s) should be tested as group representative. For more information on product grouping, please see the Emission classification's website [2].

3 References

The following documents, in whole or in part, are normatively referenced in this testing protocol and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. For informative references, see section 9 Bibliography. In the event of any conflict between the reference document and this testing protocol, the information given in this testing protocol has precedence.

EN 16516 Construction products: Assessment of release of dangerous substances – Determination of emissions into indoor air

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

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

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

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

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

4 Terms and definitions

For the purposes of this testing protocol, terms and definitions given in EN 16516, ISO 16000-6, and ISO 16000-9 and the following apply. In the event of any conflict between the reference document and this testing protocol, the definition given in this testing protocol has precedence. In this testing protocol comma (,) is used as decimal separator.

Product group
Products with very similar physical and chemical properties can form a product group. Different dimensions of a product with identical chemical composition are not considered to be a product group rather than variations of the same product.

Semi-volatile organic compound, SVOC
Organic compounds eluting after n-hexadecane (C_{16}) and up to and including n-docosane (C_{22}) on the gas chromatographic column specified as a 5 % phenyl / 95 % methyl polysiloxane capillary column, excluding all compounds listed in Annex G of EN 16516, which are considered to be VOCs even if they elute after n-hexadecane under the specific analytical conditions.

Target compound
Compound for which the test result is compared with a compound specific limit value. In this testing protocol these are compounds listed in the Agreed EU-LCI values list [4], CMR compounds (category Carc. 1A and Carc. 1B) [3], formaldehyde, and ammonia.

Testing age
The age of the test specimen at the point of emission sampling is 28 ± 3 days (counting from the moment the test specimen is finished, see 6.1) for building materials, fixtures, and non-upholstered furniture. Testing age for upholstered chairs is 3 days.

Total semi-volatile organic compounds, TSVOC
Sum of the concentrations of the identified and unidentified semi-volatile organic compounds, as defined above, calculated using the TIC response factor for toluene (i.e. as toluene equivalent) after subtracting the blank values, and after excluding compounds with reference room concentration < 5 µg/m³ and all compounds listed in Annex G of EN 16516.

Total volatile organic compounds, TVOC
Sum of the concentrations of the identified and unidentified volatile organic compounds, as defined below, calculated using the TIC response factor for toluene (i.e. as toluene equivalent) after subtracting the blank values, and after excluding compounds with reference room concentration < 5 µg/m³. All compounds listed in Annex G of EN 16516 are included in TVOC even if they elute before n-hexane or after n-hexadecane under the specific analytical conditions.

Very volatile organic compound, VVOC
Organic compounds eluting before n-hexane (C_6) on the gas chromatographic column specified as a 5 % phenyl / 95 % methyl polysiloxane capillary column, excluding all compounds listed in Annex G of EN 16516, which are considered to be VOCs even if they elute before n-hexane under the specific analytical conditions.

Volatile organic compound, VOC
Organic compounds eluting between and including n-hexane (C_6) and n-hexadecane (C_{16}) on the gas chromatographic column specified as a 5 % phenyl / 95 % methyl polysiloxane capillary column, including all compounds listed in Annex G of EN 16516, which are considered to be VOCs even if they elute before n-hexane or after n-hexadecane under the specific analytical conditions.

5 Product sampling, sample packing and delivery to testing laboratory

Sampling of the product is an important step in emission testing procedure for obtaining a representative material sample for testing. The responsibility of product sampling lies on the party applying for the Emission classification. The sample shall be collected according to this document and to instructions given by the testing laboratory. If sampling instructions in this protocol cannot be applied, Rakennustieto shall be contacted for further instructions prior to sampling.

5.1 Sampling location and maximum age of the product sample

Product sample delivered to testing laboratory shall always be as recently produced as possible. Product sample shall be collected at the production line or production storage after the normal manufacturing process as soon as the material is ready for delivery. If sampling at the production site is not possible, product sample may be collected during the delivery phase within 8 weeks of manufacturing, provided that the product has been stored in an airtight packaging under normal climate conditions since production. Canned and other airtightly packed liquid products (e.g. paints and sealants) can be sampled at any point after production as long as the best before date of the product is valid for the whole testing period.

5.2 Packing and delivery of the product sample to the testing laboratory

To protect the product sample from contamination and to store the sample during transportation, product sample shall be packed in an airtight, emission free and inert packaging immediately after sampling. Additional protective packaging might be needed to protect the integrity of the sample during transport. Products delivered in impermeable retail packages (e.g. cans) may be delivered as such as long as they are sufficiently protected during transport. Samples damaged during delivery phase and/or delivered inadequately packed shall not be used for emission testing. If multiple products are sent for testing, different product samples shall be packed separately to avoid cross-contamination.

The product sample shall be delivered to the testing laboratory without delay and the sample shall not be exposed to excessive temperature fluctuations (freezing or overheating) during transportation. The product sample shall arrive to the laboratory within 14 days of sampling. Any deviations from this shall be reported in the test report.

5.3 Product sample information

A sampling report shall be delivered to the testing laboratory together with the product sample. In the sampling report the following information shall be given:

- manufacturer of the product
- product name
- product type
- date of production, batch number
- date of assembly (furniture)
- sampling location
- date of sampling
- amount of product sampled
- storage of product before sampling
- description of the applied sampling procedure
- person responsible for sampling

The sampling report shall be attached to the test report. An example of a sampling report is given in Appendix 1 of this testing protocol.

5.4 Product sampling instructions

Instructions how to sample different product types are presented in sections 5.4.1–5.4.4. The list of product types might not be comprehensive and in unclear situations Rakennustieto shall be consulted for further instructions prior to sampling. Needed sample amount is determined by the testing laboratory. During sampling, all necessary precautions to avoid contamination of the product sample shall be taken. Products with identical chemical composition but varying thickness (e.g. building boards): if not otherwise instructed by Rakennustieto, the thickest product variant must be sampled and sent for testing.

5.4.1 Resilient materials and rolled products

Examples of product types:

- resilient floor and wall coverings
- building membranes and tapes
- wallpapers
- soft thermal insulation products (in rolls)

a) Unopened retail package(s) is sampled for testing when available.

b) Sub-sampling from large and/or heavy rolls (e.g. PVC flooring), see Figure 2:
   - discard at least two outer layers of the roll
   - cut at least 1-metre sample of full roll width
   - immediately roll the sample tightly and wrap in an airtight and inert wrapping
   - describe the sub-sampling procedure in the sampling report

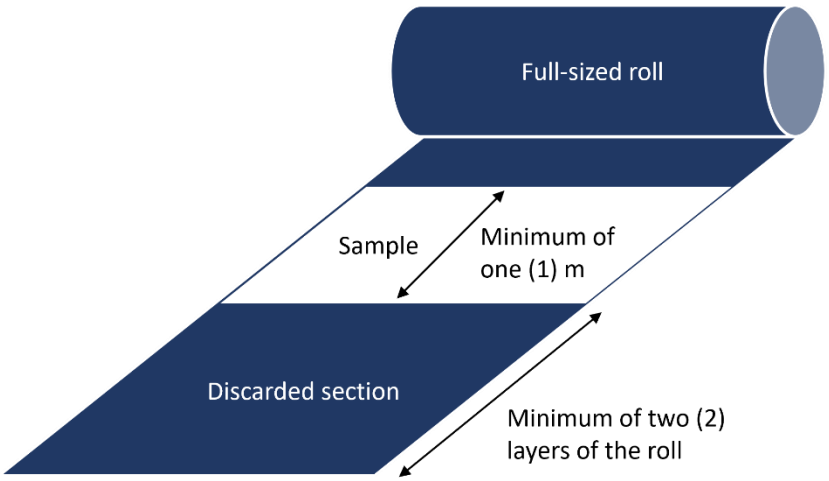


Figure 2. Sub-sampling from a large roll of resilient material.

5.4.2 Rigid materials

Examples of product types:

- parquets, laminates, floorboards and tiles
- wall and ceiling panels
- building boards
- thermal insulation boards and slabs
- building blocks, bricks and tiles

a) Unopened retail package(s) is sampled for testing when available.

b) Building blocks, bricks, and corresponding piece products are sampled as full pieces at production line. Storage sampling is possible only if product has been stored in airtight wrapping since production. Sample shall be packed in an inert and airtight packaging immediately after sampling.

c) Storage sampling of boards delivered in large pallets shall be directed to boards in the middle of the pallet. Storage sampling is possible only if product has been stored in airtight wrapping since production. Sample shall be packed in an inert and airtight packaging immediately after sampling.

d) Sub-sampling from large building boards or slabs, see Figure 3:
   - cut at least 1-metre sample of full board width from the middle of the board
   - immediately wrap the sample in an airtight and inert wrapping
   - describe the sub-sampling procedure in the sampling report

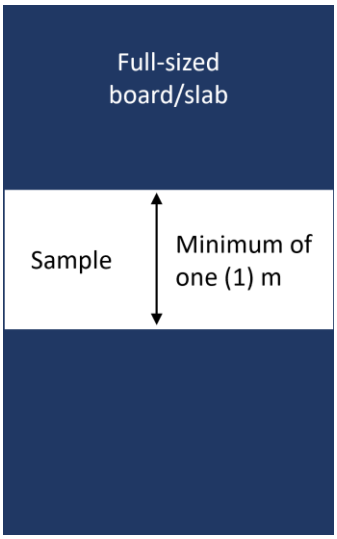


Figure 3. Sub-sampling from a large board or slab.

5.4.3 Liquid products, powders, and concrete

Examples of product types:

- paints, varnishes, and other liquid applied coatings
- adhesives
- plasters, screeds, and other products sold as powders
- ready-mixed concrete
- putties and sealants

a) Unopened retail package(s) is sampled for testing when available.

b) Sub-sampling from large bulk units:
   - take a representative sub-sample into a clean, inert, airtight, and closable container
   - describe the sub-sampling procedure in the sampling report

c) Concrete is delivered to the testing laboratory pre-mixed by the manufacturer or test specimens are prepared at the mixing site and delivered to the laboratory wrapped in airtight packaging.

5.4.4 Fixtures, furniture, doors, windows, partition walls, and other factory-made building components and elements

Fixtures, non-upholstered furniture, upholstered office chairs, and building components (e.g. doors, windows, and partition walls) are sampled as whole units. Sampling shall take place at the manufacturing site as soon as possible after the production, when the product is ready to be delivered to the customer. The product sample shall be packed in an inert and airtight packaging immediately after sampling. For testing purposes, the size of the product may need scaling. If the product sample is a scaled version of the original, the original proportions of the product shall be maintained.

6 Emission testing

Emission tests are performed using a ventilated test chamber according to EN 16516 and ISO 16000-9. Sampling and analysis of volatile organic compounds is carried out according to EN 16516 and ISO 16000-6, sampling and analysis of formaldehyde and other short-chained aldehydes according to EN 16516 and ISO 16000-3, and sampling and analysis of ammonia according to EN 16516 using a suitable validated method based on documents such as OSHA ID-188 or ISO 7150-1. Determining the acceptability of the emissions in sensory terms is carried out according to ISO 16000-28 or NT Build 482 using CLIMPAQ. Test specimen preparation is based on ISO 16000-11 and harmonised product standards.

6.1 Handling of product samples in the laboratory and time schedule of the testing

Samples damaged during delivery phase and/or delivered inadequately packed shall not be used for emission testing. The product sample is stored in its original unopened, airtight delivery package in a contamination-free zone under normal room conditions in the laboratory until initiating the emission testing period.

The maximum allowed age of a product sample at the point of initiating the testing period is 12 weeks provided that the sample has been collected and delivered according to this protocol (see Clause 5) and stored in an inert, airtight package under normal climate conditions. Age of canned and other airtightly packed liquid products (e.g. paints and sealants) when initiating the testing period can be over 12 weeks as long as the best before date of the product is valid for the whole testing period.

6.2 Loading factors and reference room

Products are tested in their main intended use category applying the largest surface and loading factor of the possible surfaces (e.g. paint applicable for both walls and ceiling is tested using wall loading). The area specific air flow rates (q) and loading factors (L) given in Table 1 are used in emission testing of building materials for the Emission classification. The values are based on the reference room (see Figure 4) defined in EN 16516, having total volume (V) of 30 m³ (3 m x 4 m, height 2,5 m) and air change rate (n) of 0,5 h^{-1}. Area specific air flow rates for sensory evaluation using CLIMPAQ-type chamber [5] with outlet air flows and air change rate of 2 h^{-1} in the reference room are also given in Table 1.

Table 1. Loading factors (L) [m²/m³], and area specific air flow rates (q) [m³/(m²h)] used in emission testing for the M1. Volume of the reference room is 30 m³. q is calculated by dividing air change rate (n) with L.

Surface / testing scenario	**Area (*A*)** [m²]	**Chemical testing and sensory assessment (ISO 16000-28)** air change rate (n) = 0,5 h^{-1}		**Sensory assessment (NT Build 482)** air change rate (n) = 2 h^{-1} outlet air flow = 0,6–0,9 dm³/s
		loading factor (L) [m²/m³]	area specific air flow rate (q) [m³/(m²h)]	area specific air flow rate (q) [m³/(m²h)]
Floor / ceiling	12	0,4	1,25	5
Wall	31,4	1	0,50	2
Small area	2	0,05	10	40
Very small area	0,2	0,007	71	286

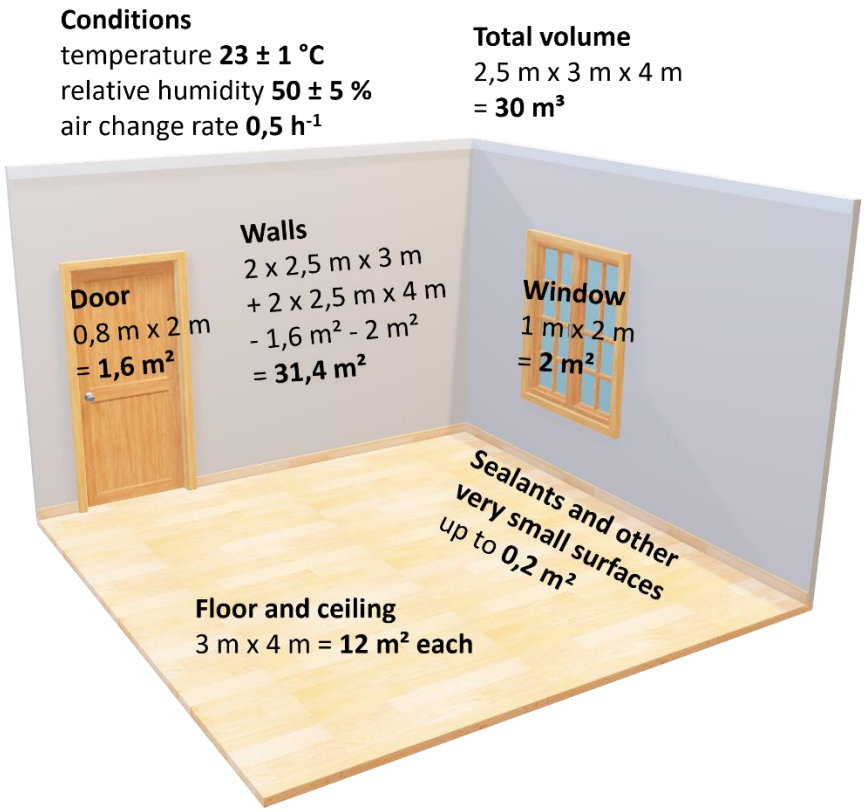


Figure 4. Reference room used in M1 testing (based on EN 16516).

Higher loading factor in chemical testing may be used to increase the reliability of the test results within the limits given in EN 16516. In case of large products both *n* and *L* can be varied within limits given in EN 16516 to achieve the specified *q*. Reference room concentrations are recalculated to n = 0,5 h^{-1} and *L* specified in Table 1. Both the *L* and *n* used in the testing, and the *L* and *n* used in the calculation of reference room concentrations shall be reported in the test report.

In some instances testing of a product requires the test specimen to take up more than 30 % of the test chamber volume and/or loading factor to be > 2,0 m^2/m^3. If this cannot be avoided, the exception and a short reasoning for it shall be documented in the test report. Mixing and flow of air in the chamber shall always be taken into consideration.

The number of furniture and items placed in the reference room is presented in Table 2. In case of large products both *n* and *L* can be varied within limits given in EN 16516 to achieve the *q* given in Table 2. Reference room concentrations are recalculated to n = 0,5 h^{-1} and *L* specified in Table 2. Both the *L* and *n* used in the testing, and the *L* and *n* used in the calculation of reference room concentrations shall be reported in the test report.

Table 2. Number of furniture and fixtures in a reference room of 30 m³ (n = 0,5 h-1) with loading factors (L) [m²/m³] and area specific air flow rates (q) [m³/(m²h)] used in emission testing for the M1. Also, example surface areas (A) [m²] of the items are given.

Item	Number of items in reference room	Area (*A*) [m²]	Loading factor (*L*) [m²/m³]	Area specific air flow rate (*q*) [m³/(m²h)]
Table / desk / conference table (80 x 140 cm)	1	1,1	0,05	10
Shelf / cabinet (180 x 80 x 40 cm)	1	1,4	0,05	10
Drawer / chest of drawers (60 x 40 x 50 cm)	1	0,24	0,007	71
Chair (non-upholstered)	4	-	0,13 [items/m³]	4 [m³/(items*h)]
Upholstered office chair	1	-	0,03 [items/m³]	17 [m³/(items*h)]
Mirror cabinet and bathroom fixture (70 x 60 x 20/50 cm)	1	0,42	0,007	71
Wall bars (200 x 70 cm)	1	1,4	0,05	10
Fixture cabinet (70 x 60 x 30/60 cm)	14	5,9	0,25	2
Fixture cabinet doors (70 x 60 cm)	14	5,9	0,25	2
Fixture countertop (300 x 60 cm)	1	1,8	0,05	10
Noticeboards, decorative acoustic boards, and screens	1	7,5	0,25	2

6.3 Test specimen preparation

The primary references for test specimen preparation are ISO 16000-11 and harmonized product standards. In the event of any conflict between reference documents and this testing protocol, the information given in this testing protocol has precedence. In unclear situations regarding test specimen preparation, Rakennustieto shall be consulted for further instructions.

Test specimens are prepared by the testing laboratory. Test specimen(s) may be prepared outside of the laboratory according to the instructions from the testing laboratory if the test specimen preparation requires special equipment, special instrumentation or special conditioning or curing methods (e.g. UV-curing, 2-part mixing equipment for glues) that cannot be required being a part of equipment in a material emission testing laboratory. Test specimen(s) prepared outside the testing laboratory shall be transported to the testing laboratory without delay. Both the drying time (if the test specimen requires drying period prior to delivery to the testing laboratory) and delivery time is included in the 28 ± 3-day test period (e.g. if the test specimen was dried for 1 day before it was packed for transport and the delivery to the laboratory took 3 days, emission samples shall be sampled minimum 1 day earlier than normal to be within 28 ± 3 days). Timepoint when the

test specimen was prepared, drying time(s), drying conditions, and timepoint when the test specimen was packed and delivered to the testing laboratory shall be reported.

If test specimen is prepared outside of the testing laboratory preparation shall be documented and reported using a test specimen preparation report. This document should include details of the test specimen preparation such as substrate(s), application amount(s), application method(s), wet layer thickness(es), drying time(s), and conditions during preparation. The preparation report shall be attached to the test report. An example of a test specimen preparation report is given in Appendix 2 of this testing protocol.

Products undergoing curing reactions with the substrate shall be tested using a product specific substrate. Test results shall be evaluated considering the emissions from the untreated substrate and possible secondary emissions from the substrate cannot be excluded. Selection of the substrate is done in agreement with Rakennustieto before the test period is started.

Products not suitable for non-absorbing surfaces (e.g. due to effects on the drying process or film thickness homogeneity) shall be tested using a product specific substrate. Absorbing substrate may be used only if the unsuitability of the non-absorbing surface has been demonstrated. Test results shall be evaluated considering the emissions from the untreated substrate and possible secondary emissions from the substrate cannot be excluded.

6.3.1 Materials used in test specimen preparation

Materials and products used in test specimen preparation shall be inert and non-emitting. If necessary, emission tests of materials or products used for test specimen preparation shall be carried out prior to using them. Typical materials used for test specimen preparation:

- sealing of edges and reverse side
  - aluminium foil and low-emitting aluminium tape
  - inert, airtight metal frame
- substrates for liquid applied products
  - glass
  - stainless steel
  - polyester

6.3.2 Resilient materials and rolled products

Examples of product types covered by this section:

- resilient floor coverings
- resilient wall coverings
- wallpaper
- building membranes
- HPL (thickness ≤ 2 mm)
- tapes used for construction

Test specimen is cut symmetrically from the middle of the product sample excluding minimum 10 cm, as far as feasible, from factory-finished edges (see Figure 5). From a roll, test specimen is cut after discarding at least two outer layers of the roll. Reverse side and edges of the test specimen are sealed. Dimensions of the unsealed primary surface are used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- thickness of the product
- material(s) and technique(s) used for sealing
- test specimen area

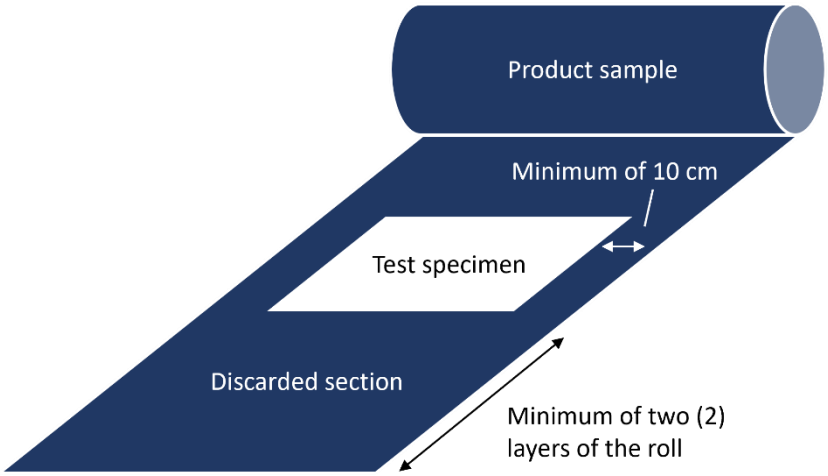


Figure 5. Cutting of a test specimen from a roll of resilient material.

Exceptions:

- resilient floor tiles and planks (e.g. textile tiles): test specimen preparation is carried out as instructed in 6.3.3 under heading Surface materials including joints
- tapes: test specimen is cut from a roll after discarding at least two outer layers and attached onto a glass substrate; in reporting the thickness of the product is replaced with the width

6.3.3 Rigid materials, panels, and boards

Examples of product types covered by this section:

- parquets, laminates, vinyl tiles, planks, and other floorboards
- wall boards and panels
- ceiling boards and panels
- building boards
- boards used for furniture manufacturing

Test specimen preparation of rigid products is carried out according to Table 3. From stacked product samples top and bottom pieces are discarded prior to test specimen preparation. Products are tested in their main intended use category applying the largest loading factor of the possible surfaces, for exceptions see Table 3Table 3. Test specimen preparation shall be documented in the test report and shall include information specified in Table 3.

If chemically identical product is manufactured in multiple thicknesses (e.g. gypsum boards), the thickest version shall be tested. If the use scenario of the thickest version differs significantly from the use scenario of the other thicknesses (e.g. thickest version is only used as beams and the rest of the thicknesses as wall or floorboards) the different thicknesses shall be separated into different product groups and both product groups shall be tested, unless otherwise instructed by the Rakennustieto. In unclear situations Rakennustieto shall be consulted prior to testing.

Table 3. Test specimen preparation and reporting instructions for rigid products.

Product type	Test specimen preparation	Information reported in the test report
Building boards, boards used for furniture manufacturing and beams		
• Building boards for construction (e.g. gypsum board) • Boards used for interior surfaces (without mechanically fastened joints)	• Test specimen is cut from the middle of the board, excluding minimum of 10 cm from the sample sides (see Figure 6) • Reverse side and edges are sealed • Unsealed primary surface is used to calculate the test specimen area • If a board can be used as both wall board and suspended ceiling, it shall be tested as suspended ceiling • If a board can be used as both construction board and for furniture manufacturing, it shall be tested as board for furniture manufacturing	• Thickness of the board • Material(s) and technique(s) used for sealing • Area of the test specimen
• Boards used for furniture manufacturing (e.g. melamine faced chipboard) • High pressure laminate (HPL), thickness > 2 mm	• Test specimen is cut from the middle of the board, excluding minimum of 10 cm from the sample sides (see Figure 6) • Both faces are left unsealed. Cut edges are partly sealed: ratio of open (unsealed) edges (U) and surface area of the test specimen (A) shall be 1,5 m/m² (U/A = 1,5 m/m²) • Only the primary surface of the test specimen is used to calculate the test specimen area • Boards used for furniture manufacturing are tested using area specific air flow rate (q) 2 m³/(m²h) (i.e. L = 0,25 m²/m³)	• Thickness of the board • Material(s) and technique(s) used for sealing • U/A • Area of the test specimen
• Building beams	• Test specimen is cut from the middle of the beam, excluding minimum of 10 cm from the sample ends (see Figure 7) • All faces are left unsealed. Cut ends of the test specimen are sealed • Unsealed surfaces are used to calculate the test specimen area • Beams are a small surface (L = 0,05 m²/m³)	• Width and thickness of the beam • Material(s) and technique(s) used for sealing • Area of the test specimen

Table 3 (continued).

Product type	Test specimen preparation	Information reported in the test report
Ceiling tiles and boards, suspended flooring systems		
• Ceiling tiles and boards not applicable as suspended ceiling	• Test specimen is cut from the board so that it contains one factory-made edge (see Figure 8) • Reverse side and cut edges are sealed, factory-made edge is left unsealed • Unsealed primary surface is used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • Area of the test specimen
• Ceiling tiles and boards applicable as suspended ceiling • Flooring tiles and boards applicable as suspended or assembly floor	• Test specimen is cut from the board so that it contains one factory-made edge (see Figure 8) • Both faces and factory-made edge are left unsealed, cut edges are sealed • Only the primary surface of the test specimen is used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • Area of the test specimen
Surface materials including joints		
• Parquet and engineered wood flooring • Laminate flooring • Vinyl planks and tiles • Panels and boards used for interior surfaces (with mechanically fastened joints) • Other interior surface materials composed of several pieces (with mechanically fastened joints) • Resilient flooring tiles	• Test specimen is arranged and cut so that it includes joints (see Figure 9): ratio between length of joint (*J*) and surface area of the test specimen (*A*) shall reflect the average in real use • Reverse side and edges are sealed • Unsealed primary surface is used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • *J*/*A* • Area of the test specimen

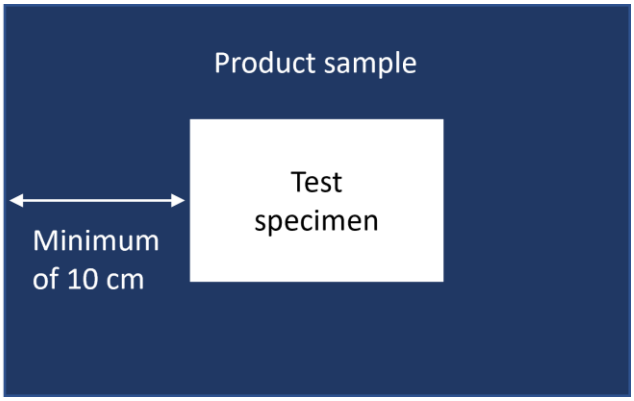


Figure 6. Cutting of a test specimen from a board.

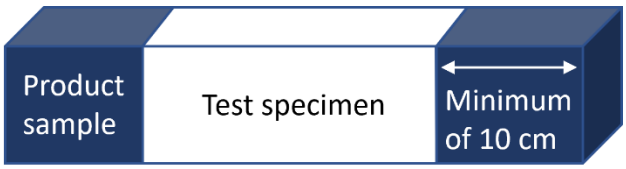


Figure 7. Cutting of a test specimen from a beam.

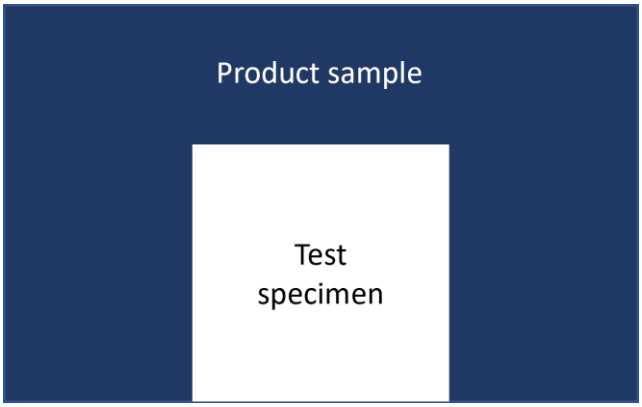


Figure 8. Cutting of a test specimen from a ceiling tile or board.

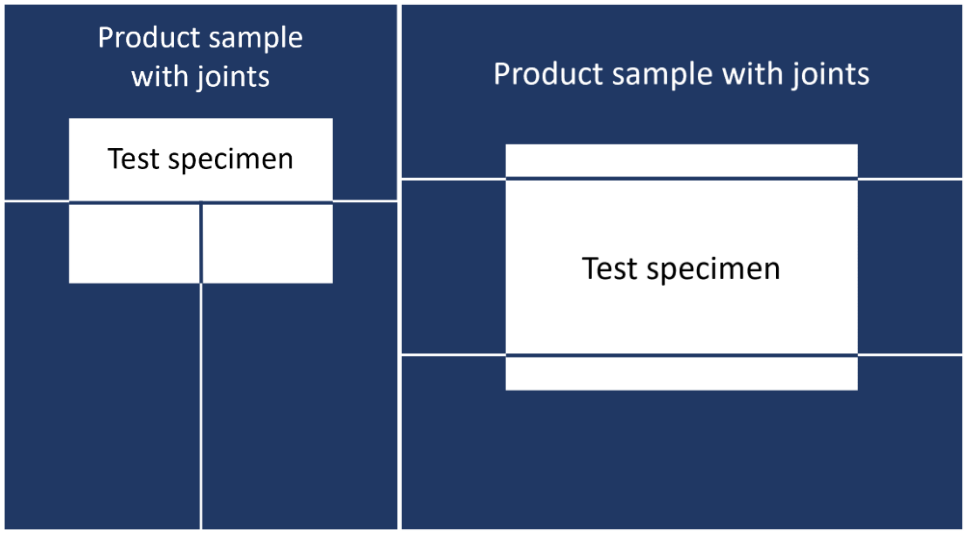


Figure 9. Cutting of a test specimen from a product with joints.

6.3.4 Insulation products

Test specimen preparation of insulation products is carried out according to Table 4. Test specimen preparation shall be documented in the test report and shall include information specified in Table 4.

Table 4. Test specimen preparation and reporting instructions for insulation products.

Product type	Test specimen preparation	Information reported in the test report
• Insulation (rolls, slabs, boards, and rigid foam insulation) without facing • Insulation (rolls, slabs, boards, and rigid foam insulation) with permeable facing (e.g. glass wool veil)	• Test specimen is cut from the middle of the roll or slab, excluding minimum of 10 cm from the sample sides (see Figure 5 and Figure 6). From rolled products minimum of two outer layers of the roll must be discarded prior to cutting the test specimen • Reverse side and edges are sealed • Unsealed primary surface is used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • Area of the test specimen
• Insulation (rolls, slabs, boards, and rigid foam insulation) with impermeable facing (e.g. aluminium foil or laminate)	• Test specimen is cut from the middle of the roll or slab, excluding minimum of 10 cm from the sample sides (see Figure 5 and Figure 6). From rolled products minimum of two outer layers of the roll must be discarded prior to cutting the test specimen • Test specimen shall contain a joint or cut edges are partly sealed (*U*/*A* = 1,5 m/m²). Reverse side and edges are sealed (or partly sealed) • Primary surface is used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • *J*/*A* or *U*/*A* • Area of the test specimen
• Loose fill products • Blowing wools	• Test specimen is prepared into an inert mould. Thickness and density of the test specimen is determined by the product specific installation instructions (U_{walls} 0,17 W/(m² K), U_{roof} 0,09 W/(m² K)) or at least 200 mm • Unsealed primary surface is used to calculate the test specimen area	• Thickness of the test specimen • Application amount [kg/m²] • *U* (if applicable) • Material(s) and technique(s) used for test specimen preparation • Area of the test specimen
• Spray applied insulations	• Test specimen is prepared by spraying onto an inert substrate or inert mould. Thickness of the test specimen is maximum application thickness specified in the product specific instructions • Primary surface is used to calculate the test specimen area	• Thickness of the test specimen • Material(s) and technique(s) used for test specimen preparation • Application amount [kg/m²] • Number of layers and drying time between layers (if applicable) • Area of the test specimen

6.3.5 Liquid-applied products

For liquid applied coating products a preconditioning period of up to 3 days (see 6.4) can be applied outside of the test chamber. This preconditioning period is included in the test period (i.e. start time of the emission test is when the test specimen is finished and transferred to preconditioning chamber). Preconditioning time and conditions shall be reported in the test report. If test specimen is aged outside of the test chamber, preconditioning is not applicable.

6.3.5.1 Liquid applied paints, lacquers, varnishes, oils, waxes, and primers

Whenever possible, liquid applied products are tested using inert, non-emitting, non-adsorbing (or non-porous) substrate. Primary substrates used for test specimen preparation are glass, stainless steel, and polyester of sufficient rigidity.

Application amount used when preparing the test specimen is the maximum application amount specified in the manufacturer's technical instructions. If the technical instructions specify different application amounts for adsorbing, rough or porous surfaces and non-adsorbing, smooth or non-porous surfaces, the maximum application amount of non-adsorbing, smooth or non-porous surfaces is applied when non-adsorbing substrate is used. If relevant technical information is not available, application amounts specified in Table 5 are used.

Table 5. Application amounts (wet consumptions) used for test specimen preparation of liquid applied coating products.

Product type	Application amount (wet consumption)
• Interior paints (both topcoat and basecoat products) • Special effect paints and coatings	• Highest application amount [g/m²] (amount corresponding to the lowest coverage [m²/L]) given by the manufacturer is used • If no other information is available, minimum application amount of 150 g/m² is used
• Lacquers • Varnishes • Wood stains • Waxes • Primers	• Highest application amount [g/m²] (amount corresponding to the lowest coverage [m²/L]) given by the manufacturer is used • If no other information is available, minimum application amount of 80 g/m² is used
• Oils	• Highest application amount [g/m²] (amount corresponding to the lowest coverage [m²/L]) given by the manufacturer is used • If no other information is available, minimum application amount of 20 g/m² is used

Product is applied as a single layer if multiple layer application is not mandatory according to the manufacturer's technical information. Multilayer test specimens are prepared according to manufacturer's instructions and drying times between layers shall be reported. Material layer applied onto the substrate shall be even.

Examples of suitable application methods are applicator, brush, spray pistol, roller, casting, pouring, and drawdown bar. The substrate shall be weighed before and after application of the product to determine the application amount. Test specimen preparation shall be documented in the test report and shall include:

- application amount [g/m²]
- substrate and technique(s) used for test specimen preparation
- multilayer test specimens: drying time(s) and drying conditions between layers
- test specimen area

6.3.5.2 Liquid applied floor coatings and coating systems

Whenever possible, liquid applied products are tested using inert, non-emitting, non-adsorbing (or non-porous) substrate. Primary substrates used for test specimen preparation are glass, stainless steel, and polyester of sufficient rigidity. For products with low viscosity and/or thick wet layer, substrate with borders or moulds may be used. Application amount used when preparing the test specimen is the maximum application amount specified in the manufacturer's technical instructions, see Table 6.

Table 6. Test specimen preparation for liquid applied floor coating products and coating systems.

Product type	Test specimen preparation / application amount
Products used as top coating only, film thickness < 1 mm	Maximum consumption [kg/m²] (amount corresponding to the lowest coverage [m²/L]) given by the manufacturer is used
Mass coatings, layer thickness ≥ 1 mm	Maximum consumption [kg/m²] (amount corresponding to the lowest coverage [m²/L]) given by the manufacturer is used and test specimen is prepared without filler or sand
Coating systems	According to manufacturer's instructions including all coating system components and using maximum consumption [kg/m²] (amount corresponding to the lowest coverage [m²/L]) of each system component

Test specimens are prepared according to manufacturer's instructions and drying times between layers shall be reported. Material layer applied onto the substrate shall be even. Examples of suitable application methods are applicator, brush, roller, casting, pouring, and drawdown bar. The substrate shall be weighed before and after application of the product to determine the application amount. Test specimen preparation shall be documented in the test report and shall include:

- application amount [g/m²]
- substrate and technique(s) used for test specimen preparation
- multilayer test specimens: drying time(s) and drying conditions between layers
- test specimen area

6.3.5.3 Waterproofing products and waterproofing systems

Liquid applied waterproofing products are tested on glass substrate. Test specimen is prepared according to manufacturer's instructions using maximum wet consumption per application and maximum number of applications. Waterproofing systems are tested on gypsum board substrate according to Table 7.

Table 7. Test specimen preparation for waterproofing systems.

System component	Specification
Substrate	Low-emitting gypsum board (test results shall be evaluated considering the emissions from the untreated substrate and possible secondary emissions from the substrate cannot be excluded)
Primer	Maximum consumption [g/m²] (amount corresponding to the lowest coverage [m²/L]) given by the manufacturer
Waterproofing membrane	Maximum consumption [kg/m²] (amount corresponding to the lowest coverage [m²/L]) and maximum number of applications given by the manufacturer
Drying times	Drying times given in installation instructions are followed at all stages
Tiling	Tile adhesive is applied using 6 mm x 6 mm notched spatula and glazed tiles (water absorption < 15 %, size 10 x 10 cm) are installed using joint width 3 mm
Tile grout	Not used
Edges and reverse side	Reverse side and edges are sealed, unsealed primary surface is used to calculate the test specimen area

NOTE: Waterproofing products tested as a system can only be classified as a system.

The substrate shall be weighed before and after application of the product to determine the application amount. Test specimen preparation shall be documented in the test report and shall include:

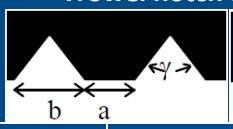
- application amount [g/m²]
- substrate and technique(s) used for test specimen preparation
- multilayer and system test specimens: drying time(s) and drying conditions between layers
- test specimen area

6.3.6 Adhesives

Whenever possible, adhesives are tested using inert, non-emitting, non-adsorbing (or non-porous) substrate. Primary substrates used for test specimen preparation are glass, stainless steel, and polyester of sufficient rigidity. If the test specimen preparation requires specialised application techniques or instrumentation, Rakennustieto shall be consulted for further instructions.

Application amount [g/m²] used when preparing the test specimen is the maximum application amount specified in the manufacturer's technical instructions. Adhesive is applied using a notched trowel specified in Table 8. Adhesives delivered in powder form are mixed with liquid according to the manufacturer's instructions using the average of given liquid amount per kg of powder.

Table 8. Test specimen preparation for adhesives.

Type of adhesive	Application amount (wet consumption) [g/m²]	Trowel type	Trowel notch dimensions [6]			
						
			a [mm]	**b** [mm]	**c** [mm]	**γ** [°]
Installation adhesives (e.g. for floor and wall coverings)	< 500	TKB B1	2,6	2,4	-	55
	500–1100	TKB B3	3,3	3,7	-	55
	> 1100	TKB B12	4,9	5,1	-	50
Assembly adhesives	500	TKB B5	14,3	5,7	-	55
Tile adhesives	-	TKB C2	6,0	6,0	6,0	-

The substrate shall be weighed before and after application of the product to determine the application amount. Test specimen preparation shall be documented in the test report and shall include:

- application amount [g/m²]
- adhesives delivered as powder: mixing ratio of powder and liquid
- substrate and technique(s) used for test specimen preparation (including the used trowel type)
- test specimen area

6.3.7 Sealants

Sealants are tested in an inert profile with depth of 3 mm and width of 10 mm. Test specimen preparation shall be documented in the test report and shall include:

- profile material and dimensions
- technique(s) used for test specimen preparation
- test specimen area

If a product can be used as both sealant and adhesive, it shall be tested as an adhesive. If no other loading factor is determined by the TDS 0,4 m²/m³ shall be used. If application with a trowel (see Table 8) is unfeasible for such a product, the product can be tested in an inert profile like a sealant, but the loading factor shall reflect the adhesive usage.

6.3.8 Sealing foams

Sealing foams are tested in an inert profile with depth of 40 mm and width at least 15 mm. The surface of the foam is cut to the profile level as soon as the foam has hardened. Test specimen preparation shall be documented in the test report and shall include:

- profile material and dimensions
- technique(s) used for test specimen preparation
- test specimen area

6.3.9 Screed-type products, tile grouts, and cast concrete

Screed-type products are tested using inert, non-emitting, non-adsorbing (or non-porous) substrate. Primary substrates used for test specimen preparation are glass and stainless steel. Powders are mixed according to the manufacturer's instructions using the average of given water amount per kg of powder. Concrete is delivered as ready-mixed by the manufacturer. Test specimen thickness is based on the application thickness of the product specified in the manufacturer's technical instructions, see Table 9.

Table 9. Test specimen wet layer thicknesses used in emission testing of screed-type products.

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

For products with low viscosity and/or thick wet layer, substrate with borders or moulds may be used. Material layer applied onto the substrate shall be even. Examples of suitable application methods are casting, pouring, and flat trowel or spatula. High-viscosity products can be drawn off over a template of the desired thickness with a flat spatula. Some materials (e.g. concrete) may settle during the first hours with some water forming on the surface. In such a case, the surface is finished with a steel tool after the bleeding water has evaporated.

The substrate shall be weighed before and after application of the product to determine the dry powder consumption. Test specimen preparation shall be documented in the test report and shall include:

- dry powder consumption [kg/m²] or [kg/m²/mm]
- wet layer thickness [mm]
- mixing ratio of powder and liquid
- substrate and technique(s) used for test specimen preparation
- multilayer test specimens: drying time(s) and drying conditions between layers
- test specimen area

6.3.10 Building bricks, blocks, and logs

Test specimen preparation of bricks, building blocks, and logs is carried out according to Table 10. Test specimen preparation shall be documented in the test report and shall include information specified in Table 10.

Table 10. Test specimen preparation and reporting instructions for building blocks, bricks, and logs.

Product type	Test specimen preparation	Information reported in the test report
• Insulated building blocks • Non-insulated building blocks	• Tested as whole pieces • Test specimen shall contain at least one horizontal and one vertical seam between blocks. No jointing materials are used • Outer border of the test specimen is sealed • Unsealed surfaces are used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • Area of the test specimen
• Homogeneous bricks • Homogeneous building blocks	• Tested as whole, uncovered pieces • Unsealed surfaces are used to calculate the test specimen area	• Thickness of the product • Area of the test specimen
• Logs	• Test specimen is cut from the middle of the beam, excluding minimum of 10 cm from the sample ends (see Figure 7) • Test specimen shall contain at least one horizontal seam between logs. No jointing materials are used • Outer border of the test specimen is sealed • Unsealed surfaces are used to calculate the test specimen area	• Thickness of the product • Material(s) and technique(s) used for sealing • Area of the test specimen

6.3.11 Building components, elements, and factory-made combined products

Building components, elements, and factory-made combined products (e.g. partition walls) shall be tested as whole products as far as feasible. In case the regular-sized product is too large for the test chamber, a scaled down version with identical proportions may be manufactured for testing. From a homogeneous product a representative sample may be prepared by cutting and sealing all cut surfaces.

Loading factors and number of furniture and items placed in the reference room are presented in Table 1, Table 2 and Figure 4. Some loading factors are specified in sections 6.3.11.1–6.3.11.3. In case of large products both n and L can be varied within limits given in EN 16516 to achieve the specified q. Reference room concentrations are recalculated to n = 0,5 h^{-1} and the specified L according to EN 16516. Both the L and n used in the testing, and the L and n used in the calculation of reference room concentrations shall be reported in the test report.

In some instances testing of a product requires the test specimen to take up more than 30 % of the test chamber volume and/or loading factor to be > 2,0 m^2/m^3. If this cannot be avoided, the exception and a short reasoning for it shall be documented in the test report. Mixing and flow of air in the chamber shall be taken into consideration.

6.3.11.1 Doors

Doors (excluding fixture doors) are tested as described in Table 11. If the doorframe is an integral part of the delivery system, the whole system shall be tested door closed and parts of the doorframe not directly in contact with indoor air are sealed.

Table 11. Test specimen preparation and reporting instructions for doors.

Product type	Test specimen preparation	Information reported in the test report
• Internal doors	• Tested as whole, uncovered unit • Unsealed surfaces (excluding edges) are used to calculate the test specimen area	• Dimensions of the product • Area of the test specimen
• External doors	• Tested as whole unit • Parts not in contact with indoor environment after installation are sealed • Unsealed primary surface is used to calculate the test specimen area	• Dimensions of the product • Material(s) and technique(s) used for sealing • Area of the test specimen
• Closet and wardrobe doors (both sliding and conventional)	• Tested as whole, uncovered unit • Only the primary surface of the test specimen is used to calculate the test specimen area • Closet and wardrobe doors are tested using area specific air flow rate (q) 2 $m^3/(m^2h)$ (i.e. loading factor 0,25 m^2/m^3)	• Dimensions of the product • Area of the test specimen
• Sliding doors used as partition wall	• Tested as whole, uncovered unit • Unsealed surfaces (excluding edges) are used to calculate the test specimen area • Sliding doors used as partition wall are tested using area specific air flow rate (q) 2 $m^3/(m^2h)$ (i.e. loading factor 0,25 m^2/m^3)	• Dimensions of the product • Area of the test specimen

6.3.11.2 Windows

Windows are tested as whole, uncovered units. Parts not in contact with indoor environment after installation are sealed and the unsealed primary surface (including the glass) is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- material(s) and technique(s) used for sealing
- test specimen area

6.3.11.3 Partition walls and screens

Partition walls and screens are tested as whole, uncovered units using area specific air flow rate (q) 2 m³/(m²h) (i.e. loading factor 0,25 m²/m³). Unsealed surfaces (excluding edges) are used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- test specimen area

6.3.12 Fixture

6.3.12.1 Doors

Fixture doors are tested as whole, uncovered units with hinges. Only the primary surface is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- test specimen area

6.3.12.2 Cabinets and mirror cabinets

Fixture cabinets are tested as whole, uncovered units with shelves. If the cabinet is tested with a door, the door shall be left open. Only the area of the door face (dimensions of the surface facing the room) is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- test specimen area

6.3.12.3 Countertops

Fixture countertops are tested as whole, uncovered units. If testing as a whole unit is not possible, a representative sample can be cut from the full-sized product. In the case of sub-sampling, the test specimen shall contain at least one factory-made edge, cut edges are sealed and both faces are left unsealed. Only the primary surface is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- material(s) and technique(s) used for sealing
- test specimen area

6.3.13 Furniture without textile coverings or padding

6.3.13.1 Cabinets, open shelves, and bookcases

Furniture cabinets and bookcases are tested as whole, uncovered units with shelves. If the cabinet is tested with a door, the door shall be left open. Only the area of the door face (dimensions of the surface facing the

room) is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- test specimen area

6.3.13.2 Tables, conference tables, and desks

Tables are tested as whole, uncovered units. Only the area of the tabletop face (dimensions of the surface facing the room) is used to calculate the test specimen area. Tables with metal of plastic legs can be tested without legs by cutting a representative sample from the tabletop and drilling holes (depth 75% of the total thickness) for the legs in proportion to the real use scenario. In the case of sub-sampling, the test specimen shall contain at least one factory-made edge, cut edges are sealed, both faces are left unsealed, and only the primary surface is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- material(s) and technique(s) used for sealing
- test specimen area

6.3.13.3 Chairs

Chairs are tested as whole, uncovered units. SER results are calculated per unit and M1 limit value examination is carried out using reference room concentration. Test specimen preparation shall be documented in the test report and shall include dimensions of the product.

6.3.13.4 Drawers and chest of drawers

Office drawers and chests of drawers are tested as whole, uncovered units drawers open. Only the area of the drawer face (dimensions of the surface facing the room) is used to calculate the test specimen area. Test specimen preparation shall be documented in the test report and shall include:

- dimensions of the product
- test specimen area

6.3.14 Upholstered office and auditorium chairs

Office chairs are tested as whole, uncovered units. SER results are calculated per unit and M1 limit value examination is carried out using reference room concentration. Test specimen preparation shall be documented in the test report and shall include dimensions of the product.

6.4 Testing period, preconditioning, and ageing of test specimen

Emission testing of building products, fixtures and furniture is performed at 28 ± 3 days. Emission testing of upholstered office chairs is performed at the day 3, sensory evaluation at the day 3 or 3+1.

NOTE: A shorter testing period than 28 ± 3 days can be used if it can be ascertained that no processes leading to increasing emissions over time can take place in the material. Minimum testing period is 3 days.

The age of the test specimen is the time elapsed between finishing the test specimen preparation (regardless of when the sample is placed in the test chamber) and the emission sampling. Test specimen is transferred to the test chamber or separate conditioning unit as soon after preparation as possible. Prior to emission testing, the test specimen is aged for 28 ± 3 days (not applicable for upholstered chairs). Conditions during ageing shall be identical to those during the emission testing. Accepted ageing units are test chamber and separate conditioning chamber. If the test specimen is aged outside the test chamber, it shall be placed into the test chamber at least 3 days prior to emission sampling.

For products undergoing curing, releasing significant amount of primary emissions and posing a significant sink effect risk, a preconditioning period of up to 3 days can be applied outside of the test chamber as described in EN 16402 [7]. This preconditioning period is included in the 28 ± 3-day test period (i.e. start time of the emission test is when the test specimen is finished and transferred to preconditioning chamber). Conditions during preconditioning shall be identical to those during the emission testing. After the preconditioning period is over, the test specimen is transferred to the test chamber. Preconditioning may not be used, if the test specimen is aged outside of the test chamber.

6.5 Test chamber and testing conditions

Test chamber conditions (see Table 12) and methods of monitoring conditions specified in EN 16516 shall be used. Loading factors and area specific air flow rates specified in Table 1 and Table 2 of this protocol shall be used. If needed, loading factor (L) and air change rate (n) can be varied within limits given in EN 16516 to achieve the specified area specific air flow rate (q).

Test chamber volume shall be at least 0,02 m³, and the test specimen shall occupy ≤ 30 % of the chamber volume. Chamber size in relation to the inhomogeneity of tested materials shall be recognized and the chamber size selected accordingly. Recommended minimum chamber size for heterogenous materials is 0,1 m³. Test specimen(s) shall be placed in the test chamber in such a way that unobstructed air flow can be confirmed. Examples of correctly placed test specimens placed in the emission test chambers are presented in Figure 10.

Table 12. Test chamber conditions used in emission testing as defined in EN 16516.

Parameter	Value
Temperature	23 ± 1 °C
Relative humidity	50 ± 5 %
Air velocity above test specimen	0,1–0,3 m/s
Air change rate (n)	0,5 h^{-1}

Figure 10. Correctly placed test specimens in test chambers.

6.6 Chemical measurements

Chemical measurements for Emission classification include determination of total volatile organic compound (TVOC) emission, emissions of individual volatile organic compounds (VOCs) listed on the EU-LCI list [4], emissions of carcinogenic substances (Carc. 1A and 1B) [3], emissions of formaldehyde and other small aldehydes listed on the EU-LCI list [4], and emission of ammonia.

6.6.1 Volatile organic compounds

Volatile organic compounds (VOCs), as defined in clause 4, are sampled and analysed using thermal desorption and gas chromatograph equipped with mass selective detector (TD-GC-MS) according to ISO 16000-6 with deviations and additional requirements specified in EN 16516. VOC sampling shall be carried out using adsorbent tubes equipped with Tenax TA.

TVOC shall be determined as described in clause 4. Target VOCs, as defined in clause 4, shall be quantified and reported using both compound specific response factor as well as toluene equivalent. Non-target VOCs shall be quantified and reported at least as toluene equivalents. Detected very volatile organic compounds (VVOCs), as specified in clause 4, and semi-volatile organic compounds (SVOCs), as specified in clause 4, shall be quantified and reported at least as toluene equivalents. As far as feasible, the quantification limit of VVOCs, VOCs, and SVOCs shall be 1 µg/m³. All compounds, target or non-target, with reference room concentration ≥ 5 µg/m³ shall be reported with their concentrations. If applicable, total semi-volatile compound (TSVOC) emission shall be determined as described in clause 4 and reported.

6.6.2 LCI compounds

LCI (Lowest Concentration of Interest) compounds [4] shall be quantified using compound specific response factor. Formaldehyde, acetaldehyde, propionaldehyde (propanal), butyraldehyde (butanal), and acetone are sampled and analysed using a method based on ISO 16000-3 and EN 16516. Other LCI-VOCs are sampled and analysed using a method based on ISO 16000-6 and EN 16516. As far as feasible, the quantitative reporting limit for LCI-VOCs is the LCI limit value or 5 µg/m³ (reference room concentration), whichever is lower.

6.6.3 Carcinogenic, mutagenic and reprotoxic (CMR) substances

CMR substances (category Carc. 1A or 1B in Table 3 of Annex VI to Regulation (EC) No 1272/2008) [3] detectable by the used methods (ISO 16000-6, ISO 16000-3 and EN 16516) shall be analysed. CMR compounds shall be quantified using compound specific response factor. As far as feasible, the quantitative reporting limit for CMR compounds is 1 µg/m³ (reference room concentration). If a substance is listed both as a CMR [3] and EU-LCI [4] compound, it is evaluated and reported as a LCI compound with a note of CMR status.

6.6.4 Formaldehyde

Sampling and analysis of formaldehyde as well as acetaldehyde, propionaldehyde (propanal), butyraldehyde (butanal), and acetone is carried out according to ISO 16000-3 and EN 16516. Quantitative reporting limit for aldehydes and acetone is 1 µg/m³ (reference room concentration), as far as feasible.

6.6.5 Ammonia

Sampling and analysis of ammonia is carried out as described in EN 16516:2017 + A1:2020. Analytical method based on OSHA ID-188 [8] is the preferred method but equivalent, validated methods, such as spectrometric method based on ISO 7150-1 [9], are accepted if the method is sensitive enough to be used for M1 emission measurements. Quantification limit of the ammonia analysis method shall be 10 µg/m³ (reference room concentration) or better.

NOTE: Amines present in the emission sample may interfere with the ammonia analysis. This interference can be reduced by using a chromatographic method.

6.6.6 Calculation and reporting of results

Calculation of test results is done as described in EN 16516. All emission results are reported as both (area) specific emission rate (SER) [mg/m²h or µg/m²h] and reference room concentrations [µg/m³]. Loading factor and air change rate used for the calculation of reference room concentrations shall be clearly reported.

6.7 Sensory evaluation

Sensory evaluation of building materials is performed at 28 ± 3 days (upholstered chairs at 3 or 3+1 days) using the acceptability scale and untrained panel according to standard ISO 16000-28. An example of an evaluation form is given in Appendix 3 of this testing protocol. Loading factors and area specific air flow rates given in Table 1 and Table 2 of this protocol are used. Sensory evaluation performed using CLIMPAQ-type chamber according to NT Build 482 [5] is also accepted. Requirements of ISO 16000-28 for the panellists, test room air, environmental conditions, and empty chamber apply.

6.7.1 Chamber technique in sensory assessment

Emission test chamber or separate sensory assessment chamber along with loading factors and area specific air flow rates given in Table 1 and Table 2 of this protocol are used for sensory evaluation. The assessment may be carried out using either direct sensory evaluation with diffuser (outlet airflow rate 0,6–0,9 L/s) or

sampling bags as described in ISO 16000-28. If needed, loading factor (*L*) and air change rate (*n*) may be adjusted to increase the outlet air flow rate within the limits specified in EN 16516.

If sensory evaluation is performed using CLIMPAQ-type chamber [5], airflow rate of 0,6–0,9 L/s through the diffuser and the corresponding test specimen area shall be calculated to match the area specific air flow rate (*q*) given in Table 1.

6.7.2 Panellists

The minimum panel size of 15 as described in ISO 16000-28 shall be used for the assessment of odour acceptability by an untrained panel. Instructions for panellists and panel selection given in ISO 16000-28 apply.

6.7.3 Odour assessment procedure and calculation of odour acceptability

The odour assessment procedure described in ISO 16000-28:2020 chapters 10.2 and 10.3 shall be used. From the results of the evaluation, arithmetic mean, standard deviation, 90 % confidence interval, and PD-value shall be calculated and reported. The PD-value is calculated using the number of dissatisfied panellists (acceptability assessment < 0).

7 Quality assurance

Emission measurements for the Emission classification may only be performed by a testing laboratory approved by Rakennustieto. An approved testing laboratory shall fulfil the following criteria:

- the laboratory shall have an accredited quality assurance system according to ISO/IEC 17025
- the accreditation shall cover the chemical testing of material emissions including chamber technique and analyses according to ISO 16000 series standards
- the laboratory shall regularly participate and prove acceptable performance in international material emission round robin tests covering chamber technique and analysis

8 Test report

The test report shall include the information listed below.

a) Testing laboratory
   - name and address of the laboratory
   - name of the responsible person
   - relevant information regarding the accreditation status of the laboratory

b) Product sample description and identification
   - product type
   - product name
   - batch number and/or other product markings
   - sample description (details specifying the tested sample, e.g. thickness or other relevant remarks on the sample)

- production date
- assembly date (applicable for office chairs and furniture)
- sampling and sending dates
- date the sample was received at the testing laboratory
- note on sample packaging and delivery
- sampling report as attachment

c) Test specimen preparation and ageing
   - date of test specimen preparation
   - detailed description of test specimen and test specimen preparation (see product type specific requirements in 6.3), e.g. sealing of edges and reverse side, used substrate, application method, applied amount per unit area and/or applied thickness, and all other test specimen related details and remarks which may influence the test results
   - if preconditioning is used, the conditions and duration of it shall be reported
   - location (test chamber or separate ageing unit) and conditions during ageing
   - if separate ageing unit has been used, timepoint when the test specimen has been transferred to the test chamber shall be reported
   - photo(s) of the test specimen

d) Experimental conditions in chemical measurements and sensory evaluation
   - chamber volume [m^3]
   - air change rate [h^{-1}]
   - temperature [°C]
   - relative humidity [RH%]
   - test specimen area [m^2]
   - loading factor [m^2/m^3] (or [items/m^3] when applicable)
   - area specific air flow rate [$m^3/(m^2h)$]

e) Emission sampling and analytical methods
   - description of sampling and analytical methods used for chemical analyses (including types of sampling devices/adsorbents used and reference(s) to standards)
   - description of method used for sensory evaluation (including panel size and reference(s) to standards)
   - quantification limits of analytical methods
   - emission sampling volumes
   - measurement uncertainties of chemical analyses

f) Results of chemical testing
   - all results are reported as both (area) specific emission rate (SER) [mg/m^2h] or [µg/ m^2h] or [mg/unit*h] and reference room concentrations [$\mu g/m^3$] (loading factor and air change rate used for the calculation of reference room concentrations shall be clearly stated)
   - test results compared to the M criteria
   - TVOC emission

- VOC emissions (results of individual VOCs are reported as toluene equivalents and target compounds also using compound specific response)
- formaldehyde emission
- ammonia emission
- VOC chromatogram

g) Results of sensory evaluation
- individual results of each panellist
- arithmetic mean of acceptability assessments
- standard deviation of acceptability assessments
- 90% confidence interval of acceptability assessments
- percentage dissatisfied (PD)

9 Bibliography

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[6] Technische Kommission Bauklebstoffe (TKB) im Industrieverband Klebstoffe e.V. (Technical Commission on Construction Adhesives of German Adhesives Association) (2007) Trowel Notch Sizes for Installation of Floor Coverings, Wood Flooring and Tiles. TKB-Technical Briefing Note 6. Available at https://www.klebstoffe.com/informationen/publications/

[7] EN 16402:2019 Paints and varnishes – Assessment of emissions of substances from coatings into indoor air – Sampling, conditioning and testing

[8] OSHA ID-188 (2002) Ammonia in Workplace Atmospheres – Solid Sorbent

[9] ISO 7150-1 Water quality – Determination of ammonium – Part 1: Manual spectrometric method

[10] EN 717-1:2004 Wood-based panels – Determination of formaldehyde release – Part 1: Formaldehyde emission by the chamber method

Appendix 1: Example of a sampling report

Sampling report for emission testing

<table>
<tr><td>Sampler (name, company, contact info)</td><td>Manufacturer of the product</td></tr>
<tr><td>Name(s) of the product</td><td>Type of product</td></tr>
<tr><td>Date of manufacturing</td><td>Batch no</td></tr>
<tr><td>Date of sampling</td><td>Amount of material sampled</td></tr>
<tr><td>Date of assembly (office chairs and furniture)</td><td rowspan="2">How was the product stored before sampling?

not stored ☐
open ☐
stacked ☐
wrapped up, ☐
specify packing material:</td></tr>
<tr><td>Sample was taken from

production line ☐
stock / storage ☐
miscellaneous, ☐
specify where:</td></tr>
<tr><td colspan="2">If a sub-sample was collected from a larger material amount, describe how the sub-sample was taken</td></tr>
<tr><td colspan="2">Observations and remarks</td></tr>
<tr><td colspan="2">Confirmation
The signer herewith confirms that the information given in this document is correct and that the sample was selected, sampled, and packed in accordance with current version of the M1 testing protocol.</td></tr>
<tr><td>Date</td><td>Signature</td></tr>
</table>

Appendix 2: Example of a test specimen preparation report

Test specimen preparation report for emission testing

Preparer (name, company, contact info)	**Number and dimensions of test specimen(s)**
Test specimen type single product ☐ system ☐	**Substrate** stainless steel ☐ glass ☐ other, ☐ specify what:
Conditions during preparation and drying	**Date of sending**

Details of the preparation process

Layer	**Time of application** (date and time)	**Product name**	**Application amount** [g/m²]	**Wet layer thickness** [mm]	**Application method**	**Drying time** [h]

Observations and remarks

Confirmation
The signer herewith confirms that the information given in this document is correct and that the test specimen preparation has been carried out in accordance with current version of the M1 testing protocol.

Date	**Signature**

Appendix 3: Example of an evaluation form for sensory assessment

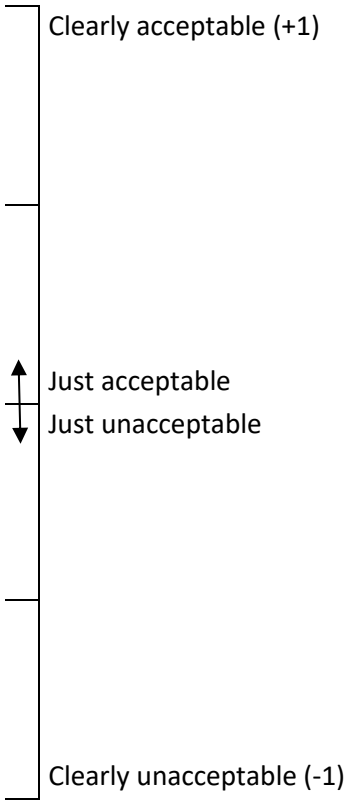
Odour acceptability assessment of building materials and furniture

Sample: _____

Date: _____

Panellist: _____

Imagine that you would daily for several hours be exposed to the air from the test chamber. How acceptable is the air quality?



Comments: