

New draft harmonized CEN standard on emissions from construction products - principles common with ISO 16000 and EN 717-1 and differences

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BACKGROUND

In Europe, the most relevant VOC and formaldehyde testing standards in use are:

- ISO 16000-3: Formaldehyde and other carbonyl compounds in air analysis
- ISO 16000-6: Volatile organic compounds in air analysis
- ISO 16000-9: Operation of emission test chamber
- ISO 16000-10: Operation of emission test cell
- ISO 16000-11: Preparation of test specimens
- EN 717-1: Formaldehyde emission testing for E1 classification
(targeted to determine steady-state concentration for products where the binder releases formaldehyde continuously due to hydrolysis with air humidity)

Recently, Working Group 2 of CEN Technical Committee 351 prepared a draft harmonized umbrella standard for determining emission of regulated dangerous substances into indoor air. This was done within the frame of Essential Requirements 3 on hygiene and safety, an interpretative document under European Construction Products Directive (89/106/EEC).

The harmonized testing standard will not be used as such. It is intended to be used by other TCs within the CE requirements for describing the required technical performance of a product. CE marking is a prerequisite for entering the EU market for many groups of construction product. EU Commission defines which parameters shall be included in the relevant standard for each product group. If the required product performance has to include a limitation of emissions into indoor air then the product specific Technical Committee will define performance classes or limit values for that purpose. In that case any emissions testing involved has to follow the rules of the recently drafted harmonized testing standard.

This forthcoming EN testing standard started with ISO 16000 series principles, but added additional specifications where ISO 16000 standards did not specify some details exactly enough. This was done mainly for improving reliability and reproducibility of testing when more than one lab is involved. Further refinements can be expected after a pending validation project will deliver additional information. Where ISO 16000 and EN 717-1 are using different testing parameters, it was tried to find a compromise.

PRINCIPLES

From product sample to test specimen

ISO 16000-11 specifies that a sample shall be taken from production as early as possible. New EN standard specifies the same principle, but sample shall be taken not earlier than when the product is ready for dispatch to client or distributor. This may include some drying and curing time at the production site.

Sample shall be selected for being representative for whole production volume. ISO 16000-11 standard remains vague on this issue, while new EN standard intends to give more specifications. While application of statistical sampling strategy was considered, probably rather a strategic sampling approach will be followed where knowledge of emission properties of the product will be used for selecting either an average sample or a worst-case sample. Proper airtight sampling is as essential as transport to test lab avoiding excessive physical or thermal stress.

The laboratory takes a test specimen out of a solid sample, typically by cutting. If only one surface is in direct contact with indoor air (e.g. for floorings) then edges and back need thorough airtight sealing.

The laboratory prepares a test specimen out of a liquid sample such as paints or adhesives by applying a specified amount on glass or metal as substrate. Other substrates may be closer to reality but have been identified to be either badly reproducible or even sources of additional VOC emissions, such as wood or gypsum plates.

It was discussed whether reduction of emissions from lower layers in structures (e.g. an adhesive below a flooring) could be taken into account by conventional reduction factors but that approach was rejected as being too simple. It will be up to the product specific TCs to specify how to deal with that issue.

The test specimen then is placed immediately into a test chamber. New EN standard additionally specifies pre-conditioning to be applied to liquid samples that require drying, with high initial emissions during a period when the room must not be used again. Such products shall be pre-conditioned in a separate test chamber with similar climate and ventilation conditions as in the test chamber.

Reference room and loading factor

Any emissions test result immediately is obtained as specific emission rate per hour and per m² surface (or per kg or per m³ product or per unit). Then it is calculated to its contribution to reference room air concentration. While ISO 16000-9 refers to a reference room which often was criticized as being smaller than realistic (7 m² surface and 2.49 m high), new CEN standard defines a slightly larger reference room (3 x 4 m surface, 2.5 m high, one door and one window). The surface of the respective product relative to room volume then is calculated for such reference room, e.g. for a flooring as $12 \text{ m}^2 / 30 \text{ m}^3 = 0.4 \text{ m}^2/\text{m}^3$. Ventilation is specified as ½ air change per hour, and climate as 23 °C in test chamber and relative humidity of supply air as 50%. EN 717-1 does not define a reference room but just defines the set chamber parameters as reference values.

Test chamber operation

Test chamber shall simulate these reference room parameters. While ISO 16000-9 just requires that the ratio between air change rate and room volume shall be kept as in reference room, new EN standard defines more narrow values for variation of both ventilation rate and loading factor in test chamber, which can be varied independently from each other. Emission rate then is transferred into contribution of emissions to reference room air concentration by calculation. For details of test chamber operation, see below table 1.

Table 1: Test chamber parameters

	New draft EN standard	ISO 16000-9	EN 717-1	Frequently used in USA *
Temperature °C	23	23	23	23
Range	± 1	± 2	± 0.5	± 1
Rel.humidity %	50	50	45	50
Range	± 5	± 5	± 3	± 5
Ventilation ach	0.5	0.5	1.0	1.0
Range	0.25 - 1.5	unlimited ²	± 0.05	± 0.05
Loading factor m ² /m ³ ^x	see below	see below ¹	1.0	0.5
- flooring m ² /m ³	0.4	0.4	-	-
- walls m ² /m ³	1.0	1.4	-	-
- small surfaces m ² /m ³	0.05	-	-	-
- very small surf. m ² /m ³	0.007	0.011	-	-
Range	± 50%, but max 2.0	unlimited ²	± 0.02	0.3 - 0.7
Air velocity at surface, m/s	0.1 - 0.3	0.1 - 0.3	0.1 - 0.3	0.05 - 0.1 ³
Test chamber size	min. 20 l	not specified	12m ³ , 1 m ³ , or 225 l	50 - 100 l

ach: air changes per hour

*: California Section 1350 along with ASTM D5116

^x: Allocation of a product to a loading factor shall occur in the product specific performance standard, based on the intended conditions of use.

¹: below are calculated values - the standard specifies only the specific ventilation rate

²: unlimited, if ratio between loading factor and ventilation is kept constant (the specific ventilation rate m³/(m² x h))

³: recommended for testing of evaporative emissions, not bindingly specified

This allows integrating several testing purposes into one test setup, e.g. new EN standard test, ISO 16000 test, EN 717-1 test, and even US American standards. On the other hand, extreme high loading as allowed by ISO 16000-9 shall be avoided for preventing unpredictable adsorption of VOC on chamber walls. Relative humidity range was specified as including both ISO 16000-9 and EN 717-1, and acceptable temperature range was set more narrow than in ISO 16000-9, but broader than in EN 717-1.

Air sampling and analysis

EN 717-1 requires repeated air sampling and analysis during 4, 10 or maximum 28 days, until emissions do not decline with more than -5% during a period of 4 days. As emissions not necessarily will reach such a steady-state for other products than wood-based panels, and in line with ISO 16000-9, new EN standard foresees air sampling after 3 days and after 28 days as a standard convention, while proven compliance with 28 days limit values may allow shorter testing duration.

New EN standard specifies Tenax TA as adsorption medium for VOC and SVOC, and DNPH for volatile aldehydes and other carbonyl compounds, in line with ISO 16000 parts 3 and 6. While duplicate air sampling and air analysis is clearly required now, backup sampling for control of any breakthrough was not foreseen. As to avoid loss of volatile substances, air sampling volume is restricted sharper than in ISO 16000-6, as maximum 5 liters.

Details of VOC analysis are specified in more detail than in ISO 16000-6. A major change is that for VOC analysis, a slightly polar gas chromatographic separation column was selected, no longer a 100% non-polar column. This shall give better separation of complex mixtures with polar VOCs. But as TVOC is defined as sum of all VOC inside the range from n-hexane to n-hexadecane on a 100% non-polar GC column, the impact of that decision on allocation of certain non-identified signals to being inside or outside TVOC range was subject to discussion. In the end this impact was judged to be non-significant because those differences were rated by experience as being small in very most cases. Detection limit for VOC analysis was defined as $1 \mu\text{g}/\text{m}^3$ and the lowest reliable quantification limit was specified as $5 \mu\text{g}/\text{m}^3$.

It is not yet clear whether the new EN standard shall cope also with other substances, such as very volatile organic compounds (e.g. acetone) and ammonia. Possibly specific air sampling and analysis methods will be added.

A number of simpler test methods are suggested for daily routine use, or for monitoring purposes. These methods are not as sophisticated and expensive as the emission test chamber protocol, but also less reliable. Therefore they should be referenced to the chamber method. Details of how this referencing can be done are not specified.

CONCLUSION

The new draft harmonized EN standard on emission of regulated dangerous substances into indoor air has used existing experience from emission testing and added further specifications for improving reliability and reproducibility of VOC emission chamber testing. A pending validation project shall further clarify the issue of reliability. The new draft standard stands for major progress for reducing differences of test results on same products when testing in different laboratories. Even though meant only for CE marking under the scope of European Construction Products Directive, it may influence the development of standards also for other applications. If also other standards - e.g. in the USA - would give more flexibility to their chamber operation parameters, then even more flexibility and harmonization between different national standards can be achieved.