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Construction products: Assessment of release of dangerous substances — Concept of horizontal testing procedures in support of requirements under the CPD

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Construction products: Assessment of release of dangerous substances - Concept of horizontal testing procedures in support of requirements under the CPD

Produits de construction - Evaluation de l'émission de substances dangereuses - Concept des méthodes d'essai horizontales à l'appui des exigences de la DPC

Bewertung der Freisetzung von gefährlichen Substanzen aus Bauprodukten - Evaluierung von horizontalen Ansätzen zur Bewertung der möglichen Freisetzung von gefährlichen Substanzen aus Bauprodukten im Rahmen von Anforderungen aus der Bauproduktenrichtlinie

This Technical Report was approved by CEN on 7 September 2010. It has been drawn up by the Technical Committee CEN/TC 351.

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Foreword

This document (CEN/TR 16098:2010) has been prepared by Technical Committee CEN/TC 351 “Construction products: Assessment of release of dangerous substances”, the secretariat of which is held by NEN.

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

The European Construction Products Directive (CPD) [1] enables the free trade of construction products that are fit for their intended use on the Single European Market. In addition to the requirements traditionally embedded in construction law, such as stability, fire protection and safety in use, it specifically refers to hygiene, health and the environment (Essential Requirement No. 3, "ER 3"). To implement ER 3, at the beginning of the year 2005 the European Commission issued Mandate M/366 "Development of horizontal standardised approaches relating to dangerous substances under the Construction Products Directive – emissions to indoor air, soil, surface water and groundwater". The mandate envisages the development of horizontal test and assessment methods by the European Committee for Standardisation (CEN), while the specific requirements for construction products will still be defined nationally by the individual Member States.

This report has been drafted under the work item ´Technical Report 2 (TR 2) of the Business plan[1] of CEN/TC 351 in response to Mandate M/366[2]. This report describes a horizontal approach, which can be applied to testing any substances and construction products covered by the Construction Products Directive (CPD). It is anticipated that the methods and procedures described in the report will also fit into the requirements of the future Construction Products Regulation [2], although this issue is outside the scope of this report[3].

To assess the feasibility of a common horizontal approach for testing emissions from construction products, the report investigates in general terms the range of construction products covered by the CPD, their intended uses, the state of the art of the relevant test procedures, and the report also makes proposals on how to fit this knowledge into a testing structure. This report addresses release of regulated dangerous substances to soil, surface water and groundwater (excluding drinking water as it is addressed elsewhere) and emission of regulated dangerous substances into indoor air. It takes into account relevant information that had become available by the end of 2009 through the activities in the working groups and task groups of CEN/TC 351 as well as the guidance provided by the European Commission.

This document is intended to present to a wider public, including the product TCs, the EC and the SCC, a general overview of the results achieved so far in CEN/TC 351 concerning horizontal testing for ER3 and the context of this work under M/366. The document describes broadly, how ER3 can be implemented under the CPD in future. Background information to this Technical Report is given in a reference [4]. Another Technical Report (TR 4, WI 00351004) commissioned under M/366 will give more detailed guidance for the selection and integration of the recommended horizontal product testing protocols on dangerous substances into hEN and ETAs. At the moment not all details of the implementation concept have yet been addressed in CEN/TC 351. The remaining questions can only be successfully addressed after the validation stage.

In cases where in the text reference is made to "Product TCs", also EOTA WG’s are meant where appropriate.

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1 See CEN/TC 351 N 0026 and N 0022 (available in Internet under: http://www2.nen.nl/cmsprod/groups/public/documents/bestand/223307.pdf).

2 See CEN/TC 351 N 004.

3 See RESOLUTION 73 taken by CEN/TC 351 (CEN/TC 351 N 0151[rev]).
Subject: Scope of CEN/TC 351 work in relation to CPD.
CEN/TC 351 thanks the European Commission for confirmation that the scope of the CEN/TC 351 work programme should only cover the existing CPD and the in-use phase of construction products.
The decision was taken by unanimity.

1 Scope

This Technical Report (TR), taking into account the state of the art in the Member States, identifies the role of testing in the assessment of construction products in view of possible emissions and makes recommendations on the testing procedures. This Technical Report reviews in accordance with the experience already gained, the basis for deciding whether the use of horizontal test method standards for construction products is practicable and/or necessary in order to implement obligations arising from the Construction Products Directive (CPD).

The time limit for all information CEN/TC 351/TG 2 has been able to consider is set to be 31 December 2009.

This Technical Report provides recommendations for complete testing procedures in the overall framework of the CPD according to the methods for the Attestation of Conformity (AoC).

2 List of abbreviations

In addition to the terms and definitions listed in CEN/TC 351 N 0218 (under development), in this document the following abbreviations are used.

AoC	Attestation of Conformity
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CEN/TC	CEN Technical Committee
CGLT	Compacted Granular Leach test
CPD	Construction Products Directive
DNPH	2,4-dinitrophenylhydrazine
DOM	Dissolved Organic Matter
ER 3	Essential Requirement 3 "Hygiene, health and the Environment" of the CPD
ETA	European Technical Approval
ETAG	European Technical Approval Guideline
FPC	Factory Production Control
hEN	harmonized European Standard
ID	Interpretative Document
ITT	Initial Type Testing
L/A	Liquid (volume) to Area (surface) Ratio
L/S	Liquid (volume) to Solid (mass) Ratio
NPD	No Performance Determined
MS	Member States

SVOC Semi Volatile Organic Compounds

TVOC Total Volatile Organic Compounds

VOC Volatile Organic Compounds

VVOC Very Volatile Organic Compounds

3 Horizontal release/emission test procedures for the CPD: an overview

NOTE The report has been prepared taking the following guidance into account:

— Mandate M/366 asks for measurement/test methods that have, whenever possible, a horizontal character applicable to one or several relevant families of construction products.

— The requests of CEN/TC 351(Res.110, Helsinki meeting) have been granted all the attention they were entitled to.

— CEN/TC 351/TG 2 asked experts from CEN/TC 351/WG 1 and CEN/TC 351/WG 2 to give input for this TR. This input, which was pre-consulted in the respective WG per correspondence, has been incorporated in the present document.

— The time limit for all information CEN/TC 351/TG 2 has been able to consider is set to be 31 December 2009. In the WGs of CEN/TC 351 work is still in progress. Discussion on certain matters is still evolving.

— The ongoing activities In the WGs of CEN/TC 351 however do not influence the scope of the present TR, i.e. to give a more general picture.

3.1 Introduction

This Technical Report covers the points included in the TR 2-description in the CEN/TC 351 Business plan and its Work Programme in response to mandate M/366[4], taking into account the specifications given in the Mandate 366 to CEN[5]. The main points from this assignment can be summarized as:

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[4] This Technical Report (TR), taking into account the state of the art in the Member States, identifies the role of testing in the assessment of construction products in view of possible emissions and makes recommendations on the testing procedures. The TR reviews in accordance with the experience already gained, the basis for deciding whether or not the use of horizontal test method standards for construction products is practicable and/or necessary in the sense of article 7.2 of the Construction Products Directive, and the Guidance Papers, in particular Guidance Papers H and M.
The Technical Report also recommends how harmonized technical specifications (e.g. harmonized product standards) should address the subject of regulated dangerous substances. The TR also recommends how the expertise of product Technical Committees and EOTA Working Groups can be used when drafting the horizontal test method standards. The TR provides recommendations for complete testing procedures in the overall framework according to the methods for the Attestation of Conformity.

[5] Taking into account the state of the art in the Member States, recommendations shall be elaborated for the testing procedures. The testing procedure shall address the following questions: 1) For which products are measurement/test schemes relevant in regard to indoor air, soil surface water or groundwater? 2) How to define clusters of products that behave similarly in release tests (release scenario)? 3) For which substances or products is the measurement/test of the content relevant? 4) How to combine individual measurement and test methods to an appropriate test programme to allow the determination of the relevant properties and to allow the assessment of the results.
This Technical Report shall review in accordance with the experience already gained the basis for deciding whether or not the use of horizontal standards for construction products is practicable and/or necessary in the sense of the CPD art. 7.2. The report shall include the mechanism by which required amendments of horizontal standards or in special cases vertical standards are identified for specific products or product families. In particular it shall identify the procedures and limitations for amending horizontal standards and describe the justification process for vertical standards. Attention shall be given to the intended use conditions as well as to the required specific use conditions for certain products especially in the definition of the testing conditions in order to allow for an adequate assessment.
The report shall also recommend how harmonized technical specifications should address the subject of regulated dangerous substances, and how the measurements of emission of regulated dangerous substances are included in its

Recommendations on testing procedures (3.2)

— The role of release/emission tests in the assessment of products and recommendations of test methods (3.2.1).

— Identification of products for measurement/test schemes relevant in regard to indoor air, soil, surface water and groundwater (3.2.2).

— Definition of clusters[6] of products that behave similarly in release tests (basic release scenario) and therefore can be assessed by one horizontal standard (3.2.3).

— Relevant substances or products for content measurement/test (3.2.4).

— Combination of individual measurement and test methods to an appropriate test programme to allow the determination of the relevant properties and the assessment of the results (3.2.5).

Recommendations regarding the implementation of testing procedures in the overall framework of the CPD (3.3)

— Review of the suitability of horizontal test standards for construction products (3.3.1).

— Mechanisms for the identification of required amendments of horizontal standards or in special cases vertical standards for specific products or product families (3.3.2).

— The role of intended use conditions in the definition of test conditions (3.3.3).

— Solutions for harmonized technical specifications: recommendations for addressing the subject of regulated dangerous substances and for inclusion of the measurements of emission of regulated dangerous substances in their testing programme (3.3.4).

— Use of the expertise of product Technical Committees when drafting the horizontal test standards (3.3.5).

— Recommendations for complete testing schemes which take into account all relevant elements according to the methods for the control and attestation of conformity according to Annex III of the CPD (3.3.6).

When judging the relevance of construction products for environment and health it was not possible to investigate in detail all currently applicable regulations for ER 3 in the member states for this report. Therefore the assessment of the relevance of products has been carried out on technical grounds. Before the horizontal test concept proposed in this report can be applied to any certain product covered by a hEN further administrative steps are necessary. It is expected that the European Commission will amend the standardisation mandates for construction products under the CPD step by step during the next years. For the preparation of the mandate amendments the applicable notified regulations will be scrutinised more thoroughly than was possible for this report. Therefore not all construction products identified as relevant here may necessarily be affected by the mandate amendments in the future. Only the construction products covered by mandate amendments for ER 3 need or are allowed to implement ER 3 in CE marking in the future.

The document CEN/TC 351 N 0230rev (´indicative list of regulated dangerous substances´) lists substances and parameters, which CEN TC 351 should look at when assessing the availability of test methods and the need for developing harmonised test methods. With this document the Commission and its Expert Group on

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testing programme. The report shall also recommend how the expertise of product Technical Committees can be used adequately when drafting the horizontal test standards. Recommendations shall be elaborated for complete testing schemes which take into account all relevant elements according to the methods for the Attestation of Conformity (see Annex III of the CPD).

6 Please note that the concept of clusters may not lead to any contradiction with the requirements of the main part of mandate M/366. Especially the clusters must be compatible with horizontal test standards.

Dangerous Substances in the field of Construction Products (EGDS) provide guidance as foreseen in Mandate M/366 for CEN/TC 351 and all product TCs and EOTA WGs in the construction sector. The term ´substances´ in this report refers to the substances listed in document N 0230[rev].

3.2 Recommendations on testing procedures

3.2.1 Release/emission[7] tests

This subclause describes the role of release/emission tests in the assessment of products and gives recommendations for release/emission tests.

The use of release/emission tests as a tool for the assessment of the environmental and health effects of construction works and the construction products used in them has been increasing during the last decade. Some EU Member States refer to emission tests in a binding way in their building regulations. CEN/TC 351 has provided harmonised draft standards for three release/emission tests that have been used most widely so far. These release/emission tests are described in detail in Clause 4. CEN/TC 351 recommends the use of these release/emission tests when implementing the essential requirement ´Hygiene, health and the environment´ of the CPD in harmonised technical specifications for construction products. The test methods for radiation are not addressed here.

Mandate M/366 requires the horizontal, harmonised methods to be based on existing test methods/standards as far as possible. The general requirements for horizontal standards used to test/evaluate construction products on their emission of dangerous substances in their intended use conditions under the CPD are the following:

— Integrate the requirements of current valid, notified regulations on emission of dangerous substances applicable to products and/or construction works;

— Make use of existing test methods for release/emission from construction products;

— Provide for tests that are efficient, precise enough, reliable and applicable for the products to be tested;

— Take into account current developments in legislation and in evaluation of release/emissions as far as they are well enough established to be included, without extra development time;

— Include a ´hierarchy of testing´ in line with the methods for the control of conformity under the CPD, i.e. a reference test used for initial type testing (ITT) and a simplified test for factory production control (FPC);

— Cover construction products mandated under the CPD.

The tests recommended in Clauses 4 and 5 have been chosen and amended in line with these requirements.

3.2.2 Relevant products

3.2.2.1 General

All products mandated under the CPD are obliged to fulfil ER3. The mandate M/366 refers to products that (1) are or risk becoming subject to technical barriers to trade arising from regulated dangerous substances and (2) influence the satisfaction of ER3 by the construction works, in which they are incorporated in. This clause identifies products that are potentially relevant in regard to indoor air, soil, surface water and groundwater due their intended use and the nature of the products. Only the currently starting revision process of the product mandates will actually show, whether tests for these products will become relevant in a mandatory context.

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7 The terms ´emission´ and ´release´ have fundamentally the same meaning. However it is convention to use the term ´emission´ when describing liberation of chemical substances or radiation into indoor air and to use the term ´release´ when describing the liberation of chemical substances into soil, surface water or ground water (see CEN/TC 351 N 0218).

The lists presented in Annex A contain the product groups that have been considered by TG 2. The information presented is based on a questionnaire enquiry of CEN construction product TCs and EOTA [4] as well as on other available documents from the EGDS, CEN and EOTA[8]. For some products or product groups content regulation may imply that the content of one or more specific substances be measured. In this report that issue is not addressed for product or product groups that are not susceptible for release or emission of dangerous substances,

The horizontal tests to be harmonised for assessing release into soil, surface and groundwater and emissions into indoor air need to be applicable to as many products covered by regulation as technically feasible. A preliminary assessment is made whether construction products covered by CEN/TCs and EOTA WGs may potentially release substances to soil, surface water and groundwater or emit into indoor air during service life. The main criterion to judge relevance beyond the regulatory requirements is whether the product is, under conditions of intended use, used outdoors and exposed to soil, ground, rain and/or surface water or indoors in contact with indoor air. From 65 CEN/TCs and 32 EOTA WGs identified by CEN/TC 351 as belonging to the construction sector, not all deal with products that may potentially release substances to soil, groundwater and/or surface water or emit into indoor air (see Annex A).

3.2.2.2 Products relevant for soil, surface water or groundwater

Based on technical considerations (see [4]), products that may immediately release substances to soil, surface water and groundwater are deemed relevant. Constituents that may contribute to release as a part of another product are deemed relevant, when they are mandated under the CPD and covered by independent hEN or ETAs. Such constituents are treated as products under the CPD.

Products only used in interiors or embedded in structures without water contact do not release substances into soil or water during service life and are therefore not considered relevant here.

Tables 1 and 2 in the Annex A show the mandated work under the CPD in the CEN/TCs and EOTA WGs. The mandates that cover products with potential leaching into soil or water during service life have been grouped together. Some mandates cited in the tables may cover products that are used both outdoors and indoors. Tables 1 and 2 have an informative character and are intended to give a broad overview.

The products identified as not relevant with respect to their impact to soil, surface and groundwater during service life, are as expected now, due to their intended use, not submitted to regulation. Here no testing for this aspect is required. However, regulations on the content of dangerous substances may apply also to these products.

3.2.2.3 Products relevant for indoor air quality

Tables 3 and 4 in the Annex A show the mandated work under the CPD in the CEN/TCs and EOTA WGs. The mandates covering products groups with potential emissions to indoor air during service life have been grouped together. Some mandates cited may cover products that are used both indoors as well as outdoors. Construction products not used in interiors are not considered relevant for indoor air quality. Tables 3 and 4 have an informative character and are intended to give a broad overview.

3.2.3 Clusters of products

3.2.3.1 General

3.2.3 defines clusters of products that behave similarly in release tests (basic release scenario) and therefore can be assessed by one horizontal standard.

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[8] By the end of 2009 the discussions in the EGDS on paints had not yet reached a conclusion. Paints are therefore not considered in this CEN Technical Report.

3.2.3.2 Release scenarios for soil, surface water and groundwater

A release scenario describes for a certain product category with the same general properties (i.e., impermeable surface, low-permeable, permeable) the dominant release mechanism expected in practice. Based on the fundamental mechanisms that determine release of substances, a basic distinction is made between construction products that are granular (percolation dominated release) or monolithic, plate like or sheet like (surface area related and mass transfer controlled release). Within the group of monolithic, plate like or sheet like construction products distinction is made between products with impermeable surfaces (like metal sheets) and products with measurable porosity and thus diffusion based release behaviour. So three clusters of products are distinguished.

Three horizontal release scenarios and a horizontal test suitable for each scenario / group of construction products respectively are recommended as described in detail in Clause 4.

For the vast majority of products and product groups the distinction granular/monolithic is straightforward. For materials for which the distinction granular/monolithic is not straightforward (e.g. metal plates, heterogeneous and coarse granular material) recommendations have been included in the horizontal test methods described in Clause 4.

Within the basic release scenarios further specifications can be made without the need of changing the main test procedure and the main basic scenario description.

3.2.3.3 Emission scenario for indoor air

For indoor air, there is consensus that one "basic emission scenario" can be used to cover all emission situations. Products used in interiors can be dealt within a single cluster. It was not considered necessary to build finer clusters. The chosen horizontal scenario is described in the horizontal draft standard currently accepted by CEN/TC 351 as a draft, ready for robustness validation. The draft standard is based on the test procedure so far established in the EN ISO 16000 series (see [19] to [23]). The different contributions of products to indoor air quality are addressed with appropriate loading factors in the reference room. The loading factors reflect the average area covered by a product. In the basic emission scenario the products are tested in the form or in the way as specified in the hEN or ETA, in direct contact to indoor air.

The possible decrease of emissions through covering layers is not taken into account unless the assembly, including the cover, is specified in the hEN or ETA.

3.2.4 Measurement of content of dangerous substances

This subclause describes in which cases the measurement of content is relevant for substances or products.

NOTE A content test may be carried out directly also for products used as constituents for other products (e.g. cement) whereas for a leaching test only a test on the final product (concrete) would be necessary to reflect the release situation.

For all construction products general regulations in the EU or in individual member states on substances that fall under restrictions on the manufacture, placing on the market and use are equally applicable. Many content regulations apply independently of the intended use to all products. Methods that may possibly be needed to demonstrate compliance with these general or product based regulations will be covered by a Technical Report on content (see CEN/TR 16045:2010 "Construction products – Assessment of release of dangerous substances – Content of regulated dangerous substances – Selection of analytical methods").

In addition to control of compliance with legal requirements, methods based on content should be used when an assessment of release is not possible, or deemed to be too expensive or not practicable.

3.2.5 Test programme

This subclause describes how to combine individual measurements and test methods to an appropriate test programme to allow determination of the relevant properties and to allow the assessment of the results.

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Testing for release/emission of dangerous substances from construction products consists of several fixed steps, the measurement chain. In short, it starts with the sampling procedure, it is followed by storage and test portion or specimen preparation, conducting the test, analysis of the eluates or measurement of concentration in test chamber air and finally, reporting the results.

The horizontal standards of CEN/TC 351 described in Clauses 4 and 5 cover as far as practicable all the steps of the measurement chain as illustrated in Figure 1. The recommended emission/release test standards are normative. For details of the sampling steps of the measurement chain guidance will be provided for the adaptation to the specific features of different products (foreseen for the forthcoming TR on Complement to sampling). For specific items in the standards options are foreseen for a product TC to select (and apply) according to the provided criteria. The mandate M/366 requires the horizontal standards developed under the mandate to make use of existing standards wherever possible. This is done by the conventional normative reference method which allows for incorporation of existing standards (or their parts) with amendments where necessary.

For each step in the test programme shown in Figure 1, a toolbox with horizontal test modules exists or is under development in CEN/TC 351, each covering a specific parameter, a specific set of parameters or a specific technique (e.g. a technique for extraction of inorganic substances and one or more techniques for extraction of organic substances). For each step in each required measurement, a TC shall select the relevant module(s) from the toolboxes made available. CEN/TC 351 will establish criteria and guidance for selection of the proper test modules. In cases where the horizontal modules cannot be made to fit for specific products, solutions should be found in cooperation between product TCs and CEN/TC 351.

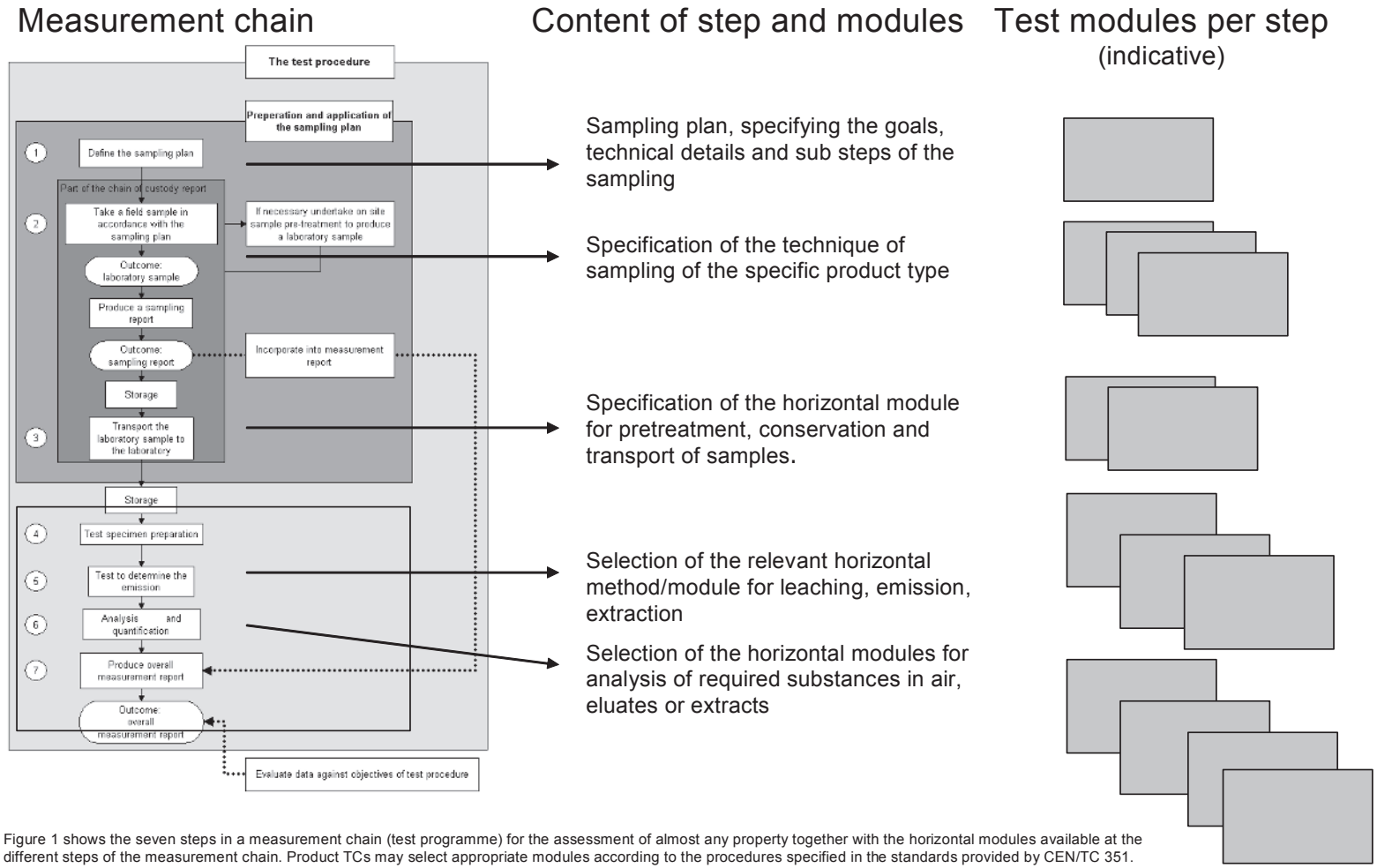

Figure 1 shows the seven steps in a measurement chain (test programme) for the assessment of almost any property together with the horizontal modules available at the different steps of the measurement chain. Product TCs may select appropriate modules according to the procedures specified in the standards provided by CEN/TC 351.

Figure 1 — A schematic test programme

3.3 Recommendations regarding the implementation of testing procedures

3.3.1 Horizontal standards

This subclause presents a review in accordance with the experience already gained on the practicability and necessity of the use of horizontal test standards for construction products in the sense of article 7.2 of the CPD[9].

The horizontal test methods currently recommended by CEN/TC 351 are based on methods that have been used widely for a number of years. There is already much (worldwide) experience with them for many different construction products. Test methods that are based on similar principles as the tank leaching test and the percolation test now drafted by CEN/TC 351 are since 1995 directly referenced in Dutch construction products regulation. In Germany the tank leaching test has been in use since 1997. The test chamber method has been applied for voluntary labels in various countries since 1999 and in the mandatory "Principles for the health assessment of construction products used in interiors" in Germany since 2004. The experience and data from a wide range of products show that horizontal standards for construction products are practicable[10]. Their use is necessary to achieve harmonisation and for the sake of efficiency, credibility and saving costs.

Once the harmonised, horizontal tests are available their use is encouraged also in such exceptional hEN that have already – in the absence of harmonised test methods – referred to product-specific test standards for environmental properties. The test protocol for treated wood developed in OECD for tests under the Biocidal Products Directive is very similar to the horizontal tank test of CEN/TC 351. For treated wood the OECD method may be the method of preference also under the CPD.

3.3.2 Adaptations for specific products

3.3.2.1 General

In this clause, the procedure to identify the necessity of amendments of horizontal standards or the need for vertical standards for specific products or product families is described.

Vertical tests (tests specific for a product, substance or specific release scenario) are not considered necessary to cover environmental aspects under the CPD for the time being. Vertical tests are normally intended to simulate the release behaviour under typical intended use conditions. From the point of view of harmonisation and costs vertical tests are undesirable. For regulatory purposes under the CPD the benefit of horizontal tests is the comparability of test results between different products.

Horizontal modules that are adapted to fit for a specific product may sometimes be needed. Examples are (in the order of the steps in the measurement chain):

— Sampling – specific products may require a specific approach;

— Storage and sample preparation – e.g. reducing properties of a product may require measures to prevent oxidation;

— Testing – slight product specific adaptations to the recommended test protocols may be necessary (e.g. for solid metal products);

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9 CPD, Article 7.2: The resulting standards shall be expressed as far as practicable in product performance terms, having regard to the interpretative documents.

10 CEN/TC 351 will take the validation data available for the established test methods into account when planning the validation phase of the horizontal standards that are currently under development in CEN/TC 351.

— Chemical analysis – e.g. bituminous material, wood and plastics may require measures that are different from predominantly inorganic material.

If it turns out that a horizontal test is not possible for a certain product or substance, product TCs are asked to consult CEN/TC 351. Vertical tests for one product group are deemed acceptable only after checking whether the intended vertical test is not suitable for other related product groups[11]. This would increase the benefit of the vertical method for harmonisation purposes. Justified vertical tests should also be based on harmonised basic standards for testing such as ISO 554 "Standard atmospheres for conditioning and/or testing – Specifications".

3.3.2.2 Composite products

The proposed tests are easy to apply on products with uniform release behaviour (e.g. a brick, a ceiling panel, a flooring tile). However a product may be composed of different constituents or components[12], often made from different materials, e.g. a door may consist of wood, paint, glass, sealants and metal parts. Such composite products may be tested as a whole, which may require large testing facilities. It may be practicable to test the individual components instead and calculate the release of the composite product. Such a procedure may reduce the necessity of testing composite products, especially when the producers of the desired components/constituents deliver adequate information on the release/emission of their products. However, tests carried out directly on individual constituents may not always be technically feasible. Therefore e.g. the release from cement is assessed with the help of a concrete manufactured for the purpose of the test.

3.3.3 Intended use conditions

3.3.3.1 General

This subclause reflects on the intended use conditions as well as required specific use conditions in the definition of the testing conditions in order to allow for an adequate assessment.

Release tests cannot directly simulate or predict the release behaviour and level of release of a product in a real use situation, because laboratory conditions will always differ from conditions in practice. Many products are fit for use in different conditions, e.g. same doors are used in different houses with a different temperature/humidity and different patterns of change of temperature and humidity over time. Therefore the chosen test conditions are always conventions that differ from the intended use conditions.

The release from a product during service life can be assessed with the help of a few default "release scenarios" in combination with the intended use conditions. At present three basic release scenarios are foreseen for emissions to soil and groundwater, based on product characteristics and resulting differences in the release mechanism. The test procedures deliver data on the levels and characteristic patterns of release of the tested product. For indoor air one basic release scenario reflecting the conditions in an average indoor living environment is considered adequate.

The general release scenarios described in the tests recommended in Clauses 4 and 5 are intended to cover most applications of the products under the CPD. The test results may also be used to calculate expected release in a specified intended use situation that differs from the test conditions.

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[11] CEN/TC 351 will provide guidance. The necessary criteria are not yet available in sufficient detail at the end of 2009. The validation phase of the horizontal test standards of CEN/TC 351 is expected to generate the basis for a precise guidance on this issue.

[12] According to CEN/TC 351 draft Terminology Document (N 0218) a component is a product which is:
- part of a kit or of the assembled system resulting from the use of a kit and
- relevant for the fitness of the assembled system for the intended use referred to in the technical specification of the kit.

NOTE Individual components of a kit or assembled system may be separately available on the market. Such a component may itself, as a construction product in the sense of the CPD, bear the CE marking on its own right on the basis of a product hEN or ETA. Nevertheless, it may need to be assessed again as component of the kit.

3.3.3.2 Intended use conditions of products in contact with soil or water

The characteristics of the construction product, such as its water permeability, and the nature of the contact with or exposure to water under the intended use conditions determine the release scenario of relevance. Therefore an appropriate scenario can be chosen on the basis of the product characteristics, taking the intended use conditions into account. The intended use conditions are a quantitative description, such as: amount of water (mm/y rainfall), angle of exposure, temperature and all other factors that determine the release in practice for a certain intended use. Clause 4 describes the release scenarios and their linkages with intended uses and intended use conditions in more detail.

3.3.3.3 Intended use conditions of products used indoors

In the process of drafting the horizontal standard for testing construction products on their emission to indoor air both EN 717-1 (see [24]) and the EN ISO 16000 series (see [19]) to [23]) and their underlying assumptions on the intended use conditions were considered. The horizontal standard described in Clause 5 is based on the standards published in the EN ISO 16000 series, but EN 717-1 was also taken into account. The harmonised method of CEN/TC 351 is very well applicable when comparing emissions of substances from products and checking compliance with regulatory limits. The results will not exactly correspond with an actual use situation, but represent a reasonable estimate of the possible emissions. The conditions in the reference room are based on a convention reached in a European collaborative action 1997[13]. Factors such as temperature and humidity, the area covered by the product to be tested in a room and the air exchange rate have a significant impact on the emission rate. Fixing the factors of influence is important to achieve comparable test results. The procedures in EN ISO 16000-9 have been adapted by CEN/TC 351 to make the standard more precise and to provide reliable test results for the CPD.

3.3.4 Implementation of tests for dangerous substances in product specifications

This clause describes ways to integrate the topic of regulated dangerous substances into harmonized technical specifications and to include the measurements of emissions of regulated dangerous substances in their test programme.

Guidance for the use of the horizontal tests in product technical specifications (hEN and ETAs) will be given in a follow-up technical report (TR 4, CEN/TC 351 WI 00351004). This CEN/TR will address, on the one hand, the implications of MS notified regulations for assessing and declaring information on the release/emission (or content, where applicable) of regulated dangerous substances from construction products. CEN/TR 00351004 will provide the means for introducing the harmonisation processes into CEN standardisation in a "staged" and manageable manner dealing with the present and looking to the future. CEN/TR 00351004 should give sufficient guidance for selecting, development and integration in hEN of product testing protocols on dangerous substances. This guidance will also include a procedure for complex products consisting of standardised components. If all components have been tested for ER 3, tests for the composite product may be omitted. Guidance for hEN and ETAs that cover products intended as constituents[14] for other products may also be included.

In CEN/TR 15858 [25] classes are recommended for product performance declarations in CE-marking. A "class" can be determined by a maximum level and a statistical definition of the certainty that the limit value of the class is met. Where a member state requires product performance to be declared, the product could be delivered with a reference to a class as far as the classes reflect the regulatory requirements. If no data on performance are required, "NPD" (No Performance Determined) can be declared. The use of classes or levels

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13 See ECA-Report 18: http://www.inive.org/medias/ECA/ECA_Report18.pdf.

14 The contribution of many constituents' release into soil and water can only be assessed by evaluating them as a part of an ´end-use product´, as direct assessment of release from e.g. a powdery constituent like cement bears no relation to its behaviour in its intended use in concrete. However, the constituent hEN is expected to integrate the release test with an end-use product manufactured for test purposes, as far as regulatory requirements exist. For example, the hEN for fly ash for concrete and for aggregates for concrete may need to incorporate a release test to be carried out with concrete manufactured for the test purpose.

to declare the results of the horizontal emission/release tests recommended in this report in hEN and ETAs will be further discussed in CEN/TC 351 WI 00351004.

3.3.5 Co-operation between CEN/TC 351 and product TCs

The use of the expertise of product Technical Committees in the process of drafting horizontal test standards is very important.

Many product TCs have been contributing to the work of CEN/TC 351 through their liaison officers. A further active contribution is sought for the preparation of CEN/TR WI 00351004. Currently construction product TCs are expected to give direct input in selecting, further developing and formalizing test standards, and in determining and evaluating validation (ruggedness testing as well as precision validation)[15]. In the next phase, product TCs have to integrate the tests for ER 3 in the product hENs as far as there are regulations that justify this. CEN/TC 351 encourages an active dialogue with the product TCs to make the horizontal test standards meet their requirements on fitness for purpose.

3.3.6 Compatibility of testing schemes with existing AoC methods

This subclause recommends complete horizontal testing procedures which take into account all relevant elements according to the methods for the Control and Attestation of Conformity (see Annex III of the CPD). The full horizontal emission test methods described in Clauses 4 and 5 are recommended as reference method common to all products for the same intended use (to be used e.g. for initial type testing (ITT) or factory production control (FPC). For factory production control other equivalent test methods ("indirect test" methods[16] with maybe a shorter duration are expected to be feasible.

The same emission tests that are suitable for ITT and FPC are also applicable in combination with other methods foreseen for the control of conformity under the CPD such as:

— Testing of samples taken at the factory in accordance with a prescribed test plan by the manufacturer or an approved body;

— Audit-testing of samples taken at the factory, on the open market or on a construction site by the manufacturer or an approved body;

— Testing of samples from a batch which is ready for delivery, or has been delivered, by the manufacturer or an approved body.

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15 For the different steps of validation see CEN Guide 13 Validation of environmental test methods (available at: ftp://ftp.cen.eu/BOSS/Reference_Documents/Guides/CEN/CEN_13.pdf).

16 According to the draft terminology document of CEN/TC 351 an indirect test is a test used to show performance to be in compliance with the results obtained from a reference test. "Indirect test" methods (also called secondary, alternative, simplified, derived methods) provide within their specific field of application a result comparable or correlated to the result of the complete horizontal reference method. Such methods may be easier to apply and/or cheaper e.g. for factory production control (FPC). They have to fulfil the requirements of mandate M/366 i.e. their comparability or correlation to the horizontal reference test method has been demonstrated in their specific field of application. The precision of this demonstration should be fit for purpose. A precise demonstration is needed when testing close to a limit to be verified and an un-precise demonstration is satisfactory when testing far below a limit to be verified. Also an indirect method derived from the horizontal reference method needs in general a simpler and cheaper demonstration. An indirect method is in general not horizontal, its specific field of application being dedicated and limited to a group of products or to a single product (as specified in a hEN or ETA).

4 Horizontal release/emission tests established by CEN/TC 351 – Background for methodology of horizontal leaching tests to determine the release of dangerous substances from construction products to soil, surface water and groundwater

4.1 Introduction and background

The horizontal standards drafted by CEN/TC 351 will enable the individual CEN Product TCs and EOTA experts to select the appropriate generic measurement procedures in relation to the intended use conditions of the different construction products.

The measurement procedure enables the CEN Product TCs to

— Select the appropriate leaching method to determine the release performance of the given product during the use phase (service life) of the product(s) for the corresponding conventional release scenarios,

— Select or adapt and fill in the necessary product specific boundary conditions for the leaching procedure from the generic horizontal standard.

Both initial type tests (reference methods) and short methods e.g. for factory production control shall be included.

The measurement procedures must be transparent, scientifically sound and reproducible to enable correct interpretation of the results by users and regulators.

Since the performance of leaching tests as well as modelling always require simplification and conventions neither a test nor modelling can mirror the release behaviour of a construction product under service life conditions. By the generic leaching test only an estimate of the release is possible.

The measurement procedure(s) allow the manufacturer to determine the information on the release/emission performance to be provided with the CE marking.

4.2 Common release mechanisms and factors that control release

For a wide range of different construction products under the CPD the number of chemical and physical factors that control the release is limited [3]. Also, the release mechanisms of many seemingly very different construction products are the same. The dominant factors can be identified and quantified with a limited number of initial type testing methods.

An important physical factor that determines the release from a product is its structure: granular or monolithic. Equilibrium or near equilibrium controlled release by percolation is characteristic for fine granular materials and surface related or diffusion-(mass transfer) controlled release is characteristic for monolithic and plate like and sheet like products. Important chemical factors include the pH, redox and acid/base buffering capacity of the product and its environment, and the chemical composition of the surrounding solution. The dominant chemical and physical factors are summarized in Table 1 (for more detailed explanations see references [4], [5] and [6]).

The predominance of common release mechanisms in different products makes it possible to determine release with few horizontal test methods for a wide range of (construction) products and a wide range of exposure conditions. For more details on leaching mechanisms see e.g. references [3], [4], [7], [8], [9], [10], [11] and [12].

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Table 1 — Dominant chemical and physical factors that control the release of substances from construction products [3, 5]

Chemical factors	Physical factors
Intrinsic water solubility of substances (e.g., metal oxides) ´Self´ pH of the product and of its surroundings Acid/base buffer capacity of the product and its surroundings Speciation (chemical form of the substance in the product) Total amount of the substance in the product (relevant for non-reactive, soluble salts) "Availability" of substances in the product (relevant for most other substances, maximum leachable amount is usually lower than total amount) Type and amount of organic ligands (e.g., dissolved organic matter, DOM) to which substances can bind (facilitated release) Type and amount of reactive surfaces (clays, oxides) to which substances can bind Redox potential in the product and of its surroundings Redox buffer capacity Reaction kinetics	Percolation rate (in particular relevant for granular products) Diffusion rate (in particular relevant for monolithic products) Surface runoff rate (in particular relevant for monolithic and plate products) Geometry and size of the product Porosity (volume of pores) Tortuosity (shape factor of pores) Water permeability Sensitivity for erosion Temperature Duration of contact with water

The starting point for the product TCs and manufacturers of construction products will be to allocate construction products to intended use conditions where a release is possible. An evaluation of the characteristics of the product and the water flow in contact with the construction work is the basis for the assessment of the impact on groundwater and surface water. Release of substances (direct leaching) to soil, ground water or surface water is always mediated through water contact. Without water contact there will be no release and no need for environmental assessment.

4.3 Selection of the appropriate test methods

4.3.1 General

Construction products are often intended for many uses. The release from the product is controlled by the different physical and chemical factors in the use conditions (see Table 1). Normally the manufacturer of the construction product has an interest to allow the use in many applications or conditions. An ideal test method covers as many conditions as possible. Conventions are necessary to define simplified release scenarios that cover most applications and to allocate each to a test method [4].

The selected test methods for any product should reflect the presumed dominant release mechanism in practice. The *general* product properties (monolithic, granular, and uncoated metallic surfaces) as well as a limited number of *specific* product properties (such as dimensional stability, hydraulic permeability) in their "intended use" determine the release mechanism. Therefore the product properties are decisive in test selection.

The "general" product properties such as shape, size and composition of the product in its intended use are easy to determine. These general properties already imply the predominant release mechanism in practice. The specific properties can be determined as a refinement to ensure that the selected test method reflects the presumed dominant release mechanism in practice.

The main release mechanisms are percolation dominated release (granular products) and mass transfer limited (surface area related) release (monolithic products). Release from metal plate material is determined by solubility.

In Figure 2 a selection scheme is given with choices based on particle size, porosity and permeability of the matrix. A more detailed scheme will be drafted within the generic leaching standards (TS-1, [13]). The scheme and the normative criteria to be set for test selection are currently finalised in CEN/TC 351/WG 1.

Two basic tests can be identified: the dynamic surface leaching test (DSLT or tank test; TS-2, [14]) and the percolation test (TS-3, [15]). The compacted granular leaching test (CGLT) is a refinement of the tank leach test for non-permeable compacted granular materials (e.g. dense clay; Annex in TS-2). In the validation phase the method will also be examined for materials like coarse slags and crushed stones from recycled construction debris.

Figure 2 shows the three steps of test selection according to the draft TS-1:

Step 1: Identification of products that may potentially emit dangerous substances to soil, surface water and ground water

Obligations for release tests for construction products may arise when the standardisation mandates to CEN are amended by the European Commission to include regulated dangerous substances relevant for the specific products. In EOTA the product experts are expected to identify the products that may release to soil and/or surface water due to the contact with water during the use phase without specific guidance in mandates.

Step 2: Selection of test method based on general product properties

The appropriate test method can be selected with the help of "general" product properties and a further refinement by "specific" product properties as indicated in Figure 2. The basic question is whether the product in its intended use shows release through:

— mainly percolation: all "granular" products

— mainly diffusion: all low permeable, "monolithic" or "sheet" products

— mainly solubility: bare (uncoated) metallic surfaces.

These three categories of general properties correspond each to one of the (presently) three "release scenarios". The release scenario is a description of the dominant release mechanisms expected in practice for a certain product category with the same general properties. Each release scenario is associated with one or two test methods:

— Release scenario I (impermeable; solubility): still under discussion TS-XX

— Release scenario II (low permeable; diffusion): tank test TS-2

— Release scenario III (permeable; percolation): percolation test TS-3.

Step 3: Special cases in which specific properties determine the test methods

For a few relevant "specific" product properties, the release mechanism may be different than inferred from the general product properties. These properties are currently under discussion in CEN/TC 351/WG1.

The final rules and criteria for test selection will be available, when the work on TS-1 has been finalised.

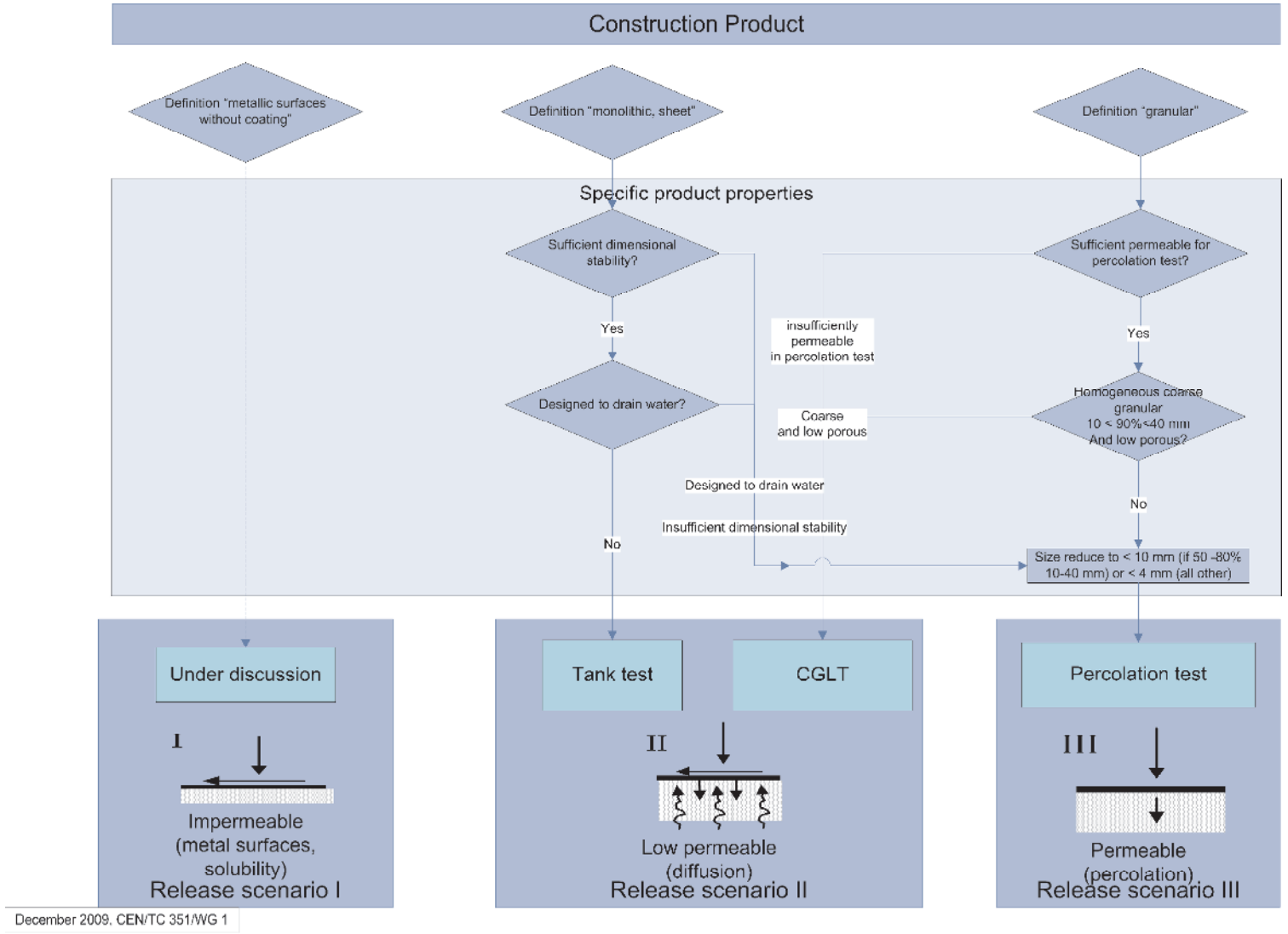

Figure 2 — Proposed scheme for selection of a test to determine the release performance of a construction product [13] (status at the end of 2009, under discussion in CEN/TC 351/WG 1)

4.3.2 Principle of the dynamic surface leaching test (TS-2)

The release from monolithic products is mainly limited by diffusion from the internal matrix to the surrounding water phase, and is thus related to the exposed surface area of the product.

The dynamic surface leaching test (DSLT) as drafted in TS-2 [14] is a method to determine as a function of time the release of substances from a monolithic, plate-like or sheet-like product with a leachant in contact with its surface. The source of this method is a the DMLT-PLR (FprCEN/TS 15863 Characterisation of waste - Leaching behaviour test for basic characterisation - Dynamic Monolithic Leaching Test with periodic leachant renewal, under fixed test conditions [16] and other similar validated national standards such as NEN 7375 "Leaching characteristics - Determination of the leaching of inorganic components from moulded or monolitic materials with a diffusion test - Solid earthy and stony materials" [26].

The test portion of the product is placed in a reactor/leaching vessel and the exposed surface is completely submerged in a leachant. The leachant is introduced in the reactor up to a given volume of liquid to surface area ratio (L/A ratio), at a given temperature and renewed at predetermined time intervals.

The following test conditions are fixed:

— The type of leachant;

— The temperature;

— L/A ratio (ml/cm^2);

— The total duration of the test;

— The number of eluates to be collected at fixed time intervals.

The eluate is collected in a fixed number of separate fractions. The eluate collection scheme is designed such that release mechanisms can be deduced from the analytical results.

The eluate fractions are filtered (centrifuged in the case of organic substances), and characterized physically and chemically according to existing standards.

The results of the test are expressed as a function of time, in terms of both mg of the substances released per litre of eluate, and mg of substances released cumulatively per m^2 of geometric surface area of the material exposed to leaching.

The test conditions (L/A ratio, leachant renewal scheme) have been designed such, that the identification of leaching mechanisms and their relative importance is enabled.

The CGLT (Figure 2) is an adaptation of the tank test to products with specific properties as listed in step 3, namely low-permeable granular products (clayey, paste-like products). It is described in an Annex of TS-2.

4.3.3 Principle of the percolation test (TS-3)

The release from granular products occurs mainly through percolation of water through the product and subsequent uptake of substances.

The percolation test TS-3 [15] is a method to determine the release of substances from a construction product, with or without size reduction, packed in a column with a leachant percolating through it. The source of this method is CEN/TS 14405 [17] and other similar validated national standards such as NEN 7375 "Leaching characteristics - Determination of the leaching of inorganic components from moulded or monolithic materials with a diffusion test - Solid earthy and stony materials". Pre-equilibration is applied to reach local equilibrium at the start. The column size is related to amount of eluate needed for subsequent analysis and testing. A continuous vertical up-flow is used, so that the column is water saturated. The test conditions, including the

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flow rate of the leachant, enable a conclusion to be drawn from the results as to which substances are rapidly being washed out and which substances are released under the influence of interaction with the matrix.

The test portion of the construction product to be tested is packed in a column in a standardized manner. The leachant is percolated in up-flow through the column at a specified flow rate up to a fixed L/S ratio. The eluate is collected in several separate fractions that are characterized physically, chemically and possibly ecotoxicologically according to existing standard methods. In the test, equilibrium conditions for inorganic substances at the outlet of the column are verified after an equilibration period by measuring a pH deviation. The leaching conditions in terms of pH, conductivity, turbidity (when measuring the leaching of organics) or DOC and optionally redox potential dictated by the material shall be recorded for each fraction.

4.3.4 Principle of the metal plate test

CEN/TC 351 is planning to include an appropriate test method for metal plates in its tool box, if deemed necessary. The available information is currently being evaluated. The discussions have not been conclusive yet.

4.4 Release scenarios

The “release scenario” reveals for a certain product category with the same general properties (i.e. impermeable surface, impermeable, permeable) the dominant release mechanism expected in practice. Each release scenario corresponds to one or two associated test methods (Figure 2).

The following three conventional release scenarios have been identified as relevant for construction products (see also Figure 2):

— Scenario I – Surface related release (external surface) - scenario and test method still under discussion in WG1.

  Water is redirected at the surface of the product. The release is mainly governed by slow dissolution of the product. This scenario mainly applies to metallic surfaces that show solubility controlled release. The scenario is also relevant for products used underground, or submerged into water. For example foundations such as steel piles covered with zinc (galvanized steel is commonly used as corrosion protection) used in ground or in water fall under this scenario[17].

— Scenario II – Matrix related release (internal surface/surface of composing grains)

  Water is transported into the matrix by capillary forces, and a fraction may be redirected at the surface of the product. In the matrix the capillary force is considered to be significant and the water movement is slow. Dissolved substances are transported out of the matrix by (capillary driven) advection and diffusion. At the surface substances will precipitate. This scenario is relevant for typical monolithic products used above ground, under ground, or submerged into water. For example, tiles (non-glazed), bricks, concrete, and pipes fall under this scenario.

— Scenario III – Combination of surface and matrix release

  Water may infiltrate into the matrix driven by gravity (pressure head gradient) and a fraction of the water may be redirected at the surface of the product. The main transport process is advection through the matrix with the gravity driven flow. Transport with any water that is redirected at the surface is considered to be negligible (for this reason the horizontal arrow has been omitted in Figure 2, pictogram III). For example, aggregates used above ground or under ground, or submerged into water fall under this scenario.

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[17] Metallic surfaces that are coated with an impermeable synthetic liner (e.g., PVDF) fall into scenario II. Also glass, PVC etc. fall in scenario II as their release is controlled by diffusion and is not simply an initial wash off.

The mode of water contact has clear links to the appropriate test method to be used in the determination of the release rate from the construction product, thus the test method can be allocated to the three release scenarios as done in Figure 2. Note that all three scenarios are relevant for products used above ground, under ground, submerged into water or have temporary contact to water. The characteristics of the construction product determine which scenario is relevant.

Together the release scenario, the test result and the intended use conditions can form the input for a mathematical (model) description of the actual release in practice.

The roles of the different involved parties are the following (Figure 3):

— CEN/TC 351 is responsible of establishing the appropriate release scenarios and development of the corresponding test methods.

— The product TCs have the responsibility to provide a qualitative description of the intended use of the product, and to provide the information to be used for CE marking, such as test results.

— The regulator is responsible for consistent release criteria, to be specified for different intended use conditions as far as practicable.

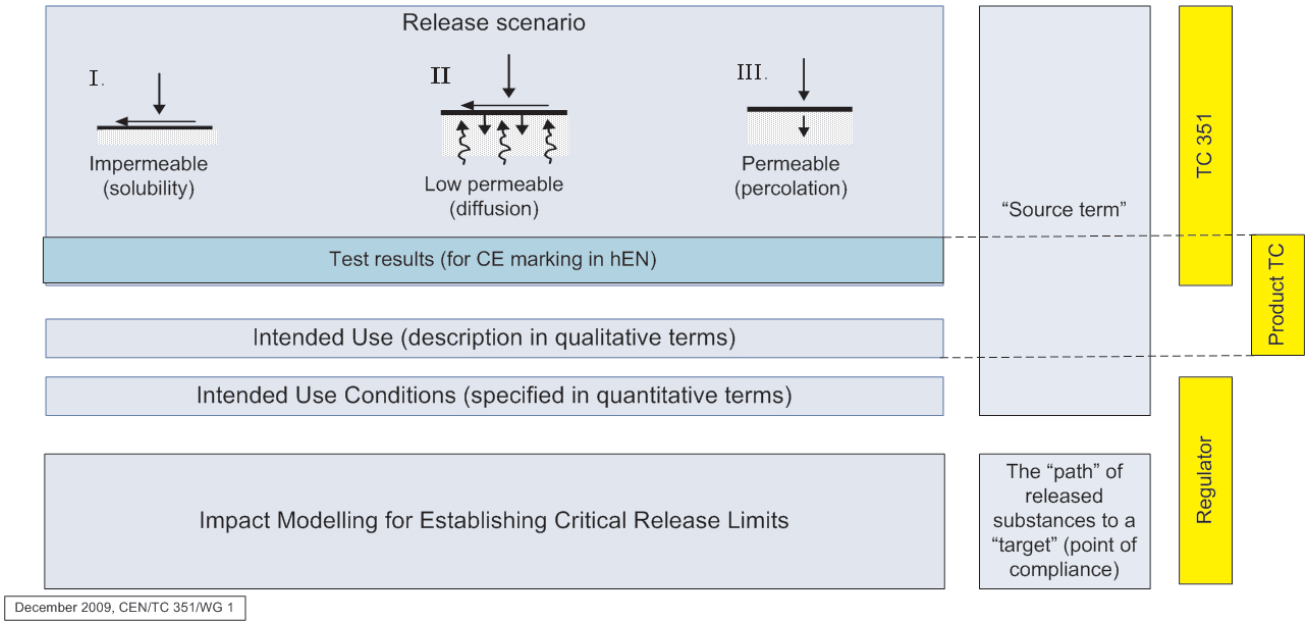

Figure 3 — The use of release scenarios in the standardisation and regulatory context

4.5 Conclusion

Based on knowledge of leaching behaviour of construction products and the existing practice of using construction products three generic release scenarios were identified to be relevant for most construction products. To these generic release scenarios two horizontal leaching methods could be allocated. For monolithic construction products the recommended method is the Dynamic Surface Leaching Test (DSLT; covered in TS-2) and for granular construction products the Upflow-Percolation test (TS-3).

The normative criteria and necessary conditions for the selection of the appropriate leaching test for the several construction products are described in TS-1 [13]. The drafts of the two generic methods (TS-2 and TS-3) were finalised bythe end of 2009. The validation programme of CEN/TC 351 shall further clarify the selection of certain parameters during the tests.

5 Horizontal release/emission tests recommended by CEN/TC 351 – Background for methodology of horizontal chamber tests to determine the emissions of dangerous substances from construction products into indoor air

5.1 Introduction and background

In this clause the principles for the testing procedure, elaborated for emissions into indoor air in CEN/TC 351 as an answer to mandate M/366, are described. For products used in interiors a single release scenario has been chosen. This release scenario covers all mandated products under the Construction Products Directive, which may come, directly or covered, into contact with indoor air. The differences in emissions caused by the differences in room area covered by a single product are addressed with different loading factors in the underlying reference room and in the test chamber.

The generic horizontal draft standard developed by CEN/TC 351 [18] enables the individual CEN Product TCs and EOTA experts to apply the measurement procedure with a loading factor appropriate to the intended use conditions of their product. The objective of the measurement procedure is to allow the product TC to determine the information on the emission performance to be provided with the CE-marking, where this is required in the product mandate given to CEN by the European Commission.

When regulating emissions from construction products into indoor air, the EU member states are currently targeting mainly volatile organic compounds (VOC[18]) and formaldehyde. Emissions from building products are usually determined in special measuring chambers consisting of inert materials, such as glass or steel, and operated at a standardised climate. In Europe at the moment, the most relevant VOC and formaldehyde testing standards in use are (the ISO standards of the 16 000 series are also available as EN ISO):

— ISO 16000-3 Formaldehyde and other carbonyl compounds in air analysis [19]

— ISO 16000-6 Analysis of volatile organic compounds in air [20]

— EN ISO 16000-9 Operation of emission test chamber [21]

— EN ISO 16000-10 Operation of emission test cell [22]

— EN ISO 16000-11 Preparation of test specimens [23]

— EN 717-1 Formaldehyde emission testing for E1 classification[19] [24]

On the basis of the current state-of–the-art Working Group 2 of CEN/TC 351 has prepared a draft harmonized umbrella standard for determining emission of regulated dangerous substances into indoor air. In the draft standard only one emission scenario is specified. The scenario defines a set of climate and ventilation conditions that are generally agreed to be representative for the use of a construction product in "normal" indoor environments, such that all construction products can be evaluated under comparable conditions. These defined conditions assume a standardised installation of the product in a reference room with standardised dimensions, climate and ventilation. The actual condition(s) of use in reality may be different. It is not considered possible or appropriate to evaluate emissions by testing in all possible use situations.

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[18] Volatile organic compounds (VOCs) are gases or vapours emitted by various solids or liquids, many of which may have short- and long-term adverse health effects if a certain dose or concentration is exceeded. Products that emit VOCs into indoor air include paints, paint strippers, cleaning supplies, glues and adhesives, wall elements, wall coverings, floor coverings, building materials made of plastics and wood, wood-based panels, and furnishings. Consequently, concentrations of many VOCs are higher indoors than outdoors. VOCs are organic chemical compounds that have high enough vapour pressures under normal conditions to significantly vaporize and enter the atmosphere. A wide range of carbon-based molecules, such as aldehydes, ketones, alcohols, glycol ethers, and hydrocarbons are VOCs.

[19] Targeted to determine steady-state concentration as required in many regulations for products where the binder releases formaldehyde continuously due to hydrolysis with air humidity.

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The method of measuring emission of VOC is roughly divided into two steps. The first step is the sampling of substances which emit from the product (test specimen) using an emission test chamber under controlled climate conditions. A small amount of clean air is continuously supplied into the air tight chamber. After a certain time, a sample of the exhaust air is taken by passing it through an adsorption tube. The chemical analysis of the air sample collected in the adsorption tube reveals the concentration of single VOCs in the sampled air. From this the specific emission rate is calculated: mass of the volatile organic compound emitted per time unit and per area unit (e.g. µg/h $\times$ m^2). The end result can also be expressed as the VOC concentration in the air of a reference room.

The forthcoming harmonised EN testing standard started with ISO 16000 series principles, but added detailed specifications for improving reliability and reproducibility of testing when more than one laboratory is involved. Further refinements can be expected after the validation programme of CEN/TC 351 has delivered additional information. Where ISO 16000 and EN 717-1 are using different testing parameters, it was tried to find a compromise.

5.2 Principles

5.2.1 From product sample to test specimen

EN ISO 16000-11 specifies that a sample shall be taken from production as early as possible. The new EN draft standard specifies the same principle in a more precise way. The 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. With this adjustment the emission test will reflect the emissions of the product in its use phase more precisely.

A sample shall be selected for being representative for the whole production volume. The EN ISO 16000-11 standard remains vague on this issue, while the new EN standard intends to give more specifications on the basis of guidance from the forthcoming TR ´Complement to sampling´. Currently a strategic sampling approach is favoured for the indoor air scenario. 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, 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 and not relevant in practice. It will be up to the product specific TCs to specify how to deal with that issue in accordance with their product specification and with the guidance/requirements provided by CEN/TC 351 for instance in the forthcoming TR "Complement to sampling" prepared by CEN/TC 351/TG 4.

The test specimen then is placed immediately into a test chamber. The new EN draft 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. Such products shall be pre-conditioned in a separate test chamber with similar climate and ventilation conditions as in the test chamber.

5.2.2 Reference room and loading factor

A result of an emission test is at first obtained as specific emission rate per hour and per m² surface (or per kg or per m³ product or per unit of product). From this the contribution of the emission from the product to the concentration in the air of the reference room air concentration is calculated. While EN ISO 16000-9 refers to a small reference room (7 m² surface and 2,49 m high), the new EN draft 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 defines the loading factor for the product in the reference room, e.g. for a flooring as 12 m²/30 m³ = a loading factor of 0.4 m²/m³. 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.

If product TCs or EOTA WGs during the process of making their standards find they do not agree with the resulting loading factors, they may suggest to CEN/TC 351/WG 2 other loading factors better representing the intended use conditions of their products as specified in their product standards (hENs), or in ETAs.

5.2.3 Test chamber operation

The test chamber shall simulate the set reference room parameters. While EN ISO 16000-9 just requires that the ratio between air change rate and room volume shall be kept as in reference room, the new EN draft standard allows the ventilation rate and the loading factor in the test chamber to be varied independently from each other. The range for variation is kept narrower though. On the basis of the measured emission rate the tested product's contribution to the reference room air concentration is calculated. Differences in chamber size are allowed, since previous studies indicate that the emission rate of a product does not differ when tested in a large and/or in a small chamber. For details of test chamber operation, see Table 2.

The compatibility of the different standards shown in Table 2 allows integrating several testing purposes into one test setup. The relative humidity range was specified as including both EN ISO 16000-9 and EN 717-1, and an acceptable temperature range was set narrower than in EN ISO 16000-9, but broader than in EN 717-1.

Table 2 — Test chamber parameters

Parameter	Unit	New draft EN standard	EN ISO 16000-9	EN 717-1
Temperature	°C	23	23	23
Range		± 1	± 2	± 0,5
Relative humidity	%	50	50	45
Range		± 5	± 5	± 3
Ventilation	ach [a]	0,5	0,5	1,0
Range		0,25 – 1,5	Unlimited [b]	± 0,05
Loading factor [c]	m^2/m^3		[d]	1,0
Flooring		0,4	0,4	-
Walls		1,0	1,4	-
Small surfaces		0,05	-	-
Very small surfaces		0,007	0,011	-
Range		± 50 %, but max. 2,0	Unlimited [b]	± 0,02
Air velocity at surface	m/s	0,1 – 0,3	0,1 – 0,3	0,1 – 0,3
Test chamber size	ℓ or m^3	min. 20 ℓ	Not specified	12 m^3, 1 m^3 or 225 ℓ

a Air changes per hour.

b Unlimited, if ratio between loading factor and ventilation is kept constant (the specific ventilation rate $m^3/(m^2 \times h)$).

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

d These are calculated values; EN ISO 16000-9 specifies only the specific ventilation rate.

5.2.4 Air sampling and analysis

The 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[20]. As emissions not necessarily will reach such a steady-state for other substances than formaldehyde and for other products than wood-based panels the new EN draft standard foresees air sampling after 3 days and after 28 days as a standard convention. A proven compliance with 28 days limit values may allow for shorter test duration[21]. These measurement times are in line with EN ISO 16000-9. The sampling duration varies between 25 min and 250 min depending on the sampling flow rate.

The new EN draft 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 litres.

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. The allocation of certain non-identified signals to being inside or outside the TVOC range was subject to discussion. TVOC is defined as sum of all VOC inside the range from n-hexane to n-hexadecane on a 100 % non-polar GC column. 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 µg/m³ and the lowest reliable quantification limit was specified as 5 µg/m³. The TVOCSUM may be determined and reported for 3 and 28 days by summing the individual concentrations of every identified and unidentified component eluting between n-hexane and n-hexadecane inclusively, at a concentration above 5 µg/m³.

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. After further analytical developments the integration of all regulated volatile substances into the horizontal approach is considered possible.

5.2.5 "Indirect" methods

A number of methods applicable for factory production control are referenced in the draft standard. These "indirect"[22] methods are generally simpler, cheaper and/or easier to apply for daily routine use or for monitoring purposes. These methods may be used provided that their results are comparable to the results of the horizontal (reference) method recommended for ITT.

5.3 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. The CEN/TC 351 validation programme 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 the CPD, it may influence the development of standards also for other applications.

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20 The backgrounds for this procedure are the current regulations that require the determination of an equilibrium concentration.

21 In Germany the mandatory limit values for VOC have been defined for 3 and 28 days and in France for 28 days.

22 In the footnote in 3.3.6 information regarding "indirect test" methods is given.

6 Summary and general conclusions

The draft methods for emission/release tests harmonised by CEN/TC 351 and described in this report are expected to meet the requirements set for test methods for ER 3 in Mandate M/366 and in the CPD and its guidance documents for ER 3. The requirement of the mandate M/366 that the mandated measurement/test methods shall have, whenever possible, a horizontal character has been fulfilled. To ensure that the draft standards provide results with a quality that is fit for purpose and meets the criteria of the mandate M/366 a validation is necessary. Assuming the validation provides the expected results, the horizontal methods presented here will be suitable as test methods for ER 3 for harmonised technical specifications under the CPD.

On the basis of the results achieved in CEN/TC 351 so far the following general conclusions are drawn:

— It is possible to implement the concept of horizontal testing widely for construction products.

— It is established that only a small number of test methods are needed to cover the whole field of construction products. These test methods have been identified.

— The need for any particular vertical standard has not emerged.

— The envisaged horizontal test methods are comparable in costs and results with the existing methods.

— Since the number of harmonised test standards necessary to implement ER3 is small, the horizontal test concept is cost-effective.

— The possibility to use "indirect test methods" for FPC is considered important to enable manufacturers to fulfil ER3 with low test costs.

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Annex A

Product mandates and related CEN/TCs and EOTA WGs

Tables A.1 and A.2 show the mandated work under the CPD in the CEN/TCs and EOTA WGs considered by CEN/TC 351 TG 2 to be relevant for potential leaching into soil or water during service life. Some mandates cited below may cover products used both outdoors as well as indoors. Tables A.1 and A.2 have an informative character and may not be fully complete or up to date.

Table A.1 — Product groups under a CEN mandate [23] with potential release into soil, surface water and groundwater

Mandate	Products covered	TCs involved
Structural engineering products for buildings and their constituents		
M/101	Doors, windows	CEN/TC 33 "Doors, windows, shutters and building hardware"
M/102	Membranes	CEN/TC 254 "Flexible sheets for waterproofing"
M/103	Thermal insulation products	CEN/TC 88 "Thermal insulating materials and products"
M/108	Curtain walling	CEN/TC 33 "Doors, windows, shutters and building hardware"
M/112	Structural timber products and ancillaries	CEN/TC 124 "Timber structures"
M/116	Masonry	CEN/TC 125 "Masonry" CEN/TC 241 "Gypsum and gypsum based products"
M/119	Floorings	CEN/TC 67 "Ceramic tiles" CEN/TC 129 "Glass in buildings" CEN/TC 178 "Paving units and curbs" CEN/TC 217 "Surfaces for sports areas" CEN/TC 229 "Precast concrete products" CEN/TC 246 "Natural stones"
M/121	Wall and ceiling finishes	CEN/TC 67 "Ceramic tiles" CEN/TC 128 "Roof covering products for discontinuous laying and products for wall cladding" CEN/TC 175 "Round and sawn timber" CEN/TC 246 "Natural stones" CEN/TC 249 "Plastics"
M/122	Roof coverings	CEN/TC 128 "Roof covering products for discontinuous laying and products for wall cladding"

23 See ftp://ftp.cen.eu/CEN/Sectors/List/Construction/Guidance/TFN337.pdf.

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Table A.1 *(continued)*

Mandate	Products covered	TCs involved
M/127	Adhesives	CEN/TC 67 "Ceramic tiles" CEN/TC 193 "Adhesives"
M/131	Pipes. tanks not in contact with drinking water	CEN/TC 133 "Copper and copper alloys" CEN/TC 155 "Plastic piping systems and ducting systems" CEN/TC 165 "Waste water engineering" CEN/TC 193 "Adhesives" CEN/TC 203 "Cast iron pipes, fittings and their joints" CEN/TC 208 "Elastomeric seals for joints in pipework and pipelines" CEN/TC 221 "Shop fabricated metallic tanks and equipment for storage and for service stations" CEN/TC 266 "Thermoplastic static tanks" ECISS/TC 29 "Steel tubes and fittings for steel tubes"
M/135	Glass	CEN/TC 129 "Glass in buildings"
M/Constr 08/815	ETICS (external thermal insulation composite systems)	CEN/TC 88 "Thermal insulating materials and products"
Civil engineering products for roads, railways, bridges, water construction, pavements, land-fills etc.		
M/107	Geotextiles	CEN/TC 189 "Geotextiles and geotextile-related products" CEN/TC 254 "Flexible sheets for waterproofing"
M/111	Circulation fixtures	CEN/TC 50 "Lighting columns and spigots" CEN/TC 226 "Road equipment"
M/124	Road construction products	CEN/TC 227 "Road materials" CEN/TC 254 "Flexible sheets for waterproofing" CEN/TC 336 "Bituminous binders"
Products for both structural and civil engineering and their constituents		
M/100	Precast concrete products	CEN/TC 229 "Precast concrete products" CEN/TC 177 "Prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure"
M/104	Structural bearings	CEN/TC 167 "Structural bearings"
M/114	Cement	CEN/TC 51 "Cement and building limes"
M/115	Reinforced and pre-stressing steel (for concrete)	CEN/TC 104 "Concrete" ECISS/TC 19 "Concrete reinforcing and pre-stressing steels"
M/118	Waste water engineering	CEN/TC 155 "Plastic piping systems and ducting systems" CEN/TC 165 "Waste water engineering"

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Table A.1 *(continued)*

Mandate	Products covered	TCs involved
M/120	Structural metallic products	CEN/TC 121 "Welding" CEN/TC 132 "Aluminium and aluminium alloys" CEN/TC 135 "Execution of steel structures and aluminium structures" CEN/TC 185 "Threaded and non-threaded mechanical fasteners and accessories" ECISS/TC 10 "Structural steels" ECISS/TC 13 "Flat products for cold working-qualities, dimensions, tolerances and specific tests" ECISS/TC 23 "Steels for heat treatment, alloy steels and free-cutting steels-qualities" ECISS/TC 31 "Steel castings"
M/125	Aggregates	CEN/TC 154 "Aggregates"
M/128	Products related to concrete, mortar and grout	CEN/TC 104 "Concrete" CEN/TC 298 "Pigments and extenders"

Table A.2 — Product groups with potential release into soil, surface water and groundwater covered by ETAGs [24]

Code	Description
ETAG 002	Structural sealant glazing systems
ETAG 004	External thermal insulation composite systems with rendering
ETAG 005	Liquid applied roof waterproofing kits
ETAG 006	Systems of mechanically fastened flexible roof waterproofing membranes
ETAG 007	Timber frame building kits
ETAG 009	Non load-bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete
ETAG 010	Self supporting translucent roof kits
ETAG 012	Log building kits
ETAG 016-2	Self supporting composite lightweight panels – Part 2: Specific aspects relating to self-supporting composite lightweight panels for use in roofs
ETAG 016-3	Self supporting composite lightweight panels – Part 3: Specific aspects relating to self-supporting composite lightweight panels for use in external walls and claddings
ETAG 017	Veture kits
ETAG 018	Fire protective products
ETAG 019	Prefabricated wood-based load bearing stressed skin panels
ETAG 021-2	Cold storage premises kits – Part 2: Cold storage building envelope and building kits

[24] See list of endorsed ETAGs under http://www.eota.be.

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Table A.2 *(continued)*

Code	Description
ETAG 023	Prefabricated building units
ETAG 024	Concrete frame building kits
ETAG 025	Metal frame building kits
ETAG 026	Fire stopping and fire sealing products

Tables A.3 and A.4 show the mandated work under the CPD in the CEN/TCs and EOTA WGs considered by CEN/TC 351 TG 2 to be relevant for potential emissions to indoor air during service life. Some mandates cited below may cover products used both outdoors and indoors. Construction products not used in interiors are not considered relevant for indoor air quality. Tables A.3 and A.4 have an informative character and may not be fully complete or up to date.

Table A.3 — Product groups used in interiors covered by a mandate to CEN [25]

Mandate	Products covered	TCs involved
M/101	Doors, windows	CEN/TC 33 "Doors, windows, shutters and building hardware"
M/103	Thermal insulation products	CEN/TC 88 "Thermal insulating materials and products"
M/106	Gypsum products	CEN/TC 241 "Gypsum and gypsum based products"
M/112	Structural timber products and ancillaries	CEN/TC 124 "Timber structures"
M/113	Wood-based panels	CEN/TC 112 "Wood-based panels"
M/114	Cement	CEN/TC 51 "Cement and building limes"
M/116	Masonry	CEN/TC 125 "Masonry"
M/119	Floorings	CEN/TC 129 "Glass in buildings" CEN/TC 134 "Resilient, textile and laminate floor coverings" CEN/TC 175 "Round and sawn timber" CEN/TC 217 "Surfaces for sports areas" CEN/TC 229 "Precast concrete products" CEN/TC 246 "Natural stones" CEN/TC 303 "Floor screeds and in-situ floorings in buildings" CEN/TC 323 "Raised access floors" CEN/TC 67 "Ceramic tiles"

25 See ftp://ftp.cen.eu/CEN/Sectors/List/Construction/Guidance/TFN337.pdf

Table A.3 *(continued)*

Mandate	Products covered	TCs involved
M/121	Wall and ceiling finishes	CEN/TC 67 "Ceramic tiles" CEN/TC 99 "Wall coverings" CEN/TC 175 "Round and sawn timber" CEN/TC 246 "Natural stones" CEN/TC 249 "Plastics" CEN/TC 277 "Suspended ceilings" BT/TF/119 "Stretched ceilings"
M/127	Adhesives	CEN/TC 193 "Adhesives"
M/128	Products related to concrete, mortar and grout	CEN/TC 104 "Concrete" CEN/TC 298 "Pigments and extenders"
M/Constr 06/769	Sealants for non-structural use in buildings	CEN/TC 349 "Sealants for joints in building construction"

Table A.4 — Product groups used in interiors covered by ETAGs [26]

Code	Description
ETAG 007	Timber frame building kits
ETAG 003	Internal partition kits
ETAG 008	Prefabricated stair kits
ETAG 009	Non load-bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete
ETAG 012	Log building kits
ETAG 016	Composite light weight panels
ETAG 018	Fire protective products
ETAG 019	Prefabricated wood-based load bearing stressed skin panels
ETAG 021	Cold storage premises kits
ETAG 022	Watertight covering kits for wet room floors and or walls
ETAG 023	Prefabricated building units
ETAG 026	Fire stopping and fire sealing products

26 See list of endorsed ETAGs under http://www.eota.be.

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