

EUROPEAN COLLABORATIVE ACTION  
**URBAN AIR, INDOOR ENVIRONMENT AND HUMAN EXPOSURE**

Environment and Quality of Life

Report No 27

# Harmonisation framework for indoor products labelling schemes in the EU



EUROPEAN COMMISSION  
JOINT RESEARCH CENTRE - INSTITUTE FOR HEALTH & CONSUMER PROTECTION  
CHEMICAL ASSESSMENT AND TESTING UNIT



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The mission of the Institute for Health and Consumer Protection is to protect the interests and health of the consumer in the framework of EU legislation on chemicals, food, and consumer products by providing scientific and technical support, including risk-benefit assessment and analysis of traceability.

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**MANDATE:** European Collaborative Action “**Urban Air, Indoor Environment and Human Exposure**” (formerly "Indoor Air Quality & its Impact on Man")

For 25 years now the European Collaborative Action ECA "*Indoor Air Quality & its Impact on Man*" has been implementing a multidisciplinary collaboration of European scientists the ultimate goal of which was the provision of healthy and environmentally sustainable buildings. To accomplish this task ECA is dealing with all aspects of the indoor environment including thermal comfort, pollution sources, the quality and quantity of chemical and biological indoor pollutants, energy use, and the ventilation processes which all may interact with indoor air quality. The work of ECA has been directed by a Steering Committee which is hosted and managed by the European Commission's Joint Research Centre.

In order to provide a broader view on air pollution exposure in urban areas, both indoors and outdoors, the ECA Steering Committee decided to put more emphasis on the links between indoor and outdoor air quality and to focus its further work under a new title "*Urban Air, Indoor Environment and Human Exposure*". The focus of the renewed activity is urban & indoor air pollution exposure assessment, seen as part of environmental health risk assessment and also considering the needs of urban and indoor air quality management. Since 1999, the new approach has been supported by those activities of the Joint Research Centre's Institute for Health and Consumer Protection in Ispra (Italy) dealing with exposure to physical and chemical agents, chemical assessment and testing and associated health effects.

This focussed activity proceeds within the broader framework of (i) health and comfort of the citizens, (ii) building technologies and source controls, and (iii) requirements of sustainability, energy efficiency and conservation of natural resources.

Specific examples of the working areas of ECA are:

- the relative importance of outdoor and indoor sources of pollution,
- the building-related interaction between outdoor urban air and indoor air,
- exposure to pollutants from the different urban outdoor and indoor sources and its relation to health and comfort.

By addressing such topics ECA will lay the ground for air quality management to minimise exposures to air pollutants. It will thus continue to contribute to pre-normative research needed by EC services and national authorities responsible for preventing pollution and promoting health, comfort and quality of life.

In this series the following reports have already been published.

- Report No. 1: Radon in indoor air. EUR 11917 EN, 1988. \*
- Report No. 2: Formaldehyde emission from wood-based materials: guideline for the determination of steady state concentrations in test chambers. EUR 12196 EN, 1989. \*
- Report No. 3: Indoor pollution by NO<sub>2</sub> in European countries. EUR 12219, EN1989.
- Report No. 4: Sick building syndrome - a practical guide. EUR 12294 EN, 1989.
- Report No. 6: Strategy for sampling chemical substances in indoor air. EUR 12617 EN, 1989.
- Report No. 7: Indoor air pollution by formaldehyde in European countries. EUR 13216 EN, 1990. \*
- Report No. 8: Guideline for the characterization of volatile organic compounds emitted from indoor materials and products using small test chambers. EUR 13593 EN, 1991.
- Report No. 9: Project inventory – 2nd updated edition. EUR 13838 EN, 1991.
- Report No. 10: Effects of indoor air pollution on human health. EUR 14086 EN, 1991.
- Report No. 11: Guidelines for ventilation requirements in buildings. EUR 14449 1992, EN.
- Report No. 12: Biological particles in indoor environments. EUR 14988 EN, 1993.
- Report No. 13: Determination of VOCs emitted from indoor materials and products. Interlaboratory comparison of small chamber measurements. EUR 15054 EN, 1993.
- Report No. 14: Sampling strategies for volatile organic compounds (VOCs) in indoor air. EUR 16051 EN, 1994.
- Report No. 15: Radon in indoor air. EUR 16123 EN, 1995.
- Report No. 16: Determination of VOCs emitted from indoor materials and products: Second interlaboratory comparison of small chamber measurements. EUR 16284 EN, 1995.
- Report No. 17: Indoor air quality and the use of energy in buildings. EUR 16367 EN, 1996.
- Report No. 18: Evaluation of VOC emissions from building products –solid flooring materials. EUR 17334 EN, 1997.
- Report No. 19: Total Volatile Organic Compounds (TVOC) in indoor air quality investigations. EUR 17675 EN, 1997.
- Report No. 20: Sensory evaluation of indoor air quality. EUR 18676 EN, 1999.
- Report No. 21: European Interlaboratory Comparison on VOCs emitted from building materials and products. EUR 18698 EN, 1999.
- Report No. 22: Risk assessment in relation to indoor air quality. EUR 19529 EN, 2000.
- Report No. 23: Ventilation, Good Indoor Air Quality and Rational Use of Energy. EUR 20741 EN, 2003.
- Report No. 24: Harmonisation of indoor material emissions labelling systems in the EU, Inventory of existing schemes. EUR 21891 EN, 2005.
- Report No. 25: Strategies to determine and control the contributions of indoor air pollution to total inhalation exposure (STRATEX). EUR 22503 EN, 2006.
- Report No. 26: Impact of Ozone-initiated Terpene Chemistry on Indoor Air Quality and Human Health. EUR 23052 EN, 2007.

\* out of print

## Abstract

**ECA-IAQ (European Collaborative Action "Urban Air, Indoor Environment and Human Exposure"), 2012. Harmonisation framework for indoor products labelling schemes in the EU, Report No 27. EUR 25276 EN. Luxembourg: Publications Office of the European Union.**

Harmonisation of indoor products labelling schemes in the EU is an important aspect of the European Commission's policy making process in the field of indoor air quality and associated health effects. This report describes the outcome of recent activities and a roadmap setting out the steps being taken by the ECA preparatory working group 27 led by the European Commission's Joint Research Centre for establishing an EU wide harmonisation framework for labelling schemes which consists of core and transitional criteria for testing and evaluation methodologies. Common core criteria are those for which consensus has already been achieved and can be applied Europe-wide, whereas transitional criteria are those for which consensus is still to be reached and these continue to be applied locally during a transitional period. However, participating labelling schemes should follow the commonly agreed measurement methods for the transitional criteria.

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## EXECUTIVE SUMMARY

Emissions from construction products can constitute a significant source of indoor pollution. A wide range of volatile organic compounds (VOCs) and formaldehyde can be released, and concentrations may be particularly elevated in new buildings and following refurbishment. A number of national and industry focused labelling schemes for low emitting products exist in Europe and each has its own specific requirements for testing and criteria for product evaluation. This results in significant costs to industries wishing to provide low emitting products in different European markets and is also potentially confusing for consumers wishing to make informed choices among a variety of available products on the market.

In response to this concern, and to further encourage the development and application of low emitting products, a Preparatory EU working expert group (ECA WG 27) coordinated by the European Commission's Joint Research Centre (EC-JRC) was established to promote and seek consensus on the scope for harmonisation of the indoor product labelling schemes and also to elaborate a harmonised framework for indoor labelling schemes in Europe.

This report describes the consensus achieved on a harmonised framework for labelling schemes in Europe during the preparatory phase of the project among the representatives of the Danish (DICL) and Finnish (M1) labelling schemes and the German and French evaluation systems (correspondingly AgBB and AFSSET/ANSES). This framework includes **common core and transitional criteria** on testing and evaluation methodologies related to chemical emissions of indoor products. *Common core criteria* are those for which consensus has already been achieved and can be applied Europe-wide, whereas *transitional criteria* are those for which consensus is still to be reached and these continue to be applied locally during a transitional period. However, participating labelling schemes should follow the commonly agreed measurement methods for the transitional criteria.

The criteria were established taking into consideration the results of round robin testing of products performed according to the individual schemes involved in the first phase and the on-going work within the European standardisation body (CEN) to prepare a harmonised test method to determine the emission of potentially dangerous substances from construction products in support of requirements for health, safety and environment under the Construction Products Directive (89/106/EEC) and subsequent Construction Products Regulation (305/2011/EU, CPR).

The recommendations made by the preparatory WG are summarised below:

### **General Framework**

A harmonised framework for indoor product emissions labelling schemes in EU should comprise core and transitional requirements for the chemical characterisation and the sensory and health evaluation of product emissions.

### **Emission Testing of Indoor Products**

Emission testing should be based on harmonised European standards, when available. Products should be tested for their emissions as they are placed in the market. The ECA Preparatory WG 27 supports the work of CEN TC 351 and recommends the use of the validated harmonised testing standard for measurement of VOCs and formaldehyde when this becomes available. Until harmonised standards are available, ISO 16000 series standards

should be used for product sampling and measurements with the following exceptions: (1) Emission testing should include two chamber air sampling times (day 3 and 28) and (2) Reference room size: use the normative proposal of CEN TC 351 instead of that defined in ISO 16000-9 informative annex B.

### **Health and Sensory Evaluation of Indoor Product Emissions**

For the evaluation of indoor product emissions, the ECA Preparatory WG 27 agreed to refer to the EU-carcinogens classification. EU carcinogens determined through the harmonised protocol are volatile compounds measurable by ISO 16000 series standards. An EU group should be established to prepare a common list of carcinogens fulfilling the above criteria. In emission testing of indoor products, if carcinogens are detected after 3 days, the test can be stopped. The evaluation criteria should cover all contaminants of concern to health and comfort and be based on scientific evidence when available. The LCI ('Lowest Concentration of Interest') approach is currently the most feasible strategy to assess the health effects of compounds from building products and the harmonisation process of LCI values for around 170 chemicals which has recently started in Europe (EU-LCI project led by the European Commission's Joint Research Centre on behalf of DG SANCO) is fully supported. Criteria should be set also for substances not having LCI values (i.e., "not-yet-assessed" substances). Total volatile organic compounds (TVOC) should not be used alone as an indicator for evaluating health effects from indoor product emissions. When evaluating the emission of construction products TVOC provides useful information when combined with the limitation of CMR (Carcinogenic, Mutagenic or Reprotoxic) substances and with the LCI concept. A common approach for TVOC definition along with an upper limit for TVOC should be established. Sensory evaluation is considered to be an important aspect of the assessment of product emissions. Results have shown that chemical characterisation of emissions is not a good predictor of sensory effects. Therefore it is important to complement the chemical assessment of product emissions with sensory evaluation. The ECA Preparatory WG 27 supports the work of ISO TC 146/SC6 in creating a standard for sensory evaluation. The draft standard ISO/FDIS 16000-28 on "Determination of odour emissions from building products using test chambers" is expected to be published soon. It includes both acceptability evaluation, using an untrained panel, and perceived intensity measurement with a trained panel. It also combines the odour evaluation chamber technique with the harmonised testing standard (reference room) prepared by CEN TC 351. The practical implication of the implementation of the ISO standard should be further discussed and clarified.

### **Data Handling and Reporting**

A shared data handling and reporting tool (e.g. as the DIBt's ADAM Excel sheet) could be used as a basis for a future harmonised European system for documentation and evaluation of data. Additional features like an import tool and integration of alternative LCI-lists are feasible improvement options.

### **Next Steps for the Implementation of the Harmonisation Framework**

The next step foresees the establishment of an expanded committee with representatives from labelling schemes in Europe and a wider range of partners and stakeholders affected by this topic. The task of this expanded committee will be to finalise the details and achieve broader consensus on the harmonised framework for indoor products labelling schemes in Europe through open consultation with regulatory and standardisation bodies and other stakeholders at both EU and national level. The intention is to align the harmonised framework across various legislative mandates, such as, the Construction Products Directive

(89/106/EEC) and the subsequent Construction Products Regulation, Energy Performance of Buildings Directive – EPBD (2002/91/EC), EC Lead Market Initiative (COM(2007)860), Integrated Product Policy (IPP), Chemicals Policy (REACH), Green Public Procurement, Thematic Strategy on Urban Environment (COM(2004)60), Integration of Environmental Aspects into European Standardisation (COM(2004)206) etc. The broader consensus would enable the efficient implementation of the harmonised framework of indoor labelling schemes in a wider and integrated context of safe, healthy, energy efficient and sustainable buildings within the EU and outside. This could be implemented by the aforementioned committee to potentially operate over a long term basis to underpin incentives and policy measures for the sustainable labelling of products and buildings under a common ‘umbrella’ involving as many strategic partners affected as possible.



# 1 INTRODUCTION

## 1.1 Background and objectives

Emissions from construction products can constitute a significant source of indoor pollution. A wide range of volatile organic compounds (VOCs) and carbonyl compounds (including formaldehyde) can be released, and concentrations can be particularly elevated in new buildings and following refurbishment. Recently the DG RTD funded EnVIE co-ordination action on indoor air quality and health effects (De Oliveira Fernandes et. al., 2008) estimated that, substantial short to medium term benefits at low cost can be expected from harmonised testing and labelling of all building products, equipment and consumer products (i.e. 10% of the estimated risk reduction potential in EU-27 corresponds to 30000 DALYs/y). A number of national and industry focused labelling schemes for low emitting products exist in Europe and each has its own specific requirements for testing and criteria for product evaluation. This results in significant costs to industries wishing to provide low emitting products in different European markets and is also potentially confusing for consumers willing to make informed choices among a variety of available products on the market.

In response to this concern, and to further encourage the development and application of low emitting products, a EU expert group convened by European Commission's Joint Research Centre (EC-JRC), Ispra, was established to promote and seek consensus on the scope for harmonisation of the indoor product labelling schemes at EU level. This group published a report (ECA, 2005) that critically reviewed the characteristics of existing schemes, identified the main similarities and differences between them and recommended further steps towards convergence:

- The need for common procedures of testing and analysis with the possibility of one emission test being sufficient to allow labelling in accordance with the different schemes; this could be achieved in advance of full harmonisation.
- Need for round robin tests to validate the common procedures.
- Need for appropriate quality control of testing.

Subsequently the initiative was taken forward during a conference organised in the context of the German EU presidency in Berlin (UBA, 2007) and gave rise to the formation of a preparatory working group with representatives of the Danish (DACL), and Finnish (M1) labelling schemes and the German evaluation system (AgBB), as well as representatives of emission test laboratories in the UK, France, Finland, Denmark, Germany and the European Commission's Joint Research Centre (JRC). The positive step taken was the development of a harmonised evaluation framework for a common European labelling scheme for emissions from building products. The need for harmonisation of labelling schemes is also included in the agenda of DG SANCO's Expert Group on Indoor Air and among the main recommendations issued by the DG RTD funded EnVIE co-ordination action on indoor air quality and health effects (EnVIE, 2008). This activity on the Harmonisation Framework for Indoor Products Labelling Schemes in the EU is coordinated by JRC in close liaison with DG SANCO, DG Enterprise, DG ENV and DG ENER of the European Commission.

This report presents the outcome of the work undertaken by the ECA Preparatory Working Group 27 on the aforementioned Harmonisation Framework and provides a firm basis for continuing the harmonisation process. It sets out the consensus among experts and representatives of various European labelling schemes and proposes that the work is continued under the guidance of an enlarged committee that includes representation from a wide range of stakeholders (which includes the chemicals industry and regulatory bodies in the EU Member States).

## 1.2 References

ECA report no. 24 (2005). Harmonisation of indoor material emissions labelling systems in the EU – Inventory of existing schemes. EUR 21891 EN, ISBN 92-79-01043-3, Office for Official Publications of the European Communities, Luxembourg.

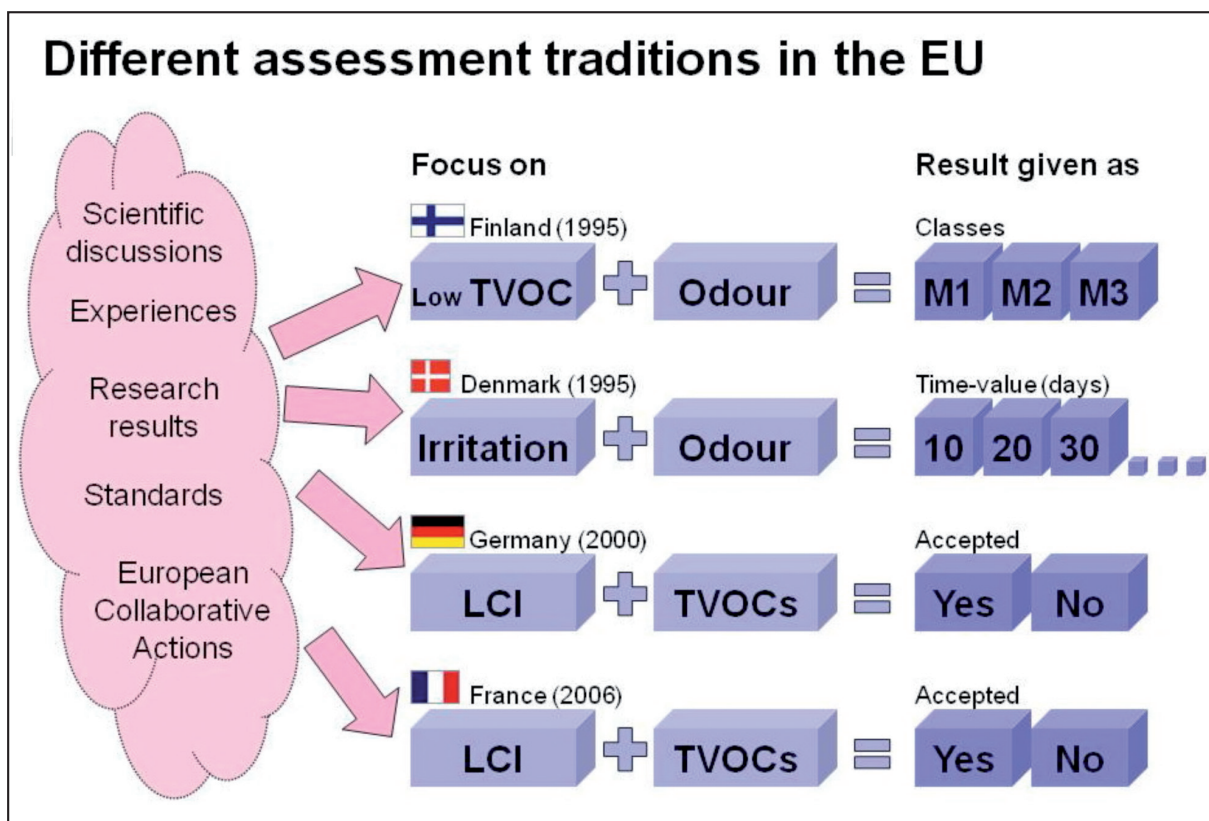
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De Oliveira Fernandes, E., Jantunen, M., Carrer, P., Seppänen, O., Harrison, P. and Kephelopoulos, S., 2008. Final Activity Report. EnVIE Project. European Commission 6<sup>th</sup> Framework Programme of Research, Brussels. <http://www.envie-iaq.eu/>

## 2 HARMONISATION FRAMEWORK FOR INDOOR PRODUCTS LABELLING SCHEMES IN EU

### 2.1 Existing indoor labelling schemes in EU

The existing labelling schemes have been developed during the last 20 years and they reflect the developments in IAQ research and the increase in the public awareness of IAQ problems. A critical review of existing labelling schemes in the EU is provided by ECA Report 24 (2005). Some of the schemes have been developed by government agencies and NGOs with an interest in protecting the public from health and comfort problems caused by product emissions. Other schemes have been developed by industrial associations to set common development targets for their industry. Figure 1 represents the different assessment traditions for indoor product labelling in the EU and details of the four schemes shown are provided in appendices 1 to 3.



LCI = Lowest concentration of interest (of individual VOCs)

TVOCs = Total volatile organic compounds

*Figure 1. Different assessment traditions for indoor product labelling in the EU.*

Significant reductions in product emissions have also been achieved by the development work encouraged by the voluntary schemes. The voluntary labelling system in use in Finland at the end of 2011 has over 2000 products that meet the emission criteria. The amount of emissions from these products are (as estimated by a product testing laboratory) approximately one fifth of the level of the early 1990s. In Denmark, the Danish Indoor Climate Label has in several cases been a tool for development of lower emitting products (for example, sealing of open edges and drilled holes in kitchen and wardrobe cabinets made of particle board). A voluntary label can be used in marketing of building products and this has increased the interest of many companies towards the scheme.

In some countries successful voluntary schemes led to a lowering of emissions from many products. For example, GUT (Gemeinschaft umweltfreundlicher Teppichboden) in Germany established a system for the emission testing of textile floor coverings in 1990. The test was performed in test chambers with a loading factor of  $0.4 \text{ m}^2/\text{m}^3$  and an air-exchange rate of  $0.5 \text{ h}^{-1}$ . During the first years the TVOC-thresholds were constantly being reduced ( $5000 \text{ }\mu\text{g}/\text{m}^3$  in 1990;  $1000 \text{ }\mu\text{g}/\text{m}^3$  in 1991;  $500 \text{ }\mu\text{g}/\text{m}^3$  in 1994;  $300 \text{ }\mu\text{g}/\text{m}^3$  in 1997) as the sources for VOC-emissions from final products could be identified. Based on an agreement between EPDLA (European Polymer Dispersion- and Latex-Producers Association) to regulate the content of VOCs in polymer dispersions the emissions of carpet specific compounds could be reduced by 80% (e.g. styrene).

In 2004 GUT adopted the AgBB-System (based on the ECA report no. 18 proposal) to evaluate carpet emissions. The emission test is performed in line with the German test requirements and ISO 16000 series recommendations. A carpet will receive a GUT-license if the following criteria are met after 3 days in the emission test chamber ( $\text{TVOC} \leq 300 \text{ }\mu\text{g}/\text{m}^3$ ;  $\text{VOC without LCI} \leq 100 \text{ }\mu\text{g}/\text{m}^3$ ;  $\text{semi-volatile organic compounds (SVOC)} \leq 30 \text{ }\mu\text{g}/\text{m}^3$ ;  $\text{R} \leq 1$ ). Whereas in the early years the overall reduction of VOC-emission was the focus, the main issue today is the reduction of compound specific emission. Included in a list of VOCs with associated threshold values are some odorous substances like 4-PCH (4-Phenylcyclohexene) with particular relevance for carpets.

Several labelling schemes have a strong position in their local markets and are recognized by industry as well as authorities, construction clients, designers and consumers. There are thousands of building products that have been labelled according to these schemes. However, in some countries the existence of many different labelling schemes may create confusion to the end user and also create unnecessary costs to industry. While there is a need to harmonise the labelling schemes on a European level, any new scheme should evolve from the existing ones to ensure that benefits already achieved are maintained.

Some of the schemes have received government support for their development, but only a few schemes are endorsed by authorities or have a mandatory status like the AgBB via DIBt (Deutsches Institut für Bautechnik) approval requirements in Germany. This may be attributed in part to the difficulties in the risk assessment (i.e. the lack of data on the exposure or dose-response relationships for several of the compounds of interest especially under low and mixed exposure conditions) and to unresolved political factors. In Europe there is, however, increasing interest in mandatory labelling from some Member State (MS) authorities, in addition to the harmonised testing of dangerous substances driven by mandate 366 from the European Commission to the European standards organisation (CEN) that is being carried out by technical committee CEN TC 351.

In Germany, the mandatory implementation of emission tests starting in October 2004 resulted in 260 approval licenses (based on 350 emission tests) for about 3000 different products that included a broad variety of floor coverings. There was a rapid increase in 2009 as old approval licences expired. The mandatory 'emissions test' has been announced in hearings since 2001, and some producers had taken advantage of the old approval procedure (licence valid for 5 years) before the start in October 2004. Other producers used the new option of emission based approval positively as a marketing instrument. Emission requirements for other product groups such as lacquers and other coatings for parquets, adhesives and underlays were implemented during 2010-2011. As long as European harmonised standards for products with known indoor air relevance are being updated or developed without defined health criteria, the German authorities for construction surveillance can define national health criteria via approval procedures.

In France, due to the lack of voluntary actions, labelling of emissions from building products has been introduced through government initiatives. The first step was contained in the 2004-2008 French National Environment and Health Action Plan (NEHAP). Action 15 of the 2004-2008 NEHAP stated that a procedure for the health-related evaluation of emissions from building products has to be developed and that 50% of the products placed on the French market should be evaluated in 2010 according to this procedure, on a voluntary basis.

In order to fulfil the first requirement of NEHAP action 15, the French Agency for Environmental and Occupational Health and Safety (AFSSET, which became in 2010 the French Agency for Food, Environmental and Occupational Health and Safety: ANSES) established a working group coordinated by CSTB and AFSSET which produced a first version of a procedure for the health-related evaluation of emissions from solid building products during 2006. This procedure was extended in 2009 to all solid and liquid building products and published by AFSSET. Even though some producers of building materials referred to this procedure for the evaluation of VOC and formaldehyde emissions from their products, currently the AFSSET procedure has not been adopted as the basis of a voluntary labelling scheme in France.

In 2007, the French Government launched a concerted action (so-called *Le Grenelle Environnement*) for the identification and improvement of key issues regarding environment and health. *Le Grenelle Environnement* (2007) defined very ambitious objectives for the building sector in terms of energy saving. As this objective should not be achieved without taking into account IAQ in building design, *Le Grenelle Environnement* also defined several actions aimed at improving IAQ which were specified in Law n° 2009-967 (August 3, 2009) and Law n° 2010-788 (July 12, 2010):

- Mandatory labelling of VOC emissions from building and decoration products,
- Ban of carcinogenic, mutagenic and toxic for reproduction substances category 1 and 2 (according to 67/548/CEE directive classification).

The first point has been transposed into French regulation by Decree n° 2011-321 (March 23, 2011) relating to the labelling of construction products, floorings, wall coverings, paints and varnishes regarding their volatile pollutant emissions and Order of April 19, 2011. Decree n° 2011-321 states that products may only be made available on the market if they are accompanied by a label indicating their emissions of volatile compounds. It lists the products concerned and sets the dates for the requirements coming into force (1<sup>st</sup> January 2012 for new

commercial references and 1<sup>st</sup> September 2013 for products already on the market before 2012). The Order of April 19, 2011 defines the list of volatile compounds to be considered (10 individual substances and TVOC), four emissions classes ranging from A+ (very low emissions) to C (high emissions), the format of the label to be placed on the product or on its packaging and the methods for the characterisation of emissions for control purposes.

The second point has been transposed into French regulation by an Order of April 30, 2009 relating to the conditions of use of building and decoration products containing CMR (Carcinogenic, Mutagenic or Reprotoxic) compounds category 1 and 2 and an Order of May 28, 2009 modifying the Order of April 30, 2009. Those orders state that building and decoration products can be placed on the market if their emissions of CMR compounds are lower than 1 µg/m<sup>3</sup> after 28 days according to ISO 16000 standards. CMR compounds concerned by this regulations are trichloroethylene (CAS no. 79-01-6), benzene (CAS no. 71-43-2), dibutyl phthalate (CAS no. 84-74-2) and bis (2-ethylhexyl) phthalate (CAS no. 117-81-7). Provisions of those orders entered into force on 1<sup>st</sup> January 2010.

Several countries do not have any schemes or policy on the topic while others have well functioning policies. Therefore, a harmonised European labelling scheme should be a framework describing the common principles for product emission labelling in EU. The harmonised framework proposes the key parameters to be assessed and makes reference to the relevant measurement and evaluation methods.

The results of emission testing can be expressed in different ways (see Figure 1), the most frequently used are 'Pass/Fail' systems or quality related classes. This issue has become a point of discussion with regard to CE-labelling under the Construction Products Directive (CPD)/ Construction Products Regulation (CPR); there is a need for an agreed convention for labelling based on the results of testing according to the harmonised test standard currently under preparation by CEN TC 351. Proposals under discussion by the DG ENTR's Expert Group on Dangerous Substances (EGDS) include the use of emission classes. This would be consistent with the consensus of the preparatory group.

## **2.2 Risk management strategies**

The purpose of building product emission labelling schemes is to protect building users (occupants) from negative health and comfort effects by source control strategies. The need for this protection has been demonstrated in several epidemiological studies and case reports (e.g. Mølhave, 2003, Heinzow et al., 2009). An example in this regard is given in Appendix 4.

Unfortunately, science has not yet been able to elucidate all substances and mechanisms causing the negative health and comfort effects. A lot of data is available on substances in the workplace environment (see chapter 4) but sufficient data to enable a full risk assessment exists only for a few substances as pointed out by INDEX (2005) and EnVIE (2008). As health is not just absence of illnesses, it will not be enough just to reduce the exposure to these known problem substances, the risks from other substances need to be reduced as well. This poses a problem for traditional risk management as the causalities and risk probabilities are not exactly known. Therefore it is also difficult to compare the effectiveness of mitigation methods.

Currently, at least the following risk management and communication strategies are in use in

existing policies or in voluntary labelling schemes:

- Ban of dangerous substances (content)
- Ban of dangerous emissions
  - Carcinogenic substances
- Restriction of emissions
  - LCI-approach (evaluation by comparison with 'Lowest Concentration of Interest')
  - LCI + limits for substances without an established LCI value ("not yet assessed substances")
  - TVOC-approach
- Sensory evaluation
- Information dissemination to consumers and manufacturers.

Banning substances from building products is an effective measure to prevent unwanted emissions. This has been applied to some category 1 carcinogens (e.g. asbestos). Nevertheless, considering a total ban of dangerous substances or products goes beyond the scope of labelling schemes.

A strategy used to assess product emissions from a health point of view is a single compound evaluation by comparison with the LCI “Lowest Concentration of Interest” values. The background of the LCI-approach was presented in ECA Report no. 18 on "Evaluation of VOC Emissions from Building Products – Solid Flooring Material" (1997). The report presented key elements of a strategy to assess chemical emissions and proposed as an example a procedure that applies the strategy to the labelling of flooring materials. The procedure is intended for the classification of these materials and as a basis for both, voluntary or mandatory purposes.

In addition to well known substances for which risk assessment dossiers are available, there are other substances that may cause negative health and comfort effects not yet assessed. Therefore, some labelling schemes have also set restrictions on these “not-yet assessed compounds”. This is justified as an analogy to the REACH regulation (Regulation (EC) no. 1907/2006) (2006) as companies should know what substances are emitted from their products. Furthermore, this directs the companies to using “assessed” compounds for which associated risks have been evaluated.

One of the strategies to manage the risks of chemical emissions has been to set an overall indicator of the emissions. The TVOC (total amount of VOC emissions) has been used in some schemes as a limit value for emissions. While it is known that TVOC *per se* is not linked with health outcomes, a low limit value for TVOC of for example 200 µg/m<sup>3</sup> indicates that the level of emissions of individual compounds is consequently presumably low. This approach needs to be complemented with checking the absence of carcinogens and other known dangerous substances (Andersson et al., 1997).

The indoor air (and product emissions) consists of hundreds of substances and for many of them there is only limited data on their related health impact. The situation is further

complicated by the chemical reactions indoors and it is obvious that current chemical measurement methods can only reveal a part of the whole picture. Humans are very sensitive to odours and irritants and our sensory system is a warning mechanism for health hazards. Results have shown that chemical characterisation of emissions is not a good predictor of sensory effects. Therefore it is important to complement the chemical assessment of product emissions with sensory evaluation (Salthammer et al., 2009).

The ECA report no. 20 “Sensory Evaluation of Indoor Air Quality” published by JRC in 1999, describes different methodologies for the sensory evaluation of indoor environmental quality. The report presents the background and gives advice on methodologies, especially for sensory evaluation of indoor air quality (IAQ). A standard on sensory evaluation (ISO/FDIS 16000-28:2011(E)) developed by ISO TC 146/SC 6 is expected to be published in 2012.

### **2.3 Proposal for a harmonisation framework for indoor products labelling schemes in EU**

The ECA preparatory WG 27 agreed upon a roadmap that foresees the development of harmonisation through two phases.

A *first phase* in which the ECA Preparatory WG 27 has described in this report the consensus achieved in establishing common criteria for an EU wide framework for indoor product emissions labelling schemes. This has taken account of the different levels of public awareness and political aspects in European countries as well as practical issues in order to synchronise the transition of the existing labelling schemes to establish a harmonised framework in Europe.

This framework includes **common core and transitional criteria** on testing and evaluation methodologies. *Common core* criteria are those for which consensus has already been achieved and can be applied Europe-wide, whereas *transitional criteria* are those for which consensus is still to be reached and these continue to be applied locally during a transitional period.

However, participating labelling schemes should follow the commonly agreed measurement methods for the transitional criteria. With this perspective, the first step of the ECA Preparatory WG 27 was to identify similarities of existing schemes and to achieve consensus on a common way forward to address differences. This process was supported by comparing the results of round robin testing of products performed according to the individual schemes involved in this phase. The group also gave consideration to the on-going work within the European standards organization (CEN) to prepare a harmonised test method to determine the emission of dangerous substances from construction products in support of requirements for health safety and environment under the Construction Products Directive (89/106/EEC) (CPD, 1989) and subsequent Construction Products Regulation (CPR, 2011).

In a *second phase* a Committee in which other parties and stakeholders interested in the topic are included, should be established. The task of this expanded Committee should be to finalise the details and achieve broader consensus on the harmonised framework of the European labelling scheme through open consultation. The broader consensus would enable the efficient implementation of the harmonised framework of indoor labelling schemes in a wider and integrated context of safe, healthy, energy efficient and sustainable buildings

within the EU and outside. This could be implemented by the aforementioned Committee to potentially operate over a long term basis to underpin incentives and policy measures for the sustainable labelling of products and buildings under a common ‘umbrella’ involving as many strategic partners affected as possible.

The harmonisation framework should ideally include all products emitting to the indoor air and cover VOCs and carbonyl compounds (including formaldehyde) with consideration given to other substances such as ammonia. Existing standards and future harmonised methods of testing should be the basis whenever possible. Possible improvements to the current situation could be included such as quality assurance requirements requiring use of reference sorbent tubes for testing analytical performance, detailed guidance for quantification and evaluation methods, and use of new software tools for data handling and reporting.

Table 1 shows the common core and transitional criteria agreed by the ECA Preparatory WG 27 for the existing labelling schemes.

The intention is to align the harmonisation framework across various legislative mandates, such as, the Construction Products Directive (89/106/EEC), Energy Performance of Buildings Directive – EPBD (2002/91/EC), EC Lead Market Initiative (COM(2007)860), Integrated Product Policy (IPP), Chemicals Policy (REACH), Green Public Procurement, Thematic Strategy on Urban Environment (COM(2004)60), Integration of Environmental Aspects into European Standardisation (COM(2004)206), etc.

**Table 1.** Common core and transitional criteria for existing labelling schemes.<sup>1</sup>

	<b>Current criteria</b>	<b>Core and transitional criteria → Step I (1 to 2 years)</b>	<b>Harmonised criteria → Step II (ca. 5 years)</b>
<b>AFSSET</b>	- R-value (based on LCI) - Carcinogens - TVOC	<b>Core criteria:</b> - R-value - Carcinogens - TVOC	<i>Harmonised criteria</i>
	- Sum of “not-yet-assessed” VOC	<b>Transitional criteria:</b> - Sum of “not-yet-assessed” VOC	
<b>AgBB</b>	- R-value (based on LCI) - Carcinogens - TVOC	<b>Core criteria:</b> - R-value - Carcinogens - TVOC	<i>Harmonised criteria</i>
	- Sum of “not-yet-assessed” VOC  - TSVOC  - Sensory evaluation	<b>Transitional criteria:</b> - Sum of “not-yet-assessed” VOC  - TSVOC  - Sensory evaluation	
<b>DICL</b>	- Irritation - Formaldehyde and other aldehydes - Carcinogens	<b>Core criteria:</b> - R-value - Carcinogens - TVOC	<i>Harmonised criteria</i>
	- Sensory evaluation	<b>Transitional criteria:</b> - Sensory evaluation	
<b>M1</b>	- TVOC - Formaldehyde - Ammonia - Carcinogens	<b>Core criteria:</b> - R-value - Carcinogens - TVOC	<i>Harmonised criteria</i>
	- Sensory evaluation	<b>Transitional criteria:</b> - Sensory evaluation	

**LCI** = Lowest Concentration of Interest (of individual VOCs); **TSVOC** = Total Semi-Volatile Organic Compounds; **VOC** = Volatile Organic Compound; **TVOC** = Total Volatile Organic Compounds; **R-value** = as defined in ECA Report no. 18 is termed ‘risk index’ of the assessable emitted compounds. It denotes the sum of the ratios of the exposure concentration over the ‘lowest concentration of interest’ (LCIs) for each of the assessed compounds emitted on day 28 of the emission test. No effect is assumed if R does not exceeds the value 1

## 2.4 Recommendations of the ECA Preparatory Working Group 27

- **A harmonisation framework for indoor product emissions labelling schemes in EU should comprise common core and transitional criteria for the chemical characterisation and the sensory and health evaluation of product emissions.**

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### 3 EXISTING STANDARDS FOR INDOOR PRODUCTS EMISSION TESTING

#### 3.1 Overview of existing standards for indoor products emission testing

Almost all existing labelling schemes actually make use of the ISO 16000 series of standards. Of particular interest are:

- ▶ ISO 16000-3 (2001) concerning active sampling of formaldehyde and other carbonyl compounds and analysis by liquid chromatography (HPLC),
- ▶ ISO 16000-6 (2004) concerning active sampling of VOC on Tenax TA and analysis by gas chromatography,
- ▶ EN ISO 16000-11 (2006) concerning the procedures for sampling, storage and preparation of test specimens,
- ▶ ISO/FDIS 16000-28:2011 (E) concerning determination of odour emissions from building products using test chambers.

The comparability of results obtained with the existing emission test procedures can be checked with round robin tests where a building product (possibly showing homogeneous emissions) is selected and distributed to several laboratories for analyses. Recently organised round robin tests based on the existing ISO standards 16000-3, -6, -9 and -11 showed that typically an uncertainty of around 20% for VOCs and formaldehyde can be expected. For compounds emitted at low concentration levels (e.g. below 20 µg/m<sup>3</sup>), for polar compounds like glycols or some aldehydes, or for tested products presenting inhomogeneous emissions, uncertainties at a level of 40% can be found (BAM, 2009; Yrieix et al., 2010). Unpolar and stable compounds like alkanes or aromatics exhibit the highest reproducibility.

A test laboratory must prove the specialist competence of the institute for emission tests necessary for a reliable health-related evaluation of building products. The testing laboratories must be independent. It must be accredited according to EN ISO/IEC 17025 including test chamber analysis. The verification of experience should be proven by participation in round robin tests ("RRT") or interlaboratory studies ("ILS"). An example of an appropriate framework for a round robin test is described by BAM (2009).

The European standards organisation (CEN) under mandate of DG ENTR is working with national standardisation bodies to develop horizontal standards under the Construction Products Directive (CPD,1989). The second generation of harmonised product standards under the CPD requires harmonised test methods for determining release or emission of dangerous substances to satisfy the requirements of Essential Requirement 3 of the CPD on Hygiene, health and the environment. Under mandate M/366 issued to CEN (2005), Work package 5 'horizontal standards: emission scenarios in indoor air', states that four horizontal standards will be developed:

1. Horizontal standard on the methods for generation of emission of dangerous substances from construction products into indoor air in standardised testing facilities
2. Horizontal standard on the measurement of regulated dangerous substances in indoor air samples as generated from construction products in the standardised testing facilities

3. Horizontal standard on the measurement of radiation and radioactive emissions from construction products
4. Horizontal standard on assessment for potential growth of relevant micro-organisms on construction products in the indoor environment.

CEN established a new technical committee (TC 351) in 2007 to undertake the work of developing the harmonised standards concerning release of regulated dangerous substances to soil, water and air and it established a working group (WG 2) specific to indoor air. As priority for their work, CEN have addressed the first two of the four proposed standards and are proposing that these should be contained within a single harmonised European standard (hEN). The aim of this hEN is not to develop a new testing method but to combine by normative references the use of existing standards complemented, when necessary, with additional and/or modified requirements so that construction products can be evaluated according to the horizontal concept specified in mandate M/366. Therefore the proposed hEN relies strongly on the ISO 16000 series of standards concerning determination of emissions of VOCs from building and furnishing products.

The information about emissions produced by applying the hEN is intended to be used for CE marking of construction products and attestation of conformity. The responsibility of product specification is with the technical committees responsible for standardisation of the various product types (the 'product TCs'). The determination of emission of dangerous substances into indoor air is supposed to be made under their in use conditions. Nevertheless, the experience of existing labelling schemes is to have the products tested alone as if they were in direct contact with indoor air.

The determination of emission specified in the proposed hEN is associated with a scenario which defines the climate and ventilation conditions of the air surrounding the product in a reference room. A reference room is needed since it is not possible to evaluate emissions by testing in all possible use situations. The proposed hEN method uses a test chamber in which emissions are generated under conditions maintained constant during the test. These conditions are selected so that the results can be converted to a concentration in the reference room by calculations within the ranges that such calculations are valid.

The test chamber is specified on the basis of performance requirements. This provides the flexibility on dimensions needed for the horizontal approach required in the mandate M/366 in view of the requirements for representative samples. It also specifies the air sampling and analysis of the chamber air to determine the relevant regulated dangerous substances under mandate M/366. The measurement of the concentration of substances in the chamber air that is used to derive the emission rate must be determined 3 days and 28 days after the sample of the product under test is placed in the chamber. A method for sensory evaluation of the emissions is not included within the current hEN.

This proposed hEN also refers to a number of "indirect" methods that provide within their specific field of application a result comparable or correlated to the result of the reference chamber method. Such methods may be easier to apply and/or cheaper. They are in accordance with mandate M/366 provided that their comparability or correlation to the reference test method has been demonstrated in their specific field of application. They may have a particular application for Factory Production Control testing (FPC).

For wood-based panels existing national regulation(s) on emissions of formaldehyde specify European standard EN 717-1 (2005) for testing emission into indoor air. EN 717-1 specifies fixed dimensions for the test chamber and different climate and ventilation conditions from the proposed hEN.

A draft hEN has been prepared by WG 2, accepted by TC 351 in 2009 and updated in 2010. As required by mandate M/366 this draft standard is undergoing robustness testing in 2012 and a validation programme (2013-2015) and will be amended as required before national bodies will vote on its acceptance.

### **3.2 Recommendations of the ECA Preparatory Working Group 27**

- **Emission testing should be based on harmonised European standards, when available.**
- **Products should be tested for their emissions as they are placed on the market.**
- **The ECA Preparatory WG 27 supports the work of CEN TC 351 and recommends the use of the validated harmonised testing standard for measurement of VOC's and formaldehyde when this becomes available.**
- **Until harmonised standards become available, ISO 16000 series standards should be used for product sampling and measurements with the following exceptions:**
  - **Emission testing should include two chamber air sampling times (day 3 and 28).**
  - **Reference room size: use the normative proposal of CEN TC 351 instead of that described in ISO 16000-9 informative annex B.**

### **3.3 References**

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## 4 HEALTH EVALUATION OF INDOOR PRODUCT EMISSIONS

### 4.1 Carcinogenic substances

Carcinogens are of special relevance for health evaluation of products. Thus, emission testing for carcinogens is of particular importance and can present a real challenge. Key considerations include:

- Their potential toxicity / risk to human health and associated public concerns
- The analytical challenge (where might they appear in low quantities in the chromatogram?)
- How they should be classified (i.e. according to which list – IARC or EU?) and
- How absence of carcinogens should be defined and reported in labelling schemes?

The EU classification of carcinogenic substances is according to Directive 67/548/EEC which has been recently updated by the CLP Regulation (EC 1272/2008) concerning classification, labelling and packaging of chemical substances and mixtures. In 2012 both regulations are co-existing and in this report the classification according to Directive 67/548/EEC (carcinogens Cat. 1 and 2) is still used.

In spite of a few exceptions, there are usually no safe limit values for carcinogenic substances, even the smallest amounts of carcinogens can, in theory, cause cancer mutations in cells. Therefore the usual practice to limit the amount of carcinogens (Cat. 1 and 2) is that they should be “under the detection limit” of the analysis system. There are practical problems with this approach because the detection limit will vary depending upon the objective of the analysis, and because analytical techniques are constantly improved and can detect smaller amounts of substances.

The first inter-laboratory comparison of the ECA preparatory WG 27 was carried out in 2007 on an odorous sample of rubber flooring. The sample was rejected by all labelling schemes, but the reasons for rejection were different. Both the M1 and DICL rejected the floor product due to results of sensory evaluation, while the product was rejected by the AgBB for the detection of a carcinogen. In fact, the most surprising result was to find measurable quantities of a category 2 carcinogen: 1,3-dichloro-2-propanol (CAS no. 96-23-1) (animal carcinogen; European list of carcinogens according to Directive 67/548/EEC). The substance is thought to be a degradation product of chlorinated flame retardants used in the cushion backing of the rubber flooring which is there for noise reduction. The cushion layer was made of recycled product.

This difference in results of the evaluation is considered in more detail below and this demonstrates the importance of having common criteria and reference lists of substances in a future harmonised approach:

▪ *M1 – Finnish labelling scheme*

VTT carried out the test in accordance with M1 protocols, i.e. focusing on TVOC, and reported only a few individual substances. The substance 1,3-dichloro-2-propanol was detected but it was not included in the report as it was below the reporting limit of 0.005 mg/(m<sup>2</sup>h) when quantified using toluene equivalents. NB - The Finnish requirements refer only to IARC (International Agency for Research on Cancer) class 1 carcinogens.

▪ *DICL - Danish Indoor Climate Label*

In the test carried out by DTI according to DICL guidelines, the substance 1,3-dichloro-2-propanol was reported with an emission rate of 18 µg/(m<sup>2</sup> h) after 3 days and 11 µg/(m<sup>2</sup> h) after 28 days. But like the Finnish scheme, DICL requirements currently refer only to IARC class 1 carcinogens and therefore no carcinogens were recorded as being present in the final report.

▪ *AgBB – German evaluation scheme*

The results of tests carried out in accordance with the AgBB protocol are not presented in a standardised test report because AgBB is not a labelling scheme as such. AgBB test results are instead summarised, aggregated and then evaluated using a so called ADAM<sup>1</sup> excel sheet. When these calculations were carried out in this case, the product failed to meet AgBB requirements for carcinogens both on day 3 (actual result 28 µg/m<sup>3</sup> vs a limit of 10 µg/m<sup>3</sup> (0.01 mg/m<sup>3</sup>) for the sum of detected carcinogens) and day 28 (actual result 9 µg/m<sup>3</sup> vs a limit of 1 µg/m<sup>3</sup> (0.001 mg/m<sup>3</sup>) for the sum of detected carcinogens). The presence of a carcinogen was confirmed by using the ADAM excel sheet with its integrated list of category 1 and 2 EU carcinogens: the substance 1,3-Dichloro-2-propanol is a category 2 carcinogen (EU list) - and the product was therefore rejected.

#### ***4.1.1 Recommendations of the ECA Preparatory Working Group 27***

- **For the evaluation of indoor product emissions, the ECA Preparatory WG 27 agreed to refer to the EU-carcinogens classification.**
- **EU carcinogens determined through the harmonised protocol are volatile compounds measurable by ISO 16000 series standards.**
- **An EU group should be established to prepare a common list of carcinogens fulfilling the above criteria.**
- **If carcinogens are detected after 3 days, the test can be stopped.**

## **4.2 The LCI-approach**

As mentioned in chapter 2, the LCI strategy is used to assess the potential risks to health arising from inhalation exposure to individual VOCs. The ECA Report no. 18 on "Evaluation of VOC Emissions from Building Products – Solid Flooring Material" (1997) presented the key elements of this strategy. During the development of the national labelling approaches in

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<sup>1</sup>AgBB DIBt Assessment Mask

Germany and in France emphasis was put especially on the evaluation of individual substances by LCI-values. Procedures have been developed in both countries that provide a transparent system for setting these values. The procedures and the main differences between them are outlined below.

#### ***4.2.1 Defining the LCI-values in Germany***

The Committee for Health-related Evaluation of Building Products, AgBB stressed that the legally implemented OEL (Occupational Exposure Limit) values provide the most broad and reliable basis for LCI setting: “Occupational exposure limit values have been defined for many substances present in workplace air in the form of gas, vapour or suspended particulate matter. These legally binding values are set at such a level that, according to current knowledge, even repeated and long-term exposure, for up to 8 hours a day within an average 40-hour working week, is generally not expected to adversely affect workers’ health over their working lives.” A working group of AgBB – complemented by manufacturers’ specialists - deals with the establishment of LCI values and in doing so uses existing OELs as a starting point. The AgBB working group takes into account the basic differences between conditions in general indoor spaces (such as homes, kindergartens and schools) and those at workplaces by application of safety factors.

In Germany (2012), ca. 470 substances (or classes of substances) have a workplace related exposure limit (via TRGS 900, TRGS: Technical Regulations for Hazardous Substances). The criteria documents for these limitations including all toxicological data are available online for 87 substances. For 374 of the 470 substances reference is given to the extended compilation of criteria documents of Deutsche Forschungsgemeinschaft (German MAK-committee). This broad documentation was the reason for AgBB giving priority to OELs for deriving LCI-values.

Since the German regulation TRGS 900, does not contain values for all VOC/SVOC possibly emitted from building products, a simplified method has been developed that permits to make use, in addition to the TRGS, of similar (workplace-related) values employed by other European countries. A stepwise procedure is used that takes into account the maximum currently available toxicological evidence for each individual substance, thus enabling the assessment of as many substances as possible. Those substances that still cannot be evaluated are subjected to a strict limitation of their total amount, within the AgBB scheme.

As a consequence of 10 years of experience in defining LCI values, recently the AgBB committee has revised the stepwise procedure in ranking the evaluation basis. Experience has shown that a strict following of the hierarchical rules set in the beginning does not always lead to the best available knowledge being applied to derive LCI values. In some of the data sources the update regimes were slow compared to the rate of development of new knowledge about hazards. In other cases the scientific criteria documents were not publicly available. The most reliable process of evaluation is by considering the best toxicological information available and this cannot be standardised in each case. The procedures for choosing the basis of LCI setting are given in Fig. 2.

AgBB 2003 - 2010

future updates AgBB

1. German TRGS 900 or EU-OEL  
take lowest value

no existing value ↓

2. OEL other EU countries  
take lowest reliable value

no existing value ↓

3. MAK (DFG) or TLV®-value  
(ACGIH) or WEEL-Wert (AIHA)  
take lowest value

no existing value ↓

4. choose structural analogy to  
existing value of similar substance  
or individual substance evaluation

**Generally**

EU-OEL  
German TRGS 900  
MAK (DFG)  
SCOEL values or recommendations  
OEL other EU countries

**Furthermore, in justified individual cases**

DNEL workplace  
TLV®-value (ACGIH)  
WEEL-Wert (AIHA)

**Alternatives, in justified individual cases for e.g.**

German guide values for indoor air quality  
WHO Air Quality Guidelines  
DNEL for the consumer

choose structural analogy to existing value of  
similar substance or individual substance  
evaluation

Figure 2. AgBB decision tree for choice of LCI setting basis.

An example of LCI values and their basis in the LCI list (update 2010) is given in table 2.

Table 2. Some AgBB-LCI values and their basis in the LCI list updated in 2010.

	Substance	CAS No.	LCI [µg/m³]	EU-OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks
12-1	1,4-Dioxane	123-91-1	73	73 000	73 000	EU: Carc. Cat. 3
12-2	Caprolactam	105-60-2	240	10 000	5 000	Individ. substance evaluation
12-3	N-Methyl-2-pyrrolidone	872-50-4	400	40 000	82 000	EU: Repr. Cat 2 (31.ATP) Individ. substance evaluation
12-4	Octamethylcyclo- tetrasiloxane (D4)	556-67-2	1 200			EU: Repr. Cat.3, Individ. substance evaluation
12-5	Hexamethylene- tetramine (Formaldehyde-release )	100-97-0	30			OELs Norway, Sweden: 3 000 µg/m³
12-6	2-Butanonoxime	96-29-7	20			EU: Carc. Cat. 3 Individ. substance evaluation
12-7	Tributyl phosphate	126-73-8				SVOC, EU: Carc. Cat. 3
12-8	Triethyl phosphate	78-40-0	25			cf. Tributyl phosphate (OELs Denmark, France: 2 500 µg/m³, TLV (ACGIH): 2 200 µg/m³)

#### ***4.2.2 Defining the LCI-values in France***

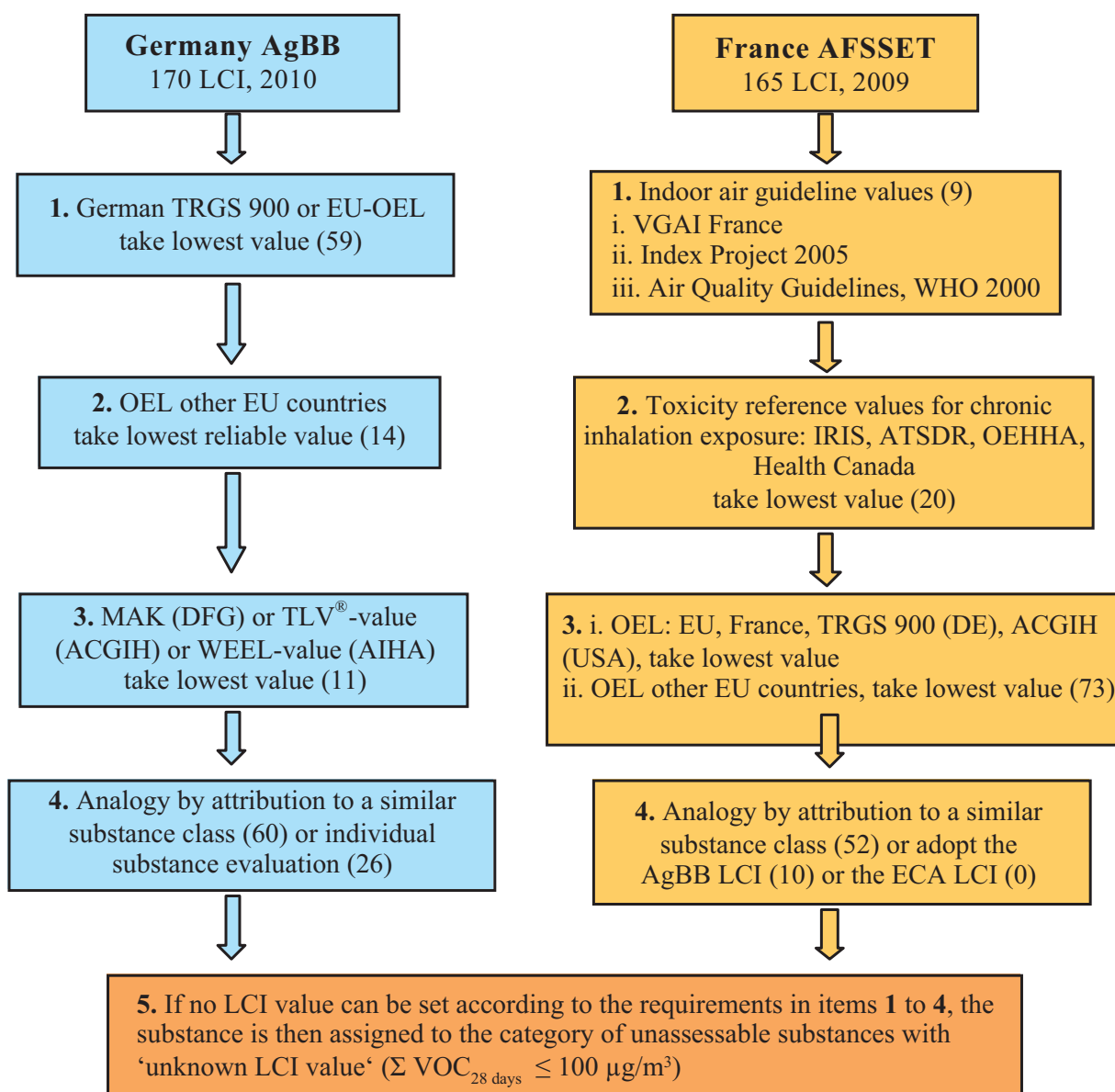
The starting basis for the AFSSET VOC WG was the approaches described in the ECA (1997) report and AgBB (2005, 2008). As the purpose was to propose a health-related evaluation procedure, the AFSSET VOC WG preferred the “ECA approach” over that used in the AgBB and therefore gave priority to IAQ guidelines and toxicological reference values when available for deriving LCIs. The main reason for this decision was that OELs are not established only on health-related aspects. At that time, national or international actions (such as the INDEX project) provided IAQ guidelines and the AFSSET VOC WG decided that this input should be taken into consideration.

LCI values have been established for 165 single VOCs which can be emitted by building and finishing products. Therefore, in order to prioritise and explain choices made by the group for drafting LCIs, it has been decided to use the following decision tree:

1. IAQ guideline values in the following priority;
  - French national IAQ guideline value (VGAI, when available)
  - Guideline value from INDEX project
  - WHO recommended IAQ guidelines.
2. If there is no guideline value available consideration is given to other exposure values derived from toxicological data: IRIS, ATSDR, OEHHA, Health Canada. If this provides more than one value, the lowest will normally be selected.
3. If no satisfactory value is given by 1 and 2 above, then occupational exposure limits when available will be used as a basis. A safety factor of 100 is applied to take into account time exposure difference between the general population and workers. A safety factor of 1000 is applied for carcinogens and mutagens category 3 and for substances toxic for reproduction category 1 to 3.
4. If no satisfactory value is given by 1, 2 and 3 above, the LCI is derived by analogy with a substance showing similarities in physico-chemical and toxicological properties (see analogies made in AgBB or ECA protocols).
5. Finally, if no value is available, then the LCI proposed by AgBB (2008) or ECA (1997) is adopted.

#### ***4.2.3 Decision tree for choice of LCI setting basis***

Comparing the two approaches (Figure 3), the main difference is that France gives most credit to indoor air guidance values putting them on top of their decision tree. In Germany, priority is given to toxicological data relied upon in OEL's. AgBB emphasises the basic difference between IAQ values and the LCI values as auxiliary values for evaluation of product emissions at day 28 in a chamber test. In AgBB, the need for taking into account also indoor air guideline values is recognised. A re-evaluation process of the ranking of priorities for LCI setting has begun.



*Figure 3. Differences in the decision trees used for setting LCI values.*

A research project on the setting of OELs in several European countries was funded by the German Federal Environment Agency (UBA) to support the standard operational procedure for deriving NIK-values in the AgBB and also to provide a sound knowledge base for future work of the harmonisation initiative. Information on limit values and criteria documents were collected in an online-database (<http://www.agbb-nik.de/>) and scientific and administrative aspects of limit-setting procedures were studied in detail (Sperk et al., 2010). Taking into consideration the importance of IAQ values in the AFSSET scheme, a selection of IAQ values from a number of institutions (WHO, INDEX, US EPA, Health Canada and others) was collected in order to provide a basis for the decision on the best available sources of toxicological evaluations.

#### 4.2.4 EU-LCI harmonisation

The consensus on the way forward in harmonising the health based evaluation of emissions from building products in Europe based on the LCI concept was achieved in late 2010 during a Workshop organised by the European Commission's Joint Research Centre (EC-JRC, 2010). Subsequently, in 2011 a preparatory working group on EU-LCI comprising toxicologists and experts in emission testing and product labelling was established by EC-JRC (as part of the PILOT INDOOR AIR MONIT administrative arrangement no. SI2.582843 with DG SANCO) to work on the development of a harmonised list using the LCI concept. The principal objectives of the EU-LCI preparatory working group are:

1. To devise a harmonised procedure for establishing a list of compounds and their associated LCI values for the evaluation of emissions from building products taking into account existing procedures used in some Member States (e.g. AFSSET/ANSES in France and AgBB in Germany) and to recommend an appropriate health-protective, science-based, transparent and yet pragmatic approach.
2. To propose a flexible framework that enables future review of the procedure to take into account new knowledge (e.g. data resulting from the REACH implementation process) and revise the content of the LCI list both in terms of number of compounds and LCI values.
3. To elaborate and propose harmonised LCI values (to be known as EU-LCIs) for the list of compounds considered.

Ultimately, this will allow voluntary and mandatory labelling schemes to evaluate product emissions in the same way using a robust health-based procedure and support the establishment of future emission classes for CE marking under the European Construction Products Regulation (CPR, 2011) with a harmonised list of LCI values. At present, only volatile organic substances (VOCs) are being considered; very volatile (VVOCs) and semi-volatile organic compounds (SVOCs) are to be addressed in the future. Nonetheless, the starting list contains around 170 VOCs commonly detected in emission tests of building materials and other products used indoors. The work builds on firm foundations laid by the labelling schemes established by AgBB and ANSES that currently apply the concept of LCI values (as described in chapters 4.2.1-4.2.3 of the present report), as well as those in Finland and Denmark. At present, the key activity of the EU-LCI preparatory group is the establishment of a robust "Standard Operating Procedure" for the derivation of EU-LCIs, based on sound toxicological and risk assessment principles.

The next step in the EU-LCI process foresees the setting up in 2012 of the EU-LCI Committee comprising both experts and representatives of EU Member States to formally establish EU-LCI values (on the basis of the proposals of the EU-LCI preparatory WG). The EU-LCI work is considered an integral part of the harmonisation framework for indoor products labelling schemes in the EU which has potential for wide application across Europe, ensuring better protection of the health of European citizens from hazardous substances in indoor materials.

### **4.3 Evaluation of substances without LCI value (“not-yet-assessed” substances)**

The central goal of the LCI-concept was to assess as many of the emitting substances as possible in order to enable a real health based evaluation of emissions. This can reduce uncertainty for consumers and product manufacturers. The problem with this concept is that there are still remaining gaps due to lack of data to derive LCI values. Also substances whose health effects are poorly understood (see Appendix 4) and substances which cannot be identified with existing analytical capabilities cannot be evaluated using the LCI concept. Those substances are referred to as 'not-yet-assessed' substances. Additional criteria are needed to tackle this problem.

Two strategies have been used to limit the potential problems with these “not-yet-assessed” substances:

- ECA report 18, AgBB and AFSSET schemes restrict the "not-yet-assessed" compounds to 10% of the TVOC amount.
- The M1-scheme in Finland has a very low allowed total amount of VOC emission (TVOC 0.2 mg/m<sup>2</sup>.h) (including assessed and "not-yet-assessed" substances). The idea behind this approach is the following: low TVOC reflects low emission of the individual compounds that constitute the TVOC.

More toxicological information about the "not-yet-assessed" substances is expected in the course of the REACH process. However, degradation or reaction products – not falling under the REACH regulation- will still need to be tackled.

### **4.4 The TVOC-approach**

The TVOC-approach is one of the strategies to manage the risks of chemical emissions and it was set as an overall indicator of the emissions. The TVOC (total amount of VOC emissions) has been used in some schemes as a limit value for emissions. While it is known that TVOC per se is not directly linked with health outcomes, a low limit value for TVOC of, for example, 200 µg/m<sup>3</sup> indicates that the level of emissions of individual compounds is consequently presumably low. This approach can be used to complement the LCI approach to control the emissions from "not-yet-assessed" substances.

As an example labelling schemes mainly based on TVOC restriction have opted for a low TVOC value (e.g. TVOC of 200 µg/m<sup>3</sup> in the M1 labelling scheme) while labelling schemes basing their evaluation on individual substances allow for higher TVOC values (e.g. TVOC of 1000 µg/m<sup>3</sup> in the AgBB and the AFSSET protocols).

The TVOC approach will continue to be part of the harmonisation framework. During the transition period, the existing labelling systems will most likely use their existing criteria for the TVOC until a common approach for TVOC definition along with an agreed upper limit value for TVOC will be established.

#### 4.5 Recommendations of the ECA Preparatory Working Group 27

Considering the results of the comparison tests and all/ recent experiences of the different labels, the ECA Preparatory WG 27 has come to the following recommendations:

- **The evaluation criteria should cover all contaminants of concern for health and comfort and be based on scientific evidence when available.**
- **The LCI approach is currently the most feasible strategy to assess the health effects of compounds from buildings products and the harmonisation process of LCI values for around 170 chemicals which has recently started in Europe is fully supported.**
- **Criteria should be set also for substances not having LCI values (“not – yet-assessed” substances).**
- **TVOC should not be used alone as an indicator for evaluating health effects from indoor product emissions. When evaluating the emission of construction products TVOC provides useful information when combined with the limitation of CMR substances and with the LCI concept.**
- **A common approach for TVOC definition along with an agreed upper limit value for TVOC should be established.**

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## 5 SENSORY EVALUATION OF INDOOR PRODUCT EMISSIONS

### 5.1 Overview and comparison of sensory evaluation methodologies in EU

The ECA report no. 20 “Sensory Evaluation of Indoor Air Quality”, published by EC-JRC in 1999, describes different methodologies for the sensory evaluation of indoor environmental quality. The report presents the background and gives advice on methodologies, especially for sensory evaluation of indoor air quality (IAQ).

Human subjects are indispensable in the measurement of perceived indoor air quality. Chemical and physical methods of characterisation often have difficulty with taking into account the combinations of different pollutants in a meaningful way. There is, however, on-going work aiming at developing electronic sensor-based systems for the evaluation of IAQ, e.g. the SYSPAQ project (2009).

A continuous visual analog scale has been used for rating of acceptability of IAQ (Gunnarsen and Fanger, 1992). The scale end-points are labelled ‘clearly acceptable’ (often assigned the value of +1) and ‘clearly unacceptable’ (often assigned the value of -1). The middle of the scale is indicated as the transition between ‘just acceptable’ and ‘just not acceptable’. Votes may therefore be interpreted both as binary votes and as votes on a continuous scale. This allows for a conversion of the votes on the continuous scale to an estimate of the percentage of dissatisfied. This can be done with reduced standard deviation compared to direct binary votes. A slightly modified version of the scale with a gap between ‘just acceptable’ and ‘just not acceptable’ has been developed. This version is now most commonly used.

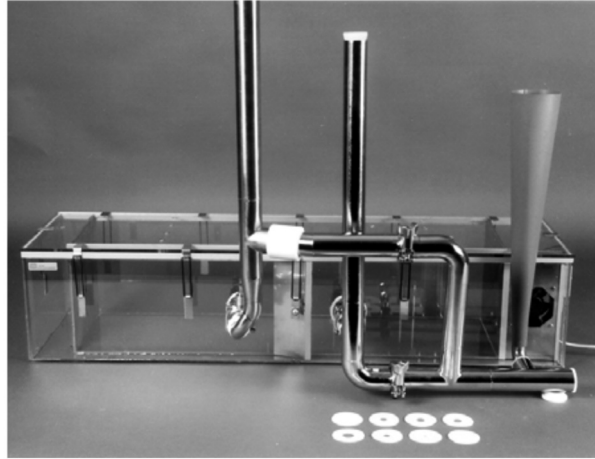
A five point intensity scale, originally introduced by Yaglou, was initially used as a category scale and later modified to be continuous (Yaglou et al., 1936). The scale ranges from ‘no odour’ to ‘overpowering odour’. An additional intensity scale was developed by Bluysen (1990) and developed further by Müller (2008) based on the comparison of the odour with a comparative standard (different acetone concentrations). With this procedure the number of test participants can be reduced to 8-10 trained panelists.

The ECA report no. 20 does not include methods that involve description of odours, using descriptors e.g. ‘pleasant’, ‘unpleasant’, ‘woody’, ‘metallic’, ‘heavy’, ‘stale’ or ‘fresh’.

The result of the sensory evaluation depends on several factors, e.g. the number of subjects in the panel performing the evaluation, trained or untrained panel, etc. In the M1 and DICL labelling schemes, the CLIMPAQ or a similar test chamber is used for the sensory evaluations (Figure 4). For the AgBB evaluation the CLIMPAQ and the use of emission test chambers according to ISO 16000-9 is proposed.

Examples of the scales used by M1 and DICL for sensory evaluation are shown in Appendix 3.

The differences and similarities of the methods used by the Danish Indoor Climate Labelling (DICL, 2005; 2007), the Finnish M1 (M1, 2001) classification and the AgBB (at proposal stage, a 2-year pilot phase starts 2012) are listed in Table 3.



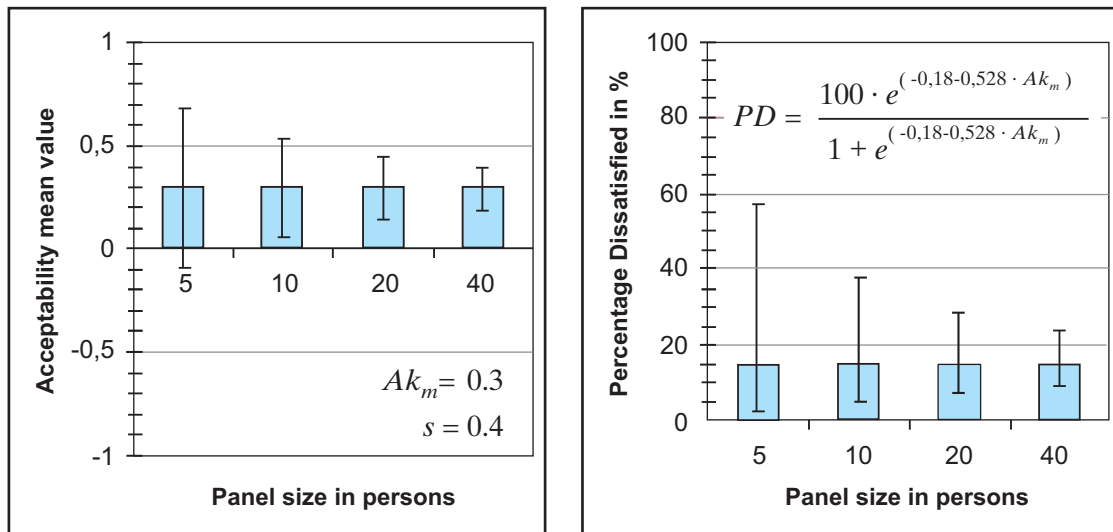
**Figure 4.** *CLIMPAQ (Nordtest 482, 1998).*

As can be seen in Table 3 the common features in these three evaluation procedures cover only a part of the basic variables such as chamber type, air flow in the presenting funnel and selection and instruction of the panel members. Factors including the chamber loading, panel size and the evaluation procedure differ in the current procedures.

**Table 3.** Comparison of sensory evaluation by the DICL, M1 and AgBB schemes.

	<b>M1</b>	<b>DICL</b>	<b>AgBB (proposal)</b>
<b>Test chamber</b>	CLIMPAQ	CLIMPAQ or similar	CLIMPAQ or ISO 16000-9 + sampling bags
<b>Air flow in presenting funnel</b>	0.9 l/s	0.9 l/s	0.6 - 1 l/s
<b>Panel type (trained/untrained)</b>	Untrained	Untrained	Trained
<b>No. of panel members</b>	5 (+10 in certain cases)	Minimum 20	Minimum 8; defined accuracy must be complied with
<b>Criteria for inclusion in panel</b>		Age: 18 to 50 years Smoking habits: recorded Olfactory sense: normal (equal distribution of both sexes and max. 40% smokers in the panel is preferred)	The panel members shall not be anosmic and shall not be too sensitive. See ISO/FDIS 16000-28
<b>Instruction of panel members</b>	Panel members should: - refrain from eating garlic on the day before sensory assessments - take a shower in the morning of the assessment day and refrain from using strong-smelling cosmetic products - wear odourless clothes (no leather jackets etc.) - abstain from drinking coffee and smoking between sensory assessments and an hour before they begin	Panel members should: - refrain from eating garlic or spicy food on the day or the day before the evaluation - refrain from eating or smoking during the last hour prior to evaluation - have a high personal hygiene and refrain from using strong-smelling cosmetics - wear clothes washed in a neutral detergent	See ISO/FDIS 16000-28
<b>Evaluation include the use of:</b>			
- acceptability	Yes	Yes	No
- odour intensity	No	Yes	Yes
- descriptors	Yes	No	No
- hedonics	No	No	Yes
<b>Evaluation based on</b>	2 evaluations (2 min. interval)	First impression (1 inhalation)	Evaluation with comparative scale
<b>Accept criteria</b>	Mean value of votes: Acceptability >0.1 ('just acceptable')  If the mean value of acceptability falls within the range [-0.4; +0.4] the evaluation procedure is repeated with 5 more subjects	Median of votes: Acceptability >0 ('acceptable') Odour intensity ≤2 (2='moderate odour')	Proposal to be checked during pilot phase: Accept if perceived intensity ≤ 9 pi (± 2 pi) and hedonic ≥ 1.2 (± 0.8)
<b>Model room conditions:</b>			
- model room	17 m <sup>3</sup> (DS90)	17 m <sup>3</sup> (DS90)	17 m <sup>3</sup> (DS90)
- material loading	According to DS90	According to DS90	ISO 16000-9
- air change rate	2 per hour	0.5 per hour	0.5 per hour
<b>Relative material loading factor (based on air change rate)</b>	1	4	Depend on type of product (ISO 16000-9)

The methods have been compared and discussed (Müller et al., 2008). This discussion includes aspects of accuracy of the methods. The factor which affects the accuracy most is the standard deviation (s) of the evaluations, followed by the panel size. In general the panel size shall be large enough to meet the requirements of the accuracy of the odour evaluation. The standard deviation of an untrained panel can be estimated to 0.4 on the acceptability scale. From the acceptability, the percentage of dissatisfied can be calculated. The two graphs below show the 90% confidence interval of the acceptability mean value, dependent on the panel size (Figure 5). The accuracy requirement set for the labelling acceptance criteria thus determines the panel size both when using untrained and trained panels.



**Figure 5.** Impact of panel size on 90% confidence interval of the acceptability mean value ( $Ak_m$ ) and percentage of dissatisfied (PD) (Müller et al., 2008)

## 5.2 ISO/FDIS 16000-28: Determination of odour emissions from building products using test chambers

The draft ISO standard on “Determination of odour emissions from building products using test chambers” is currently adopted as ISO/FDIS 16000-28.

The objective of the standard is to provide a cost effective method for evaluation of the odour of the material emissions even from big building products. It uses EN ISO 16000-9 type test facilities and test conditions. Odour determination is done using a defined funnel or other equipment validated to perform equally.

The standard also sets requirements for the testing environment.

ISO/FDIS 16000-28 has two alternative assessment methods, the acceptability of the odour emission and the perceived intensity of the odour emission. The methods can be used separately. As a complementary method the standard also allows for the assessment of the hedonic tone using an untrained panel.

The acceptability method uses a discontinuous scale ranging from “clearly acceptable” to “just acceptable” and from “just unacceptable” to “clearly unacceptable”.

The perceived intensity  $\Pi$  is determined by comparing the intensity of the sample with different specified intensities of the reference substance (e.g. acetone). The smelling capability varies from human to human. The use of comparative sources reduces the inter-individual variance of the test result since all panel members evaluate air quality based on the same reference scale.

The unit of  $\Pi$  is [pi]. The comparative scale consists of reference substance-air mixtures. The comparative scale of intensity is defined by the following points:

0 pi = odour threshold concentration of the acetone-air mixtures (e.g. 20 mg acetone/m<sup>3</sup> air) at which 50% of the panel can perceive the odour.

Concentrations for 1 to n pi follow a linear gradation of the acetone concentrations. The hedonic tone describes the emotional effect of an odour. This assessment method uses a 9 step scale from "extremely unpleasant" (-4) to "extremely pleasant" (+4).

The requirements, testing of panel members, tasks and behaviour of the odour panel are defined. The minimum size of the acceptability panel is 15 untrained panelists and of the intensity panel 8 trained panelists. The standard defines for both methods the limits of the accuracy of odour evaluation.

### **5.3 Recommendations of the ECA Preparatory Working Group 27**

Considering the experiences of the different labelling schemes and the results of the comparison test, the ECA Preparatory WG 27 has come to the following recommendations:

- **Sensory evaluation is considered to be an important part of the assessment of product emissions. Results have shown that chemical characterisation of emissions is not a good predictor of sensory effects. Therefore it is important to complement the chemical assessment of product emissions with sensory evaluation.**
- **The ECA Preparatory WG 27 supports the work of ISO TC 146/SC6 in creating a standard for sensory evaluation. The draft standard ISO/FDIS 16000-28 on "Determination of odour emissions from building products using test chambers" is expected to be published soon. It includes both acceptability evaluation using an untrained panel and perceived intensity measurement with a trained panel. It also combines the odour evaluation chamber technique with the harmonised testing standard (reference room) prepared by CEN TC 351.**
- **The practical implication of the implementation of the ISO standard should be discussed and clarified at a later stage.**

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## **6 DATA HANDLING, EVALUATION AND REPORTING**

### **6.1 Introduction**

In the existing labelling schemes M1 and D1CL the testing report is based on ISO 16000-6. The reporting of test results includes information on the measurement, starting from the point of air sampling from the test chamber and the analytical details and results. In addition to the sampling and analytical details, the test report shall also include information about product sampling and test specimen preparation. The latter topics are included in the harmonised standard method for determining the emissions of dangerous substances from construction products under development in CEN TC 351. In addition to the technical details to be reported, data handling and evaluation procedures must be specified by the harmonised European labelling scheme. It was agreed within the ECA Preparatory Working Group 27 to use the LCI approach for assessing the health effects of the emissions.

According to the draft horizontal test standard it is required to report:

- identified target compounds, provided with CAS number
- identified non-target compounds, provided with CAS number
- non identified compounds
- carcinogenic substances
- TVOC
- TSVOC.

### **6.2 Tools for data handling and evaluation**

#### **6.2.1 The ADAM tool for aggregation and reporting of results**

The Excel based calculation tool ADAM has been developed for use in the approval procedure in DIBt:

1. to allow a quick overview of test results in the evaluation sheet
2. to allow better comparability by standardised layout of parameters and results
3. to screen single contributions of LCI quotients to the final result
4. to allow the use of different updated or former LCI lists
5. to help in the identification of carcinogens.

The ADAM excel sheet has proven its suitability in DIBt and AgBB. As its application is obligatory in the approval procedure it can be purchased for a nominal fee through DIBt. For the purpose of statistical analysis of the data a research programme has been set up by DIBt to improve different features. The import of data from different laboratories is not facilitated yet; for this an automatic transfer of data into the software would be suitable.

The ADAM excel sheet (Figure 6) will be adapted also to other LCI lists e.g. the French CLI list and the upcoming harmonised EU-LCI list and could therefore facilitate the evaluation according to the different requirements: AgBB list (NIK values), AFSSET list (LCI values), EU-LCI list.

<b>Probenbezeichnung</b> Marking of the sample	XYZ						<b>Wichtige Informationen</b> (important information)		<b>Tabellenblätter schützen</b> protect worksheets	
<b>Aktenzeichen beim DIBt</b> File number of DIBt	II42-1.156.613...								<b>Blattschutz aufheben</b> unprotect worksheets	
<b>Prüfinstitut</b> Testing laboratory	ABC									
<b>Ergebnisüberblick</b> General view of the results <small>ADAM_2008_04_Urversion</small>	<b>3 Tage (days)</b>			<b>7 Tage (days)</b>			<b>28 Tage (days)</b>			
	<b>Ergebnisse</b> results	<b>AgBB</b> Anforderungen requirements	<b>Abbruchkriterien</b> break-off criteria	<b>Ergebnisse</b> results	<b>Abbruchkriterien</b> break-off criteria	<b>Ergebnisse</b> results	<b>AgBB</b> Anforderungen requirements	<b>Ergebnisse</b> results	<b>AgBB</b> Anforderungen requirements	<b>Ergebnisse</b> results
	µg/m³	mg/m³	mg/m³	µg/m³	mg/m³	µg/m³	mg/m³	µg/m³	mg/m³	mg/m³
[A] TVOC (C <sub>6</sub> - C <sub>16</sub> )	456	0 ≤ 10 mg/m³	0,5 !! ≤ 0,3 mg/m³	380	0,4 ≤ 0,5 mg/m³	300	0,3 ≤ 1,0 mg/m³			
[B] Σ SVOC (C <sub>16</sub> - C <sub>22</sub> )	90	keine none	0,09 !! ≤ 0,03 mg/m³	90	0,09 !! ≤ 0,05 mg/m³	75	0,1 ≤ 0,1 mg/m³			
[C] R (dimensionlos/dimensionless)	0,700	keine none	0,7 !! ≤ 0,5	0,500	0,5 ≤ 0,5	0,400	0 ≤ 1			
[D] Σ VOC o. NIK without LCI	127	keine none	0,13 !! ≤ 0,05 mg/m³	88	0,09 !! ≤ 0,05 mg/m³	70	0,1 ≤ 0,1 mg/m³			
[E] Σ Cancerogene	2	0,00 ≤ 0,01 mg/m³	0,002 !! ≤ 0,001 mg/m³	0	0,000 ≤ 0,001 mg/m³	0	0,000 ≤ 0,001 mg/m³			
<b>Dieser Block liefert zusätzliche Information</b> This part gives some additional information										
[F] VVOC (< C <sub>6</sub> )	25			2		0				
[G] VOC (C <sub>6</sub> - C <sub>16</sub> ) als Toluoläquivalent as toluene equivalent	400	<b>Wert manuell eingeben!</b> Enter value manually!		300	<b>Wert manuell eingeben!</b> Enter value manually!	250	<b>Wert manuell eingeben!</b> Enter value manually!			

**Figure 6.** ADAM-excel sheet as it is currently used by DIBt for submission of emission test data in the approval procedure. This example shows the ADAM evaluation sheet for a floor covering tested after 3, 7 and 28 days. The exclamation marks mean that the criteria for a break-off of the test are not fulfilled.

### 6.3 Recommendations of the ECA Preparatory Working Group 27

- A shared data handling and reporting tool (e.g. as the ADAM Excel sheet) could be used as a basis for a future harmonised European system for documentation and evaluation of data.
- Additional features like an import tool and integration of alternative LCI lists are feasible improvement options.

### 6.4 References

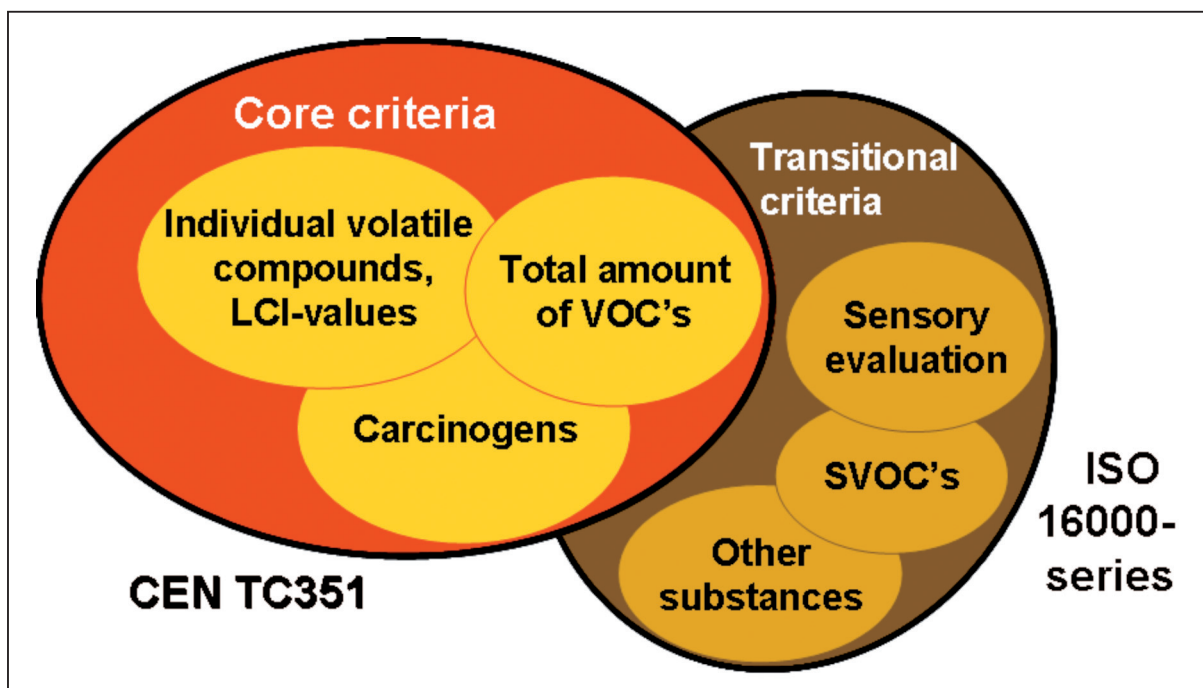
ADAM: AgBB DIBt Assessment Mask. More info can be retrieved at the following address:  
[http://www.dibt.de/en/data/Aktuelles\\_Ref\\_II\\_4\\_4.pdf](http://www.dibt.de/en/data/Aktuelles_Ref_II_4_4.pdf)

## 7 GENERAL CONCLUSIONS AND RECOMMENDATIONS

The ECA Preparatory working group 27 co-ordinated by EC-JRC and composed of representatives of AFSSET, AgBB, DICL and M1 labelling systems, CSTB, VTT, BAM, DTI and IEH Cranfield University, elaborated a harmonised framework for a European labelling scheme featuring the following:

- ⇒ The framework should include common core criteria and the associated testing methodologies, and transitional criteria.
- ⇒ The criteria should cover all volatile substances of concern to health and comfort. Risk assessment data should be used, when available.
  - Single volatile compounds (using the LCI values and EU carcinogenicity data).
  - Total amount of volatile organic compounds (TVOC).
- ⇒ The LCI-approach will not be able to cover all the contaminants of interest for the health and comfort of consumers.
  - Additional strategies (e.g. sensory evaluation) will be needed.
  - The application of these strategies could be included at a later stage.These strategies are termed “transitional criteria” in this report.
- ⇒ Testing should be based on harmonised European standards (CEN TC 351), when they are available.

This concept is graphically represented in figure 7.



*Figure 7. The concept of the harmonisation framework for indoor labelling schemes in EU.*

The consensus so far reached for the measurement methods, the common core and the transitional criteria for the harmonisation framework is summarised in Table 4.

Table 4. Consensus reached for the measurement methods, the common core and the transitional criteria.

Requirements / Parameter	M1 Finland	DICL Denmark	AgBB Germany	AFSSET France	Consensus
Measuring method / Chamber	ISO 16000 series	ISO 16000 series	ISO 16000 series	ISO 16000 series	Harmonised CEN Standard (based on ISO 16000 series)
Measuring points (days)	28	3, 10 and 28	3 and 28	3 and 28	3 and 28
<b>Core criteria</b>					
Single VOCs evaluated (R = $\sum Ci/LCI < 1$ )	No	comparison with irritation threshold	R < 1 170 LCIs (2010)	R < 1 165 LCIs (2009)	R < 1 Harmonised list of LCIs
Carcinogens evaluated according to concentration emitted	IARC class 1 SERA < 5 $\mu\text{g}/\text{m}^2\text{h}$ SERA < 200 $\mu\text{g}/\text{m}^2\text{h}$	IARC class 1	EU classes 1 and 2 56 listed compounds Sum < 1 $\mu\text{g}/\text{m}^3$ 1000 $\mu\text{g}/\text{m}^3$	EU classes 1 and 2 2 listed compounds < 1 $\mu\text{g}/\text{m}^3$ 1000 $\mu\text{g}/\text{m}^3$	Harmonised list of EU carcinogens classes 1 and 2 compounds to be checked 200-1000 $\mu\text{g}/\text{m}^3$
TVOC measured	SERA < 50 $\mu\text{g}/\text{m}^2\text{h}$	No	No <sup>1</sup>	10 $\mu\text{g}/\text{m}^3$ (LCI)	Value to be discussed
Formaldehyde measured		75 $\mu\text{g}/\text{m}^3$			
<b>Transitional criteria</b>					
Compounds without LCI assessment ('not-yet-assessed' substances)	No	No	Sum < 100 $\mu\text{g}/\text{m}^3$	Sum < 100 $\mu\text{g}/\text{m}^3$	Sum < 100 $\mu\text{g}/\text{m}^3$
Other compounds evaluated	Ammonia	Aldehydes			
TSVOC measured	No	No	< 100 $\mu\text{g}/\text{m}^3$	No	Await validation CEN TC 351
Sensory evaluation	Acceptability untrained panel 15 persons	Acceptability and intensity; untrained panel, minimum 20 persons	Yes (Pilot phase using ISO/FDIS 16000-28)	No	Await ISO 16000-28

<sup>1</sup> Formaldehyde measurement required for approval application at DIBt

Considering the experiences of the different labelling schemes and the results of the comparison tests undertaken so far, the ECA Preparatory WG 27 has come to the following conclusions and recommendations.

### **General Framework**

- A harmonised framework for indoor product emissions labelling schemes in EU should comprise core and transitional criteria for the chemical characterisation and the sensory and health evaluation of product emissions.

### **Emission Testing of Indoor Products**

- Emission testing should be based on harmonised European standards, when available.
- Products should be tested for their emissions as they are placed on the market.
- The Preparatory WG supports the work of CEN TC 351 and recommend the use of the validated harmonised testing standard for measurement of VOC's and formaldehyde when this becomes available.
- Until harmonised standards become available, ISO 16000 series standards should be used for product sampling and measurements with the following exceptions:
  - Emission testing should include two chamber air sampling times (day 3 and 28).
  - Reference room size: use the normative proposal of CEN TC 351 instead of that described in the ISO 16000-9 informative annex B.

### **Health and Sensory Evaluation of Indoor Product Emissions**

- For the evaluation of indoor products emissions, the ECA Preparatory WG 27 agreed to refer to the EU-carcinogens classification.
- EU carcinogens determined through the harmonised protocol are volatile compounds measurable by ISO 16000 series standards.
- If carcinogens are detected after 3 days, the test can be stopped.
- An EU group should be established to prepare a common list of carcinogens fulfilling the above criteria.
- The evaluation criteria should cover all contaminants of concern to health and comfort and be based on scientific evidence when available.
- The LCI-approach is currently the most feasible strategy to assess the health effects of compounds from buildings products and the harmonisation process of LCI values for around 170 chemicals which has recently started in Europe is fully supported.
- Criteria should be set also for substances not having LCI values ("not-yet-assessed" substances).
- TVOC should not be used alone as an indicator for evaluating health effects from indoor product emissions. When evaluating the emission of construction products TVOC provides useful information when combined with the limitation of CMR substances and with the LCI concept.

- A common approach for TVOC definition along with an upper limit for TVOC should be established.
- Sensory evaluation is considered to be an important part of the assessment of product emissions. Results have shown that chemical characterisation of emissions is not a good predictor of sensory effects. Therefore it is important to complement the chemical assessment of product emissions with sensory evaluation.
- The ECA Preparatory WG 27 supports the work of ISO TC 146/SC6 in creating a standard for sensory evaluation. The draft standard ISO/FDIS 16000-28 on "Determination of odour emissions from building products using test chambers" is expected to be published soon. It includes both acceptability evaluation using an untrained panel and perceived intensity measurement with a trained panel. It also combines the odour evaluation chamber technique with the harmonised testing standard (reference room) prepared by CEN TC 351.
- The practical implication of the implementation of the ISO standard should be discussed and clarified at a later stage.

### **Data Handling and Reporting**

- A shared data handling and reporting tool (e.g. as the ADAM Excel sheet) could be used as a basis for a future harmonised European system for documentation and evaluation of data.
- Additional features like an import tool and integration of alternative LCI lists are feasible improvement options.

### **Next Steps for the Implementation of the Harmonisation Framework**

It is planned to continue the harmonisation work under the umbrella of an expanded group representing a broad range of stakeholders concerned with the labelling of construction products on the basis of the emissions to indoor air. This work will take account of developments in standardisation (CEN and ISO) and regulations at European and national level. The aim is for a harmonised basis for emission testing and evaluation that can be applied in voluntary and mandatory schemes that provide a cost effective method for identifying and promoting low emitting products in Europe with consequential benefits for concerned consumers and the quality of air in buildings.

**APPENDIX 1: Short summaries of evaluation procedures in AFSSET, AgBB, DIDL and M1**

**A: AFSSET protocol and mandatory labelling of emissions from building products in France**

In the framework of the 2004-2008 French NEHAP, the French Agency for Environmental and Occupational Health Safety (AFSSET) has been mandated for establishing the health-related protocol for the evaluation of VOC and formaldehyde emissions from building products. A working group established by AFSSET and co-chaired by CSTB started its work in 2004. In October 2006, a first protocol for the evaluation of VOC and formaldehyde emissions from solid building products, based on similar approaches developed previously (ECA, 1997; AgBB, 2005), proposed by the working group and approved by the AFSSET Air experts group and by AFSSET has been presented. This protocol has been updated and was expanded to liquid and finishing products in 2009 (AFSSET, 2009). The protocol is based on the ISO 16000 standards series and on VOC and formaldehyde sampling and analysis after 3 and 28 days of emission testing in emission test chambers or cells. The protocol has been presented in detail elsewhere (AFSSET, 2009; Rousselle et al., 2008). Criteria for the health-related evaluation of emissions from building products according to the AFSSET protocol are:

- TVOC
- Carcinogenic and mutagenic compounds category 1 and 2 (according to 67/548/CEE Directive classification): 2 listed compounds : benzene and trichloroethylene
- Identification of respiratory sensitizer: information on product requirements
- R (risk index) calculated as the sum of ratio of individual VOC concentrations above 5 µg/m<sup>3</sup> to their respective Lowest Concentrations of Interest (LCI):  $R = \sum (C_i / LCI)$
- Sum of ‘not-yet-assessed’ compounds with concentrations above 5 µg/m<sup>3</sup> (unidentified compounds or VOC without LCI):  $\sum C_{ni}$ .

For individual VOC evaluation through the R ratio, AFSSET established a list of 165 LCIs in 2009. Limit values of exposure concentrations according to the AFSSET protocol are presented in Table A1.1.

*Table A1.1. Limit values of exposure concentrations according to the AFSSET protocol (µg/m<sup>3</sup>).*

<b>Limit values (µg/m<sup>3</sup>)</b>	<b>Day 3</b>	<b>Day 28</b>
TVOC	10000	1000
Carcinogens (C1, C2)	10	1
$R = \sum (C_i / LCI)$	-	1
$\sum C_{ni}$	-	100

Mandatory labelling of volatile emission from construction products, floorings, wall coverings, paints and varnishes has been established in France by Decree n° 2011-321 (March 23, 2011) and Order of April 19, 2011. Decree n° 2011-321 states that products may only be made available on the market if they are accompanied by a label indicating their emissions of volatile compounds. The products which are concerned by this mandatory labelling procedure are specified: floor, walls and ceiling coverings, claddings, insulation materials, doors and windows, products used for the installation or the preparation of above listed products. Mandatory labelling of emissions from building products entered into force on 1<sup>st</sup> January 2012 for new commercial references and on 1<sup>st</sup> September 2013 for products already on the market before 2012. The Order of April 19, 2011 defines the list of volatile compounds to be considered (10 individual substances and TVOC) and the four emissions classes ranging from A+ (very low emissions) to C (high emissions) (see Table A1.2.). The 10 individual substances have been selected because of their occurrence indoors in French dwellings and of their classification as dangerous substances through inhalation according to EU classification. Details regarding mandatory labelling can be found on the Ministry web pages (in French):

- <http://www.developpement-durable.gouv.fr/Chapitre-I-Mode-d-emploi-de-l.html>
- <http://www.agissons.developpement-durable.gouv.fr/L-etiquette-vous-guide,271>

**Table A1.2.** List of substances and emission classes for mandatory labelling (units:  $\mu\text{g}/\text{m}^3$  after 28 days).

Substances	CAS	standard	emission classes			
			C	B	A	A+
formaldehyde	50-00-0	ISO 16000-3	> 120	< 120	< 60	< 10
acetaldehyde	75-07-0	ISO 16000-3	> 400	< 400	< 300	< 200
toluene	108-88-3	ISO 16000-6	> 600	< 600	< 450	< 300
tetrachlorethylene	127-18-4	ISO 16000-6	> 500	< 500	< 350	< 250
xylene	1330-20-7	ISO 16000-6	> 400	< 400	< 300	< 200
1,2,4-trimethylbenzene	95-63-6	ISO 16000-6	> 2000	< 2000	< 1500	< 1000
1,4-dichlorobenzene	106-46-7	ISO 16000-6	> 120	< 120	< 90	< 60
ethylbenzene	100-41-4	ISO 16000-6	> 1500	< 1500	< 1000	< 750
2-butoxyethanol	111-76-2	ISO 16000-6	> 2000	< 2000	< 1500	< 1000
styrene	100-42-5	ISO 16000-6	> 500	< 500	< 350	< 250
TVOC		ISO 16000-6	> 2000	< 2000	< 1500	< 1000

The Order of April 19, 2011 also specifies the format of the label to be placed on the product or on its packaging and the methods for the characterisation of emissions for control purposes (ISO 16000 standards).

### **B: AgBB protocol for evaluating indoor product emissions**

To establish the fundamentals for a uniform and reproducible health-related evaluation of building products in Germany, the Committee for Health-related Evaluation of Building Products (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten - AgBB) has developed criteria for testing and evaluating VOC emissions from building products. The evaluation scheme sets quality standards relevant to health for future production of building products for use indoors and thus stimulates the development of particularly low-emission products. It is not aimed at subsequent evaluation of products already installed.

German authorities published the first version of AgBB-scheme in 2000. Basically, until 2002 it was a set of criteria for limiting emissions from products for two different levels:

1. The main level is a mandatory VOC emission scheme. It contains limitations for building products proving their 'fitness to use' under the Essential Requirement No. 3 of the European Construction Products Regulation (CPR, 2011).
2. The second level was a proposal for voluntary use. This level is to show very low emission profiles for particular products.

The AgBB scheme has been integrated into the approval procedure for selected construction products (so far flooring coverings in occupational rooms: textile floorings, resilient floor coverings, linoleum, laminates, parquets, floor coatings; screed products; floorings for sports areas; decorative wall coverings (coming); adhesives, coatings and sealings, underlayers) in Germany by DIBt since 2004. In this context it is a mandatory scheme. It was notified to the European Commission in 2005 (and 2008 in an updated version).

According to the AgBB-scheme VOC and SVOC emissions are measured after 28 days ventilated storage in a test chamber, following the test methods of ISO 16000 series. The three fundamentals of the evaluation are:

1. limits for the total amount of emissions,
2. assessment of toxicological relevance of detected single substances and
3. limits for 'not-yet-assessed' substances.

The basis for the evaluation of single substances in (2) is a list of about 170 LCI-values (Lowest Concentration of Interest), which are updated periodically based on current toxicological knowledge (updated LCI-list May 2010).

Table A1.3. presents the limit values for the emissions according to the AgBB-scheme.

*Table A1.3. Limit values for the emissions according to the AgBB-scheme.*

Limit values for	Day 3 ( $\mu\text{g}/\text{m}^3$ )	Day 28 ( $\mu\text{g}/\text{m}^3$ )
TVOC	10000	1000
Carc. Cat. 1 and 2	10	1
SVOC	-	100
$R = \sum (C_i / \text{LCI})$	-	1
$\sum C_{ni}$	-	100

- R calculated as the sum of ratio of individual VOC concentrations above  $5 \mu\text{g}/\text{m}^3$  to their respective LCI
- $\sum C_{ni}$ : sum of 'not-yet-assessed' compounds with concentrations above  $5 \mu\text{g}/\text{m}^3$  (unidentified compounds or VOC without LCI).

Starting in 2012 a two-year Pilot Phase on the feasibility of developed criteria on sensory evaluation according to the results of a research project (Müller et al., 2011) will be performed.

## **C: DICL (The Danish Indoor Climate Label)**

The Indoor Climate Label was initiated in 1993 by the Danish Ministry of Housing and Urban Affairs. It was originally introduced in Denmark to reduce emissions from building products and products used in the indoor environment.

The main principle of the Indoor Climate Label is the determination of the indoor-relevant time value. The time value is based on chemical analysis of the emission of single volatile organic compounds (VOCs) and aldehydes. These are evaluated in relation to sensory irritation (eye and upper airways) combined with a sensory evaluation of air acceptability and intensity of odour. The emission test is carried out on a newly manufactured product.

The indoor-relevant time value is the time (in days) from when the product is first released for sale until the concentration (converted into a standard room) of all individual compounds is below half the threshold value for irritation of mucous membranes. The threshold values for irritation of mucous membranes are those given in VOCBASE (Jensen and Wolkoff, 1996). Analysis is carried out on at least two occasions. According to the General Labelling Criteria common to all product areas (DICL, 2007) and Standard Test Method (DICL, 2005), which is based on the ISO 16000-series standards, testing times of 72 hours and 28 days should as a principal rule be included.

At the same time the product must fulfil the requirements for the sensory evaluation of the air quality. The sensory evaluation criteria for an acceptable air quality is: 1) the air quality shall be perceived as “acceptable” (median of minimum 20 persons’ evaluations) using the acceptability scale, and 2) the odour intensity shall be below 2 (“moderate odour”) using a 6-point continuous scale for odour intensity.

For all product areas a maximum allowed time-value is set in the criteria.

In addition to the chemical analysis and sensory evaluation, ceiling products are also tested for the release of fibres and particles. The method is based on the Nordtest method NT Build 347 (Nordtest, 1989), in which test specimens are installed in a test chamber and vibrated with sound from a loudspeaker.

The Indoor Climate Label also requires the product to be accompanied by instructions or storage, installation, application, use, cleaning and maintenance etc. to ensure a low impact on the indoor air quality throughout the normal lifetime of the product.

As of 2012 more than 2000 individual products are covered by a labelling license. The largest product groups are:

- Furniture
- Ceiling and wall systems
- Kitchen, bath and wardrobe cabinets
- Floorings.

## D: M1 Emission classification of Building Products (Finland)

The first version of the emission classification was developed by the Finnish Society of Indoor Air Quality and Climate (FiSIAQ) in 1995 as part of Classification of Indoor Climate, Construction, and Finishing Products. The first emission classifications were granted in 1996. In May 2000 the system changed its name into emission classification of building products.

The goal of the classification is to enhance the development and use of low-emitting building products so that product emissions do not increase the requirement for ventilation. The classification presents requirements for the products used in ordinary work spaces and residences. The classification does not overrule official building codes or interpretations of them.

The emission classification of building products has three emission classes. Emission class M1 corresponds to the best quality and emission class M3 includes products with the highest emission rates. Classified products have to fulfil the following criteria at the age of 28 days.

*Table A1.4. Criteria for the M1 and M2 emission classes.*

Examined qualities	M1 [mg/m <sup>2</sup> h]	M2 [mg/m <sup>2</sup> h]
The emission of total volatile organic compounds (TVOC). A minimum of 70% of the compounds shall be identified.	< 0.2	< 0.4
The emission of formaldehyde (HCOH)	< 0.05	< 0.125
The emission of ammonia (NH <sub>3</sub> )	< 0.03	< 0.06
The emission of carcinogenic compounds belonging to category 1 of the IARC monographs (IARC 1987) <sup>1*</sup>	< 0.005	< 0.005
Odour (dissatisfaction with odour shall be below 15 %) <sup>2*</sup>	Is not odorous	Is not significantly odorous

1\* IARC 1987, does not apply to formaldehyde (IARC 2004)

2\* The result of sensory evaluation shall be > + 0,1

- Plasters and tiling products, levelling agents, putty, mastics, fillers, screeds and renders shall not contain casein.
- Emission class M3 includes products whose emissions exceed the values specified for products in category M2.
- Products that have not been tested shall not be granted a classification label. However, design guidance provided in the Classification of Indoor Climate places no restrictions on the use of uncoated brick, stone, ceramic tile, glass and metal surfaces as well as board and log surfaces made of wood (Finnish wood) may be used as M1 classified products. The VOC emissions of fresh wood may nevertheless exceed the limit value of emission class M1.

Sample selection, analysis and measurements of product emissions are to be conducted as stipulated in documents based on the ISO 16000 series of standards.

- Protocol for the Chemical and Sensory Testing of Building Products for the Emission Classification of Building Products.
- Protocol for the Sensory Testing of Building Products for the Emission Classification of Building Products.

Applications for an emission classification for a building product are submitted to the Building Information Foundation RTS on an application form. Additional information can be found at [www.rts.fi](http://www.rts.fi).

A more detailed description of the whole testing and acceptance method can be seen on the Web site of RTS (Building Information Foundation) (Saarela et al., 2004).

The reliability of the whole procedure rests on the chemical and sensory tests done by well-known, skilled and certified or officially accredited laboratories. Today, seven laboratories from Finland, Denmark, Germany and Sweden are accepted for M1-testing. The system is open to any laboratory with the capacity to carry out testing according to the ISO 16000 series of standards, a reliable quality assurance system and performance demonstrated by e.g. participation in European round-robin tests.

According to references and experience, the general accuracy of the chemical tests is about 20%. The probable error of the sensory tests (the classification used small untrained two step panels (5/15) is 10%. In every case the overall risk of wrong conclusions in accepting and classifying products seems to be sufficiently low and functional for this purpose (Saarela, 2003).

An essential part of the classification is product quality control, which makes the system more reliable. The quality of classified products is verified also through sample testing. The products to be tested are selected annually by the committee developing and supervising classification work.

### **Emission Classified Products**

Today there are over 2000 classified products from over 110 manufacturers or importers. The largest product groups among classified products are:

- plaster, rendering, putties, fillers etc.
- flooring
- paints and varnishes
- building boards
- mineral wool.

Classification requires that the product has been tested by an approved testing laboratory in accordance with the required methods. Sample selection, analysis and measurements of product emissions must be performed at a competent and impartial laboratory approved by the classification working group.

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## APPENDIX 2: Sampling, storage and test specimen preparation - an overview on the procedural details in existing labelling schemes in EU

- According to EN ISO 16000-11:2006
- See Remarks

	EN ISO 16000-11:2006	M1	DICL	DIBt/ AgBB	AFSSET	Remarks
<b>Sample collection</b>						
- responsible parties	- not clearly defined	■	■	■	■	
- chain of custody/sampling report	- not required	■	□	□	■	□ DICL: yes □ DIBt: yes
- sampling at the factory	- asap after normal manufacturing process	■	■	■	■	
- other possible sampling points	- product samples from retail stores/stock	■	■	■	■	
- time interval between production and sampling	- minimise, no exact limit	■□	■	□	■	□ M1: if possible within 1 hour from manufacturing □ DIBt: coatings and adhesives sell-by date still valid
Sample packaging after sampling	- inert, airtight - standard delivery package when suitable	■	■	■	■	

	EN ISO 16000-11:2006	M1	DICL	DIBt/ AgBB	AFSSET	Remarks
<b>Product specific instructions</b>						
<b>- sampling</b>						
Sampling from rolls (resilient products)	- discard 1 m or at least the outer layer of the roll - cut full width - amount depends on the need - pack within 1 hour from sampling	■□	□	■□	■	□ M1: discard min 2 m of the roll □ DICL: shall be arranged with the test lab □ DIBt: cut 1 – 1,5 m, width ≤ 2m
Sampling rigid products	- unopened standard package - if necessary: cut sample from the middle of large board	■	□	■	■	□ DICL: shall be arranged with the test lab
Liquid products	- unopened standard package	■	■	■	■	
- e.g. paints, varnishes, levelling compounds, concrete, adhesives, sealants, surface coatings						

Sample storage and shipment	MI	DICL	DIBt/ AgBB	AFSSET	Remarks
Sample storage before shipment	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> M1: sampling asap after manufacturing
Shipment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> M1: asap after sampling and packing <input type="checkbox"/> DICL: at the shortest transport <input type="checkbox"/> DIBt: normal transport services
Storage at the laboratory before testing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> M1: storage time max 3 weeks <input type="checkbox"/> DICL: storage time max 3 weeks, for concrete immediately
Test specimen preparation	MI	DICL	DIBt/ AgBB	AFSSET	Remarks
<b>Solid products</b>					
Rolled products	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> DIBt textile floorings may be blanked out, sealing of edges not required
Rigid products	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/> DIBt: sample area vs. joint length min 2,5:1 or max gap-ratio depending on the product width
<b>Liquid products</b>					
- paints	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/> DICL: wall paint on gypsum, other paints on spruce

- adhesives - levelling compounds, synthetic resin floorings and plasters	- inert substrate, 300 g/m <sup>2</sup> - inert substrate, wet layer thickness 3 mm	■ ■	■ □	■ □	■ □	■ □	■ □	■ □	■ □	□ DIBt: floor coatings: on inert substrate according to manufacturer's instructions, edges sealed □ DICL: 300 g/m <sup>2</sup> or higher according to manufacturer's instructions
- screed materials, concrete	- inert substrate, wet layer thickness 50 mm	■							■	
- sealants and fillers	- inert U-profile, wet layer thickness 3 mm, width 10 mm	■							■	
- sealant foams		□								□ M1: inert U-profile height 40 mm, width min 15 mm
- putty	- inert substrate, wet layer thickness 2 mm	■							■	
-care and maintenance products							□			□ DICL: floor oil on beech according to manufacturer's instruction
Combined products	- recommended method: using controlled reference specimen	□					□		■	□ M1: pre-manufactured combined products tested as delivered from the factory □ M1: prepared in laboratory according to the product related instructions □ DICL: prepared in laboratory according to the relative amount of different materials □ DIBt: hard floorings surface-treatment on-site: preparation according to technical fact sheet of the surface treatment agent

It is noted that there are a number of shortcomings in the aforementioned protocols for particular product groups, for example:

- insulation materials of different types
- other adhesives than floor covering adhesives
- building blocks
- care and maintenance products.

It is also recognised that in cases where the protocol allows options more detailed operating guidance is needed for enhancing the homogeneity of the test results.



### APPENDIX 3: Examples of scales for sensory evaluation

3a. Example of scales used for sensory evaluation of acceptability and odour intensity by M1.

RESULTS		RESULTS	
First assessment	Description of odour:	Second assessment	Air of test room
Clearly acceptable ACCEPTABLE Just acceptable Just unacceptable UNACCEPTABLE Clearly unacceptable	good <input type="checkbox"/> pleasant <input type="checkbox"/> satisfactory <input type="checkbox"/> unpleasant <input type="checkbox"/> disgusting <input type="checkbox"/>  woody <input type="checkbox"/> metallic <input type="checkbox"/> sweet <input type="checkbox"/> odourless <input type="checkbox"/> plastic-like <input type="checkbox"/> glue-like <input type="checkbox"/>  fresh <input type="checkbox"/> humid <input type="checkbox"/> dry <input type="checkbox"/> heavy <input type="checkbox"/> stale <input type="checkbox"/> pungent <input type="checkbox"/>  some other: _____	Clearly acceptable ACCEPTABLE Just acceptable Just unacceptable UNACCEPTABLE Clearly unacceptable	<input type="checkbox"/> acceptable <input type="checkbox"/> unacceptable

3b. Example of scales used for sensory evaluation of acceptability and odour intensity by DICL.

*Imagine that during your work day you are exposed to this air quality. How do you rate the air quality?*

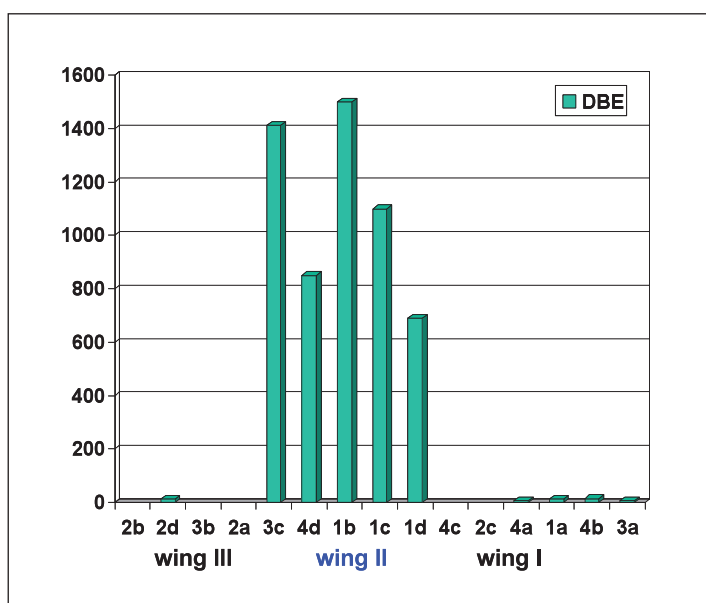
Clearly acceptable
Just acceptable
Just unacceptable
Clearly unacceptable
No odour
Slight odour
Moderate odour
Strong odour
Very strong odour
Overwhelming odour

Note: In the current standard (ISO 16000-28) the aforementioned figures on scales used for sensory evaluation and acceptability of odour intensity by M1 and DICL are provided without the gap between the ticks 'Just acceptable' and 'Just unacceptable'.

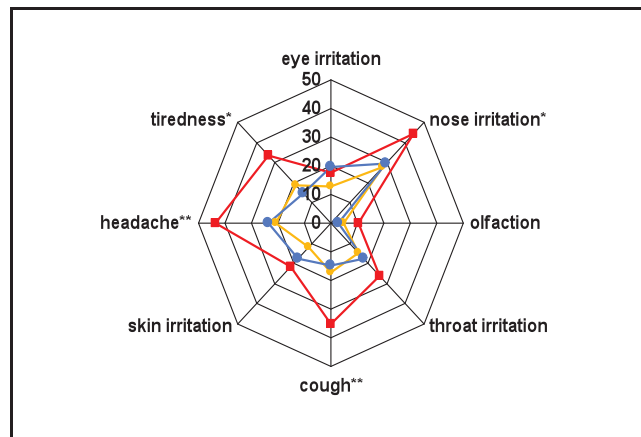


#### APPENDIX 4: Dibasic esters as new and relevant indoor air contaminants

A case study on indoor air contamination due to dibasic esters (CAS no. 95481-62-2, DBE, dimethyl adipate, dimethyl glutarate, dimethyl succinate) is presented. Health problems of children (age 6 to 10 years) and teachers in a primary school in Germany were found to be associated with elevated indoor air concentrations in the range between 1 and 2 mg/m<sup>3</sup> for the sum of the C4-C6 dibasic esters (Figure A4.1.). These semi-volatile chemicals (Bp > 200 C°) are novel indoor air contaminants and no reference values or guidance values exist for the mixture or the single components. Odour threshold according to DIN EN 13725 2003 was determined as 0.47 mg/m<sup>3</sup> (95% confidence interval: 0.33 -0.67 mg/m<sup>3</sup>). Using a benchmark value of 5 mg/m<sup>3</sup> for nasal irritation from animal experiments an indoor air guidance value of 0.5 mg/m<sup>3</sup> is proposed. Health effects in children were assessed by means of a questionnaire with 8 sick-building-syndrome items (Figure A4.2.). A statistically significant difference was found for nasal irritation, cough, headache and fatigue between exposed children and an unexposed control group and 3 weeks after the children had left the contaminated rooms. We speculate that the symptoms and complaints are most likely caused by indoor exposure to dibasic esters originating from a polyurethane floor component (barrier layer) and recommend that these semi-volatile and otherwise preferable substitutes for conventional solvents should not be used in building products, where longer lasting release could occur.



**Figure A4.1:** Concentration of the dibasic esters in 5 class rooms in wing II renovated using a polyurethane ground coat as water barrier in the floor. Epoxide based products were used in wings I and III. (Heinzow et al., 2009)



**Figure A4.2:** Health complaints of children. (Heinzow et al., 2009)

## References

Heinzow, B. et al. (2009). Raumlufbelastung mit Dicarbonsäuredimethylestern. *Gefahrstoffe – Reinhaltung der Luft* **69**, 4, 159-164.

## **APPENDIX 5: Members of the ECA “Urban Air, Indoor Environment & Human Exposure” Steering Committee**

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European Commission

## **EUR 25276 EN – Joint Research Centre – Institute for Health and Consumer Protection**

**Title:** *ECA-IAQ (European Collaborative Action, Urban Air “Indoor Environment and Human Exposure”), 2012. Harmonisation framework for indoor product labelling schemes in the EU, Report No 27.*

**Author(s):** *Stylianos Kephelopoulos, Derrick Crump, Christine Däumling, Lis Winther-Funch, Wolfgang Horn, Marion Keirsbulck, François Maupetit, Jorma Säteri, Kristina Saarela, Ana Maria Scutaru, Tiina Tirkkonen, Thomas Witterseh, Caroline Sperk*

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### **Abstract:**

This report describes the outcome of recent activities and a roadmap setting out the steps being taken by the ECA Preparatory working group 27 led by the European Commission's Joint Research Centre for establishing an EU wide harmonised framework for labelling schemes (which consists of core and transitional criteria) and obtaining broad consensus through open consultation. The recommendations made by the ECA Preparatory WG 27 are:

### **General Framework**

A harmonisation framework for indoor product emissions labelling schemes in EU should comprise core and transitional requirements for the chemical characterisation and the sensory and health evaluation of product emissions.

### **Emission Testing of Indoor Products**

Emission testing should be based on harmonised European standards, when available. Products should be tested for their emissions as they are placed on the market. The WG supports the work of CEN TC 351 and recommends the usage of the validated harmonised testing standard for measurement of VOC's and formaldehyde when this will become available. Until harmonised standards become available, ISO 16000-series standards should be used for product sampling and measurements with the following exceptions: (1) Emission testing should include two chamber air sampling times (day 3 and 28) and (2) Reference room size: use the normative proposal of CEN TC 351 instead of the ISO 16000-9 informative annex B.

### **Health and Sensory Evaluation of Indoor Product Emissions**

For the evaluation of indoor product emissions, the ECA Preparatory WG 27 agreed to refer to the EU-carcinogens classification. EU carcinogens determined through the harmonised protocol are volatile compounds measurable by ISO 16000 series standards. In emission testing of indoor products, if carcinogens are detected after 3 days, the test can be stopped. The evaluation criteria should cover all contaminants of concern to health and comfort and be based on scientific evidence when available. The LCI approach is currently the most feasible strategy to assess the health effects of compounds from building products and the harmonisation process of LCI values for around 170 chemicals which has recently started in Europe is fully supported. Criteria should be set also for substances not having LCI values (i.e., “not-yet-assessed” substances). TVOC should not be used alone as an indicator for evaluating health effects from indoor product emissions. When evaluating the emission of construction products TVOC provides useful information when combined with the limitation of CMR substances and with the LCI concept. A common approach for TVOC definition along with an upper limit for TVOC should be established. Sensory evaluation is considered to be an important aspect of the assessment of product emissions. Results have shown that chemical characterisation of emissions is not a good predictor of sensory effects. Therefore it is important to complement the chemical assessment of product emissions with sensory evaluation. The ECA Preparatory WG 27 supports the work of ISO TC 146/SC6 in creating a standard for sensory evaluation. The draft standard ISO/FDIS 16000-28 on "Determination of odour emissions from building products using test chambers" is expected to be published soon. It includes both acceptability evaluation, using an untrained panel, and perceived intensity measurement with a trained panel. It also combines the odour evaluation chamber technique with the harmonised testing standard (reference room) prepared by CEN TC 351. The practical implication of the implementation of the ISO standard should be discussed and clarified at a later stage

### **Data Handling And Reporting**

A shared data handling and reporting tool (e.g. as the DIBT's ADAM Excel sheet) could be used as a basis for a future harmonised European system for documentation and evaluation of data. Additional features like an import tool and integration of alternative LCI-lists are feasible improvement options.

### **Next Steps for the Implementation of the Harmonised Framework**

It is planned to continue the harmonisation work under the umbrella of an expanded committee representing a broad range of stakeholders concerned with the labelling of indoor products emissions in Europe. This work will take account of developments in standardisation (CEN and ISO) and regulations across various legislative mandates at both, European and national level. The aim is to achieve broad consensus for a harmonised framework for emission testing and evaluation of indoor products that can be applied in voluntary and mandatory schemes and enable its implementation in a wider and integrated context of safe, healthy, energy efficient and sustainable buildings within the EU and outside.

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