EUROPEAN COLLABORATIVE ACTION

URBAN AIR, INDOOR ENVIRONMENT AND HUMAN EXPOSURE

Environment and Quality of Life

Report No 24

Harmonisation of indoor material emissions labelling systems in the EU

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DIRECTORATE JOINT RESEARCH CENTRE
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2005 **EUR 21891 EN**

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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.

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Abstract

ECA-IAQ (European Collaborative Action, Urban Air, Indoor Environment and Human Exposure), 2005 Harmonisation of indoor material emissions labelling systems in the EU Inventory of existing schemes, Report No 24. EUR 21891 EN. Luxembourg: Office for Official Publications of the European Communities

Indoor Air Quality (IAQ) and emissions from building materials have been over the last decades a major challenge for scientists, industry and consumers. In response to the need for improved consumer protection different kinds of labelling systems for material emissions have been developed in many European countries and by industrial organisations. The main purpose is to protect consumers from exposure to chemical pollutants and resulting adverse health effects (i.e., carcinogenic, teratogenic, irritant) or annoyance by bad odours, which could be caused by chemical emissions from materials. This protection can be effectively achieved by supporting the market demand for low emitting materials. The labelling systems developed are typically voluntary for the manufacturers. In spite of a trend towards European harmonisation, most of these labelling systems are mainly focussed on national markets and often require specific tests. Despite a common market there is no harmonised system for material emission labelling available in Europe.

This report reviews and discusses recent developments concerning the indoor material labelling schemes at European level.

MANDATE: European Collaborative Action "**Urban Air, Indoor Environment and Human Exposure**" (formerly "Indoor Air Quality & it's Impact on Man")

For more than 19 years now the European Collaborative Action ECA "Indoor Air Quality & it's 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 has dealt 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 may all interact with indoor air quality. The work of ECA has been directed by a Steering Committee.

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. The new approach will be hosted by and supporting the activities of the Joint Research Centre's Institute for Health and Consumer Protection in Ispra (Italy) dealing with Physical and Chemical Exposures.

This focussed activity will proceed 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.

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PREFACE

Indoor Air Quality (IAQ) and emissions from building materials have been over the last decades a major challenge for scientists, industry and consumers. In response to the need for improved consumer protection different kinds of labelling systems for material emissions have been developed in many European countries and by industrial organisations. The main purpose is to protect consumers from exposure to chemical pollutants and resulting adverse health effects (i.e., carcinogenic, teratogenic, irritant) or annoyance by bad odours, which could be caused by chemical emissions from materials. This protection can be effectively achieved by supporting the market demand for low emitting materials. The labelling systems developed are typically voluntary for the manufacturers. In spite of a trend towards European harmonisation, most of these labelling systems are mainly focussed on national markets and often require specific tests. Despite a common market there is no harmonised system for material emission labelling available in Europe.

This situation has been a topic of seminars, workshops and papers in recent years (e.g., Healthy Buildings 2000 Conference, FLEC Symposium 2001). The aim was to discuss the scientific background and practical limitations of material emission declaration and labelling systems, and to identify principles for minimum requirements (e.g. measurement data and criteria) for a generally acceptable labelling system. The main outcome of these still ongoing discussions is that - although all of these voluntary systems are for labelling the indoor-related properties of building products, - there are big differences between them, e.g., the criteria and for what kind of materials the systems have been created. Therefore, a strong need for harmonisation of material labelling systems has been identified. In the second half of 2001, the European Collaborative Action on «Urban Air, Indoor Environment & Human Exposure» co-ordinated by the EC Joint Research Centre, undertook the initiative to establish a working group to bring forward the harmonisation of the indoor material labelling schemes at European level. In this WG participate stakeholders from research institutions and the industry, mainly from the countries who have a labelling scheme (such as, Finland, Denmark, Germany). In this report the recent developments concerning the efforts of this WG to promote harmonisation of the indoor material labelling schemes at European level are presented and discussed.

1. INTRODUCTION

Harmonisation of the evaluation of emissions from building products is an important task. In the past, procedures for how to determine such emissions have been developed and standardised in EN 13419 and ISO 16000. To evaluate emissions and give information on product quality different labelling systems and evaluation schemes are currently being used in Europe.

This report has been prepared by an ECA Working Group to provide an inventory of existing labelling schemes in Europe. Such an inventory is of particular interest in the framework of the actions of the European Commission (DG Enterprise) which created in early 2003 an expert group on the “dangerous substances”. This expert group is the interface between the Commission Services, Member States authorities and other relevant stakeholders concerning technical and scientific aspects of Essential Requirement n° 3 (ER3) of the Construction Product Directive (CPD) (89/106/EEC). The Commission sent in March 2005 the M/366 mandate to CEN concerning the execution of standardisation work for the development of horizontal standardised assessment methods for harmonised approaches relating to dangerous substances under the CPD with a focus on emissions to indoor air, and release to soil, to surface water and to ground water. The CPD is one of the 'New Approach' Directives (European Community regulations) adopted to create a single European market by removing technical barriers to trade between Member States. The second generation of harmonised standards will assess the ER3 on health, safety and environment including the impact of emissions on indoor air. Products meeting the technical specifications of ER3 of the CPD will be eligible for 'CE marking' and may be placed on the market anywhere within the European Economic Area (EEA). On the contrary to the various existing labelling schemes which are mostly voluntary, the CE marking of building products is mandatory.

The existing labelling schemes have been prepared for different purposes. They may focus on specific product groups like adhesives, carpets or paints. Other systems, like the German “Blue Angel system”, the Danish Indoor Climate Label and the Finnish M1 emission classification have worked out precise testing procedures for several product groups. In this report, the main features of the existing labelling systems are compiled.

2. DEVELOPMENT OF THE PRODUCT LABELLING SYSTEMS OVER THE YEARS

One reason for the diversity of the labelling schemes is the different approaches to the topic. Due to a lack of harmonised standards for sampling, emission measurement and analytical procedures in the past, various industrial groups, scientists, authorities and commercial laboratories created their own labelling systems.

For most of the industrial organisations starting with emission measurement in the late 80´s or the early 90´s the environmental aspect of the product was the most important factor. At the Healthy Buildings Conference in Stockholm 1988 “The choice of material for indoor environments” became one of the leading topics. The discussion resulted in a list of six recommendations for further development (BFR 1988, BFR 1989):

- A list of safe materials,
- Specifications for testing and conditioning of materials,
- A program for certification of building products,
- Continued toxicological research,
- Increased exchange of information,
- Make best choice based on emission tests.

Showing that the products have been produced in an environmentally friendly way without any harmful substances and have been tested on their relevance to indoor air quality was the basis for the industrial labels. One example for this approach was the industrial label GUT (Gemeinschaft umweltfreundlicher Teppichboden – Association for Environmentally Friendly Carpets), which appeared in the market in 1990 and was focussed on carpets. Within the 90´s a variety of other labelling systems appeared, being more or less based either on the initiative of industrial organisations in co-operation with scientists, or proposals coming directly from scientists, like the ECA report no.18 scheme (ECA 1997a). There has been progress in standardisation of emission measurements, the overall standard EN 13419 Part 1-3 (CEN 2003) being currently at a final stage of adoption, and furthermore the adoption of part 4 of this standard (ISO 16000-6) (ISO 2004) which describes the analytical procedure to be used is also pending. However there are still significant differences between the different labelling schemes. After scientific discussions in European projects (e.g. VOCEM, European Database Project (SOPHIE) (Bluyssen et al 2000)) some of the labels changed their criteria for better comparability and harmonisation (Cochet et al 1998, De Bortoli et al 1999, Jensen and Wolkoff 1996). This movement towards harmonisation accelerated significantly after publication of the drafts of standards EN 13419 parts 1, 2 and 3 and ISO 16000 parts 3 and 6.

Another important factor influencing the knowledge about the indoor air relevance of products are the big differences in the European countries. Most of the present systems have been developed in Scandinavia, Germany and Austria. In Scandinavia this development is part of a national and industrial strategy, mainly initiated because of the time spent indoors and the harsh climate during the winter season. On the other hand, the ecological movement in Germany and the German speaking countries has focussed on consumer safety of indoor air relevant products. Other countries in the EU, such as some of the Mediterranean countries do not have any labelling systems.

All these evaluation and labelling systems are voluntary systems. Although the test procedures and the product classification differ between the different labelling systems, the voluntary labels induced an important improvement of products as regards emissions into indoor air, some labels even promoted new product groups like the EMICODE EC1 adhesives.

But in spite of the common European market area, many of these labelling systems still have a national preference, due to the fact that they were developed for a national market. Despite a common market, there is no harmonised system for material emission available in Europe and therefore consumer protection measures have in some cases created a new kind of barrier to trade and promoting of national industry. All labelling systems are open for applicants from other countries, but testing and applying for several different emission labels all over Europe is time- and costs- consuming for the industry. It may be difficult to realise the market advantages offered by the low emissions labels to the extent that these efforts are paid back.

In 1997, a report (no. 18: ”Evaluation of VOC Emissions from Building Products”) was published by the European Collaborative Action (ECA) “Indoor Air Quality and its Impact on Man”, following the discussions within an ECA working group established in 1992. In this report, a concept was developed for a labelling system with a focus on flooring materials. It was the intention of this European undertaking to provide countries with a science-based and harmonised “starting point” should they envisage establishing an evaluation scheme at the national level. Based on this ECA report no. 18, a German Governmental Task Force (AgBB, Ausschuss zur gesundheitlichen Bewertung von Bauprodukten) published the so-called AgBB scheme in 2001. Following a hearing with manufacturers, a modified version was published in 2002. Based on this modification, a 2-year introductory test period was started. A second expert hearing was organised in November 2004 to share the experience gained so far with the aim of further improving the scheme which was widely accepted by manufacturers. This activity was intended to cover the Essential Requirement no. 3 of the Construction Product Directive 89/106/EEC (available at *http://europa.eu.int/comm/enterprise/construction/internal/cpd/cpd.htm*). At the end of 2004, the German Institute for Building Technology (DIBt) made the test procedure as described by the AgBB scheme, mandatory for flooring materials that need approval with respect to resistance against fire (DIBt 2004). An approach similar to the procedure described in ECA report no. 18 and the AgBB scheme has been proposed by CSTB in France and by LQAI in Portugal.

Another important aspect of classification is its legal status. Though nearly all of the indoor labelling schemes are voluntary, some of them have reached high market coverage. Well-known systems established in Germany but now in use in several European countries apply to emissions of adhesives and other products for the installation of floor coverings (EMICODE by GEV, *www.emicode.com*), and carpets (GuT, *www.gut-ev.de*). These systems have been developed by industry to define the state of the art for the respective product category and are used as a basic requirement by many architects and consumers. Due to the private status, these product labels do not have any legal relevance in terms of basic requirements. Nevertheless, 80% of the flooring adhesives used in Germany now are EMICODE EC1 adhesives. Use of the EMICODE classification is becoming more and more popular also in other countries like the Netherlands, Sweden, Austria, Switzerland, and the United Kingdom.

The best known German ecolabel is the Blue Angel, which is the first and oldest environment-related label for products in the world. It was created in 1977 on the initiative of the Federal Minister of the Interior and approved by the Ministers of the Environment of the national government and the German federal states. It was designed as an instrument of environmental policy which would harmonise with the market and enable the positive features of products and services to be labelled on a voluntary basis. The intention of the label is defined clearly: the Blue Angel promotes the concerns of both environmental protection and consumer protection. Therefore, it is awarded to products and services which are particularly beneficial for the environment in an overall consideration and which also fulfil high standards of health and occupational safety and fitness for use. The Blue Angel environmental label is the property of the Federal Ministry of the Environment, Nature Protection and Nuclear Safety. It is sponsored and administered by the Federal Environmental Agency (UBA) and the quality assurance and product labelling institute RAL (Deutsches Institut für Gütesicherung und Kennzeichnung e.V.). All technical requirements for products and services for gaining the Environmental Label are decided by an independent jury which has its secretariat office at UBA. UBA is responsible, among other things, for the development of Blue Angel award requirements.

Starting in 1986, the German Blue Angel system has set up product standards with chamber testing for different product categories. The first product criteria concerning the indoor environment were those for wood products (RAL-UZ 38), such as for furniture, parquet, laminate, wall panels. Originally, the criteria only included requirements for the limitation of formaldehyde emissions. In 1998, criteria have been revised to also limit VOC emissions.

The RAL-UZ 38 standard was developed by the German Federal Institute for Materials Research and Testing (BAM) as a chamber test method with respect to the relevant emissions from wood and wood based materials. Meanwhile, further product standards with chamber testing exist for floor coverings such as parquet, laminate, rubber, linoleum and polyolefin flooring and floor covering adhesives, through furniture, upholstered furniture and other furnishings, to electronic devices such as printers, multi-functional devices, copiers, etc. The more recent product standards take into account the requirements of the AgBB scheme (see section 3.2.8).

Similar standards were established for Austria by a consumer protection organisation, supported by the Austrian government, for wooden products, carpets and for resilient floorings like linoleum, rubber and polyolefin.

Another well established labelling system was first published in Finland in 1995 by the Finnish Society for Indoor Air Quality (FiSIAQ) under the title “Classification of Indoor Climate, Construction and Finishing Materials”. The work was done in close co-operation with experts from research institutes and associations of technology, building engineering and architecture and with support from the Ministry of the Environment. The classification has been practically carried on by The Building Information Foundation, RTS, which has close contacts with the construction sector. This has helped the classification to be accepted and become widely used in a matter of a few years and to get a significant coverage of the market.

Also in 1995 the Danish “Indoor Climate Labelling” was presented to a wider public at the Healthy Building Conference in Milan. The ICL scheme was prompted by a request in late 1992 from The Minister of Housing and Building in Denmark and was together with the

Finnish “Emission Classification of Building Materials” one of the very first emission classifications with respect to indoor air quality. The primary objective was to develop a system to label building products according to their impact on the indoor air quality of emitted VOCs and later other pollutants, e.g. release of mineral fibres. The ultimate objective of developing the original Danish indoor climate labelling system was to improve and secure a better indoor air in buildings on the basis of a previously developed Danish Standard for emission testing and evaluation (DS/INF 90, 1994). Market coverage is medium and growing.

3. CHARACTERISTICS OF THE MAJOR EUROPEAN LABELLING SYSTEMS

For the classification of emission labelling systems various aspects have to be considered. One outcome of this project is a matrix, in which the differences in the labelling systems are explained. But before the characteristics of the different labelling systems are set out (in chapter 3.2), the common standardised basis according to the CEN and ISO standards regarding the emission aspects will be examined.

3.1 Current situation in standardisation work

The relevant standard concerning the emission behaviour of materials is EN 13419, Parts 1-3. EN 13419 can be considered a “horizontal” standard applicable to many categories of building products. In Part 1 of this standard the testing procedures using a small emission test chamber are prescribed in detail including precise requirements for parameters such as chamber material, quality of purge air, as well as temperature, humidity and the air flow rate and air velocity over the sample. This standard also fixes the point in time of sampling (72 h and 28 days) independently of the different materials. In part 2 of this standard the same requirements are written down for the use of so called emission test cells, for example the FLEC cell. Part 3 of this standard describes in detail the sample preparation for different types of building products classified as solid, liquid and combined products. As it is impossible to describe all possible contributions of materials only one example method for preparation of combined materials is mentioned in this standard. The three parts of EN 13419 will be also adopted as international standards ISO 16000-9, -10 and -11 (ISO 2005a, 2005b and 2005c).

Parts 1, 2 and 3 of this standard are expected to be adopted as EN standards but they will not have a full validation of the test method as prescribed by the full standard that includes Part 4, the sampling and analytical method. This was developed by an ISO subgroup and they have published this as ISO 16000-6. Under the Vienna Agreement, ISO 16000-6 will become identical with prEN 13419-4. In this part the analytical procedure for the determination of single VOC, the calculation of the TVOC value and a procedure to report compounds out of this range is given. Instead of the classification used for volatile compounds in indoor air given by the WHO (WHO 1989) which defined VOCs as being compounds with a range of boiling points between 50-100^{o}C and 240-260 ^{o}C a slightly different approach is used that relies on a definition given in ECA report no. 18. The new approach combines physical and analytical properties. VOCs are considered to be the compounds between n-hexane (n-C_6) and n-hexadecane (n-C_{16}) measured on a non-polar gas-chromatographic column. This corresponds to a VOC boiling point range of 50-290^{o}C. Compounds below n-C_6 are considered to be very volatile organic compounds (VVOC), substances appearing in the chromatogram beyond n-C_{16} are considered as semi-volatile organic compounds (SVOC). For the calculation of TVOC (Total Volatile Organic Compounds) all compounds between n-hexane (n-C_6) and n-hexadecane (n-C_{16}) are considered and quantified using their toluene equivalent for calibration (ISO 16000-6). A further report from ECA, report no. 19 (ECA 1997b), proposes the calculation of TVOC based on individual response factors, quantifying as many VOCs as possible, but at least those contained in a list of known VOCs of special interest and those representing the 10 highest peaks.

To characterise emissions of formaldehyde and other very volatile carbonyl compounds from building products ISO 16000-3 standard (ISO 16000-3, 2001) should be applied.

Some specific situations need to be mentioned in addition. For historical reasons, wood based panels are not covered by this standard but are tested for the formaldehyde steady-state concentration according to the ENV 717-1 standard (CEN 1998). For adhesives testing a special pre-standard was published by CEN TC 193. (ENV 13999 parts 1 to 4) (CEN EN 13999-1-4, 2001). This standard describes the preparation of the test specimen, chamber operation, VOC/TVOC determination, and aldehydes and isocyanates measurement. Also, CEN TC 134 has published a draft standard prEN 15052 that describes requirements for VOC emissions of textile, laminate and resilient flooring materials.

While under health considerations it is interesting to have as much information as possible on the emission of individual VOCs, under the view point of practicability and cost it is beneficial to characterise emissions by indicators or leading parameters that are easy to monitor such as TVOC. At present, many of the existing labelling systems require to monitor both the TVOC and individual substances. Also ISO 16000-6 requires identification and reporting of single VOCs and calculation and reporting TVOC concentration. The standard also requires identification and reporting the compounds outside the C_6-C_{16} range.

Round-robin tests still show large variation of test results between laboratories with ± 50% relative standard deviation and difference between minimum and maximum results between 1:10 and 1:15 (Windhövel and Oppl 2005).

3.2 Short presentation of existing labelling systems

Looking at the different labelling systems, certain key characteristics can be identified such as legal status, product relation, analytical procedures, quality assurance, and costs. By answering the following questions, the differences between the labelling systems can be identified:

- **Legal status:**
  Are the labels voluntary (private) industrial labels, are they promoted by a government organisation or are these labels legally binding requirements?
- **Product relation:**
  Are the labels focussed on specific product groups, like adhesives, wooden materials or carpets, or is the label applicable to different product groups?
- **Analytical procedures:**
  Are there basic requirements, like a ban of certain dangerous substances documented by ingredient analysis, or a limit on contaminant content? How is the emission testing performed, as a short term or long term test or a combination of both? Are there any sensory evaluations of the material? Is there –besides emission testing- consideration of functionality of the product as well?
- **Quality assurance:**
  Are the labels and the test laboratories accredited and are detailed prescriptions for test specimen preparation and sampling available? Is there a description of the analytical procedures, including quantification and expression of results? Have any round robin

tests been performed on the materials and the analytical procedures and are these data open to public?

- **Costs:**
  Is there an open price list or are the prices for certificates connected to a certain membership fee?

To avoid any misinterpretation and for better understanding of the different labelling systems, information about general descriptions and testing procedures are presented in the Annexes of this report (or as pdf-documents in the electronic version).

There has been a lot of data and discussion about the labelling systems published in different workshops and papers in recent years. This will be broadly presented in this chapter, but the main basis of this review will be the matrix based on parameters mentioned above.

As mentioned in the introduction, this paper will not cover every single label involving a limit value for the emissions of certain compounds from products because in some cases the criteria and test methods are not clear, the available information is insufficient and the market share is low. This report will cover the information available for the following labelling systems and concepts:

- ECA report no. 18. (A concept for a global scheme for the evaluation of VOC emissions from building materials, established by a European working group),
- AgBB scheme (Germany) (Annex 1),
- CESAT - Evaluation of environmental and health-based properties of building products (France) (Annex 2),
- M1- Emission classification of Building Materials (Finland) (Annex 3),
- Indoor Climate Label (ICL-Denmark) (Annex 4),
- LQAI scheme (Portugal) (Annex 5),
- Natureplus (Germany and Europe) (Annex 6),
- The Blue Angel (Germany) (Annex 7),
- Ecolabel scheme (Austria),
- GUT for carpets (Germany and Europe) (Annex 8),
- Emicode system by GEV for adhesives and related material (Germany and Europe) (Annex 9), and
- the schemes applied in Belgium and UK and The Scandinavian Trade standards (Annex 10).

The above list of schemes shows that some are specific to a particular country and others concern certain product types in more than one country. Annex 10 summarises the situation in some of the countries that do not have a specific scheme.

3.2.1 ECA Report No. 18

In 1997 within the European Collaborative Action “Indoor Air quality & Its Impact on Man” (ECA IAQ) a report “Evaluation of VOC Emissions from Building Products – Solid Flooring Materials” has been published. The report presents a basic scheme for the evaluation of VOC emissions from building products (ECA 1997a). The procedure consists of the following steps:

- Determination of emission factors of individual VOCs and of TVOC (Total Volatile Organic Compounds) using emission test chamber measurements,
- Modelling of indoor relevant VOC and TVOC concentrations using emission factors and simple exposure scenarios,
- Toxicological evaluation of the indoor relevant concentrations. Available air quality guidelines (AQGs), no observed effect levels (NOELs) and other relevant information are used for the definition of “lowest concentrations of interest” (LCIs) with which the relevant indoor VOC concentrations are compared. The emission of VOC for which no LCI values are available is restricted.

Sensory evaluation had been foreseen but no procedure has been given in ECA report no. 18. A review of sensory evaluation methods was given in ECA report no. 20 (ECA 1999).

With these parameters a testing scheme was proposed for flooring materials, based on a sequence of three emission measurements. The first one after 24h only concerns carcinogenic substances. In the second measurement after 72h VOC emissions are determined. The TVOC value is used as a criterion of whether or not the next step of the evaluation procedure will be carried out. The third measurement after 28 days takes into account the TVOC value, and the concentration of individual VOC.

This approach formed the basis for the German AgBB and the French CESAT schemes and is also applied in Portugal. Blue Angel, GUT and Natureplus are using modified versions of this approach as basis for their new criteria.

3.2.2 AgBB Scheme

In 2001 a Task Force convened by the German federal states (Länder)[1] with members also from the German Environmental Protection Agency and the German Institute for Construction Technology (DIBt) published an assessment scheme for the evaluation of emissions from building products. The scheme is essentially based on the ECA no. 18 report, with a number of modifications. The latest version is attached to the report in Annex 1.

Modifications include the removal of the short-term test after 24h hours and the introduction of a step to determine potential emissions of SVOC (Semi-Volatile Organic Compounds). Although the sensory evaluation is mentioned in the testing procedures, no such evaluation is currently being carried out because no agreement has been reached yet on the test method to be used.

[1] In Germany, the responsibility for construction matters is with the federal states.

In the scheme proposed initially in 2001 classification of products according to two quality levels was foreseen. After a hearing with industry and test laboratories in Spring 2002, it was decided to run a 2-year test phase with only a single stage decision at the end ("accepted"/"not accepted" decision). Representatives of industry and other interest groups were asked to participate in different subgroups to define criteria for sample preparation and enlarge the list of relevant individual VOC. For each VOC in this list, a so-called NIK value is defined (in analogy to the LCI values of ECA report no. 18). The list of NIK values is updated and expanded by a task force with representatives from science, authorities and industry. The latest list was published in 2005, see Annex 1. An updated list is published every year and available at the site of the AgBB scheme: *http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/voc.htm*.

After the 2-year test phase the concept was again discussed with industry and test laboratories stakeholders. Today, the scheme has become mandatory for all floorings materials that need authorisation of DIBt under the German Building Construction Regulations (in a first step, these are only flooring materials that need approval with respect to resistance to fire, but expansion of this scope is under preparation). Besides the close co-operation with industrial groups, a political discussion about the relevance of the criteria and the co-existence of private labels and essential requirements has started.

The German AgBB scheme forms the basis also for CEN TC 134 suggestions for a standard on flooring materials, for new GUT criteria for carpets, and for Blue Angel criteria for specific products (e.g., RAL-UZ 117 on upholstered furniture, RAL UZ 120 on elastic floor coverings and RAL-UZ 113 on floor covering adhesives, see Annex 7), and for the latest Natureplus criteria.

3.2.3 Evaluation of environmental and health-based properties of building products (CESAT)

An evaluation scheme of the environmental and health-based characteristics of building products has been introduced in France in 2003. This evaluation scheme is proposed on a voluntary basis, in association with the Technical Agreement procedure (Avis Technique in French) for the evaluation of the fit-for-use properties of building products. It is presented in more details in Annex 2 of the present report.

The proposed evaluation scheme is based on an Environmental Product Declaration (EPD) for environmental characteristics according to the NF P 01-010 standard and on specific health-related criteria for the product in use:

- VOC and formaldehyde emissions,
- Odour emissions (optional),
- Aptitude for growth of fungi,
- Aptitude for growth of bacteria (optional),
- Natural radioactive emissions (only for concerned products).

For the characterization of VOC and formaldehyde emissions from building products, the EN 13419 standard is used for the sampling and preparation of test specimens, and for the conditioning of the test specimen in emission test chambers or cells. VOC are sampled and

analysed using the ISO 16000-6 standard and formaldehyde emissions are measured using the ISO 16000-3 standard.

The procedure used for the assessment of chemical emissions from building products is similar to the ECA Report no. 18 (see section 3.2.1).

This evaluation scheme has been accepted by the French “Comité Environnement Santé de l’Avis Technique” (CESAT) which is the horizontal group aimed at tackling environmental and health-related topics related to building products under Technical Agreement. The CESAT committee is composed of representatives of Ministries (Environment, Health, Building, Work), of French research centres (CSTB, INRS) and of representatives of the construction sector. The procedure is operational and the first technical agreements including environment and health characteristics were delivered in 2003.

3.2.4 M1 - Emission classification of Building Materials

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 Materials (Annex 3). The first emission classifications were granted in 1996. In May 2000 the system changed its name into emission classification of building materials and it is a part of a process, which aims at reaching a good indoor quality as defined by S1 to S3 target values in the *Indoor climate 2000* classification.

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

The emission classification of building materials has three emission classes M1, M2 and M3. Emission class M1 corresponds to the best quality and emission class M3 includes materials with the highest emission rates.

Classified materials have to fulfil criteria at the age of 4 weeks for the following emissions:

- TVOC, formaldehyde, ammonia,
- carcinogenic compounds,
- odour,

and the products shall not contain casein.

The tests must be carried out by an approved testing laboratory in accordance with the required methods. Sample selection, analysis and measurements of material emissions must be performed at a competent and impartial laboratory approved by the classification working group.

Emission Classified Products

Today there are over 800 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.

Applications for an emission classification for a building material are submitted to the Building Information Foundation RTS on an application form (see Annex 3). Additional information can be found at *www.rts.fi*.

3.2.5 Indoor Climate Label

The Indoor Climate Labelling scheme (ICL) was presented in 1995 as one of the very first emission classification schemes with respect to the indoor air quality. The emissions from the products are measured in climate chambers and converted into standard room concentrations. These are evaluated in relation to sensory irritation (eye and upper airways) and odour, which are common complaints in the indoor environment.

The Danish ICL scheme has requirements for the standard room concentration of the VOCs of concern and includes also a sensory evaluation of the emissions. VOCs of concern are those VOCs believed to have an impact on the odour intensity or result in sensory irritation. The parameter used as a criterion of acceptance is the time required for the emission of the VOCs to decay to the point where their room concentrations are below their indoor relevant values. These values are based on 50% of the lowest of either odour threshold or sensory irritation estimate for each individual VOC cited in VOCBASE (Jensen and Wolkoff, 1996). The odour threshold is in most cases the determining factor of the time value of a given VOC, because sensory irritation estimates generally are at least one order of magnitude higher. The use of 50% of the odour threshold is a pragmatic safety factor that accounts for the possibility of contributions of the same VOC from other pollution sources. The time required for the model room concentrations to fall below the threshold is the so-called indoor-relevant time-value. Carcinogenic compounds belonging to Category 1 of the IARC Monographs (IARC, 2004) (except formaldehyde) must not be present in the emission.

The results of the chemical analyses are supplemented by a sensory evaluation of the emitted odours. The evaluation covers acceptability and odour intensity and is performed by an untrained panel of at least 20 persons.

In addition to the chemical emission testing, ceiling systems are tested for the release of particles and fibres. Release of particles and fibres is classified in one of three categories: low, medium or high. Only ceiling systems with low or medium particle release achieve the Indoor Climate Label.

Emission testing of VOCs and release of fibres and particles have to be performed every 5 years. Furthermore, the ICL requires the manufacturer to provide manuals for handling, storage, cleaning and maintenance of the labelled products in order not to deteriorate the product's IAQ properties during use.

The ICL scheme was peer-reviewed and published in 1996 (Wolkoff and Nielsen 1996) and appears as a recommendation in the Danish Building Code of 1995 and 2005, and in many performance requirements of Danish building societies. Since 1998, the scheme has been implemented in Norway under "Technical Regulations under the Norwegian Planning and Building Act".

The structure of the ICL is open and allows easy implementation of new product areas. The 10 already existing product standards cover a wide range of products representing large surface areas in the indoor environment: e.g. ceiling and wall systems, textile flooring materials, resilient and wood-based floors, interior building paint and furniture. The maximum allowed time-value is set individually from product area to product area. This makes it possible to set the accept criteria dependent on the performance of the products on the market. As per January 2005 50 product groups covering approx. 400 individual products have been labelled.

The principles of the ICL labelling scheme and the details are given in Annex 4 of this report. Additional information is also available in *www.dsic.org* and *www.indeklima.org*.

3.2.6 LQAI scheme

In Portugal, the procedure introduced in the ECA report 18 has been applied by LQAI (Laboratório da Qualidade do Ar Interior) to evaluate emissions from flooring products since 2000, but with some simplifications that were achieved after discussion with the manufacturers of building materials: the sensory evaluation is not being used, and the chemical measurement is done at 72 hours and 28 days. The carcinogenic compounds are quantified at 72 hours. Each material is tested 3 times to include the heterogeneous factor in the final result. If the material fulfils all the conditions of the toxicological evaluation at one of the three area specific ventilation rates, a declaration of quality is produced in three languages (Portuguese, English and German). Each declaration of quality of a certain material has a validity of 5 years; but annually a single test is done to confirm the first result. The experimental procedure for the sampling and preparation of test specimen in test chambers is done according EN 13419 standard. VOC are sampled and analysed using the ISO 16000-6 standard and formaldehyde emissions are measured using the Modified Pararosaniline Method. The value of TVOC is calculated as recommended by ECA in report no. 19, i.e., using the response factor of each compound for the major part of compounds. Additional compounds with relevance to the industry are taken into account even if they belong to VVOC or SVOC, and the toxicological evaluation is done identically to the other VOC, contributing to the calculation of R value. Formaldehyde is also determined and evaluated using the same approached. Until now, about 40 materials had received a declaration of quality. This evaluation scheme is proposed on a voluntary basis. The scheme is presented in more detail in Annex 5 of the present report.

3.2.7 Natureplus

Natureplus is an initiative for an international label of quality for building products, construction materials, and home furnishings that are environmentally friendly, do not endanger health and function satisfactorily. The Natureplus sign of quality has been available since June 2002, when the first eight manufacturers received the documents of certification. The initiative Natureplus was conceived by the International Association for Sustainable Building and Living e.V. Members include manufacturers, traders, consumer and environmental affairs organisations, planners, consultants and laboratories. Natureplus has national offices in Austria, Belgium, Germany, Hungary, Netherlands, Switzerland.

Objectives of Natureplus are:

- one single and uniform label of quality in which various existing "eco-labels" are incorporated,
- a label of approval that is known and accepted in many European countries,
- straightforward and credible communication of all products that have no adverse effects on the environment or health,
- a step towards ecological product optimisation.

Only products made of at least 85% regenerative or mineral material are labelled. The indoor air quality with Natureplus-certified products is proofed with the different VOC limits, the limits of formaldehyde depend on product type.

More detailed description of the Natureplus labelling scheme is presented in Annex 6. Further information is also available at *www.natureplus.org*.

3.2.8 The Blue Angel

The Blue Angel was created by the Federal and Länder governments in Germany in 1977. The purpose of its creation was, and still is, to promote products which have considerably better environmental and health characteristics than comparable conventional goods. The Blue Angel is currently borne by nearly 4000 products in more than 100 product categories.

The Blue Angel as a voluntary, multiple-criteria-based third party product labelling programme is referred to as “Type I” within the ISO system. Since product comparisons are involved, the EN ISO 14024 standard provides for a transparent procedure. This applies to the selection of product categories, environmental criteria, testing methods etc. Interested parties are involved right from the very beginning, including companies, associations, non-government organisations and scientific institutes.

The German Institute for Quality Assurance and Labelling (RAL) in St. Augustin awards the Blue Angel on behalf of the Federal Environmental Agency. Potential applicants first turn to the institute to determine whether an award criteria document already exists for the product in question, or whether criteria need to be established. If basic criteria already exist, the next step merely involves an informal application which is reviewed by the RAL and the Federal Environmental Agency. If the product meets the requirements, a contract is drawn up to

cover use of the Blue Angel. Application forms and background information concerning the basic criteria for the award can be found on the Internet at *www.blauer-engel.de*.

From the very beginning, the criteria for award of the Blue Angel also included health requirements, such as exclusion of substances posing a toxicological risk. 1986 saw the introduction of test chamber measurements, which were used initially for determining formaldehyde emissions from furniture. In the mid-1990s, extensive research work was started whose aim was the comprehensive measurement of emissions of volatile and semi-volatile organic compounds and inclusion of emission limitation requirements in the Blue Angel criteria for furniture (see Annex 7). Today, there are 11 criteria documents for construction products, furniture and electronic devices which limit emissions of volatile and semi-volatile organic compounds on the basis of test chamber measurements (EN 13419-1) such as:

- RAL-UZ 62 copiers,
- RAL-UZ 85 printers,
- RAL-UZ 76 low-emission wood based products like fibreboards, chipboards, wood-core plywood, medium-density fibreboards (MDF) veneer plywood boards, solid wood boards and OSB boards,
- RAL-UZ 102 low-emission wall paints,
- RAL-UZ 113 low-emission floor covering adhesives and other installation materials,
- RAL-UZ 114 multifunction devices (for office use using toner or inkjet technology),
- RAL-UZ 117 low-emission upholstered furniture,
- RAL-UZ 119 mattresses,
- RAL-UZ 120 resilient flooring materials as rubber, linoleum and polyolefin flooring.

For recent criteria documents for building products and furnishings, the AgBB scheme (see Section 3.2.2) was used as assessment basis. While the AgBB scheme assesses construction products with respect to their fitness for use, the Blue Angel is designed to be awarded to products which have a particularly high quality and particularly low emissions. Depending on product group and the material-specific reduction possibilities, emissions of Blue Angel products remain well or very well below the AgBB requirements. Three criteria documents – for upholstered furniture, elastic floor coverings and floor covering adhesives – are shown in Annex 7 as examples of these requirements. Further criteria documents as well as information on the Blue Angel can be found at *www.blauer-engel.de*. A list of the products which bear the label is also available at this address.

3.2.9 Austrian Ecolabel scheme

General status

The Austrian Eco Label is awarded by the Federal Ministry of Agriculture, Forestry, Environment and Water Management. It identifies overall environmental preference of a product or service within a specific product/service category and addresses itself primarily to consumers. It is a voluntary label which is promoted by a governmental organisation. The Austrian Consumer Association VKI is responsible for criteria development.

The Austrian Eco Label is applicable to different product groups. At the moment criteria documents for 47 product and service groups are published. Emission requirements are part of the following criteria:

- UZ 06 Wooden furniture,
- UZ 07 Timber and derived timber products,
- UZ 35 Textile floor coverings,
- UZ 42 Resilient floor coverings.

Most of the involved requirements concern TVOC and a small number of VOC related parameters after 28 days in the test chamber. In some cases there are additional requirements on special substances after 24 hours.

3.2.10 GUT for carpets

Since the early 90's, the European carpet industry has taken the lead by creating GUT and by continuously raising its environmental standards. GUT members in the European carpet industry are committed to act in an environmentally responsible way. GUT today has 66 members from all over Europe, covering more than 80 % of the EU production volume and about 30 associated members**.** More than 3500 products are registered under the GUT scheme. Actual information for every licensed product can be found online on the GUT webpage (*www.gut-ev.de*).

In co-operation with officially recognised test laboratories across Europe, GUT continuously tests products against the highest standards. Furthermore GUT promotes environmentally friendly solutions for carpet installation as well as recycling projects.

Compliance with GUT’s criteria is achieved by means of GUT’s comprehensive product test.

This product test is divided in three sectors:

- Pollutant test,

  This test is done to determine those substances for which either limit values exist or the use is forbidden according to the GUT Test criteria. In general these are substances which cannot be detected or analysed by using the emission chamber method (Heavy metals, flame retardants, pesticides, pyrethroids, TBT etc.).

- Emission test,
- Odour test.

The GUT product test is conducted on freshly produced carpets.

- **Control tests:** Not only new carpets are tested by GUT, but maximum product quality safety is achieved by regular annual control tests at manufacturers' plants and dealers' sales outlets. So called subsequent annual controls are carried out in compliance with specified criteria on no less than 10 % of a manufacturer's certified articles.
- **Market controls:** In addition to the annual controls on manufacturers' certified articles, GUT carries out regular market controls. Random checks are made at dealers' sales outlets without previous notification.

Textile floor coverings are analysed for emissions of volatile organic compounds and other selected substances in a test chamber examination.

For the evaluation of VOC emissions GUT adopted the AgBB scheme in 2004. The emissions are measured after 3 days on freshly produced merchandise according to EN 13419, part 1 and 2. The currently available list of NIK values as published by AgBB is used. Compared to the AgBB scheme lower concentration criteria are used for TVOC and SVOC.

More details of the GUT testing criteria are listed in Annex 8. The procedures and the testing method were revised in 2004 (available at *www.gut-ev.de*).

3.2.11 EMICODE System by GEV for adhesives and related material

GEV was founded in 1997 by the German Adhesives Manufacturers as a non-profit organisation. GEV now has 34 member companies from 8 countries (January 2004) and represents more than 90% of the German industry of the respective branch. More than 800 products have been licensed EMICODE® EC 1 indicating a product of "very low emission". The EMICODE® labelling system was established by GEV for consumer protection. In the absence of any legal regulations reliable standards were created for insuring the consumer of 'low emission products' and eliminating confusion in the market. GEV administers the system. Member companies apply for a license on the basis of a test certificate. Only solvent-free products for which no hazardous substances (like CMR) can be labelled. If reaction products from the adhesive require measures for occupational safety during installation then this is marked separately with a suffix "R" (regulated). A new test is required when the volatile ingredients in the formulation are changed. Random market controls are tested at least once a year. Two round robin tests have been organised so far with almost 20 participating laboratories from the whole Europe.

Substances with proven or suspected carcinogenic effect that may be found in a product due to trace impurities of raw material are monitored after 24 h (but after 3 days for cement-based products). Seven such substances were defined for which these impurities cannot be excluded with sufficient security.

Total Volatile Organic Compounds

The TVOC air concentration in the test chamber after 10 days (but after 1 day for dry products like underlays and tapes) determines the classification of a product into the appropriate emission class (see Annex 9 "GEV-Specifications and classification criteria, section 3.2.3").

The GEV testing method was defined by the Technical Council of the GEV. It differentiates between different groups of flooring installation materials depending upon the processing consistency, the way of application and the typical emission characteristics. The installation materials were therefore subdivided into the following groups for which in each case a separate, strictly defined test method is prescribed:

1. **Liquid (low viscosity)** laying materials, e.g. Primers,
2. **Powdery** laying materials, e.g. Levelling Compounds, Tile and Joint Mortars,
3. **Pasty** laying materials, e.g. Adhesives for floor coverings, parquet floor and tiles,
4. **Underlays, tapes**.

Also sealant systems are covered by EMICODE.

Details of the testing procedure and the classification can be found in Annex 9 (available at *www.emicode.com*).

4. SUMMARY OF THE LABELLING SCHEMES

The parameters mentioned at the beginning of chapter 3.2 and the information given for the different labelling procedures (sections 3.2.1 – 3.2.11) form the basis for the comparison provided in Table 1. The table contains a number of additional parameters of interest to characterise the different schemes. Although the initial scheme developed in ECA report no. 18 has been mentioned in the text, this scheme has not been included in Table 1 because it has not been and will not be implemented as such.

In interpreting the information in the table it should be noted that there are systems which are proper evaluation schemes that do not currently have the direct consequence of assigning of a label but may form the basis for subsequent label creation. An example of this kind of system is the AgBB scheme. There are also others which have been established mainly as a labelling system for specific product groups. In this case, specific evaluation requirements have been set. An example of this type of system is the GUT procedure.

From the Table 1 it may be observed that the labelling schemes are already using similar testing methodology to a certain extent.

Emission testing and analysis:

Most of the schemes apply newly developed EN or ISO standards (EN-13419 parts 1-4 and the ISO 16000 parts 3,6,9,10,11) or very similar methods. Most labels apply a short-term test for initial emissions after 1 or 3 days, and all labels apply a test for characterising long-term emissions after 28 days - or even earlier (after 10 or even 3 days) if the initial emissions of all covered products will decrease very fast.

TVOC definition is different. While the ISO 16000-6 definition is used in many schemes, the old ECA definition also is used in a number of countries. AgBB is contributing still another definition.

TVOC threshold is between 200 and 500 µg/m³ for all private labels, the actual value depending on product group, and on the point of time of measurement. While these labels attempt to describe the low emission products, the AgBB is meant to set the minimum requirement for a safe long-term use. The AgBB scheme shows higher threshold values (1000 µg/m³) assuming further decay of the emissions after the end of the test.

Formaldehyde is monitored by most surveyed schemes.

Odour evaluation:

Only some labels are applying an odour test but documentation on reliability and reproducibility of such tests is still lacking. A large variety of odour testing methods are applied. These tests are mainly based on either desiccator tests (derived from SNV195651 (1968)), or on dynamic chamber tests as described in the European database project (Bluyssen et al 2000), Nordtest Standard (Nordtest 1998) and ECA report no. 20 (ECA 1999) on sensory evaluation. A number of labels do not include any odour testing at all.

Some of the schemes include control of labelled products in certain intervals or frequency. Most labels require involved testing laboratories to apply for approval. Only some labels organise round-robin tests for checking the quality of the testing labs.

Table 1. Comparison of the different emission labelling systems (for detailed information Annexes need to be consulted).

	AgBB	CESAT	M1	ICL	LQAI scheme	Natureplus, examples: Linoleum + carpets	Blue Angel, example: RAL UZ 120 floor coverings	Austrian Ecolabel, example: Ö UZ 42 resilient floor coverings	GUT	EMICODE EC1, example: adhesives	Scandinavian Trade Standards
General											
Origin	Germany	France	Finland	Denmark	Portugal	Germany	Germany	Austria	Germany	Germany	Sweden
Source for more information	http://www.umweltbundesamt.de/building-products/agbb.htm	www.cstb.fr	www.rts.fi	www.indeklima.org	www.markelink.com/directorios/ct2004/lab-qual-ar-int.htm	www.natureplus.org	www.blauer-engel.de	www.umweltzeichen.at	www.gut-ev.de	www.emicode.com	www.golvbranschen.se
Legal status	basic concept for Germany	voluntary, complement to French technical Agreement	voluntary (private), promoted by government	voluntary (private), promoted by government	voluntary (association between private organization and public institution)	voluntary (private), promoted by several retailer chains	voluntary (private), promoted by government	voluntary (private), promoted by government	voluntary (private)	voluntary (private)	trade agreement
Scheme/label is based on	ECA report 18	ECA report 18	N/A	N/A	ECA report 18	AgBB	AgBB	ECA report 18	AgBB	N/A	N/A
Product types covered	meant for all types of construction products relevant to indoor air	several types of construction products	all type of construction products	open to all types of products relevant to indoor air	several types of products for indoor use	several types of construction products	several types of products for indoor use	several types of construction products	textile floor coverings	products for installation of floor coverings	several types of construction products

	AgBB	CESAT	M1	ICL	LQAI scheme	Natureplus, examples: Linoleum + carpets	Blue Angel, example: RAL UZ 120 floor coverings	Austrian Ecolabel, example: Ö UZ 42 resilient floor coverings	GUT	EMICODE EC1, example: adhesives	Scandinavian Trade Standards
Testing procedures and standards											
Sampling and Test specimen	based on EN 13419-3	EN 13419-3	similar to EN 13419-3	EN 13419-3	EN 13419-3	EN 13419-3	based on EN 13419-3	EN 13419-3	like DIBt, based on EN 13419-3	similar to EN 13419-3	specified for each type of product, principally similar to EN 13419-3
- Chamber operation	EN 13419-1	EN 13419-1/-2	EN 13419-1/-2	EN 13419-1/-2	EN 13419-1	EN 13419-1 / ENV 717-1	EN 13419-1	EN 13419-1	EN 13419-1	EN 13419-1	EN 13419-2
- Chamber type	EN 13419-1/2	EN 13419-1/-2	EN 13419-1/-2	EN 13419-1/-2	EN 13419-1	EN 13419-1 / ENV 717-1	EN 13419-1	EN 13419-1	EN 13419-1	EN 13419-1 but minimum 100 litres	EN 13419-2
- Analyses / VOC	similar to ISO 16000-6	ISO 16000-6	ISO 16000-6	ISO 16000-6	ISO 16000-6	ISO 16000-6	similar to ISO 16000-6	ISO 16000-6	ISO 16000-3/-6	similar to ISO 16000-6	similar to ISO 16000-6
- Analyses / aldehydes	ISO 16000-3	ISO 16000-3	ISO 16000-3 or ENV 717-1	ISO 16000-3	special method	ENV 717-1	ISO 16000-3	ISO 16000-6	ISO 16000-3	ISO 16000-3	ISO 16000-3
- First testing	3 days	24 h carcinogens	28 days	3 days	3 days	24 h carcinogens	3 days	24 h	3 days	24 h carcinogens	28 days after manufacturing
- Second testing	28 days	3 days	N/A	10 days	28 days	3 or 28 days	28 days	28 days	N/A	10 days	26 weeks
- Third testing	N/A	28 days	N/A	28 days	N/A	28 days (carpets / SVOC)	N/A	N/A	N/A	N/A	N/A
- Odour test	no, but intended later	CLIMPAQ, intensity	CLIMPAQ 28 days, acceptance >0	CLIMPAQ, acceptance>0, intensity<2	no	desiccator test < 3	no, but intended later	no	desiccator test < 3	no	for self-levelling compounds only

	AgBB	CESAT	M1	ICL	LQAI scheme	Natureplus, examples: Linoleum + carpets	Blue Angel, example: RAL UZ 120 floor coverings	Austrian Ecolabel, example: Ö UZ 42 resilient floor coverings	GUT	EMICODE EC1, example: adhesives	Scandinavian Trade Standards
Emission evaluation											
- TVOC definition applied	based on ISO 16000-6 but modified	ISO 16000-6	ISO 16000-6	no TVOC monitored	ECA report 19	ECA report 18	based on ISO 16000-6, but modified (AgBB)	ECA report 18	ECA report 18	GEV specific, based on ISO 16000-6, sum of TVVOC+TVOC+TSVOC (ca. C_5-C_{22})	based on ISO 16000-6, but modified C_6—C_{18},
- TVOC	(3rd day) TVOC 10 mg/m³, (28th day) 1,0 mg/m³	TVOC 5000 µg/m³ (3 days), 200 µg/m³ (28 days)	TVOC 200 µg/m²h (28 days)	all VOC after calculation for model room below 0,5 OT and 0,5 IT	TVOC 5000 µg/m²h (3 days); 200 µg/m²h (28 days)	TVOC 200 or 300 µg/m³(28 days)	(3rd day) TVOC 1200 µg/m³, (28th day) 360 µg/m³	380 µg/m²h (28 days)	TVOC 300 µg/m³ (3 days)	TVOC 500 µg/m³ (10 days)	declaration of TVOC at 28 days and at 26 weeks, no limits specified
- SVOC	(28th day) TSVOC 100 µg/m³	no	no	no	not included in TVOC; Comparison with respective LCI	TSVOC (ISO) 100 µg/m³ (28 days)	(28th day) TSVOC 40 µg/m³	no	TSVOC 30 µg/m³ (3 days)	included in TVOC	no
- VVOC	no	no	no	no	comparison with respective LCI	no	no, but intended later	no	no	included in TVOC	no
- Aldehydes, additional requirements	DIBt: 120 µg/m³ day 28	formaldehyde 10 µg/m³ after 28 days	formaldehyde 50 µg/m²h (28 days)	all aldehydes after calculation for model room below 0,5 OT and 0,5 IT	formaldehyde 10 µg/m³ after 28 days	formaldehyde 36 µg/m³ after 3 or 28 days	(28th day) formaldehyde 60 µg/m³	hexanal 70 µg/m²h , nonanal 20 µg/m²h	formaldehyde 10 µg/m³ after 3 days	formaldehyde, acetaldehyde each 50 µg/m³ (24 h)	formaldehyde according to WHO recommendation for self-levelling compounds

	AgBB	CESAT	M1	ICL	LQAI scheme	Natureplus, examples: Linoleum + carpets	Blue Angel, example: RAL UZ 120 floor coverings	Austrian Ecolabel, example: Ö UZ 42 resilient floor coverings	GUT	EMICODE EC1, example: adhesives	Scandinavian Trade Standards
- list with target compounds	NIK, updated yearly, and R value	LCI as of 1997 and R value	no	database with IT and OT (VOCBASE)	list of identified compounds with respective LCI as of 1997 and R value	several limits for single VOC and groups of VOC	NIK (AgBB), updated yearly, and R value	some limits for single VOC and groups of VOC	NIK (AgBB), updated yearly, and R value	no	all > 5 µg/m^3
- restricted emission of unknown or not assessable VOC	100 µg/m³	as considered in ECA report 18	no	no	sum of identified compounds without respective LCI < 20 µg/m³ after 28 days	no	100 µg/m³	no	100 µg/m³	no	no
-restriction of other emitted compounds	no	no	ammonia 30 µg/m²h (28 days) and restriction on casein in the products	all compounds below 0,5 OT and 0,5 IT	no	no	N-nitrosamine	no	vinyl chloride, vinyl acetate	no	no
- restriction of carcinogenic VOC	C1+C2 3rd day: 10 µg/m³ , 28th day: 1 µg/m³	as considered in ECA report 18	C1: 5 µg/m²h (28 days)	C1 n.d. (any time)	C1+C2 as considered in ECA report 18	CMR (1+2) and national classifications: 1 µg/m³ (24 h)	C1+C2 3rd day: 10 µg/m³, 28th day: 1 µg/m³	no	C1+C2 n.d. (3 days)	list of 5 substances (C1 – 2 µg/m³, C2 - 10 µg/m³, C3 - 50 µg/m³)	no

	AgBB	CESAT	M1	ICL	LQAI scheme	Natureplus, examples: Linoleum + carpets	Blue Angel, example: RAL UZ 120 floor coverings	Austrian Ecolabel, example: Ö UZ 42 resilient floor coverings	GUT	EMICODE EC1, example: adhesives	Scandinavian Trade Standards
Quality assurance											
- control system for labelled products	DIBt: control test 1x/year, full test every 5 years	depends on duration of Technical agreement	control measurements of two randomly chosen products / year	full test every 5 years plus random site control	control test 1x/year, full test every 5 years	control test 1x/year, full test every 3 years	renewal every 4 years	full test every 4 years	market control of 10% of labelled products 1x/year	random market control tests 1x/year	no
- requirements for testing labs	DIBt: List of approved laboratories	no	list of approved laboratories	list of approved laboratories	no	list of approved laboratories	list of approved laboratories	ISO 17025 accredited and listed by VKI	list of approved laboratories	ISO 17025 accredited	ISO 17025 accredited preferred
- round-robin tests	yes	no	only in the past	only in the past	no	planned	yes	no	yes	yes	yes
Management											
- criteria and test method published	in detail	in general terms	in detail	in detail, partly only in Danish	presented in PhD thesis in detail	in detail	in detail	in detail, partly only in German	in general terms	in detail	test methods published
- costs for application	no	fee per application	fee per application	fee per application	fee per application	membership + fee per application	fee depending on sales volume	fee per application	membership + fee per application	membership in GEV	regular testing fees at the testing laboratory

N/A= not applicable

Table 2. TVOC calculation procedures

Standard	TVOC calculation procedure
ISO 16000-6	Sum of all signals between n-hexane and n-hexadecane (C_6 – C_{16}), calculated as toluene equivalent
ECA Rep. 18	Sum of all signals (C_6 – C_{16}), as many of these as possible calculated with their respective response factors, but non-identified VOC calculated as toluene equivalent
GEV	Total sum of all signals > 2 µg/m³ (TVOC (C_6 – C_{16}), TSVOC (>C_{16} – ca. C_{22}) plus TVVOC (ca. C_5 – <C_6), all calculated as toluene equivalent
AgBB - TVOC	Sum of all signals > 5 µg/m³ (C_6 – C_{16}), all VOC with NIK value calculated with their respective response factors, all other VOC as toluene equivalent
AgBB - TSVOC	Sum of all signals > 5 µg/m³ (>C_{16} – C_{22}), calculated as toluene equivalent

Abbreviations in Tables 1 and 2.

AgBB Ausschuss zur gesundheitlichen Bewertung von Bauprodukten

CEN European Standardisation Committee

CESAT Comité Environnement – Santé de l'Avis Technique

CLIMPAQ Chamber for Laboratory Investigations of Materials, Pollution and Air Quality

DIBt Deutsches Institut für Bautechnik

ECA European Collaborative Action

EN European Norm, issued by CEN

GUT Gemeinschaft umweltfreundlicher Teppichboden

IARC International Agency for Research on Cancer

ICL Indoor Climate Label

ISO International Standard Organisation

IT Irritation threshold

LCI Lowest Contration of Interest

LQAI Laboratório da Qualidade do Ar Interior

M1 Material class 1

NIK Niedrigste Interessierende Konzentration (= German LCI)

OT Odour threshold

R value	Sum of (concentration / LCI) expressions
RAL	Deutsches Institut für Gütesicherung und Kennzeichnung
RTS	Building Information Foundation
SVOC	Semi-volatile organic chemical
TSVOC	Total semi-volatile organic chemicals
TVOC	Total volatile organic chemicals
TVVOC	Total very volatile organic chemicals
UBA	Umweltbundesamt
UZ	Umweltzeichen
VKI	Verein für Konsumenten-Information
VOC	Volatile organic chemical
VVOC	Very volatile organic chemical

5. CONCLUSIONS

From the state of the art review of the different labelling systems, the following conclusions can be drawn:

- The potential to undertake actions towards harmonising indoor material emission labelling schemes in the EU is evident because the existing labelling schemes are based on widely accepted principles: emission testing (using “chamber” technology) with characterisation of VOC. Most labels rely on the European and International testing standards (EN 13419 series and ISO 16000 series). The intention of the 1997 report no. 18 of the European Collaborative Action “Indoor Air Quality and its Impact on Man” (“Evaluation of VOC Emissions from Building Products”) was to serve as a guideline and has in fact laid good grounds for harmonising systems.
- Achieving more convergence between the different labels should mean that undertaking one test would be sufficient to provide the information required to apply for several labels. A pan-European label on emissions from products is not supported by most existing labels. Especially the labels that had been initiated by industry are claiming that specific labels with special criteria may support innovative products that would not be encouraged by a very general label.
- Special attention should be given (a) to the sampling and preparation of test specimens and (b) to the analytical procedures since these are essential for reliable material emission characterisation.
- Originally labelling systems were developed to be applicable on national markets. However a number of these systems have received wider acceptance at the European level. In recent years a certain tendency for increasing convergence between labels had been observed.
- The private schemes have set the technical state of the art for some product groups. These labels have achieved a demand for, and promoted development of, low emission products.
- Any label and the supporting analytical procedures should include a specific quality assurance system, setting the minimum requirements for the co-operating laboratories and the reporting.

6. RECOMMENDATIONS

- The process of further harmonisation requires labelling systems to use common procedures for testing and analysis (including sensory tests if relevant). This would permit easier comparison of emission test results. Also, in advance of full harmonisation this would allow one emission test to be sufficient to permit labelling in accordance with a number of the existing systems.
- There is a need for further round robin tests in order to validate the common procedures for testing and analysis.
- There should be further work towards convergence of the existing labelling systems.
- The minimum requirement for a testing laboratory should be that the emission testing methods are part of an accreditation according to standard ISO 17025. The laboratory should show satisfactory performance in regular round-robin tests.

The strong experience gained through the establishment of existing labelling systems for VOC emissions from building products should be considered in the framework of the implementation of essential requirement no. 3 of the CPD concerning indoor air.

LITERATURE

BFR, D21 (1988). Healthy Buildings ’88. Volume 3: Systems, Materials and Policies for Healthier Indoor Air, Swedish Building Research Foundation (BFR), 1988.

BFR, G6 (1989). Sunda hus ur Byggmaterialtillverkarens synvinkel, rapport från Healthy Buildings ’88, Swedish Building Research Foundation (BFR), 1989.

Bluyssen, P.M., de Oliveira Fernandes, E., Molina, J.L. (2000). Database for Source of Pollution for Healthy and Comfortable Indoor Environment (SOPHIE): Status 2000. Proceedings of Healthy Buildings 2000, 4: 385-390.

CEN ENV 717-1 (1998). Wood-based panels - Determination of formaldehyde release, Part 1: Formaldehyde emission by the chamber method.

CEN EN 13419 1-3 (2003). Building products - Determination of the emission of volatile organic compounds.

CEN EN 13999-1-4 (2001). Adhesives – Short term method for measuring the emission properties of low-solvent or solvent-free adhesives after application.

Cochet, C,. Kirchner, S. and de Bortoli, M. (1998). “Further development and validation of a small test chamber method for measuring VOC emissions from building materials and products”, Contract SMT4-VT95-2039 supported by the European Commission.

De Bortoli, M., Kephalopoulos, S., Kirchner, S., Schauenburg, H. and Vissers, H. (1999). “State-of-the-Art in the Measurement of Volatile Organic Compounds Emitted from Building Products: Results of an European Interlaboratory Comparison”, Indoor Air, **9**, 103-116.

DIBt (Deutsches Institut für Bautechnik) (2004). Zulassungsgrundsätze zur gesundheitlichen Bewertung von Bauprodukten in Innenräumen – Stand Juni 2004 (Approval guidelines for the health-related evaluation of indoor construction products) DIBt-Mitteilungen 4/2004, 119-141. For an updated and English version see

http://europa.eu.int/comm/enterprise/tris/pisa/cfcontent.cfm?vFile=120050255EN.DOC.

DS/INF 90 (1994). Directions for the determination and evaluation of the emission from building products. Copenhagen, Danish Standards Association.

ECA (1997a). European Collaborative Action “Indoor Air Quality and Its Impact on Man“ Evaluation of VOC Emissions from Building Products, Report No. 18, EUR 17334 EN, ISBN 92-828-0384-8, Office for Official Publications of the European Communities, Luxembourg.

ECA (1997b). European Collaborative Action “Indoor Air Quality and Its Impact on Man“Total volatile organic compounds (TVOC) in indoor air quality investigations, Report No. 19, EUR 17675 EN, ISBN 92-828-1078-X, Office for Official Publications of the European Communities, Luxembourg.

ECA (1999). European Collaborative Action “Indoor Air Quality and Its Impact on Man“ Sensory evaluation of indoor air quality, Report No. 20, EUR 18676 EN, ISBN 92-828-5699-2, Office for Official Publ. of the European Communities, Luxembourg.

Gunnarsen, L. and Fanger, PO (1989). The influence of adaptation on acceptability of indoor air pollution. In: Proceedings of CLIMA 2000, Sarajevo, Yugoslavia, Vol.3, 49-52.

Gustafsson, H. (1992). Building Materials as Major Emission Sources for Indoor Air Pollutants - a critical review of case studies, Document D10, Swedish Council for Building Research, 1992, ISBN 91-540-5471-0.

ISO 16000-3 (2001). Indoor air - Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method.

ISO 16000-6 (2004). Indoor air – Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MSD/FID.

ISO/FDIS 16000-9 (2005a). Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber method.

ISO/FDIS 16000-10 (2005b). Indoor air - Part 10: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test cell method.

ISO/FDIS 16000-11 (2005c). Indoor air - Part 11: Determination of the emission of volatile organic compounds from building products and furnishing - Sampling, storage of samples and preparation of test specimens.

Jensen, B. and Wolkoff, P. (1996). VOCBASE - Odour and Mucous Membrane Irritation Thresholds and other Physico-Chemical Properties, Ver. 21, National Institute of Occupational Health (*http://www.ami.dk*).

Nordtest (1998). Building materials: Emissions of pollutants by CLIMPAQ chamber, NT Build 482, approved 1998-06. Espoo, Finland:Nordtest.

Oppl R and Winkels K (2002). Uncertainty of VOC and SVOC Measurement? How Reliable are Results of Chamber Emission Testing? Proc. Indoor Air Conf., Monterey 2002, pp 902-907.

SNV 195651, Ausgabe (1968). Textilien; Bestimmung der Geruchsentwicklung von Ausrüstungen (Sinnenprüfung). Schweizerische Normen-Vereinigung available at *www.snv.ch*.

Windhövel, U. and Oppl, R. (2005). Praktische Überprüfung des Konzepts zur gesundheitlichen Bewertung von Bauprodukten (Verification of the health-related evaluation procedure of building products in practice). Gefahrstoffe Reinhaltung der Luft 65:81-89.

Wolkoff, P. and Nielsen, PA (1996). A new approach for indoor climate labeling of building materials - Emission testing, modeling, and comfort evaluation. Atmospheric Environment 30:2679-2689.

World Health Organization, WHO, (1989). Indoor Air Quality: Organic Pollutants EURO Reports and Studies No.111, Copenhagen 1989.

ANNEXES

These Annexes present further information including the detailed descriptions of the different labelling systems. These documents can be found on the Internet at *http://www.jrc.cec.eu.int/pce/eca_reports/ECA_Report24.pdf*.

Annex 1: AgBB-Scheme (Germany)

- Health-related Evaluation for Volatile Organic Compound Emissions (VOC and SVOC) from Building Products – September 2005.
- Health-related evaluation procedure of VOC and SVOC emissions from building products – a contribution to the European construction products directive; C. Däumling *et al* , Gefahrstoffe Reinhaltung der Luft 65 pp 90-92 (3/2005).

Annex 2: CESAT evaluation scheme (France)

- A voluntary evaluation scheme of the environmental and health-based characteristics of building products in France, F. Maupetit *et al*., Harmonisation of indoor material emission labelling scheme in the EU, May 19-20, 2005 meeting, JRC Ispra.

Annex 3: Emission Classification of Building Materials (Finland)

- Protocol for chemical and sensory testing of building materials (2004).
- Application for emission classification of finishing materials.

Annex 4: Indoor Climate Label (Denmark, Norway)

- Introduction to the principles behind the Indoor Climate Labelling, Danish Society of Indoor Climate, 2003.
- General Labelling Criteria, 3rd ed., Danish Society of Indoor Climate, 2004.
- Standard Test Method for Determination of the Indoor-Relevant Time-Value by Chemical Analysis and Sensory Evaluation, 2nd ed., Danish Society of Indoor Climate, 2003.
- Larsen A, Hanssen SO, Juhl HD, Nielsen PA, Norang AR, Tesli J and Wolkoff P (1999). Further progress of the (former Danish) Indoor Climate Labelling scheme, Proceedings of Indoor Air 99, Vol. 1, p. 534-539.

- Witterseh, T (2002). Status of the Indoor Climate Labelling Scheme in Denmark, Proceedings of Indoor Air 2002, Monterey, CA, USA, Vol. 3, 612-614.

Annex 5: LQAI scheme (Portugal)

- Presentation of the criteria applied by LQAI.
- LQAI brochure.
- Example of the Declaration of Quality.

Annex 6: Natureplus (Austria, Belgium, Germany, Hungary, Netherlands, Switzerland)

- Mötzl H., Natureplus – controlling and assessing the environmental perfomance of building products by an international label of quality.
- Natureplus brochure.
- Natureplus example: Laboratory testing requirements for indoor air emissions of varnishes.

Annex 7: The Blue Angel (Germany)

- ECO-Label for low-emission wood products and wood base products (RAL UZ 38)- Part 1: Criteria and requirements for labelling, Proceedings of Healthy Buildings 2000, Vol. 4, 519-524.
- ECO-Label for low-emission wood products and wood base products (RAL UZ 38)- Part 2: Test procedure and results, Proceedings of Healthy Buildings 2000, Vol. 4, 525-530.
- RAL-UZ 117 Low-Emission Upholstered Furniture, Edition July 2004, RAL German Institute for Quality Assurance and Certification. *http://www.blauer-engel.de/englisch/vergabe/download_uz_e/e-UZ-117.PDF.*
- RAL-UZ 120 Elastic Floor Coverings, Edition July 2005, RAL German Institute for Quality Assurance and Certification. *http://www.blauer-engel.de/englisch/vergabe/download_uz_e/e-UZ-120.pdf.*
- RAL-UZ 113 Low-Emission Floor Covering Adhesive and other Installation Materials February 2005, RAL German Institute for Quality Assurance and Certification. *http://www.blauer-engel.de/englisch/vergabe/download_uz_e/e-UZ-113.pdf.*

Annex 8: Association of environmentally friendly carpets (GUT-Germany)

- GUT Product Test, criteria and limit values (2004).
- GUT-image brochure 2002.

Annex 9: Association for the control of emissions in products for flooring installations (GEV-Germany)

- GEV-Testing Method (dated 12.05.2004).
- GEV-Specifications and classification criteria.
- Winkels K (2000). EMICODE labelling of GEV for flooring installation products-new developments, Proceedings of Healthy Buildings 2000, Vol. 4, 513-518.
- GEV Round robin test 2003 (summary can be found at *http://technikwissen.de/gest/article.php?data[article_id]=7146).*

Annex 10: Labelling schemes applied in Belgium and UK, and the Scandinavian Trade Standards

Belgium

Belgium has not adopted a specific labelling scheme for building materials but applies for some products European labelling schemes. For example, the German GUT label (Gemeinschaft umweltfreundlicher Teppichboden) is delivered for carpets by an independent laboratory associated to the textile industrial sector.

The European Öko-tex label (see *http://www.oeko-tex.com/en/start/start.html*) is also delivered in Belgium for textiles that have been tested regarding their allergenic and carcinogenic content but also regarding their formaldehyde and other VOC releases.

Glues (for carpets mainly), are classified according to the GEV – EMICODE labelling scheme.

Concerning wood-based panels, the European standard 13986 is applied for the CE labelling (mechanical performances and formaldehyde emissions). Other specific certifications exist, such as CTIB-TCHN and ATG labels and are also based on the European standard.

UK

The UK has also not adopted a specific labelling scheme for building materials although a number of UK based manufacturers have products tested according to schemes applied in other countries. The importance of emissions from building materials on indoor air quality is recognised in the proposed amendments (July 2004 consultation document, *www.odpm.gov.uk/*) to Approved Document F of the Building Regulations which concerns ventilation requirements. The requirement is met where a ventilation system is provided which under normal conditions is capable (if used) of restricting the accumulation of such moisture and pollutants originating within a building as would otherwise become a hazard to the health of the people in the building.

The new Part F has moved away from the current prescriptive approach to a performance based approach to give more freedom for designers to include appropriate provisions for a particular building. For example, one of the performance criteria is that TVOC levels should not exceed 300 $\mu g/m^3$ averaged over an eight hour period.

The airborne pollutants are stated to include those that are released from materials and products used in the construction, decoration and furnishing of a building, and as a result of the activities of the building occupants. 'Source control' is identified as a complementary strategy for achieving good indoor air quality and this may allow ventilation rates to be lowered and thus provide a potential saving in energy use. However source control is not considered within the main guidance of the Approved Document due to 'limited knowledge about the emission of pollutants from construction and consumer products used in buildings and a lack of suitable labelling schemes.' The guidance refers to low emitting products (e.g. glass, stone), paints labelled for their VOC content and low formaldehyde emitting boards(BS EN 13986:2002) that may be chosen when good IAQ is a priority. However it is stated that at the present time it is not practical to make an allowance for use of these products in the ventila-

tion requirements, although work is continuing for inclusion in either companion guidance or future revisions of Approved Document F. The reader is referred to BRE Digest 464 for further information on control of emissions from construction products (Yu and Crump 2002).

The Scandinavian Trade Standards

Discussions in Sweden concerning declaration of emissions from building materials were started 1990, especially oriented towards surface materials constituting large areas in an indoor environment.

In co-operation with different trade associations and in particular the Swedish National Flooring Trade Association voluntary trade standards were developed in 1992 for measurements and the declaration of chemical emissions. In a joint effort between Swedish and Danish researchers the FLEC (field and Laboratory Emission Cell) had been developed. The emission procedure was later on published as a NORDTEST standardised procedure in NT BUILD 438 (Nordtest 1995); “Building materials: Emission of Volatile organic compounds – Field and Laboratory Emission Cell, FLEC”.

Totally six different trade standards have been developed covering the following products:

- Flooring materials,
- Levelling compounds
- Smoothing compounds,
- Paint and varnishes,
- Wallpaper,
- Complete floor constructions.

In the process of the development and in proceeding studies of materials on the Scandinavian market more than 1100 building materials were studied concerning chemical emissions. The information is collected in a data base METS (Materials Emission by Trade Standards) held by Swedish National Testing and Research Institute for research purposes.

The procedure requires the material to be tested twice. It was tested first time four weeks after the manufacturing (the estimated time to reach the market) and a second time 6 month after manufacturing. The material is conditioned at 23 ºC and 50 % RH for at least two weeks before the testing. The material needs to be conditioned under the FLEC at least 24 hour before the measurement of emission from the material. When not under test in the FLEC equipment the material is conditioned in 23 ºC and 50% relative humidity (RH) with good ventilation. The test results were declared as TVOC for comparison between different materials of the same type and also reported as individual compounds to the manufacturer.

The results are expressed as concentrations in toluene equivalents. The information of individual components was intended as a tool for improvement of low-emitting material for the manufacturer of the product. The Swedish National Flooring Trade Association developed a form for the declaration of the emission of the various products based on the observed TVOC result and a formula of how to calculate the total emission in a specific application.

The declarations of emissions have been used in tenders to the state and communities in Sweden and to larger building entrepreneurs. The request from the ordinary customer has been limited in power and not managed to promote a general declaration of emissions from

the building materials. However, the educated customer has been able to take advantage of the produced declarations required in the community commissioning.

The behaviour of the materials in the complete construction became important because of the continued reporting of secondary emissions observed in damp flooring constructions. The degradation of components in the adhesive or the plasticiser material became a factor of concern in the development of low-emitting materials and adhesives. The relevance of the whole construction needed to be introduced in the materials testing when drying or sealing procedures became evident before adding flooring surface materials to humid concrete surfaces. A new type of testing procedure involving the complete flooring construction were developed.

The latest trade standard or rather an industrial protocol was developed for testing the emission characteristics of individual components in a complete composite floor structure and thereby qualifying components for complete composite floor structures. The protocol may be described as a provocation test for alkaline hydrolysis and enables materials such as concrete, smoothing compound, various types of barrier layers and moisture barriers, adhesives and surface materials to be tested, either individually or in combination, to determine their effect on, or contribution to, the overall emission characteristics of the entire floor construction.

When the behaviour of a new single product is to be tested, it is incorporated into a floor structure of which all the other components are well characterised and defined as reference products. The floor structure prepared in this way is referred to as the 'test specimen'. At all times a 'reference specimen' is prepared at the same time, consisting of the reference concrete, the reference adhesive and the reference floor-covering. The reference specimen and the test specimen are prepared at the same time and handled in as an identical manners as possible. Studies have demonstrated the need for simultaneous preparation in order to single out the material behaviour from varying procedures in the manipulation of the specimen. The emissions of the test specimen and the reference specimen are performed according to ENV 13419-2 and the analysis of the emissions according to ISO 16000-6 measured 26 weeks after the application of the surface covering.

The curing time as well as the concrete composition for both the reference and the test specimen has been chosen in order to achieve a constant RH of 85% under the floor-covering. The use of these conditions will result in alkaline hydrolysis in the adhesive and the floor-covering for the reference specimen giving emission of 1-butanol and 2-ethyl hexanol. Extensive testing at SP Swedish National Testing and Research Institute and other institutes indicate that the average sum of emissions of these two compounds from the reference specimen is approximately 500 µg/m^2*h, however, with a wide spread in results (which has also been observed in other similar measurements). Thus, the emission result from the reference specimen is only used to confirm the existing aggressiveness of the underlying reference structure.

The ***reference specimen*** should reveal a sum of emission of alcohols in the range of 300 to 1200 µg/m^2*h to be valid.

The sum of alcohols from the ***test specimen*** is the base for the classification of the emissions into three classes as:

AN 1, sum of alcohols < 30 µg/m^2*h

AN 2, sum of alcohols between 30 to 100 µg/m^2*h

AN 3, sum of alcohols > 100 µg/m^2*h.

The new complete protocol consists of three parts with appendixes:

Part A, describes the preparation and emission measurement of the reference specimen, which consists of reference concrete, reference adhesive and a reference floor-covering.

Part B, describes the preparation and emission measurement of the test specimen, in which the new product is incorporated in the reference system by replacing one of the reference materials (e.g. the adhesive) or by adding the new product to the standardised reference specimen (e.g. as smoothing compound).

Part C, describes how to present the results from the emission measurement.

The appendixes, comprises report sheets used during the preparation of specimens, a sheet for presenting the results from the emission measurements of the test and reference specimens. The final two appendices present the declaration of composition of the reference adhesive and the reference flooring material.

The cost for performing one test of one structure including test and reference specimens is approximately 270€ and 135€ for a repeated test on the same sample.

References

Nordtest NT Build 438 (1995). Building materials; Emission of volatile compounds- Field and Laboratory Emission Cell (FLEC) approved 1995-11, 4 pages, Espoo, Finland:Nordtest.

Yu C and Crump D (2002). VOC emissions from building products: Part 1; Sources, testing and emission data, Part 2; Control, evaluation and labelling schemes. BRE Digest 464, BRE Garston, 2002.

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