Ausschuss zur gesundheitlichen Bewertung von Bauprodukten

Committee for Health-related Evaluation of Building Products

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Updated List of LCI values 2012 in Part 3

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This version applies from the date it is published. The version it replaces will continue to be valid for one more year. This also applies to updated lists of LCI values. However, old and new versions must each be applied as a complete document; they may not be mingled.

A contribution to the Construction Products Directive:

Health-related Evaluation Procedure for Volatile Organic Compounds Emissions (VOC and SVOC) from Building Products

1 Introduction

The health and comfort of the occupants of indoor spaces is influenced by the indoor climate in a room (in particular temperature, air exchange rate and relative humidity) and by potential indoor air pollutants. Such pollutants may be emitted by a variety of sources. Among these sources building products are of particular importance here since their selection is often not within the occupants' discretion and many of them cover large surface areas in a room.

In Germany the use of building products is subject to the provisions of the building codes of the Federal States (Länder). These provisions require that built structures shall be designed, built, and maintained in such a way that life, health or the natural environment are not endangered (Article 3, Standard Building Code (Musterbauordnung) [MBO, 2002]). Building products used in the construction of buildings or integrated in the building have to satisfy these requirements so that chemical, physical or biological influences do not result in any hazard or unacceptable nuisance (Article 13 MBO).

In the European Union, the importance of building products is accounted for by the European Construction Products Directive (CPD) which came into force in 1989 [Council of the European Communities, 1989]. An important objective of this Directive, in addition to eliminating barriers to trade, is the integration of health concerns. In 1992, the European Construction Products Directive was transposed into German national legislation by the Building Products Act (Bauproduktengesetz, [BauPG 1992]) and by amendments to the building codes of the Federal States (Länder).

On 04/04/2011, the Construction Products Regulation (No 305/2011) adopted by the European Parliament on 9 March 2011 was published in the European Official Journal L 88/5.

The regulation aims to "laying down harmonised conditions for the marketing of building products and repealing Council Directive 89/106/EEC (CPD)" and entered into force on 24/04/2011. After a transition period, building products marketed before 1 July 2013 in accordance with Directive 89/106/EEC (CPD), must be conform to the new Construction Products Regulation. Implementation of the new Construction Products Regulation (BauPVO) into national law is not required as European regulations take effect immediately in all Member States. Thus, the new regulation also applies to building products in Germany since 24/04/2011. However, significant chapters of the Construction Products Regulation according to Article 68 - Entry into force – apply not before 1 July 2013. The new Construction Products Regulation updates the Construction Products Directive and expands the scope of the environmental and health requirements.

One of the objectives of the building codes of the Federal States (Länder) and of the European Construction Products Directive as well as the future Construction Products Regulation is to protect the building users' health. "Hygiene, Health and Environment" are among the basic requirements for built structures and the building products incorporated therein. By complying with these essential requirements health must not be endangered. The prevention and control of indoor pollutants, e.g. volatile organic compounds (VOC), are hereby explicitly covered (Annex I, Construction Products Regulation (No 305/2011)).

The European Union has recognised the insufficient implementation of the essential requirements for building products regarding health protection and issued a mandate to CEN. The mandate[1] envisaged the development of horizontal assessment methods for dangerous substances in and their emission from building products. For this purpose, CEN has established the technical committee CEN TC 351. The horizontal assessment methods to be developed by this committee will form the basis for the technical specifications for building products in standardisation activities and national technical approvals. As a result of the standardization work, the publication of a VOC assessment method for building products as a Technical Specification (CEN/TS) is expected to appear in 2013 and as a European Standard (EN) about two years later.

National and international bodies, in particular the European Collaborative Action (ECA) "Indoor Air Quality and its Impact on Man", have already dealt with the evaluation of VOC emissions from building products in the 1990s. Within ECA that is now working under the title "Urban Air, Indoor Environment and Human Exposure", experts from the EU Member States and from Switzerland and Norway are thoroughly examining the specific knowledge available in Europe over a wide range of indoor issues. The results of their work have been published in reports, which contain sufficiently detailed information to be considered as 'pre-normative' documents. One of them is Report No 18 "Evaluation of VOC Emissions from Building Products" in which a flow chart for the evaluation procedure of emissions from floor coverings is given as an example [ECA, 1997a].

The Committee for Health-related Evaluation of Building Products, *AgBB*[2] *(Ausschuss für die gesundheitliche Bewertung von Bauprodukten)* considers as one of its main tasks to establish

[1] Mandate M366 "Development of horizontal standardised assessment methods for harmonised approaches relating to dangerous substances under the Construction Products Directive (CPD)". European Commission, DG Enterprise, Brussels, 16 March 2005.

[2] Composed of representatives of the health authorities of the *Länder*, the Federal Environmental Agency (UBA) with the AgBB Secretariat, the German Institute for Building Technology (DIBt), the Conference of the *Länder* Ministers and Senators responsible for urban development, construction and housing (ARGEBAU), the Federal Institute for Materials Research and Testing (BAM), the Federal Institute for Risk Assessment (BfR) and Coordination Committee 03 – hygiene,

in Germany the fundamentals for a uniform health-related assessment of building products so that the requirements specified in the building codes of the Federal States (Länder) and the European Construction Products Regulation are satisfied, and an evaluation procedure results which is as traceable and objective as possible.

In this context, the Committee has presented a procedural scheme for health-related evaluation of VOC emissions from building products used for application indoors [AgBB, 2000]. Within this scheme, volatile organic compounds include compounds within the retention range of C_6 to C_{16}, which are considered both as individual substances and as a sum parameter following the TVOC concept (TVOC = Total Volatile Organic Compounds), as well as semi volatile organic compounds (SVOC) within the retention range from C_{16} up to C_{22}.

The scheme was extensively discussed with representatives of manufacturers and professionals after having been published first in 2000 [AgBB 2000/2001] and at the end of its introductory phase from 2002 to 2004 [Proceedings of the technical dialogues in 2001 and 2004]. As a result of these processes, the scheme was revised [AgBB, 2005] and the Deutsche Institut für Bautechnik (DIBt) incorporated the evaluation scheme into its approval guidelines for the health-related evaluation of building products [DIBt, 2004, current version 2010]. Some of the new knowledge gained in the meantime, is taken into account in the current version [Däumling, 2012]. For other issues, further research is needed, e. g. for inclusion of certain VVOCs that have proven to be relevant for emissions from building products [e.g. Gellert and Horn, 2005]. For this purpose, the currently used VOC measurement methods are not suitable enough.

By adhering to the test values set in the scheme, the minimum requirements of the aforementioned building codes for health protection with regard to VOC emissions can be met. Even though, the scheme endorses initiatives of manufacturers to produce products with lower emissions. Manufacturers can therefore declare better performance parameters (VOC emissions) for their products, e. g. by means of labels [ECA, 2005; ECA 2012].

2 Health-related evaluation of VOC emissions from building products

The effects of indoor air pollution have been dealt within a large number of publications (e.g. [ECA, 1991b; WHO, 2000, 2010; Doty, 2004; Rumchev, 2004; Weschler, 2004; Wolkoff, 2006; Ad-hoc, 2007; Arif and Shah, 2007; Mendell, 2007; Bernstein, 2008; Heinzow, 2009; Hsu, 2012]). Volatile organic compounds may have effects ranging from odour perception and irritation of the mucous membranes of the eyes, nose and throat to acute systemic effects and long-term effects. These include effects on the nervous system, allergenic and allergy-promoting properties and, in particular, carcinogenic, mutagenic or reprotoxic potential.

The toxicological evaluation of substances from building products can be based on available information which, at best, includes knowledge on dose-effect-relationships. Such relationships permit to establish concentration levels below which there would be no concern about adverse effects.

The most comprehensive evaluation system is available for the workplace area, in the form of occupational exposure limit values (OELs). However, where hazardous substances are

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handled at workplaces under typical conditions, much higher substance concentrations than under indoor living conditions are generally encountered. Also, much shorter exposure times occur at workplaces in comparison to indoor situations. When extrapolating to indoor living spaces, this must be accounted for by suitable factors, as must the inclusion of particularly sensitive population groups and the absence of exposure monitoring through measurements and occupational health surveillance [ECA, 1997a].

The procedure used to establish auxiliary parameters to evaluate building products, the so-called LCI (Lowest Concentration of Interest)[3] values, is explained in detail in the introduction of the LCI values listed in the Annex (Part 3 of this document).

The aforementioned evaluation criteria are based on the assessment of individual compounds although building occupants are exposed to a multitude of substances. This is accounted for by the total concentration of volatile organic compounds (TVOC) [Seifert, 1999; ISO 16000-6; Ad-hoc, 2007]. However, it has to be emphasized that a TVOC guideline value – due to the varying composition of the VOC mixture occurring in indoor air – cannot be based on toxicological conditions. However, there is sufficient evidence that with increasing TVOC concentration the likelihood of complaints and adverse health effects also increases [ECA, 1997b; Ad-hoc, 2007].

3 Sensory aspects

Emissions from building products are often associated with odour perception, which may result in annoyance and health impairment. Sensory testing is therefore an important element of the evaluation of emissions from building products. In the past, different measurement methods have been used for sensory testing [e. g. Fischer et al., 1998; ECA, 1999], but there was no harmonized, generally accepted procedure for odour assessment. Research projects on measurement of odour emissions from building projects using test chambers [UBA Texte, 2007 and 2011] have developed a method which has now become an international standard [ISO 16000-28].

Based on current knowledge and the test chamber method according to ISO 160000-28, it is now possible within the AgBB evaluation scheme to determine and objectively evaluate odour emissions from building products on the basis of perceived intensity and hedonic note. In order to gain further experience by applying the test method to different building products, the AgBB has launched a two-year pilot phase for sensory testing which will begin in 2012. The aim of the pilot phase is to examine different building products, test the applicability of the proposed method and carry out two round robin tests in cooperation with representatives of relevant industrial associations, manufacturers and test laboratories. The results from the pilot phase will enable a broader basis for the decision on how sensory testing can be incorporated into the AgBB evaluation scheme in future.

[3] In the original German text the acronym NIK is used standing for Niedrigste Interessierende Konzentration, which is the translation of LCI.

4 Measurement and evaluation of VOC emissions from building products

4.1 Test chamber method for VOC emissions measurement

VOC emissions from building products can be suitably measured in test chambers. Important parameters that have an influence on the result are temperature, air exchange rate, relative humidity and air velocity in the test chamber, and the amount or surface area of the material in the chamber and the method of sample preparation. The influence of these and other parameters became evident in international intercomparison tests [ECA, 1993; ECA, 1995]. Based on the results of these tests and an earlier publication on the test procedure [ECA, 1991a], a European standard for the determination of emissions from building products was published [ISO 16000-9 to -11]. Parts 9 and 10 describe the procedure when using a test chamber and a test cell, respectively. Part 11 covers sampling and storing of samples, and preparation of test specimens.

4.2 Exposure scenarios

Health evaluation of a building product is based on the predicted indoor air exposure concentrations for a room occupant resulting from VOC (and SVOC) emissions by that product. The evaluation cannot be carried out using solely the area-specific emissions rates of the building product as determined in test chamber measurements according to the AgBB scheme (see 4.1). Rather, it is necessary to additionally consider the indoor air situation likely to be encountered under practical conditions. The exposure scenario creates the link between product emission and concentration in indoor air. Thus, the evaluation must take into account the emissions from the product, the size of the room, the air exchange rate and the emitting surface area of the building product to be installed in the room.

Under current building law in Germany, the building shell of newly constructed or extensively remodelled buildings is increasingly fitted with airtight insulation for energy reasons. This reduces the air exchange with outdoor air unless compensated by increased active airing. However, from the viewpoint of air quality, regular air exchange with ambient air is necessary to reliably transport humidity (produced e.g. by cooking or washing) as well as odours and emissions out of indoor spaces and create the prerequisites for a healthy indoor climate.

In order to take both energy and air quality aspects sufficiently into account, the AgBB scheme assumes an air exchange rate of 0.5/h for exposure analysis [DIN 1946-6; Gundermann, 1991]. Rooms equipped with modern sealed windows according to the energy-saving regulations normally have much lower air exchange rates. This, however, is too little from the perspective of indoor air quality. Therefore, the air exchange rate of 0.5/h assumed in the AgBB scheme presupposes increased active airing to prevent harmful consequences in terms of hygiene. Increased intensive airing by the occupants after introduction of new materials (e.g. during renovation) especially must be presupposed. Furthermore, in low energy buildings, the aim must be to consistently use low-emission building products and other materials and products for indoor use.

The AgBB requirements also must take into account as broad a range of building types and uses as possible. Since much of the building stock in Germany still consists of energy-inefficient old buildings, the requirements must consider the different air exchange rates in

these buildings. From both the perspective of indoor air quality and the broad range of buildings, an air exchange rate of 0.5/h remains the minimum air exchange rate target for all buildings, including old, new and future buildings. It is therefore deemed to be an appropriate basis for the calculations in connection with evaluation of test chamber emission results.

$$C = \frac{E_a \cdot A}{n \cdot V} = \frac{E_a}{q} \qquad (1)$$

Equation (1) describes the indoor air concentration C, resulting from a building product, as a function of the area-specific emissions rate E_a [µg/(m^2 h)] of the product, the air exchange rate n [h^{-1}] in the room considered and the ratio of product surface area A [m^2] to the room volume V [m^3]. Parameters n, A and V can be combined into the new parameter q [m^3/(h m^2)] called the area-specific air exchange rate.

The model room in the AgBB scheme has a base area of 3 m x 4 m and a height of 2.5 m.

4.3 Evaluation scheme for volatile organic compounds

For health evaluation, a product has to undergo a series of tests as shown in the flow chart in Fig. 1. The procedure starts from a product wrapped in an airtight cover. The start of the experiment (t_0) is defined as the time at which the product to be tested is unwrapped and placed into the test chamber or cell. The product remains in the test chamber or cell over the entire period of the test. For certain product groups it is necessary to define special test conditions. These specific requirements are defined separately (see Approval guidelines for the health-related evaluation of indoor construction products, Part I and Part II [DIBt, 2010]). They may also include the definition of criteria for anticipated termination of the emission measurement. In principle, anticipated termination of the test is permitted at the earliest 7 days after placing the test specimen into the chamber and under the condition that the values determined are less than half the requirements for the 28-day values and no significant increase in the concentration of individual substances is observed in comparison to the measurement on day 3. The fulfilment of these criteria has to be sufficiently demonstrated by the testing body.

In accordance with ISO 16000-6 the following definitions apply for the emission to be determined in the test chamber:

VOC: all individual substances within the retention range C_6 - C_{16}

TVOC: sum of the concentration of all individual substances with concentrations equal to or greater than 5 µg/m^3 within the retention range C_6 - C_{16}

SVOC: all individual substances within the retention range > C_{16} - C_{22}

∑SVOC: sum of the concentration of all individual substances with concentrations equal to or greater than 5 µg/m^3 within the retention range > C_{16} - C_{22}

The assignment of the individual substances to the retention ranges C_6 - C_{16} and C_{16} - C_{22} is based on the separation on a non-polar column. Individual substances comprise identified and non-identified compounds.

In the AgBB scheme, the identification of all individual substances is based on a presumed uniform detection limit of 1 µg/m^3 in order to cover the emission spectrum as fully as possible in a qualitative way.

All individual substances have to be quantified as required and need to be considered individually and in the summation if their concentration is equal to or greater than 5 µg/m^3. Exceptions apply to carcinogenic substances belonging to EU categories 1 and 2 (formerly Directive 67/548/EEC Appendix I respectively Regulation (EC) No 1272/2008 Appendix VI Table 3.2) or EU categories 1A and 1B according to the new GHS system (Regulation (EC) No 1272/2008 Appendix VI Table 3.1) (see 4.3.1).

Identified substances with LCI values as well as carcinogens have to be quantified using their individual calibration factors. Identified substances without LCI values and non-identified ("unknown") substances are quantified on the basis of toluene equivalents.

VOC and SVOC shall be measured using Tenax sampling and subsequent thermodesorption and analysis by GC/MSD according to ISO 16000-6. Aldehydes, in particular low-chained aldehydes listed in Group 7 of the list of LCI values, shall be determined using the DNPH method according to ISO 16000-3 (see Note III in the Annex).

The following explanations are given to the flow chart in Figure 1:

4.3.1 Measurement and testing after 3 days

- $TVOC_3$

A product satisfies the criteria, if the TVOC value after 3 days ($TVOC_3$) is ≤ 10 mg/m³.

- Carcinogenic substances

Every building product has to meet the general requirement of not emitting any carcinogenic, mutagenic or reprotoxic substances. Emission of carcinogenic substances belonging to categories 1 and 2 (according to the old classification) or categories 1A and 1B (according to the GHS system) is first tested at this stage of the flow chart. Substances with mutagenic or reprotoxic properties and those with potential carcinogenic effects (EU category 3 (according to the old classification) or EU category 2 (according to the GHS system)) are checked within the LCI concept (see Part 3) and assigned higher safety factors if necessary. Carcinogens have to be quantified using their individual calibration factors.
No carcinogen belonging to EU categories 1 and 2 respectively EU categories 1A and 1B may exceed a concentration of 0.01 mg/m³ after 3 days.

- Sensory testing

The results of the research projects show that sensory testing after 3 days generates no significant additional information. Therefore, in the pilot phase, no odour measurement is performed at that time.

4.3.2 Measurement and testing after 28 days

- $TVOC_{28}$

In order to assess the long-term behaviour of the VOC emissions from a building product, the TVOC value is determined again after 28 days. This is done in the same way as described for $TVOC_3$. When calculating the $TVOC_{28}$ value, in addition to the instructions given in ISO 16000-6, it is important to be as complete as possible in the identification of compounds to permit the evaluation of individual substances.
A product satisfies the criteria, if the $TVOC_{28}$ value is ≤ 1.0 mg/m³. Products with a TVOC value higher than that are rejected.

- Semi volatile organic compounds (SVOC)

Products that satisfy the criteria for VOC emissions but instead exhibit increased emission of SVOC should not be given advantages. To prevent this from happening, the SVOC concentration in the chamber air shall also be determined[4].

A product satisfies the criteria if the sum of the SVOC concentrations in the chamber air does not exceed 0.1 mg/m³. This corresponds to an additional content of 10 % of the maximum allowable $TVOC_{28}$ concentration of 1.0 mg/m³. Higher concentrations result in rejection.

- Carcinogenic substances

The emission of carcinogenic substances of EU categories 1 and 2 respectively 1A and 1B is tested again, with an emphasis on the long-term behaviour from the user's point of view. No carcinogen of categories 1 and 2 respectively 1A and 1B may exceed the value of 0.001 mg/m³ after 28 days. .

- Sensory testing

In the pilot phase, sensory testing for intensity and hedonic note is performed after 28 days. Perceived intensity is determined by a trained panel (ISO 16000-28, section 10.3). Hedonic note is measured by the same panel according to VDI 4302 Part 1 (greenprint).

- Evaluation of individual substances

In addition to evaluating the emissions of a product via the TVOC value, the evaluation of individual VOC is also necessary. For this purpose all compounds whose concentration in the chamber air equals or exceeds 1 µg/m³ are first identified, listed with their CAS number, and quantified according to the following:

a) VOC assessable via LCI

For a large number of VOC found in indoor air a list of so-called LCI values (Lowest Concentration of Interest see footnote 3) is contained in the Annex. The details of how these LCI values have been derived are documented in the introduction to the list. Listed substances whose concentrations in the test chamber exceed 5 µg/m³ are evaluated based on LCI. They are quantified using their individual calibration factors.

For the evaluation of each compound *i* the ratio R_i is established as defined in equation (2).

$$R_i = C_i / LCI_i \qquad (2)$$

where C_i is the chamber concentration of compound *i*. For $R_i < 1$, it is assumed that there will be no effects. If several compounds with a concentration > 5 µg/m³ are detected, additivity of effects is assumed and it is required that R, the sum of all R_i, shall not exceed the value 1.

$$R = \text{sum of all } R_i = \text{sum of all ratios } (C_i / LCI_i) \leq 1 \qquad (3)$$

[4] Emission of semi volatile organic compounds with a retention time >C_{16} (hexadecane) can be quantitatively determined by chamber or cell measurements over 28 days using today's modern analysis apparatus up to a volatility comparable to that of docosane (C_{22} alcane, boiling point 369 °C). According to current knowledge, the analysis of semi volatile organic compounds with an even lower volatility will encounter increasing difficulty if the method of Tenax sampling and thermodesorption is used in chamber tests.

Products which do not fulfil this condition are rejected.

b) VOC not assessable via LCI
In order to avoid the risk of a positive evaluation of a product which emits larger quantities of nonassessable VOC, a limit is set for those VOC which cannot be identified or do not have an LCI value. This limit equals 10 % of the permitted TVOC value, for the sum of such substances. A product meets the criteria when the sum of such VOC determined at concentrations ≥ 0.005 mg/m^3 does not exceed 0.1 mg/m^3. Higher concentrations result in rejection.

4.4 Conclusion

A building product which fulfils the requirements set out in the flow chart (see Figure 1) is suitable for use in enclosed building spaces from a health perspective in accordance with Articles 3 and 13 of the Standard Building Code (MBO).

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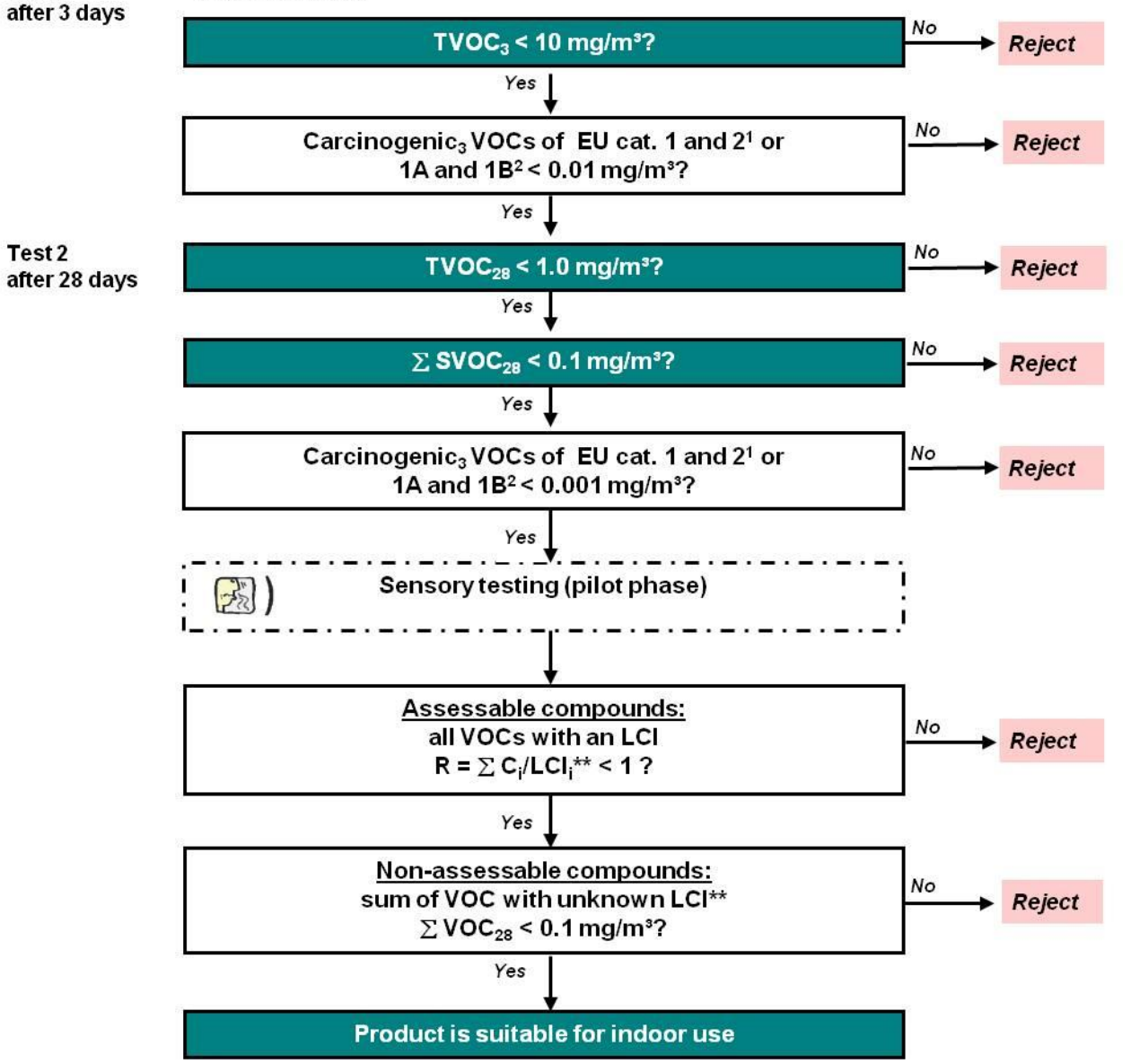
Fig. 1: **Flow chart for the evaluation of VOC* and SVOC* emissions from building products**

Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (Committee for Health-related Evaluation of Building Products)



See notes in the text

*** VOC, TVOC: Retention range C_6 – C_{16}, SVOC: Retention range C_{16} – C_{22}**

**** LCI: Lowest Concentration of Interest (German: NIK)**
European Emission Test Standard prEN ISO 16000-9 to -11

1 Classification according to Directive 67/548/EEC Appendix I respectively Regulation (EC) No 1272/2008 Appendix VI Table 3.2

2 Classification according to Regulation (EC) No 1272/2008 Appendix VI Table 3.1

6. Annex

Establishing LCI values

6.1 Basic considerations

Volatile organic compounds belong to the most common indoor air pollutants. Building products are important potential indoor sources of volatile organic compounds. German building law requires building products to satisfy certain health-related requirements, among others. This means that their emissions must be reduced to such a level that – assuming long-term occupancy of a room - concentrations in indoor air resulting from such emissions do not pose any threat to the health of sensitive persons even under unfavourable but still realistic assumptions (concerning e.g. product loading factor, air exchange rate and indoor climate conditions). However this requires regular, proper airing (see Section 4.2). The health-related evaluation of emissions from building products is based on the derivation of substance-specific values, the so-called LCI values (Lowest Concentration of Interest). In deriving LCI values, an AgBB working group – complemented by manufacturers' specialists - mainly uses existing health-based evaluations of substances at the workplace as a starting point, as proposed by an international expert group [ECA, 1997a].

The working group draws upon a broad base of recognised scientific data, thus taking into account the maximum currently available toxicological evidence and facilitating the assessment of as many substances as possible.

LCI values are used solely for evaluating emissions from building products on the basis of test chamber measurements and do not constitute guideline values for indoor air quality for individual substances. The derivation methodology and the way LCI values are applied make such values an adequate expression of the criteria required in building regulations to safeguard against health risk caused by volatile organic compounds, bearing in mind that the emissions from building products into indoor air result in multi-compound mixtures.

6.2 Derivation procedure

For derivation of LCI values, the LCI Working Group normally uses existing assessment values for substances at the workplace, including in particular:

- indicative occupational exposure limit values (EU-IOELVs) and binding occupational exposure limit values (EU-BOELVs), set by the European Commission,
- occupational exposure limit values (AGW) according to TRGS 900,
- MAK values (maximum concentrations at the workplace), set by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG)
- SCOEL-values or SCOEL-recommendations to the European Commission (SCOEL: Scientific Committee on Occupational Exposure Limits),
- occupational exposure limit values applied in other EU Member States.

In justified individual cases, the LCI Working Group uses the following assessment values as a basis for the derivation:

- DNEL (derived no-effect level) determined for inhalative occupational exposure under the REACH Regulation
- TLVs® (threshold limit values) of the American Conference of Governmental Industrial Hygienists (ACGIH),

- WEEL (workplace environmental exposure limit) values of the American Industrial Hygiene Association (AIHA).

Factors are applied to these assessment values to account for the following basic differences between conditions in indoor spaces like homes, kindergartens and schools and those at workplaces:

- continuous exposure in contrast to a changing and regularly interrupted workplace exposure,
- existence of risk groups which are not present in the workplace at all (children, senior citizens) or are particularly protected by occupational health regulations (pregnant women, allergic persons),
- absence of exposure measurements and medical checks and, in principle, undefined overall indoor exposure.

A factor of 100 is normally applied to the assessment values for the workplace. A smaller safety factor may be chosen in the case of substances whose irritative effects are predominantly local. An additional factor of 10 should be considered in the case of potential carcinogens classified into EU category 3 under the old system (formerly Directive 67/548/EEC Appendix I respectively Regulation (EC) No 1272/2008 Appendix VI Table 3.2) or EU category 2 according to the new GHS system (Regulation (EC) No 1272/2008 Appendix VI Table 3.1). Reprotoxic and mutagenic substances are evaluated on a case-by-case basis with regard to the additional factor. No LCI values are derived for substances with demonstrated carcinogenic properties according to EU categories 1 and 2 (according to the old classification) or EU categories 1A and IB (according to the GHS system); these substances are regulated separately within the AgBB scheme (see Figure 1).

As a further option, the LCI Working Group also uses, in justified individual cases, consumer-related values as a basis for derivation of LCI values, for example:

- indoor air guideline values set by the Ad-hoc working group of the Federal Environment Agency's Indoor Hygiene Commission and the supreme health authorities of the Federal States,
- WHO indoor air quality guidelines
- DNELs (derived no-effect levels) determined for long-term inhalative consumer exposure under the REACH Regulation.

If no LCI value can be derived for a substance on the basis of such values, the Working Group considers whether an individual substance assessment can be performed, preferably by referring to a substance class with similar chemical structure and comparable toxicological assessment.

The derivation of LCI values must be based on scientifically sound principles.

Substances which cannot be evaluated are subjected to a strict limitation of their total amount, within the AgBB scheme ("VOCs with unknown LCI", see Figure 1).

6.3 Publication

LCI values are exclusively determined by the AgBB's LCI Working Group, whose members also include representatives of industrial associations. The working group meets regularly to discuss LCI values to be added or revised. Its work priorities are determined by need, urgency and data availability. An updated version of the list of LCI values is published at regular

intervals (http://www.umweltbundesamt.de/produkte-e/bauprodukte/agbb.htm, last retrieved on 26.09.2012) and is provided in Table 1 along with brief notes on how the values were derived. Furthermore, at the same internet address, currently discussed or agreed changes of LCI values and new substances under consideration are given in the list of prospective LCI value changes (last retrieved on 26.09.2012) for information before the next update.

For substances not yet included in the list of LCI values, manufacturers have the possibility to apply for LCI values to be established by submitting available data to the AgBB. They may also submit substantiated requests for revision of an existing LCI value. An application form is available for download at the above internet address.

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Table 1

List of LCI values

Closing date: June 2012

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
1. Aromatic hydrocarbons						
1-1	Toluene	108-88-3	**1 900**	192 000	190 000	EU: Repr. 2 Individ. substance evaluation
1-2	Ethyl benzene	100-41-4	**4 400**	442 000	440 000	
1-3	Xylene, mix of o-, m- and p-xylene isomers	1330-20-7	**2 200**	221 000	440 000	
1-4	p-Xylene	106-42-3	**2 200**	221 000	440 000	
1-5	m-Xylene	108-38-3	**2 200**	221 000	440 000	
1-6	o-Xylene	95-47-6	**2 200**	221 000	440 000	
1-7	Cumene	98-82-8	**1 000**	100 000	100 000	
1-8	n-Propyl benzene	103-65-1	**1 000**			cf. lowest LCI of saturated alkylbenzenes, e.g. No 1-10
1-9	1-Propenyl benzene (ß-methyl styrene)	637-50-3	**2 400**			EU-OEL for α-methyl styrene: 246 000 µg/m³
1-10	1,3,5-Trimethylbenzene	108-67-8	**1 000**	100 000	100 000	
1-11	1,2,4-Trimethylbenzene	95-63-6	**1 000**	100 000	100 000	
1-12	1,2,3-Trimethylbenzene	526-73-8	**1 000**	100 000	100 000	
1-13	2-Ethyltoluene	611-14-3	**1 000**			cf. lowest LCI of saturated alkylbenzenes
1-14	1-Isopropyl-2-methylbenzene (o-cymene)	527-84-4	**1 100**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-15	1-Isopropyl-3-methylbenzene (m-cymene)	535-77-3	**1 100**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-16	1-Isopropyl-4-methylbenzene (p-cymene)	99-87-6	**1 100**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-17	1,2,4,5-Tetramethylbenzene	95-93-2	**1 100**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-18	n-Butylbenzene	104-51-8	**1 100**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-19	1,3-Diisopropylbenzene	99-62-7	**1 400**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-20	1,4-Diisopropylbenzene	100-18-5	**1 400**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-21	Phenyloctane and isomers	2189-60-8	**1 600**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-22	1-Phenyldecane and isomers	104-72-3	**1 800**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-23	1-Phenylundecane and isomers	6742-54-7	**1 900**			cf. lowest LCI of saturated alkylbenzenes; conversion via molecular weight
1-24	4-Phenyl cyclohexene (4-PCH)	4994-16-5	**1 300**			cf. styrene; conversion via molecular weight
1-25	Styrene	100-42-5	**860**		86 000	
1-26	Phenyl acetylene	536-74-3	**840**			cf. styrene; conversion via molecular weight
1-27	2-Phenylpropene (α-Methylstyrene)	98-83-9	**2 500**	246 000	250 000	
1-28	Vinyl toluene (all isomers: o-, m-, p-methyl styrenes)	25013-15-4	**4 900**		490 000	

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
1-29	Other alkylbenzenes, unless individual isomers have to be evaluated otherwise		**1 000**			cf. lowest LCI of saturated alkylbenzenes
1-30*	Naphthalene	91-20-3	**5**	50 000	500	EU: Carc. 2
1-31	Indene	95-13-6	**450**			OELs Denmark, France: 45 000 µg/m³
2. Aliphatic hydrocarbons (n-, iso- and cyclo-)						
2-1	3-Methylpentane	96-14-0				VVOC
2-2	n-Hexane	110-54-3	**72**	72 000	180 000	EU: Repr. 2
2-3	Cyclohexane	110-82-7	**7 000**		700 000	
2-4	Methyl cyclohexane	108-87-2	**8 100**		810 000	
2-5	--					2)
2-6	-					2)
2-7	--					2)
2-8	n-Heptane	142-82-5	**21 000**	2 085 000		
2-9	Other saturated aliphatic hydrocarbons, C6-C8		**15 000**		1 500 000	
2-10*	Other saturated aliphatic hydrocarbons, C9-C16		**6 000**			cf. TRGS 900 for other saturated aliphatic hydrocarbons, fraction C9-C15
3. Terpenes						
3-1	3-Carene	498-15-7	**1 500**			cf. 3-2 to 3-5
3-2	α-Pinene	80-56-8	**1 500**			OEL Sweden: 150 000 µg/m³
3-3	ß-Pinene	127-91-3	**1 500**			OEL Sweden: 150 000 µg/m³
3-4	Limonene	138-86-3	**1 500**			OEL Sweden: 150 000 µg/m³
3-5	Other terpene hydrocarbons		**1 500**			OEL Sweden: 140 000 µg/m³ (This group includes all mono-terpenes, sesquiterpenes and their oxygen containing derivatives)
4. Aliphatic alcohols						
4-1	Ethanol	64-17-5				VVOC
4-2	1-Propanol	71-23-8				VVOC
4-3	2-Propanol	67-63-0				VVOC
4-4	Tertbutanol, 2-methyl-2-propanol	75-65-0	**620**		62 000	
4-5	2-Methyl-1-propanol	78-83-1	**3 100**		310 000	
4-6	1-Butanol	71-36-3	**3 100**		310 000	
4-7	Pentanol (all isomers)	71-41-0 30899-19-5 94624-12-1 6032-29-7 548-02-1 137-32-6 123-51-3 598-75-4 75-85-4 75-84-3	**730**			MAK-DFG: 73 000 µg/m³
4-8	1-Hexanol	111-27-3	**2 100**		210 000	
4-9	Cyclohexanol	108-93-0	**2 100**			TLV (ACGIH): 206 000 µg/m³
4-10*	2-Ethyl-1-hexanol	104-76-7	**540**		110 000	MAK-DFG: 54 000 µg/m³
4-11*	1-Octanol	111-87-5	**500**		106 000	Individ. substance evaluation
4-12	4-Hydroxy-4-methyl-pentane-2-one (diacetone alcohol)	123-42-2	**960**		96 000	
4-13*	Other saturated n- and iso-alcohols, C4 to C10		**500**			cf. 1-octanol, saturated cyclic alcohols are excluded

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
4-14*	Other saturated n- and iso-alcohols, C11 to C13		**500**			cf. 1-octanol, saturated cyclic alcohols are excluded
5. Aromatic alcohols						
5-1*	Phenol	108-95-2	**10**	8 000	8 000	EU: Muta. 2 Individ. substance evaluation
5-2	BHT (2,6-di-tert-butyl-4-methylphenol)	128-37-0	**100**			OELs Denmark, Finland, France, Great Britain: 10 000 µg/m³
5-3	Benzyl alcohol	100-51-6	**440**			WEEL (AIHA): 44 000 µg/m³
6. Glycols, Glycol ethers, Glycol esters						
6-1	Propylene glycol (1,2-Dihydroxypropane)	57-55-6	**2 500**			Individ. substance evaluation
6-2	Ethanediol	107-21-1	**260**	52 000	26 000	
6-3*	Ethylene glycol-monobutylether	111-76-2	**490**	98 000	49 000	
6-4	Diethylene glycol	111-46-6	**440**		44 000	
6-5*	Diethylene glycol-monobutylether	112-34-5	**670**	67 500	67 000	MAK-DFG: 67 000 µg/m³
6-6	2-Phenoxyethanol	122-99-6	**1 100**		110 000	
6-7	Ethylene carbonate	96-49-1	**370**			cf. ethanediol; conversion via molecular weight
6-8	1-Methoxy-2-propanol	107-98-2	**3 700**	375 000	370 000	
6-9	2,2,4-Trimethyl-1,3-pentane diol monoisobutyrate (Texanol®)	25265-77-4	**600**			Individ. substance evaluation
6-10	Butyl glycolate	7397-62-8	**550**			cf. glycolic acid, metabolite of ethanediol; conversion via molecular weight
6-11*	Diethylene glycol monomethyl ether acetate	124-17-4	**850**		85 000	MAK-DFG: 85 000 µg/m³
6-12	Dipropylene glycol monomethyl ether	34590-94-8	**3 100**	308 000	310 000	
6-13*	2-Methoxyethanol	109-86-4	**3**[#]	3 110	3 200	EU: Repr. 1B
6-14*	2-Ethoxyethanol	110-80-5	**8**	8 000	7 600	EU: Repr. 1B
6-15	2-Propoxyethanol	2807-30-9	**860**			
6-16	2-Methylethoxyethanol	109-59-1	**220**			
6-17	2-Hexoxyethanol	112-25-4	**1 200**			cf. ethylene glycol monobutyl ether; conversion via molecular weight
6-18	1,2-Dimethoxyethane	110-71-4	**4**[#]			EU: Repr. 1B; cf. 2-methoxyethanol (metabolite methoxyacetic acid); conversion via molecular weight
6-19*	1,2-Diethoxyethane	629-14-1	**10**			EU: Repr. 1B; cf. 2-ethoxyethanol (metabolite ethoxyacetic acid); conversion via molecular weight
6-20*	2-Methoxyethyl acetate	110-49-6	**5**	4 900	4 900	EU: Repr. 1B
6-21*	2-Ethoxyethyl acetate	111-15-9	**11**	11 000	10 800	EU: Repr. 1B
6-22	2-Butoxyethyl acetate	112-07-2	**1 300**	133 000	130 000	
6-23	2-(2-Hexoxyethoxy)-ethanol	112-59-4	**740**			cf. diethylene glycol-monobutyl ether; conversion via molecular weight
6-24	1-Methoxy-2-(2-methoxy-ethoxy) ethane	111-96-6	**28**		28 000	EU: Repr. 1B
6-25	2-Methoxy-1-propanol	1589-47-5	**19**		19 000	EU: Repr. 1B
6-26	2-Methoxy-1-propyl acetate	70657-70-4	**28**		28 000	EU: Repr. 1B
6-27	Propylene glycol diacetate	623-84-7	**670**			cf. propylene glycol; conversion via molecular weight

[#] An evaluation within the framework of the LCI-concept will take place only at and above a measured concentration of 5 µg/m³.

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
6-28	Dipropylene glycol	110-98-5 25265-71-8	**670**		67 000 (CAS No. 25265-71-8)-	
6-29	Dipropylene glycol monomethyl ether acetate	88917-22-0	**3 900**			cf. dipropylene glycol-monomethyl ether; conversion via molecular weight
6-30	Dipropylene glycol mono-n-propylether	29911-27-1	**740**			cf. diethylene glycol-monobutyl ether; conversion via molecular weight
6-31	Dipropylene glycol mono-n-butylether	29911-28-2 35884-42-5	**810**			cf. diethylene glycol-monobutyl ether; conversion via molecular weight
6-32	Dipropylene glycol mono-t-butylether	132739-31-2 (Mixture)	**810**			cf. diethylene glycol-monobutyl ether; conversion via molecular weight
6-33	1,4-Butanediol	110-63-4	**2 000**		200 000	
6-34*	Tripropylene glycol monomethyl ether	20324-33-8 25498-49-1	**1 200**			Individ. substance evaluation
6-35	Triethylene glycol dimethyl ether	112-49-2	**7**			EU: Repr. 1B; cf. 2-methoxy-ethanol (metabolite methoxyacetic acid); conversion via molecular weight
6-36	1,2-Propylene glycol dimethyl ether	7778-85-0	**25**			cf. 2-methoxy-1-propanol (metabolit methoxypropionic acid), conversion via molecular weight
6-37	TXIB	6846-50-0	**450**			Individ. substance evaluation
6-38	Ethyldiglycol	111-90-0	**350**		35 000	
6-39	Dipropylene glycol dimethyl ether	63019-84-1 89399-28-0 111109-77-4	**1 300**			
6-40	Propylene carbonate	108-32-7	**250**			Individ. substance evaluation
6-41	Hexylene glycol (2-methyl-2,4-pentanediol)	107-41-5	**490**			MAK-DFG: 49.000 µg/m³
6-42*	3-Methoxy-1-butanol	2517-43-3	**500**			Individ. substance evaluation
6-43*	1,2-Propylene glycol n-propylether	1569-01-3 30136-13-1	**1 400**			Individ. substance evaluation
6-44*	1,2-Propylene glycol n-butylether	5131-66-8 29387-86-8 15821-83-7 63716-40-5	**1 600**			Individ. substance evaluation
6-45*	Diethylene glycol phenylether	104-68-7	**1 450**			cf. 2-Phenoxyethanol; conversion via molecular weight
6-46*	Neopentyl glycol (2,2-dimethylpropane-1,3-diol)	126-30-7	**1 000**			Individ. substance evaluation
7. Aldehydes						
7-1	Butanal	123-72-8				VVOC
7-2	Pentanal	110-62-3	**1 700**			OEL Denmark, France, TLV (ACGIH): 175 000 µg/m³
7-3	Hexanal	66-25-1	**890**			cf. butanal; conversion via molecular weight
7-4	Heptanal	111-71-7	**1 000**			cf. butanal; conversion via molecular weight
7-5	2-Ethyl-hexanal	123-05-7	**1 100**			cf. butanal; conversion via molecular weight
7-6	Octanal	124-13-0	**1 100**			cf. butanal; conversion via molecular weight
7-7	Nonanal	124-19-6	**1 300**			cf. butanal; conversion via molecular weight
7-8	Decanal	112-31-2	**1 400**			cf. butanal; conversion via molecular weight
7-9	2-Butenal (crotonaldehyde, cis-trans-mix)	4170-30-3 123-73-9 15798-64-8	**1**[#]			EU: Muta. 2 [1)]
7-10	2-Pentenal	1576-87-0 764-39-6 31424-04-1	**12**			cf. 2-butenal, but no EU classification as mutagen; conversion via molecular weight
7-11	2-Hexenal	16635-54-4	**14**			cf. 2-pentenal;

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
		6728-26-3 505-57-7 1335-39-3				conversion via molecular weight
7-12	2-Heptenal	2463-63-0 18829-55-5 29381-66-6	**16**			cf. 2-pentenal; conversion via molecular weight
7-13	2-Octenal	2363-89-5 25447-69-2 20664-46-4 2548-87-0	**18**			cf. 2-pentenal; conversion via molecular weight
7-14	2-Nonenal	2463-53-8 30551-15-6 18829-56-6 60784-31-8	**20**			cf. 2-pentenal; conversion via molecular weight
7-15	2-Decenal	3913-71-1 2497-25-8 3913-81-3	**22**			cf. 2-pentenal; conversion via molecular weight
7-16	2-Undecenal	2463-77-6 53448-07-0	**24**			cf. 2-pentenal; conversion via molecular weight
7-17	Furfural	98-01-1	**20**			Individ. substance evaluation EU: Carc. 2
7-18	Glutardialdehyde	111-30-8	**2**[#]		200	
7-19	Benzaldehyde	100-52-7	**90**			WEEL (AIHA): 8 800 µg/m³
7-20	Acetaldehyde	75-07-0				VVOC
7-21	Propanal	123-38-6				VVOC
8. Ketones						
8-1	Ethylmethylketone	78-93-3	**6 000**	600 000	600 000	
8-2	3-Methylbutanone-2	563-80-4	**7 000**		705 000	OEL Denmark, France: 705 000 µg/m³
8-3	Methylisobutylketone	108-10-1	**830**		83 000	
8-4	Cyclopentanone	120-92-3	**900**			OEL Denmark: 90 000 µg/m³
8-5	Cyclohexanone	108-94-1	**410**	40 800	80 000	
8-6	2-Methylcyclopentanone	1120-72-5	**1 000**			cf. cyclopentanone; conversion via molecular weight
8-7	2-Methylcyclohexanone	583-60-8	**2 300**			OEL Denmark, France, Finland: 230 000 µg/m³
8-8	Acetophenone	98-86-2	**490**			TLV (ACGIH): 49 000 µg/m³
8-9	1-Hydroxyacetone (1-Hydroxy-2-propanone)	116-09-6	**2 400**			oxidation product of propylene glycol, cf. ethanediol; conversion via molecular weight
8-10	Acetone	67-64-1				VVOC
9. Acids						
9-1*	Acetic acid	64-19-7	**1 250**	25 000	25 000	Individual substance evaluation
9-2	Propionic acid	79-09-4	**310**	31 000	31 000	
9-3	Isobutyric acid	79-31-2	**370**			cf. propionic acid; conversion via molecular weight
9-4	Butyric acid	107-92-6	**370**			cf. propionic acid; conversion via molecular weight
9-5	Pivalic acid	75-98-9	**420**			cf. propionic acid; conversion via molecular weight
9-6	n-Valeric acid	109-52-4	**420**			cf. propionic acid; conversion via molecular weight
9-7	n-Caproic acid	142-62-1	**490**			cf. propionic acid; conversion via molecular weight
9-8	n-Heptanoic acid	111-14-8	**550**			cf. propionic acid; conversion via molecular weight
9-9	n-Octanoic acid	124-07-2	**600**			cf. propionic acid; conversion via molecular weight
9-10	2-Ethylhexane acid	149-57-5	**50**			EU: Repr. 2; TLV (ACGIH): 5 000 µg/m³
10. Esters and Lactones						
10-1	Methyl acetate	79-20-9				VVOC
10-2	Ethyl acetate	141-78-6				VVOC

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
10-3	Vinyl acetate	108-05-4				VVOC
10-4	Isopropyl acetate	108-21-4	**4 200**			MAK-DFG, OEL Finland: 420 000 µg/m³
10-5	Propyl acetate	109-60-4	**4 200**			MAK-DFG, OEL Finland: 420 000 µg/m³
10-6	2-Methoxy-1-methylethyl acetate	108-65-6	**2 700**	275 000	270 000	
10-7	n-Butyl formiate	592-84-7	**2 000**			TRGS 900: 120 000 µg/m³ for methylformiate; conversion via molecular weight
10-8	Methyl methacrylate	80-62-6	**2 100**	205 000	210 000	
10-9	Other methacrylates		**2 100**			cf. methylmethacrylate
10-10	Isobutyl acetate	110-19-0	**4 800**			MAK-DFG: 480 000 µg/m³
10-11	1-Butyl acetate	123-86-4	**4 800**			MAK-DFG: 480 000 µg/m³
10-12*	2-Ethylhexyl acetate	103-09-3	**690**			cf. 2-ethyl-1-hexanol; conversion via molecular weight
10-13	Methyl acrylate	96-33-3	**180**	18 000	18 000	
10-14	Ethyl acrylate	140-88-5	**210**	21 000	21 000	
10-15	n-Butyl acrylate	141-32-2	**110**	11 000	11 000	
10-16	2-Ethylhexyl acrylate	103-11-7	**380**		38 000	
10-17	Other acrylates (acrylic acid ester)		**110**			cf. n-butyl acrylate
10-18*	Dimethyl adipate	627-93-0	**50**		8 000	Dicarbonic acid (C4-C6)-dimethylester, mixture MAK-DFG: 5 000 µg/m³ Individ. substance evaluation
10-19	Dibutyl fumarate	105-75-9	**50**			Individ. substance evaluation
10-20*	Dimethyl succinate	106-65-0	**50**		8 000	Dicarbonic acid (C4-C6)-dimethylester, mixture MAK-DFG: 5 000 µg/m³ Individ. substance evaluation
10-21*	Dimethyl glutarate	1119-40-0	**50**		8 000	Dicarbonic acid (C4-C6)-dimethylester, mixture MAK-DFG: 5 000 µg/m³ Individ. substance evaluation
10-22	Hexamethylene diacrylate	13048-33-4	**10**			WEEL (AIHA): 1 000 µg/m³
10-23	Maleic acid dibutylester	105-76-0	**50**			Individ. substance evaluation
10-24	Butyrolactone	96-48-0	**2 700**			Individ. substance evaluation
10-25	Dibutyl glutarate	71195-64-7	**100**			Individ. substance evaluation
10-26	Dibutyl succinate	925-06-4	**100**			Individ. substance evaluation
11. Chlorinated hydrocarbons						
	currently not occupied					
12. Others						
12-1	1,4-Dioxane	123-91-1	**73**	73 000	73 000	EU: Carc. 2
12-2	Caprolactam	105-60-2	**240**	10 000	5 000	Individ. substance evaluation
12-3	N-Methyl-2-pyrrolidone	872-50-4	**400**	40 000	82 000	EU: Repr. 1B Individ. substance evaluation
12-4	Octamethylcyclotetrasiloxane	556-67-2	**1 200**			EU: Repr. 2 Individ. substance evaluation
12-5	Hexamethylenetetramine	100-97-00	**30**			OEL Norway, Sweden: 3 000 µg/m³
12-6	2-Butanonoxime	96-29-7	**20**			EU: Carc. 2 Individ. substance evaluation
12-7	Tributyl phosphate	126-73-8				SVOC, EU: Carc. 2
12-8*	Triethyl phosphate	78-40-0	**75**			cf. tributyl phosphate (MAK-DFG: 11 000 µg/m³); conversion via molecular weight
12-9	5-Chloro-2-methyl-2H-isothiazol-3-one (CIT)	26172-554	**1**[#]			Individ. substance evaluation

	Substance	CAS No.	LCI [µg/m³]	EU OEL [µg/m³]	TRGS 900 [µg/m³]	Remarks[3)]
12-10	2-Methyl-4-isothiazoline-3-on (MIT)	2682-20-4	**100**			Individ. substance evaluation
12-11	Triethylamine	121-44-8	**42**	8 400	4 200	
12-12	Decamethylcyclopentasiloxane (D5)	541-02-6	**1 500**			cf. Octamethylcyclotetra-siloxane; conversion via molecular weight
12-13	Dodecamethylcyclohexa-siloxane (D6)	540-97-6	**1 200**			cf. Octamethylcyclotetra-siloxane; Individ. substance evaluation
12-14*	Tetrahydrofuran	109-99-9	**1 500**	150 000	150 000	
12-15*	Dimethylformamide	68-12-2	**15**			EU. Repr. 1B MAK-DFG: 15 000 µg/m³

*: new or altered in 2012

#: An evaluation within the framework of the LCI-concept will take place only at and above a measured concentration of 5 µg/m³.

VVOC very volatile organic compounds are not currently considered in the AgBB evaluation scheme.

1) The occupational exposure limit value for this substance, on which LCI derivation was based, has been annulled. The current LCI value will continue to apply until suitable data are available or a new OELV has been defined.

2) In order to maintain compatibility with the ADAM template, assigned numbers in the LCI list cannot be reassigned when a substance or a group of substances has been deleted or moved to another place.

3) In the LCI-list the classification of the substances with regard to their carcinogenic, mutagenic and reprotoxic properties is made according to the new GHS-system of the CLP- Regulation (EC) No 1272/2008, appendix VI, Table 3.1:
Category 1A in the GHS-system corresponds to category 1 in the Directive 67/548/EEC,
Category 1B in the GHS-system corresponds to category 2 in the Directive 67/548/EEC, and
Category 2 in the GHS-system corresponds to category 3 in the Directive 67/548/EEC.

Additional remarks:

I) **Links to lists of carcinogenic substances** of categories 1A and 1B according to the new GHS-system (or categories 1 and 2 according to the Directive 67/548/EEC). These substances are to be checked for in the AgBB-scheme and are severally evaluated.

- Institute for Occupational Safety and Health of the German Social Accident Insurance
  http://www.dguv.de/ifa/de/fac/kmr/index.jsp
- BAuA, Bundesanstalt für Arbeitsschutz und Arbeitsmedizin
  (Federal Institute for Occupational Safety and Health)
  http://www.baua.de/

II. **Data treatment**

A software tool (ADAM, AgBB-DIBt-Auswertemaske) has been developed for the collection and storage of emissions data and the calculation of the test result. This software can be obtained from the DIBt against payment of a nominal fee (contact DIBt, Ms. Semrau, Kolonnenstr. 30B, 10829 Berlin, phone +49(0)30 78730-353, fax +49(0)30 78730-11353).

III. **Analysis of aldehydes**

Determination of the emission of saturated and unsaturated aldehydes of Group 7 of the LCI list by gas chromatography poses problems in the concentration range of interest. For example, in the case of butanal and glutaric dialdehyde, the ratio of the limit of quantification and the LCI value is very small if the GC/MS method with Tenax thermodesorption (ISO 16000-6) is applied. In addition, sampling on Tenax is only suitable to a limited extent for quantitative determination of butanal, butenal and pentanal. Since butenal in particular, but also unsaturated aldehydes and glutaric dialdehyde have a very low LCI value, an analytical method with a particularly low limit of quantification (LOQ) has to be chosen for these substances. The DNPH method with HPLC analysis (ISO 16000-3) is well suited for this purpose due to a LOQ in the range of < 1µg/m^3 for the aldehydes contained in the LCI list.
Therefore, for quantitative determination of aldehydes, in particular butenal, pentenal, pentanal and glutaric aldehyde, the DNHP method should be used for sampling.
Use of the DNHP method enables the quantitative determination not only of aldehydes belonging to the class of VOC, but also of some VVOC such as butanal, acetone, formaldehyde and acetaldehyde. Although the determination of these compounds is not required in the AgBB evaluation scheme, it will generate additional information for product evaluation.

IV **Analysis of saturated aliphatic hydrocarbons (LCI 2-9 and LCI 2-10)**

Subdividing this group of compounds is necessary because of their different LCIs. It is based on the appearance of an “alkane hump” in the gas chromatogram at the retention time of n-nonane, i.e. an LCI of 15 000 applies to aliphatic hydrocarbons with a retention time shorter than that of n-nonane and an LCI of 6 000 to aliphatic hydrocarbons with a retention time equal to or exceeding that of n-nonane.

The allocation of individual peaks of saturated aliphatic hydrocarbons which cannot be identified exactly shall also be based on the retention time of n-nonane.