**Ausschuss zur gesundheitlichen Bewertung von Bauprodukten**

**Committee for Health-related Evaluation of Building Products**

**AgBB - 1st March 2008**
**Updated List of LCI values 2008 in Part 3**

Ausschuss zur gesundheitlichen Bewertung von Bauprodukten

Committee for Health-related Evaluation of Building Products

*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 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 16 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*)*[1] and by amendments to the building codes of the Federal States (Länder).

One of the objectives of the building codes of the Federal States (Länder) and of the European Construction Products Directive is to protect the building users' health. This general objective has been formally documented in the Interpretative Document – Essential Requirement N° 3 ("Hygiene, Health and Environment"; ER 3 for short) prepared by the European Commission, which explicitly mentions that indoor pollutants, e.g. volatile organic compounds (VOC), be avoided and controlled [EC, 1994].

The European Union has recognised the insufficient implementation of ER3 and issued a mandate to CEN for implementation of ER3. The mandate[2] provides for the development of horizontal assessment methods for dangerous substances in and their emission from, construction 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.

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*[3] *(Ausschuss für die gesundheitliche Bewertung von Bauprodukten,)* considers as one of its main tasks to establish 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 Construction Products Directive are satisfied, and an evaluation procedure will result which is as traceable and objective as possible.

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[1] Building Products Act (BauPG 1992): Act on marketing and free movement of building products to implement Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (Bauproduktengesetz – BauPG). Bundesgesetzblatt (Federal Law Gazette) I, No 39 of 14 August 1992, 1495-1501; amendment 1998: publication of the revision of the Building Products Act of 28 April 1988. Bundesgesetzblatt I, No 25 of 8 May 1998, 812-819.

[2] 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.

[3] 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, health and environmental protection - of the Building and Civil Engineering Standards Committee of the German Institute for Standardisation (DIN-KOA 03)

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 in calculating a sum parameter following the TVOC concept (TVOC = Total Volatile Organic Compounds), and semivolatile 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 Deutsches Institut für Bautechnik (DIBt) has incorporated the evaluation scheme into its approval guidelines for the health-related evaluation of building products [DIBt, 2004, 2007], and a revised scheme was presented [AgBB, 2005]. The present version takes new experience gained into account.

By adhering to the test values set in the scheme, the minimum requirements of the 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 for their products (with regard to VOC emissions) [ECA, 2005].

# 2 Health-related evaluation of VOC emissions from building products

The effects of indoor air pollution have been dealt with in a large number of publications (cf. e.g. [ECA, 1991b; Maroni et al., 1995; WHO, 2000; Doty, 2004; INDEX, 2005; Ad-hoc, 2007; Arif and Shah, 2007; Mendell, 2007]). 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, in the 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 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)[4] 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

Since VOC emission is often combined with odour perception, which may result in health impairment, sensory testing is an important element of the evaluation of building products. However, it has not yet been possible to integrate this aspect into the current evaluation of building products. Although many different odour measurement methods exist [Fischer et al., 1998; ECA, 1999], a harmonised and generally accepted procedure for odour assessment of building products is not yet available.

A research project completed in 2006 [UBA Texte, 2007] produced a method for sensory testing of building products on the basis of emission measurement in test chambers. This method, which is based on the assessment of odour intensity by a panel of trained persons with the aid of a standard of comparison, has proved its suitability and good reproducibility in a round robin test. Since the method is now generally accepted, it is currently undergoing international standardisation [ISO TC 146 / SC 6]. Once the method has been internationally harmonised and standardised and assessment limits have been defined for it, it may become a module of the AgBB evaluation scheme.

[4] 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 [DIN 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

To relate the results of test chamber measurements to realistic exposure situations a number of boundary conditions must be assumed. It is most important to consider a scenario that reflects exposure under practical conditions.

According to equation (1) the indoor air concentration C, for a surface-emission source depends on the area-specific emission 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.

$$C = \frac{E_a \times A}{n \times V} = E_a / q \ [\mu g/m^3] \qquad (1)$$

According to DIN 1946-6 [DIN 1998], for residential rooms, the outdoor air flow rate per square metre, i.e. the area-specific air exchange rate is between 1 and 1.5 $m^3$/(h $m^2$) depending on the actual living area. Taking the upper limit of this range and using equation (1), an air exchange rate of approx. 0.5 $h^{-1}$ is obtained for a room 2.7 m high and with a surface area of 3m x 4m. This value corresponds to the average encountered under practical conditions. Choosing these conditions for the chamber test of, e.g., flooring materials, the substance concentration measured in the test chamber corresponds approximately to that to be expected in such a room. However, differences due to potential sorption effects are not taken into account here.

## 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, 2007]). 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/m³ 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(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 DIN 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 DIN 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

- $\underline{TVOC_3}$

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 EU Directive 67/548/EEC 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) 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 or 2 [Directive 67/548/EEC] may exceed a concentration of 0.01 mg/m³ after 3 days.

- First sensory testing

For determining the equally important sensory properties it will be necessary to agree upon more precise details before an initial sensory test can be performed at this stage of the flow chart. Until an adequate test method is available, there is only a reference in the flow chart to the necessity of a sensory test.

### 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 DIN 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.

- Semivolatile 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[5].

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 [Directive 67/548/EEC] is tested again, with an emphasis on the long-term behaviour from the user's point of view. No carcinogen of categories 1 or 2 [Directive 67/548/EEC] may exceed the value of 0.001 mg/m³ after 28 days. .

- Second sensory testing

Until the test procedure has been agreed upon finally, the requirement for a second sensory test after 28 days is indicated. The reason for a second test is that chemical reactions may only occur within the product which may lead to odour or other sensory perception.

- Evaluation of individual substances

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[5] Emission of semivolatile 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 semivolatile organic compounds with an even lower volatility will encounter increasing difficulty if the method of Tenax sampling and thermodesorption is used in chamber tests.

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 4) 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.

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

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/m³ does not exceed 0.1 mg/m³. 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.

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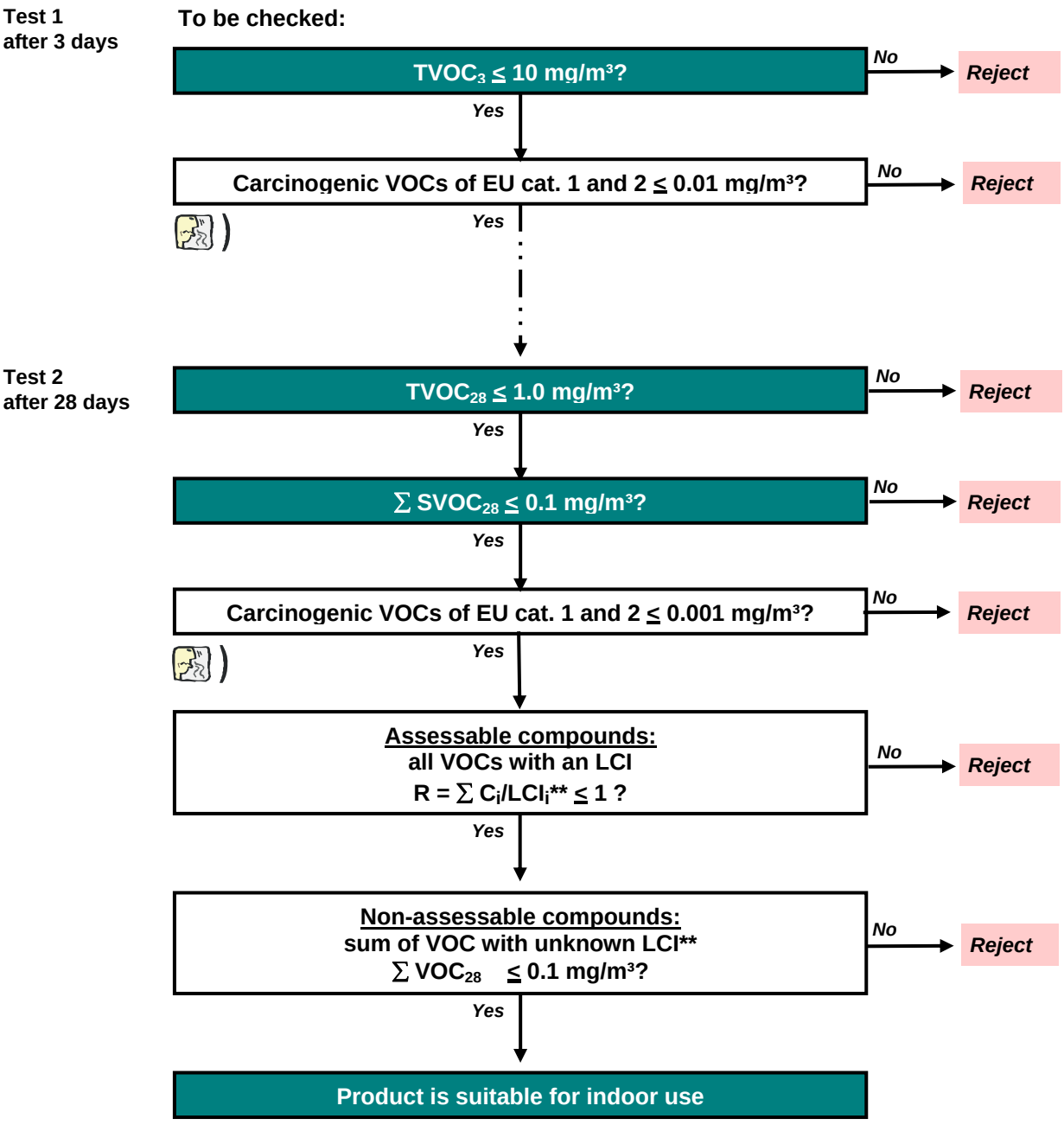
## Fig. 1: FLOW CHART FOR THE EVALUATION OF VOC* AND SVOC*EMISSIONS FROM BUILDING PRODUCTS

Ausschuss zur gesundheitLCIhen Bewertung von Bauprodukten

(Committee for Health-related Evaluation of Building Products)




) **Generally accepted methods for sensory tests expected to be performed at this stage have yet to be agreed upon.**

* **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**

**UBA II 1.3 - AgBB 2008**

# 6. Annex

## Establishing LCI values

### 1. Basic Considerations

Volatile organic compounds (VOC and SVOC) belong to the most common indoor air pollutants. Building products are important indoor sources of VOC and SVOC. German building law requires building products to satisfy certain health-related provisions with regard to their VOC/SVOC emissions in addition to technical criteria. This means that their emissions (technically speaking: their product- and material-specific emission factors in µg/m² h) 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 product loading factor, air exchange rate and indoor climate conditions). A procedure is presented here to derive substance-specific values for health-related evaluation of the emission from building products, the so-called LCI values (Lowest Concentration of Interest; cf. footnote 4).

Occupational exposure limit values (OELVs) have been defined for many substances present in workplace air in the form of gas, vapour or suspended particulate matter. These legally binding values are set at such a level that, according to current knowledge, even repeated and long-term exposure, for up to 8 hours a day within an average 40-hour working week, is generally not expected to adversely affect workers' health over their working lives. OELVs are updated continuously. They are published in *Technische Regeln für Gefahrstoffe:Arbeitsplatzgrenzwerte* [TRGS 900, 2004], and compliance with them is monitored. The German Research Foundation (DFG)'s Senate Commission for the investigation of health hazards of chemical compounds at the workplace derives and publishes maximum concentrations at the workplace (MAK-DFG values) for protection of health at work. These MAK-DFG values are usually adopted into TRGS 900. A working group of AgBB – complemented by manufacturers' specialists - deals with the establishment of LCI values and in doing so uses existing OELVs as a starting point, as proposed by an international expert group [ECA, 1997a]. The working group takes into account the following basic differences between conditions in general indoor spaces (such as 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 medicine (pregnant women, allergic persons),
- lack of exposure measurements and medical checks and, in principle, undefined overall indoor exposure.

On both objective and regulatory grounds, the LCI values for individual compounds are to be considered as calculation values used for the evaluation or certification of building products and not as indoor air limit values. Due to their origin the LCI values represent an adequate expression of the criteria required in building regulations to safeguard against health risk caused by VOC/SVOC mixtures bearing in mind that the emissions from building products into indoor air result in multi-compound mixtures.

## 2. Procedure

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

I. First, each individual substance is checked, whether it has been evaluated via TRGS 900 and/or an OEL (Occupational Exposure Limit) value by the European Commission. If this is the case, the lowest value is used to establish the LCI value.
II. If condition I is not met, relevant lists from other countries for evaluation of substances in workplace air are examined and the lowest scientifically plausible value used to establish an LCI value.
III. As a further option, a MAK value of the German Research Association (Deutsche Forschungsgemeinschaft, DFG) and/or a TLV® value of the American Conference of Governmental Industrial Hygienists (ACGIH) or a Workplace Environmental Exposure Limit (WEEL) of AIHA (American Industrial Hygiene Association) may be used.
IV. In case a substance cannot be evaluated using conditions I., II. or III., it is checked if an individual substance assessment can be performed, preferably by referring to a substance class with similar chemical structure and comparable toxicological assessment. The lowest LCI value for a substance within this assigned substance class is then used.
V. If a substance fails to meet any of the requirements in items I. to IV., it is then assigned in the scheme to the category of the substances ‘with unknown LCI value’, the so-called nonassessable compounds (see flow chart). Non-identified substances fall also into this category.

## 3. Calculation

Since different exposure times and different sensitivity should be considered for the general population in comparison to workplace conditions, the relevant OEL value is generally divided by 100 applying safety factors as defined elsewhere[ad-hoc-AG, 1996]). For potential carcinogenic substances of EU category 3 (Directive 67/548/EEC) the value is usually divided by 1000. Reprotoxic and mutagenic substances are evaluated on a case-by-case basis with regard to the additional factor. Substances with carcinogenic properties according to EU categories 1 and 2 (EU Directive 67/548/EEC) are considered separately (see main text for AgBB evaluation scheme).

## 4. Publication

The LCI values are exclusively determined by the AgBB committee together with experts of industrial and manufacturer associations and published in the list of LCI values. The current list of LCI values and brief notes on their origin are printed in Table 1. AgBB and manufacturers perform individual assessments for currently interesting substances regularly or if there is a need. The LCI list is a closed list which is revised and re-published approximately, depending on the needs, currently every year.

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.
For transparency in establishing LCI values, the published list of LCI values contains, as a minimum, the following data:

(1) Name(s) of substance
(2) CAS No.
(3) LCI value
(4) The value used for the derivation, with source and substance-related classifications
(5) Remarks that may provide additional information on the substance or the basis for the LCI setting procedure.

**References:**

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## Table 1

# List of LCI values

**Closing date : December 2008**

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| **1. Aromatic hydrocarbons** | | | | | | |
| 1-1 | Toluene | 108-88-3 | **1 900** | | 190 000 | EU: Repr. Cat. 3 |
| 1-2 | Ethyl benzene | 100-41-4 | **4 400** | | 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 | 250 000 | |
| 1-8 | n-Propyl benzene | 103-65-1 | **1 000** | | | cf. lowest LCI of saturated alkylbenzenes, e.g. No1-10 |
| 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 |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| 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 | |
| 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 | **50** | 50 000 | 50 000 | EU: Carc.Cat. 3 |
| 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 | 7 200 | | 720 000 | VVOC |
| 2-2 | n-Hexane | 110-54-3 | **72** | 72 000 | 180 000 | EU: Repr.Cat.3 |
| 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, up to C8 | | **15 000** | | 1 500 000 | |
| 2-10* | Other saturated hydrocarbons, C9 or higher | | **6 000** | | 600 000 | |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| **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 | 9 600 | | 960 000 | VVOC |
| 4-2 | 1-Propanol | 71-23-8 | 2 400 | | | VVOC; OEL-Norway: 45 000 µg/m³ |
| 4-3 | 2-Propanol | 67-63-0 | 5 000 | | 500 000 | VVOC |
| 4-4 | Tert-butanol, 2-methylpropanol-2 | 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<br>30899-19-5<br>94624-12-1<br>6032-29-7<br>548-02-1<br>137-32-6<br>123-51-3<br>598-75-4<br>75-85-4<br>75-84-3 | **730** | | | MAK-DFG: 73 000 µg/m³ (2007) |
| 4-8* | 1-Hexanol | 111-27-3 | **2 100** | | 210 000 | |
| 4-9 | Cyclohexanol | 108-93-0 | **1 100** | | 210 000 | |
| 4-10* | 2-Ethyl-1-hexanol | 104-76-7 | **2 700** | | 110 000 | |
| 4-11* | 1-Octanol | 111-87-5 | **1 100** | | 106 000 | |
| 4-12* | 4-Hydroxy-4-methyl-pentane-2-on (diacetone alcohol) | 123-42-2 | **960** | | 96 000 | |
| 4-13* | Other $C_4$ - $C_{10}$ saturated alcohols | | **1 100** | | | cf. 1-octanol and 2-ethyl-1-hexanol |
| **5. Aromatic alcohols** | | | | | | |
| 5-1* | Phenol | 108-95-2 | **10** | 7 800 | 7 800 | Evaluation as individual substance EU: Mut. Cat. 3 (29 ATP) |
| 5-2 | BHT (2,6-di-tert-butyl-4-methylphenol) | 128-37-0 | **100** | | 10 E | 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 | **320** | | | cf. ethanediol; conversion via molecular weight |
| 6-2 | Ethanediol | 107-21-1 | **260** | 52 000 | 26 000 | |
| 6-3 | Ethylene glycol-monobutylether | 111-76-2 | **980** | 98 000 | 98 000 | |
| 6-4 | Diethylene glycol | 111-46-6 | **440** | | 44 000 | |
| 6-5* | Diethylene glycol- | 112-34-5 | **670** | 67 500 | | MAK-DFG: 67 000 µg/m³ |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| | monobutylether | | | | | (2007) |
| 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 propanol-2 | 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** | | | Evaluation as individual substance |
| 6-10 | Butyl glycolate | 7397-62-8 | **550** | | | cf. glycolic acid, metabolite of ethane-1,2-diol; conversion via molecular weight |
| 6-11* | Diethylene glycol monomethyl ether acetate | 124-17-4 | **850** | | | MAK-DFG: 85 000 µg/m³ (2007) |
| 6-12 | Dipropylene glycol monomethyl ether | 34590-94-8 | **3 100** | | 310 000 | |
| 6-13* | 2-Methoxyethanol | 109-86-4 | **16** | | | EU: Repr.Cat. 2; |
| 6-14 | 2-Ethoxyethanol | 110-80-5 | **19** | | | EU: Repr.Cat. 2; |
| 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 | **20** | | | EU. Repr.Cat. 2; cf. 2-methoxy-ethanol (metabolite methoxyacetic acid); conversion via molecular weight |
| 6-19 | 1,2-Diethoxyethane | 73506-93-1 | **25** | | | cf. 2-ethoxyethanol (metabolite ethoxyacetic acid); conversion via molecular weight |
| 6-20 | 2-Methoxyethyl acetate | 110-49-6 | **25** | | | EU: Repr.Cat. 2; |
| 6-21 | 2-Ethoxyethyl acetate | 111-15-9 | **27** | | | EU: Repr.Cat. 2; |
| 6-22 | 2-Butoxyethyl acetate | 112-07-2 | **1300** | | | |
| 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** | | | EU: Repr.Cat. 2; |
| 6-25 | 2-Methoxy-1-propanol | 1589-47-5 | **19** | | | EU: Repr.Cat. 2; |
| 6-26 | 2-Methoxy-1-propyl acetate | 70657-70-4 | **28** | | | EU: Repr.Cat. 2; |
| 6-27 | Propylene glycol diacetate | 623-84-7 | **670** | | | cf. propylene glycol; conversion via molecular weight |
| 6-28* | Dipropylene glycol | 110-98-5<br>25265-71-8 | **2 000** | | - | MAK-DFG: 200 000 µg/m³ (2007) |
| 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 |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| 6-31* | Dipropylene glycol-mono-n-butylether | 29911-28-2<br>35884-42-5 | **810** | | | cf. diethylene glycol-monobutyl ether; conversion via molecular weight |
| 6-32* | Dipropylene glycol-mono-t-butylether | 132739-31-2<br>(Mixture) | **810** | | | cf. diethylene glycol-monobutyl ether; conversion via molecular weight |
| 6-33 | 1,4-Butandiol | 110-63-4 | **2000** | | 200000 | |
| 6-34 | Tripropylene glycol-monomethyl ether | 20324-33-8<br>25498-49-1 | **1000** | | | Individ. substance evaluation |
| 6-35* | Triethylene glycol-dimethyl ether | 112-49-2 | **37** | | | EU: Repr. Cat. 2;<br>cf. 2-methoxy-ethanol (metabolite methoxyacetic acid); conversion via molecular weight |
| 6-36 | 1.2.-Propylene glycol-dimethyl ether | 7778-85-0 | **25** | | | cf. 1,2-dimethoxy-ethane and 2-methoxy-1-propanol; 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 ethers | 63019-84-1<br>89399-28-0<br>111109-77-4 | **1 300** | | 35 000 | |
| **7. Aldehydes** | | | | | | |
| 7-1 | Butanal | 123-72-8 | 640 | | 64 000 | 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<br>123-73-9<br>15798-64-8 | **1** | | | EU: Mut.Cat.3 [1)] |
| 7-10 | 2-Pentenal | 1576-87-0<br>764-39-6<br>31424-04-1 | **12** | | | cf. 2-butenal, but no EU classification as mutagen; conversion via molecular weight |
| 7-11 | 2-Hexenal | 16635-54-4<br>6728-26-3<br>505-57-7<br>1335-39-3 | **14** | | | cf. 2-pentenal; conversion via molecular weight |
| 7-12 | 2-Heptenal | 2463-63-0<br>18829-55-5<br>29381-66-6 | **16** | | | cf. 2-pentenal; conversion via molecular weight |
| 7-13 | 2-Octenal | 2363-89-5<br>25447-69-2<br>20664-46-4<br>2548-87-0 | **18** | | | cf. 2-pentenal; conversion via molecular weight |
| 7-14 | 2-Nonenal | 2463-53-8<br>30551-15-6<br>18829-56-6<br>60784-31-8 | **20** | | | cf. 2-pentenal; conversion via molecular weight |
| 7-15 | 2-Decenal | 3913-71-1<br>2497-25-8 | **22** | | | cf. 2-pentenal; conversion via molecular weight |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| | | 3913-81-3 | | | | |
| 7-16 | 2-Undecenal | 2463-77-6<br>53448-07-0 | **24** | | | cf. 2-pentenal; conversion via molecular weight |
| 7-17 | Furfural | 98-01-1 | **20** | | | Individ. substance evaluation EU: Carc.Cat.3 |
| 7-18* | Glutardialdehyde | 111-30-8 | **2** | | | |
| 7-19 | Benzaldehyde | 100-52-7 | **90** | | | WEEL (AIHA): 8 800 µg/m$^3$ |
| 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/m$^3$ |
| 8-3 | Methylisobutylketone | 108-10-1 | **830** | | 83 000 | |
| 8-4* | Cyclopentanone | 120-92-3 | **900** | | | OEL Denmark: 90 000 µg/m$^3$ |
| 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/m$^3$ |
| 8-8 | Acetophenone | 98-86-2 | **490** | | | TLV (ACGIH): 49 000 µg/m³ |
| 8-9 | 1-Hydroxyacetone<br>(2 Propanone, 1-hydroxy-) | 116-09-6 | **300** | | | 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 | **500** | 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.Cat. 3;<br>TLV (ACGIH): 5 000 µg/m$^3$ |
| **10. Esters and Lactones** | | | | | | |
| 10-1 | Methyl acetate | 79-20-9 | | | | VVOC |
| 10-2 | Ethyl acetate | 141-78-6 | | | | VVOC |
| 10-3 | Vinyl acetate | 108-05-4 | | | | VVOC;<br>EU: Carc.Cat.3 |
| 10-4 | Isopropyl acetate | 108-21-4 | **4 200** | | | OEL Finland, MAK-DFG: 420 000 µg/m$^3$ (2007) |
| 10-5 | Propyl acetate | 109-60-4 | **4 200** | | | OEL Finland, MAK-DFG: 420 000 µg/m$^3$ (2007) |
| 10-6 | 2-Methoxy-1-methylethyl | 108-65-6 | **2 700** | 275 000 | 270 000 | |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| | acetate | | | | | |
| 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** | | 210 000 | |
| 10-9 | Other methacrylates | | **2 100** | | | cf. methylmethacrylate |
| 10-10 | Isobutyl acetate | 110-19-0 | **4 800** | | | MAK-DFG: 480 000 µg/m$^3$ (2007) |
| 10-11 | 1-Butyl acetate | 123-86-4 | **4 800** | | | MAK-DFG: 480 000 µg/m$^3$ (2007) |
| 10-12* | 2-Ethylhexyl acetate | 103-09-3 | **1 400** | | | cf. 2-ethyl-1-hexanol; ; conversion via molecular weight |
| 10-13 | Methyl acrylate | 96-33-3 | **180** | | 18 000 | |
| 10-14 | Ethyl acrylate | 140-88-5 | **210** | | 21 000 | |
| 10-15 | n-Butyl acrylate | 141-32-2 | **110** | 11 000 | 11 000 | |
| 10-16 | 2-Ethylhexyl acrylate | 103-11-7 | **820** | | 82 000 | |
| 10-17 | Other acrylates (acrylic acid ester) | | **110** | | | cf. n-butyl acrylate |
| 10-18 | Dimethyl adipate | 627-93-0 | **7 300** | | | cf. methanol (metabolite, TRGS 900: 270 000 µg/m$^3$) conversion via molecular weight |
| 10-19 | Dibutyl fumarate | 105-75-9 | **4 800** | | | cf. butanol (metabolite), conversion via molecular weight |
| 10-20 | Dimethyl succinate | 106-65-0 | **6 200** | | | cf. methanol (metabolite, TRGS 900: 270 000 µg/m$^3$) conversion via molecular weight |
| 10-21 | Dimethyl glutarate | 1119-40-0 | **6 800** | | | cf. methanol (metabolite, TRGS 900: 270 000 µg/m$^3$) conversion via molecular weight |
| 10-22 | Hexamethylene diacrylate | 13048-33-4 | **10** | | | WEEL (AIHA): 1 000 µg/m³ |
| 10-23* | Maleic acid dibutylester | 105-76-0 | **190** | | | Individ. substance evaluation |
| 10-24 | Butyrolactone | 96-48-0 | **2 700** | | | Individ. substance evaluation |
| **11. Chlorinated hydrocarbons** | | | | | | |
| 11-1* | Tetrachloroethene | 127-18-4 | **70** | | | EU: Carc.Cat.3 OELs Denmark, Finland, Sweden : 70 000 µg/m$^3$ |
| **12. Others** | | | | | | |
| 12-1 | 1.4-Dioxan | 123-91-1 | **73** | | 73 000 | EU: Carc.Cat.3 |
| 12-2* | Caprolactam | 105-60-2 | **240** | 10 000 | 5 000 | Individ. substance evaluation |
| 12-3* | N-methyl-2-pyrrolidon | 872-50-4 | **820** | | 82 000 | |
| 12-4 | Octamethylcyclotetra-siloxane | 556-67-2 | **1 200** | | | EU: Repr.Cat.3 Individ. substance evaluation |
| 12-5 | Hexamethylenetetramine | 100-97-00 | **30** | | | OELs Norway/Sweden: 3 000 µg/m³, |
| 12-6 | -2-Butanonoxime | 96-29-7 | **20** | | | EU: Carc.Cat.3 Individ. substance evaluation |
| 12-7 | Tributyl phosphate | 126-73-8 | **25** | | | EU: Carc. Cat.; 3 OELs Denmark, France: 2 500 µg/m$^3$; TLV (ACGIH): 2 200 µf/m$^3$ |
| 12-8 | Triethyl phosphate | 78-40-0 | **25** | | | cf. tributyl phosphate |

| | Substance | CAS No. | LCI [µg/m³] | EU OEL** [µg/m³]** | TRGS 900** [µg/m³]** | Remarks** |
|---|---|---|---|---|---|---|
| 12-9* | 5-Chloro-2-methyl-2H-isothiazol-3-one (CIT) | 26172-554 | **1** | | | Individ. substance evaluation |
| 12_10* | 2-Methyl-4-isothiazoline-3-on (MIT) | 2682-20-4 | **100** | | | Individ. substance evaluation |
| 12-11* | Triethylamine | 121-44-8 | **42** | | 4,200 | |

*: new or altered in 2005
** for better comparison, concentration values are given in micrograms per cubic meter
VVOC in the list are marked by grey shading. They 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.

Additional remarks:

**I)** **Links to lists of carcinogenic substances** of categories 1 and 2 according to Directive 67/548/EEC:

- **BGIA**, Berufsgenossenschaftliches Institut für Arbeitsschutz (BG-Institute for Occupational Safety ) http://www.hvbg.de/d/bia/fac/kmr
- **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. Gerloff, Kolonnenstr. 30L, 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 (DIN 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 (DIN 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.