ARBEITSGEMEINSCHAFT
ÖKOLOGISCHER
FORSCHUNGSINSTITUTE e.V.
Association of Ecological Research Institutes e.V.

AGÖF Guidance Values for Volatile Organic Compounds in Indoor Air

28 November 2013 Edition

1 Introduction

In Germany, an Ad Hoc Working Group[1] has issued indoor air guideline values since 1993. These are toxicologically based values for individual chemical compounds or compound groups. These guideline values can be used to assess indoor air testing results in terms of their relevance to health. After having published hardly more than 10 such guideline values until 2007, now a total of 36 guideline values for volatile organic compounds have been released until June 2013.[2] For the majority of compounds measurable in indoor air, however, the uncertainty of evaluation remains.

For the assessment of indoor air contaminants, the Ad Hoc Working Group suggests a ranking scheme, whereby toxicologically derived guideline values and preliminary statistical estimates are applied to individual compounds and the TVOC. Statistically derived parameters should be updated as timely as possible to reflect the current spectrum of compounds in a given indoor space.[3]

Based on their decades-long testing experience, the members of the Association of Ecological Research Institutes (AGÖF) have developed a knowledge base about the presence of VOCs and health and odor problems associated with them. To assist in the assessment of indoor air measurements, statistically derived attention values were determined for indoor air; and for the first time in 2004, they were presented to peers in Germany as the AGÖF Guidance Values.[4] The guidance values allow classifying testing results according to their statistical probability; consequently, their relevance can also be weighted when searching for causes of health complaints. However, it is not possible to use the guidance values for evaluating a specific health risk.

The publication attracted great interest and formed the basis of a Federal Environment Agency-supported AGÖF research project with the title “Provision of a Database for the Presence of Volatile Organic Compounds in Indoor Air”.[5] From the results of this research project, AGÖF presented a revised edition of its guidance values for over 150 volatile compounds in the fall of 2007 and also

---

[1] “Ad-hoc-Arbeitsgruppe [Ad Hoc Working Group]” with experts from the „Innenraumlufthygiene-Kommission (IRK) [Indoor Air Hygiene Commission]“ of the Federal Environment Agency and the Indoor Air Working Group of the Environmental Health Committee of the „Arbeitsgemeinschaft der Obersten Landesgesundheitsbehörden (AOLG) [Working Group of the State-Level Health Authorities]“

[2] http://www.umweltbundesamt.de/gesundheit/innenraumhygiene/richtwerte-irluft.htm

[3] Working Group of UBA and AGLMB (2007): Beurteilung von Innenraumluftkontaminationen mittels Referenz- und Richtwerten [Assessment of indoor air contaminations through reference and guideline values]. Bundesgesundheitsblatt 7, p. 990-1005

[4] AGÖF (2004): AGÖF-Orientierungswerte für Inhaltsstoffe von Raumluft und Hausstaub [AGÖF guidance values for constituents of indoor air and house dust]. 7th Expert Conference at Munich. p. 24-39

[5] Hofmann H, Plieninger P (2008): Bereitstellung einer Datenbank zum Vorkommen von flüchtigen organischen Verbindungen in der Innenraumluft [Provision of a Database for the Presence of Volatile Organic Compounds in Indoor Air]. WaBoLu-Hefte 05/08 Umweltbundesamt, Dessau-Roßlau Available at: http://www.umweltbundesamt.de/publikationen/bereitstellung-einer-datenbank-vorkommen-von

Energie- und Umweltzentrum 1 * 31832 Springe-Eldagsen
Tel.: 05044/ 97575 * Fax: 05044/ 97577
Email: info@agoef.de * Internet: www.agoef.de

made them available on the AGÖF home page. In addition to statistical parameters such as sampling size, the 50th and 90th percentile, the very detailed table also provided the guidance value. It is this guidance value that indicates the threshold, above which the indoor air concentration of a compound must be considered a problem based on statistical significance or toxicological knowledge.

Ever since experts, consultants, and others have frequently used the guidance values, which quickly have become an effective tool for assessing the hygienic quality of indoor air.

In 2012 another AGÖF research project[6], which again was financially supported by the Federal Environment Agency, was launched to update the AGÖF Guidance Values. The update includes statistical data from 4846 data sets, which had been collected by AGÖF institutes as part of their routine assessments between 2006 and 2012.

2 Exposure Assessment of Indoor Air Pollutants

For the assessment of volatile organic compounds (VOC)[7], there are mainly two types of assessment guidelines that have gained relevance:

- Toxicologically derived assessment concepts
- Statistically derived assessment concepts.

It should be noted here that there are also pragmatic or precaution-based assessment concepts such as the ALARA principle[8], which, among others, is used in radiation safety or even for setting exposure limits for pesticides in drinking water based on the limit of quantification.

Assessment concepts are based on conventions, which are meant to reflect a scientific sociopolitical consensus.

Toxicologically derived assessments result in guideline values that are meant to answer health-related questions. In experiments, laboratory animals are exposed to different concentration levels of a compound in order to find the concentration level, at which observable effects are not triggered. An alternative approach to the development of guideline values is based on the observations from occupational studies, in which employees are exposed to relatively high concentrations. In order to evaluate the effects of low-emission indoor exposures in susceptible population groups (infants, sick people), so-called uncertainty factors are applied. A detailed discussion about how the guideline values of the so-called Ad-hoc-AG [Ad Hoc Working Group] were derived was published in 1996.[9]

With a toxicological approach, it remains open to what extent nonspecific health symptoms such as headaches, concentration problems, etc. can be recognized in animal experiments or investigations of laboratory workplaces. The health problems that are most frequently mentioned in the context of indoor air problems are nonspecific symptoms. Furthermore, indoor air usually contains compound mixtures that cannot be evaluated by toxicological reasoning alone. The definition of uncertainty factors, e.g. a factor of one hundred, cannot be justified anymore by toxicological reasoning and is based on conventions. The rather high cost of generating toxicological data is an important reason why there are only such a small number of guideline values available. This approach is not adequate for establishing verified assessments for the myriad of chemical compounds occurring in indoor air. However, it is an important tool for answering questions regarding threats to public health.

In the statistically derived assessment concept, reference values are developed. From a large number of representative investigations, a “usual, average” level of indoor air pollutants is established and

---

[6] UFOPLAN Project FKZ 3709 62 211: Zielkonflikt energieeffiziente Bauweise und gute Raumluftqualität - Datenerhebung für flüchtige organische Verbindungen in der Raumluft von Wohn- und Bürogebäuden (Lösungswege) [Conflict of Goals between Energy-efficient Buildings and Good Indoor Air Quality Data Collection of Volatile Organic Compounds in Indoor Air of Residential and Office Buildings (solution-based strategies)], not yet published

[7] In this document, the AGÖF uses a somewhat extended definition of VOC; all chemical compounds that can be identified with the analytical procedures listed in chapter 3 are in first approximation defined as volatile, regardless whether according to WHO conventions they would more likely be regarded as “very volatile”, “volatile,” or “semivolatile.”

[8] ALARA = As Low As Reasonable Achievable

[9] Ad hoc Working Group of UBA and AGLMB (1996): Richtwerte für die Innenraumluft: Basisschema [Indoor air guideline values: basic scheme]. Bundesgesundheitsblatt 39, p. 422-426

defined as “normal.” In many cases, the so-called 90th or 95th percentile is chosen as the concentration threshold, whereby any value exceeding the latter indicates an unusual exposure.[10] [11] [12]

Based on the available frequency distribution, AGÖF sets the 90th percentile of the measurement values for event-specific data as the upper reference value because this can be interpreted as the upper limit of the background level deemed as safe.[13]

With regard to new chemical compounds or compound groups released into indoor air, no reference values will be available at first. In the event of an increased application of known compound groups due to a change in production (e.g. when solvents in paints were replaced), established reference values can also consistently be exceeded. Updating the reference values on a regular basis can counteract both occurrences.

Toxicologically and statistically derived concepts need to respond to a changing environment. New medical and toxicological knowledge helps keep the toxicological approach up to date. In case of the statistically derived values, changes in VOC concentrations in indoor air, which are associated with new product formulas and consumer habits, need to be tested.

A complete and user-specific assessment of indoor air problems needs to rely on both concepts. Only by considering statistical relationships as well as toxicological data, health risks can be weighted and the sources of indoor air problems identified. Odor problems, however, are not satisfactorily addressed by either one of the two concepts.

From testing experiences, it is known that, depending on the problem and situation, both assessment guidelines are important and need to be utilized by the professional indoor air consultant with different weighting strategies. Additional guidelines or assessment tools such as the TVOC concept, information on odors and the consultant’s personal experience complement both. It is the consultant’s responsibility to apply and weight the various assessment guidelines and to present his or her reasoning in a clear and comprehensible manner in a report.

The reasons why indoor air is tested for volatile organic compounds can often vary greatly, and sometimes the given problems can be intricately complex. Therefore, it is also an important task of the consultant to first define the scope of the assessment in consultation with the client and, based on this definition, to then coordinate the necessary measurement and assessment strategy.

The published AGÖF Guidance Values below support consultants in their work. On the one hand, they represent an up-to-date compendium of statistical reference values, and beyond that, they also show toxicologically relevant guideline values of other authors. Thus they contribute to promoting preventive healthcare.

3 Data Collection and the Procedure of How AGÖF Guidance Values Are Established

The currently available guidance values are based on an updated database from the years 2006 through 2012, which was generated as part of the research project “Conflict of Goals between Energy-efficient Buildings and Good Indoor Air Quality - Data Collection of Volatile Organic Compounds in

[10] Solberg HE (1987) International Federation of Clinical Chemistry (IFCC), Scientific Committee, Clinical Section, Expert Panel on Theory of Reference Values. Approved recommendation (1986) on the theory of reference values. Part 1. The concept of reference values. J Clin Chem Clin Biochem 25, p. 336-42

[11] Hauptverband der gewerblichen Berufsgenossenschaften (Ed.) (2005): Innenraumarbeitsplätze - Vorgehensempfehlung für die Ermittlungen zum Arbeitsumfeld [Indoor workplaces - Precautionary recommendations for the investigations of work environments]

[12] Neumann HD, Buxtrup M, Weber M et al. (2012): Vorschlag zur Ableitung von Innenraumarbeitsplatz-Referenzwerten in Schulen [Recommendation for adjusting indoor workplace reference values for use in school environments]. Gefahrstoffe – Reinhaltung der Luft 72, p. 291-297
Available at http://www.dguv.de/medien/ifa/de/pub/grl/pdf/2012_106.pdf

[13] LABO (BUND-LÄNDER-ARBEITSGEMEINSCHAFT BODENSCHUTZ) (2003): Hintergrundwerte für anorganische und organische Stoffe in Böden [Background levels of inorganic and organic compounds in soils]. Beschlussfassung der 33. StäA4-Sitzung 29./30.1.2003. - 58 p. Quoted according to LfU Bayern (Bavarian Environment Agency). 2013. Was sind Hintergrundwerte genau [What exactly are background levels] – Available at http://www.lfu.bayern.de/boden/hintergrundwerte/index.htm

Indoor Air of Residential and Office Buildings (solution-based strategies)]." Sample taking procedures and methods will only be summarized here. For more detailed information, see the project reports.[14]

For sample taking, the procedures set out in the VDI Guideline 4300 Sheet 1 and Sheet 6 were followed, most of which were adopted into DIN EN ISO 16000. In general, samples were taken after a space had not been ventilated for a minimum of eight hours because this type of sample taking leads to the most reproducible results. Active sampling techniques were used to collect air samples. In addition to thermal desorption techniques, methods based on solvent desorption (activated carbon or Anasorb) with the corresponding set of two samples for analyzing compounds with different polarity were also permitted for identification. In the analysis of the desorbent compounds, mostly gas chromatography with a mass-selective detector was used, but in some cases flame ionization and electron capture detectors were also used.

In addition, data on aldehyde and ketone concentrations were also collected, samples were taken with impingers (formaldehyde) and DNPH-based methods and analyses were performed (desorption with acetonitrile, analysis based on high-pressure liquid chromatography with UV detector), as well as flame retardant concentrations from the adsorption on PU foam and GC/MS analysis.

For the detection of low molecular alkanoic acids, Tenax is not the optimal adsorption medium. Due to their high polarity, false low readings must be assumed. It is, therefore, recommended to use special procedures such as derivatization/GC/MS or ion chromatography. However, we do not have sufficient measurement results yet for these procedures to be able to set any reference values.

To ensure quality of the various analytical methods, the participants of the research project conducted comparative laboratory measurements[15] over the past years.

The list of AGÖF Guidance Values contains more than 300 individual compounds. It also includes compounds that go beyond the TVOC range (C_6 to C_{16}), but which were detected with the above-mentioned methods and are relevant to the assessment. In contrast, compounds and compound groups that have their own analytical method and require considerably lower limits of quantification such as additional phenols, chlorophenols, MVOCs, and PAHs were not included because they would require separate assessments.

For each compound, the statistical parameters of sampling size (n), 50th percentile (P 50), and 90th percentile (P 90) are listed with reference to the findings of the most current AGÖF research project. The parameters were derived by considering concentrations below the limit of quantification with the imputed one-half of the limit of quantification. Should the value calculated in this way fall below the limit of quantification, the corresponding percentile value of the limit of quantification is given with the sign "<".

In addition to the statistically derived percentiles, guidance values are only provided for those compounds for which a sufficiently large number of reliable measurement values were available. The guidance values were rounded (less than 10 with 2 significant figures and from 10 only whole numbers). When both the normal value and the attention value were below the limit of quantification, no guidance value was set.

For numerous compounds, the normal value and the attention value were below the limit of quantification. Detecting those compounds above the limit of quantification may already indicate an unusual level. Even compounds whose indoor air concentrations were in most cases below the limit of quantification may in selected cases reach high or assessment-relevant levels.

In most cases, the AGÖF guidance values correspond with the attention value and thus with the 90th percentile. The statistical analysis of the AGÖF data show that the 95th percentile is more heavily influenced by the random nature of a given measurement situation.

The guidance values for the parameters formaldehyde and TVOC were lowered in relation to their attention value because in event-specific measurements targeted at individual parameters (individual compound or a sum total value, respectively) concentrations are higher than when measuring individual compounds as part of screenings.

---

[14] Available at http://www.umweltbundesamt.de/publikationen/bereitstellung-einer-datenbank-vorkommen-von, final report of the second project is not yet available

[15] http://www.agoef.de/agoef/oewerte/agoef_laborvergleichsmessung2006_07.html

The statistical analysis of the TVOC value corresponds with the TVOC value that is determined for the retention range of n-hexane to n-hexadecane by taking the sum of compound-specific quantifiable bonds and additional bonds via toluene equivalents.

The list below should not be misunderstood as if all listed compounds would have to be tested for at all times. For each situation, the consultant will have to make a suitable selection, which may include selected individual compounds from this AGÖF list but also additional compounds not listed here. Even if the quantification of a large number of compounds is desirable in many cases, the number of compounds is not the only crucial factor. It is very important that procedures are used that can detect relevant and potential exposure levels beyond the known or compound-specific, quantifiable spectrum of compounds, respectively.

4 Assessment of Odorous Compounds

As part of the research project,[16] the major reasons for indoor air investigations were identified (see Figure 1). Odors, health complaints, and suspicions of exposure are the most frequently named reasons for indoor air investigations. A noticeable or unpleasant odor is the reason for 26% of the indoor air investigations conducted by AGÖF institutes. In addition to other not further specified reasons, 15% of the measurements are carried out as final measurements prior to release or acceptance of a new or restored building.

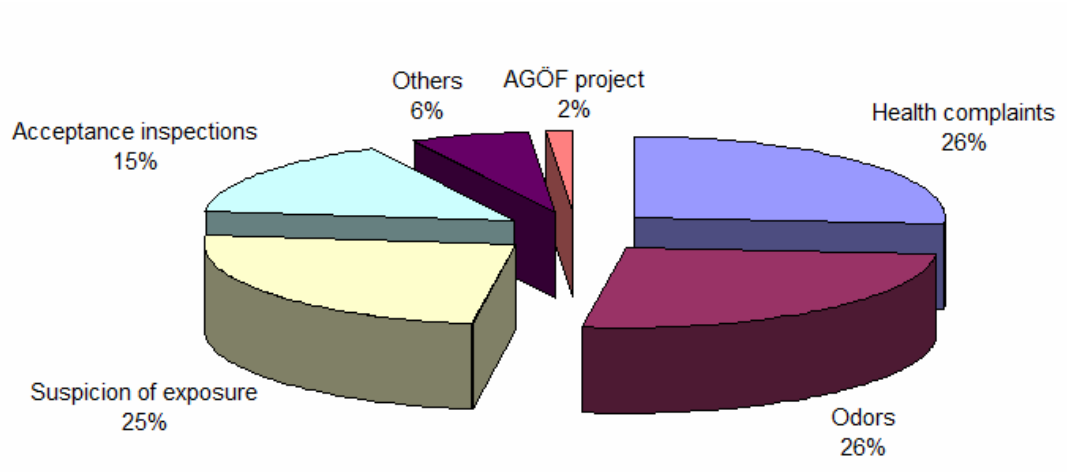

Figure 1: Reasons for Indoor Air Investigations 2006-2012 (n=6624)

This high percentage of odor-related investigations shows that the measurement and assessment of odors in indoor spaces has great priority.

In contrast to volatile organic compounds, however, there are no proven chemical-analytical testing methods for odors in indoor spaces. For the assessment of odors, concepts based on individual compounds are often not sufficient. It is, therefore, important to fall back on other procedures such as establishing odor values or sensory procedures.

Even though it is possible to chemically analyze some odors in indoor air with sufficient detection sensitivity, common odors are often caused by a complex mixture of several sometimes hundreds of

[16] UFOPLAN Project FKZ 3709 62 211: Zielkonflikt energieeffiziente Bauweise und gute Raumluftqualität - Datenerhebung für flüchtige organische Verbindungen in der Raumluft von Wohn- und Bürogebäuden (Lösungswege) [Conflict of Goals between Energy-efficient Buildings and Good Indoor Air Quality Data Collection of Volatile Organic Compounds in Indoor Air of Residential and Office Buildings (solution-based strategies)], not yet published

individual compounds. Many of these compounds can already be perceived at concentrations of only a few nanograms per cubic meter of air, but analytically they are hardly detectable. When assessments are based on odor thresholds, it is important to consider that aromatic compounds interact with each other in mixtures. Interactions such as synergisms can have a substantial impact on the odor characteristics of compound mixtures.

The quality of existing odor threshold levels varies. Alongside up-to-date odor threshold levels established by well-documented procedures, there are also rather old odor threshold levels in the literature that were established by incompatible methods. For many indoor air pollutants, we lack the data of their odor threshold levels. In many cases, it is also unclear whether the provided data refers to the odor threshold or the odor detection threshold level. Therefore, the chemical analysis of odor-intensive compounds in indoor air is often not sufficient to fully capture and expertly assess odor problems. The AGÖF is convinced that it is very important to establish odor threshold values for additional compounds. The pollutant exposure profile of indoor air is subject to constant changes and for many volatile organic compounds that have only been recently detected in indoor air very little information is available. The List of AGÖF Guidance Values reflects the currently available exposure profile of indoor air conditions and thus is also very well suited as a priority list for identifying odor threshold levels.

In many cases, VOC measurements are not sufficient for clarifying odor problems in indoor spaces. Since odor nuisances often occur at very low concentration levels and can be caused by the interaction of different compounds, their detection through physical-chemical measurement procedures is extremely costly or simply impossible. Therefore, it may prove necessary to include olfactory-sensory procedures. Sensory methods that use the human nose as a measurement instrument can detect odors at sufficiently low levels. However, the same compound at the exact same level is perceived differently by different individuals. Furthermore, odor perceptions are interpreted in the brain and, based on past experience, are assessed differently by different individuals. For an objective measurement, therefore, it is important to ensure that the range of odor perception levels among the inspectors corresponds with the odor threshold distribution in the population. For more information, see the AGÖF Guideline “Odors in Indoor Spaces - Sensory Detection and Assessment".[17]

5 Explanatory Notes for the List of AGÖF Guidance Values VOC

Column 1: Name of chemical compound

Column 2: CAS number

Column 3: Number n

It provides the number of data values the statistical analysis is based on.

Column 4: Normal value P 50

The normal value represents the “average” exposure situation in a given group. It is equivalent to the 50th percentile. Even indoor air concentrations within the normal-value range are usually the result of one or several emission sources, but in general, it is not considered sufficient evidence for an urgent call to action to minimize the exposure.

Column 5: Attention value P 90

The attention value refers to the 90th percentile value. It shows that common indoor air concentrations are exceeded and thus indicates that a respective emission source must exist.

Column 6: AGÖF guidance value

The guidance value is equivalent to the rounded attention value or the toxicologically derived values, provided that the latter are below the attention value.

It is the opinion of the AGÖF that whenever a guidance value is reached or exceeded, it should be checked whether additional preventive actions are called for to minimize VOC exposures even further. Its relevance to health and the necessity for remediation should also be reviewed. The extent and

[17] http://agoef.de/agoef/oewerte/agoef_geruchsleitfaden.html

procedure of the testing must as far as possible be left to the expert's judgment. In addition to the local conditions during testing, there should also be attention paid to the fact that:

a) Procedural uncertainties exist for VOC measurements. Additional information on this topic can be learnt from the round robin tests and comparative measurements conducted by the AGÖF;

b) Fluctuations in indoor VOC concentrations are to be expected as a function of climatic conditions and users' habits;

c) Depending on the emission source, a reduction of the exposure may follow an attenuation pattern.

Column 7: Notes

In this column, relevant notes are provided on additional assessment guidelines for individual compounds or compound groups such as toxicological reference values (GV II and GV I) of the so-called Ad-hoc-AG and additional reference values of other agencies or individual authors. Notes regarding compound characteristics, which may be relevant to the assessment, are also included.

The AGÖF is dedicated to up-to-date information; when in doubt, however, the up-to-dateness of a given guideline value should be checked at the link listed or the original paper, respectively.

6 AGÖF List of Guidance Values VOC

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Aliphatic Hydrocarbons						
n-Hexane	110-54-3	3598	1.8	8.0	**8.0**	
2-Methylpentane	107-83-5	1734	1.0	7.0	**7.0**	
3-Methylpentane	96-14-0	1753	1.0	4.0	**4.0**	
n-Heptane	142-82-5	3624	2.0	9.0	**9.0**	
2-Methylhexane	591-76-4	1196	1.0	4.0	**4.0**	
3-Methylhexane	589-34-4	1832	1.0	6.3	**6.3**	
2,3-Dimethylpentane	565-59-3	750	<1	4.4	**4.4**	
n-Octane	111-65-9	3616	1.0	5.0	**5.0**	
2-Methylheptane	592-27-8	738	<1	1.2	**1.2**	
3-Methylheptane	589-81-1	706	<1	1.3	**1.3**	
2,2,4-Trimethylpentane (Isooctane)	540-84-1	2952	<1	1.0	**1.0**	
n-Nonane	111-84-2	3626	<1	5.0	**5.0**	Ad-hoc-AG: Sum total of aliphatics C9-C14 GV I = 0.2 mg/m³; GV II = 2 mg/m³
2,3-Dimethylheptane	3074-71-3	1123	<1	<1		
n-Decane	124-18-5	3627	1.0	11.0	**11**	
n-Undecane	1120-21-4	3624	2.0	14.0	**14**	
n-Dodecane	112-40-3	3625	1.0	9.0	**9.0**	
2,2,4,6,6-Pentamethylheptane	13475-82-6	2943	<1	4.8	**4.8**	
n-Tridecane	629-50-5	3624	1.0	5.0	**5.0**	
n-Tetradecane	629-59-4	3626	1.0	4.0	**4.0**	
n-Pentadecane	629-62-9	3622	1.0	3.0	**3.0**	
n-Hexadecane	544-76-3	3615	1.0	2.0	**2.0**	
2,2,4,4,6,8,8-Heptamethylnonane	4390-04-9	2826	<1	1.0	**1.0**	
n-Heptadecane	629-78-7	2292	<1	2.0	**2.0**	

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
n-Octadecane	593-45-3	2276	<1	1.0	**1.0**	
n-Nonadecane	629-92-5	2279	<1	<1		
n-Eicosane	112-95-8	2233	<1	<1		
n-Heneicosane	629-94-7	1186	<1	<1		
n-Docosane	629-97-0	1185	<1	<1		
Cycloalkanes						
Cyclopentane	287-92-3	965	<1	4.0	**4.0**	
Cyclohexane	110-82-7	3606	1.0	9.0	**9.0**	BWG: pGV I = 400µg/m³; pGV II = 4000µg/m³
Methylcyclopentane	96-37-7	3633	<1	3.0	**3.0**	
Methylcyclohexane	108-87-2	3642	<1	4.0	**4.0**	
Dimethylcyclohexane	589-90-2	791	<1	<1		
trans-Decahydronaphthalene	493-02-7	986	<1	1.0	**1.0**	
Decalin	91-17-8	640	<2	2.7	**2.7**	
Alkenes						
1-Heptene	592-76-7	1109	<1	2.0	**2.0**	
1-Octene	111-66-0	3438	<1.5	<2		
1-Nonene	124-11-8	1849	<2	<2		
1-Decene	872-05-9	3440	<1.5	<2		
1-Undecene	821-95-4	1828	<1.5	<2		
1-Dodecene	112-41-4	1207	<2	<2		
1-Tridecene	2437-56-1	1141	<2	<2		
1-Propene, 2-methyl-, trimer (Triisobutylene)	7756-94-7	2970	<1	<1.5		
Cyclohexene	110-83-8	964	<1	<1.5		
4-Vinylcyclohexene	100-40-3	2961	<1	<1		
4-Phenylcyclohexene	4994-16-5	3584	<1	<1		

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Aromatic Hydrocarbons						
Benzene	71-43-2	3647	1.0	3.0	**3.0**	Carcinogen (Category 1A) 39. BImSchV: limit values for ambient air: 5 µg/m³ WHO: “no safe level”
Toluene	108-88-3	3664	7.0	30.0	**30**	Ad-hoc-AG: GV I = 0.3 mg/m³; GV II = 3 mg/m³ BWG: Sum total of C1-C4 alkylbenzenes pGV I = 300 µg/m³; pGV II = 3000 µg/m³. BMLFUW: WIR = 75 µg/m³ WHO: GV = 260 µg/m³ (toxicity), GV = 1,000 µg/m³ (odor)
Ethylbenzene	100-41-4	3652	1.0	10.0	**10**	Ad-hoc-AG: GV I = 0.2 mg/m³; GV II = 2 mg/m³ BWG: Sum total of C1-C4 alkylbenzenes pGV I = 300 µg/m³; pGV II = 3000 µg/m³
m,p-Xylene	1330-20-7	3650	3.0	29.0	**29**	BWG: Sum total of C1-C4 alkylbenzenes pGV I = 300 µg/m³; pGV II = 3000 µg/m³
o-Xylene	95-47-6	3643	1.0	9.0	**9.0**	
n-Propylbenzene	103-65-1	3639	<1	2.1	**2.1**	Ad-hoc-AG: Sum total of C9-C15 alkylbenzenes: GV I = 0.1 mg/m³; GV II = 1 mg/m³ BWG: Sum total of C1-C4 alkylbenzenes: pGV I = 300 µg/m³; pGV II = 3000 µg/m³
1-Methylethylbenzene (Cumene)	98-82-8	3635	<1	1.0	**1.0**	
2-Methylethylbenzene (2-Ethyltoluene)	611-14-3	3608	<1	3.0	**3.0**	
3-Methylethylbenzene (3-Ethyltoluene)	620-14-4	1826	1.0	6.7	**6.7**	
4-Methylethylbenzene (4-Ethyltoluene)	622-96-8	1815	<1	3.0	**3.0**	
3/4-Ethyltoluene	620-14-4/622-96-8	1195	1.0	5.0	**5.0**	
1,2,3-Trimethylbenzene (Hemimellitene)	526-73-8	3607	<1	2.6	**2.6**	
1,2,4-Trimethylbenzene (Pseudocumene)	95-63-6	3639	1.0	10.9	**11**	
1,3,5-Trimethylbenzene (Mesitylene)	108-67-8	3640	<1	3.0	**3.0**	
n-Butylbenzene	104-51-8	2462	<1	<1		

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
1,2,4,5-Tetramethylbenzene (Durene)	95-93-2	2842	<1	<1		Ad-hoc-AG: Sum total of C9-C15 alkylbenzenes: GV I = 0.1 mg/m³; GV II = 1 mg/m³ BWG: Sum total of C1-C4 alkylbenzenes: pGV I = 300 µg/m³; pGV II = 3000 µg/m³
1,2,3,5-Tetramethylbenzene (Isodurene)	527-53-7	1704	<1	<1		
o-Cymene	527-84-4	1125	<1	<1		
m-Cymene	535-77-3	1125	<1	1.0	**1.0**	
p-Cymene	99-87-6	3618	<1	2.0	**2.0**	
1,3-Dimethyl-5-ethylbenzene	934-74-7	940	<1	1.0	**1.0**	
1,3-Diisopropylbenzene	99-62-7	1380	<1	<1		Ad-hoc-AG: Sum total of C9-C15 alkylbenzenes: GV I = 0.1 mg/m³; GV II = 1 mg/m³
1,4-Diisopropylbenzene	100-18-5	1380	<1	<1		
1,3-/1,4-Diisopropylbenzene	99-62-7 /100-18-5	1074	<1	<1		
n-Octylbenzene (Phenyloctane)	2189-60-8	615	<1	<1		
Styrene	100-42-5	3652	1.0	12.0	**12**	Ad-hoc-AG: GV I =0.03 mg/m³; GV II = 0.3 mg/m³ BMLFUW: WIR = 40 µg/m³ WHO: GV = 260 µg/m³ (toxicity). GV = 30 µg/m³ (odors)
Methylstyrene	98-83-9	1453	<1	<3		
2-Vinyltoluene (o-Vinyltoluene)	611-15-4	964	<1	<1		
3-Vinyltoluene	100-80-1	964	<1	<1		
4-Vinyltoluene	622-97-9	964	<1	<1		
Vinyltoluene	25013-15-4	615	<1	<1		
Phenylacetylene	536-74-3	1579	<1	<1		
Phenol	108-95-2	2598	<1	3.0	**3.0**	Ad-hoc-AG: GV I = 0.02 mg/m³; GV II = 0.2 mg/m³
2-Cresol (o-Cresol)	95-48-7	465	<1	<1		Ad-hoc-AG: Sum total of cresols: GV I = 0.005 mg/m³; GV II = 0.05 mg/m³
m-,p-Cresol	108-39-4/106-44-5	464	<1	<1		
2,6-Di-tert-butyl-4-methylphenol (Butylated hydroxytoluene BHT)	128-37-0	2641	<1	<1		
Naphthalene	91-20-3	3619	<1	1.2	**1.2** [NB 1]	Carcinogen (K2) Ad-hoc-AG: GV I = 0.01mg/m³; GV II = 0.03mg/m³ WHO: maximum annual average concentration 0.01 mg/m³ BUI: Sum total of PAHs including toxicity factors

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
1-Methylnaphthalene	90-12-0	1124	<0.1	<1		Ad-hoc-AG: Sum total of bicyclic and tricyclic hydrocarbons: (p)GV I = 0.01 mg/m³; (p)GV II = 0.03 mg/m³
2-Methylnaphthalene	91-57-6	1124	<0.1	<1		
Diisopropylnaphthalene	38640-62-9	1166	1.0	3.0	**3.0**	
1,2,3,4-Tetrahydronaphthalene	119-64-2	1231	<0.1	<1		
Indene	95-13-6	619	<1	<1		
Indan	496-11-7	2204	<1	1.0	**1.0**	
Halocarbons						
Trichloromethane	67-66-3	1155	<1	<1		
Carbon tetrachloride	56-23-5	1863	<1	<1.5		
1,2-Ethylene dichloride	107-06-2	2061	<1	<1		
Epichlorohydrin	106-89-8	1187	<1	<1		
1,1,1-Trichloroethane (Methylchloroform)	71-55-6	3614	<1	<1		
Trichloroethylene	79-01-6	2501	<1	<1		Carcinogen (Category 1B) WHO: “no safe level“
Tetrachloroethylene (Perchloroethylene)	127-18-4	3615	<1	<1		2. BImSchV: 0.1 mg/m³ WHO: GV = 250µg/m³ BMLFUW: WIR = 250 µg/m³
cis-1,2-Dichloroethylene	156-59-2	1102	<1	<1		
Chlorobenzene	108-90-7	1099	<1	<1		
1,2-Dichlorobenzene	95-50-1	2718	<1	<1		
1,3-Dichlorobenzene	541-73-1	2713	<1	<1		
1,4-Dichlorobenzene	106-46-7	3548	<1	<1		
1-Chloronaphthalene	90-13-1	1972	<1	<1		
2-Chloronaphthalene	91-58-7	1281	<1	<1		
1,4-Dichloronaphthalene	1825-31-6	1134	<1	<1		
1,5-Dichloronaphthalene	1825-30-5	961	<1	<1		
1,3-Dichloro-2-propanol	96-23-1	1826	<1	<1		

Chemical Compound (Synonym)	CAS	n	Normal Value P 50 [in µg/m³]	Attention Value P 90 [in µg/m³]	Guidance Value [in µg/m³]	Notes (see chapter 6.1)
Alcohols						
1-Propanol	71-23-8	1086	<1	18.0	**18**	
2-Propanol (Isopropyl alcohol)	67-63-0	1835	20.0	91.4	**91**	
1-Butanol	71-36-3	3556	8.0	35.0	**35**	
2-Methyl-1-propanol (Isobutyl alcohol)	78-83-1	3393	1.0	10.0	**10**	
t-Butyl alcohol	75-65-0	627	<1	<1		
1-Pentanol (Amyl alcohol)	71-41-0	2459	<1	5.4	**5.4**	
2-Pentanol	6032-29-7	203	0.4	<1		
3-Methyl-1-butanol (Isoamyl alcohol)	123-51-3	849	<1.5	<1.5		
1-Hexanol	111-27-3	2455	<1	1.0	**1.0**	
1-Heptanol	111-70-6	1759	<1	<1		
1-Octanol	111-87-5	1936	<1	<1		
2-Ethylhexanol (2-Ethyl-1-hexyl alcohol)	104-76-7	3592	3.0	13.0	**13**	Ad-hoc-AG: GV I = 0.1 mg/m³; pGV II = 1 mg/m³
1-Nonanol	143-08-8	1759	<1	<1		
1-Decanol	112-30-1	2397	<1	<1.5		
Cyclohexanol	108-93-0	617	<1	<1		
1-Octen-3-ol	3391-86-4	792	<0.4	0.5	**0.5**	
Benzyl alcohol	100-51-6	3311	<1	4.6	**4.6**	Ad-hoc-AG: GV I = 0.4 mg/m³; GV II = 4 mg/m³
Diacetone alcohol	123-42-2	632	<1	<1		
Terpenes						
alpha-Pinene	80-56-8	3591	4.0	68.0	**68**	Ad-hoc-AG: Sum total of bicyclic terpenes GV I = 0.2 mg/m³; GV II = 2 mg/m³
beta-Pinene	127-91-3	3593	1.0	8.7	**8.7**	
3-Carene ((+-)-delta3-Carene)	13466-78-9	3574	1.0	25.9	**26**	
Limonene	138-86-3	3648	4.0	23.0	**23**	Ad-hoc-AG: Sum total of monocyclic terpenes GV I = 1 mg/m³; GV II = 10 mg/m³

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Linalool (beta-Linalool)	78-70-6	2709	<1	<1		
Camphor	76-22-2	2854	<1	<1.5		Ad-hoc-AG: Sum total of bicyclic terpenes GV I = 0.2 mg/m³; GV II = 2 mg/m³
Camphene	79-92-5	2320	<1	2.1	**2.1**	
Eucalyptol	470-82-6	2859	<1	<2		Ad-hoc-AG: Sum total of monocyclic terpenes GV I = 1 mg/m³; GV II = 10 mg/m³
Racementhol (Menthol)	89-78-1	1756	<1	<1		
alpha-Terpinene	99-86-5	3312	<1	<1.5		Ad-hoc-AG: Sum total of monocyclic terpenes GV I = 1 mg/m³; GV II = 10 mg/m³
gamma-Terpinene	99-85-4	712	<1.5	<1.5		
Longicyclene	1137-12-8	651	<1	<1		
Borneol	507-70-0	2134	<1	<1		Ad-hoc-AG: Sum total of bicyclic terpenes GV I = 0.2 mg/m³; GV II = 2 mg/m³
Isolongifolene	1135-66-6	2218	<1	<1.5		
Longifolene	475-20-7	3437	<1	2.0	**2.0**	
Levoverbenone	1196-01-6	2122	<1	<1		Ad-hoc-AG: Sum total of bicyclic terpenes GV I = 0.2 mg/m³; GV II = 2 mg/m³
Caryophyllene (beta-Caryophyllene)	87-44-5	1750	<1	<1.5		
Citronellol	106-22-9	1607	<1	<2		
Myrcene	123-35-3	1383	<1	2.0	**2.0**	
alpha-Phellandrene	99-83-2	416	<1	<1		
(6Z)-beta-Farnesene	28973-97-9	416	<1	<1		
alpha-Longipinene	5989-08-2	416	<1	<1		
alpha-Terpineol	98-55-5	988	<1	1.0	**1.0**	
Aldehydes						
Formaldehyde	50-00-0	2035	35.0	81.0	**30*** [NB 2,3]	Carcinogen (Category 2) [NB 4] BGA: 0.1 ppm (≡ 120 µg/m³) Sagunski: pGV I = 0.03 mg/m³; pGV II = 0.1 mg/m³ [NB 3] WHO: Maximum guideline value of 0.1 mg/m³ as a 30-minute average * Under user conditions

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Acetaldehyde	75-07-0	911	20.0	54.0	**54**	Ad-hoc-AG: GV I = 0.1 mg/m³; GV II = 1 mg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
Propionaldehyde (Propanal)	123-38-6	891	4.0	14.0	**14**	BWG: vGV I = 20 µg/m³ BWG: Sum total of C3-C6 alkanals: pGV I = 100 µg/m³; pGV II = 1000 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
Butyraldehyde (Butanal)	123-72-8	2948	2.0	10.0	**10**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ BWG: pGV I = 10 µg/m³ BWG: Sum total of C3-C6 alkanals: pGV I =100 µg/m³; pGV II = 1000 µg/m³ B.A.U.CH. (b): GV = 44 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
Pentanal (Valeraldehyde)	110-62-3	3698	4.0	20.3	**20**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ BWG: Sum total of C3-C6 alkanals: pGV I =100 µg/m³; pGV II = 1000 µg/m³ B.A.U.CH. (b): GV = 53 µg/m³ B.A.U.CH. (b): Sum total of n-aldehydes C2-C10 GV = 60 ppb
3-Methyl-1-butanal (Isovaleraldehyde)	590-86-3	360	<1	<3		Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³ ; GV II = 2 mg/m³
n-Hexanal (Capronaldehyde)	66-25-1	3725	11.0	55.0	**55**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ BWG: pGV I = 20 µg/m³ BWG: Sum total of C3-C6 alkanals: pGV I = 100 µg/m³; pGV II = 1000 µg/m³ B.A.U.CH. (b): GV = 61 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
2-Ethylhexaldehyde	123-05-7	2313	<1	<2		Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³
n-Heptanal (Heptanal)	111-71-7	3632	2.0	6.7	**6.7**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ B.A.U.CH. (b): GV = 70 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60ppb

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
n-Octanal (Caprylic aldehyde)	124-13-0	3630	2.0	8.0	**8.0**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ B.A.U.CH. (b): GV =79 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
n-Nonanal (Pelargonic aldehyde)	124-19-6	3637	6.0	19.0	**19**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ B.A.U.CH. (b): GV =87 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
n-Decanal (Caprinic aldehyde)	112-31-2	3622	2.0	7.0	**7.0**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³ B.A.U.CH. (b): GV =96 µg/m³ B.A.U.CH. (b): Sum total of C2-C10 n-aldehydes GV = 60 ppb
Undecanal	112-44-7	2013	<1	1.0	**1.0**	Ad-hoc-AG: Sum total of saturated acyclic aliphatic alkanals C4-C11: GV I = 0.1 mg/m³; GV II = 2 mg/m³
n-Dodecanal (Lauryl aldehyde)	112-54-9	1139	<1	1.0	**1.0**	
Benzaldehyde	100-52-7	3684	4.0	15.0	**15**	Ad-hoc-AG: GV I = 0.02 mg/m³; GV II = 0.2 mg/m³
4-Methylbenzaldehyde	104-87-0	505	<1	<1.3		
Cuminaldehyde	122-03-2	978	<1	<1		
Methacrolein (Methacrylic aldehyde)	78-85-3	601	<1	< 3		
2-Butenal (Crotonic aldehyde)	4170-30-3	1313	<1	<2		
trans-2-Pentenal	1576-87-0	693	<1	<1		
2-Hexenal	505-57-7	693	<1	<1		
2-Heptenal	2463-63-0	702	<1	<1		
2-Octenal	2363-89-5	693	<1	<1		
2-Nonenal	2463-53-8	694	<1	1.0	**1.0**	
2-Decenal	3913-71-1	693	<1	<1		
2-Undecenal	2463-77-6	693	<1	<1		
Acrolein	107-02-8	774	<5	<5		
Glutaral	111-30-8	761	<1	<3		

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
2-Furaldehyde (Furfural)	98-01-1	1611	1.0	4.0	**4.0**	Ad-hoc-AG: GV I = 0.01 mg/m³; GV II = 0.1 mg/m³
5-Methyl-2-furfural	620-02-0	288	<1	<4		
Ketones						
Acetone	67-64-1	606	42.0	161.0	**161**	
2-Butanone (Methyl ethyl ketone MEK)	78-93-3	3740	4.1	33.4	**33**	
Methyl propyl ketone	107-87-9	250	<2	<3		
2-Hexanone (Methyl butyl ketone MBK)	591-78-6	1892	<1	1.0	**1.0**	
3-Methyl-2-butanone (Methyl isopropyl ketone MIPK)	563-80-4	865	<1	<3		
4-Methyl-2-pentanone (Methyl isobutyl ketone MIBK)	108-10-1	3642	<1	4.0	**4.0**	Ad-hoc-AG: GV I = 0.1 mg/m³; GV II = 1 mg/m³
Diisobutyl ketone	108-83-8	1681	<1	<2		
2-Heptanone (Methyl pentyl ketone)	110-43-0	1957	<1	1.9	**1.9**	
3-Heptanone (Ethyl-n-butyl ketone)	106-35-4	2411	<1	2.0	**2.0**	
3-Octanone (Ethyl pentyl ketone)	106-68-3	851	<0.5	<0.5		
2,4-Dimethyl-3-pentanone (Diisopropyl ketone)	565-80-0	643	<1.5	<1.5		
Cyclopentanone	120-92-3	621	<1	<1		
Cyclohexanone	108-94-1	3697	1.0	5.0	**5.0**	
2-Methylcyclopentanone	1120-72-5	618	<1	<1		
2-Methylcyclohexanone	583-60-8	617	<1	<1		
3,3,5-Trimethyl-2-cyclohexen-1-one (Isophorone)	78-59-1	239	<1	<2		
Acetophenone (Methyl phenyl ketone)	98-86-2	3409	1.3	4.0	**4.0**	
Benzophenone	119-61-9	1032	<1	<1		
Hydroxyaceton (Acetone alcohol or acetol)	116-09-6	617	<1	<1		

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Esters of Monohydric and Dihydric Alcohols						
Formic acid, butyl ester (n-Butyl formate)	592-84-7	2847	<1	1.0	**1.0**	
Methyl acetate	79-20-9	2029	1.0	6.0	**6.0**	
Ethyl acetate	141-78-6	3636	3.0	22.9	**23**	
Vinyl acetate	108-05-4	1008	<1	<1		
n-Propyl acetate	109-60-4	2466	<1	<2		
Isopropyl acetate	108-21-4	2474	<1	<1.5		
n-Butyl acetate	123-86-4	3596	2.0	26.6	**27**	
Isobutyl acetate	110-19-0	3613	<1	<2		
n-Amyl acetate	628-63-7	1616	<1	<2		
Isoamyl acetate	123-92-2	639	<2	<2		
1-Butanol, 3-methoxy-, 1-acetate (3-Methoxybutyl acetate *or* Butoxyl)	4435-53-4	1775	<1	<1		
n-Hexyl acetate	142-92-7	976	<1	<1		
2-Ethylhexyl acetate	103-09-3	619	<1	<1		
Isopropyl myristate	110-27-0	887	<1	<1		
4-tert-Butylcyclohexyl acetate	32210-23-4	966	<1	<1		
Benzoic acid, methyl ester (Methyl benzoate)	93-58-3	1224	<1	<1		
Acrylic acid, methyl ester (Methyl acrylate)	96-33-3	1807	<1	<1		
Acrylic acid, ethyl ester (Ethyl acrylate)	140-88-5	1752	<1	<1		
Acrylic acid, butyl ester (n-Butyl acrylate)	141-32-2	1807	<1	<1		
2-Ethylhexyl acrylate	103-11-7	806	<1	<1		
1,6-Hexanediol diacrylate	13048-33-4	1587	<1	<1		
Methacrylic acid, methyl ester (Methyl methacrylate)	80-62-6	3619	<1	<1.5		BWG: pGV I = 100 µg/m³; pGV II = 1000 µg/m³
N-Butyl methacrylate	97-88-1	621	<1	<1		

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Bornyl acetate	76-49-3	1712	<1	<1.5		
Butyl glycolate	7397-62-8	615	<1	<1		
Ethylenglykole mono methyl ether acetate (EGMEA, 2-Methoxyethanol acetate)	110-49-6	3474	<1	<1.5		Ad-hoc-AG: "Default" - GV I = 0.005ml/m³; "Default"- GV II = 0.05 ml/m³
Ethylene glycol monoethyl ether acetate (EGEEA, 2-Ethoxyethyl acetate)	111-15-9	3519	<1	<2		Ad-hoc-AG: GV I = 0.2 mg/m³; GV II = 2 mg/m³
Ethylene glycol monobutyl ether acetate (EGBEA, 2-Butoxyethyl acetate)	112-07-2	3565	<1	<1		Ad-hoc-AG: pGV I = 0.2 mg/m³; pGV II = 2 mg/m³
Diethylene glycol diacetate	628-68-2	975	<1	<1		Ad-hoc-AG: "Default" - GV I = 0.005 ml/m³; "Default" - GV II = 0.05 ml/m³
Propylene glycol diacetate	623-84-7	618	<1	<1		
Propylene glycol mono methyl ether acetate (PGMEA, 1-Methoxy-2-propanol acetate)	108-65-6	3472	1.0	7.8	**7.8**	
Ethoxypropyl acetate	98516-30-4	1721	<1	<1.5		
Propanol, (2-methoxymethylethoxy)-, acetate (Propanol, 1(or 2)-(2-methoxymethylethoxy)-, acetate)	88917-22-0	2267	<1	<1.5		Ad-hoc-AG: "Default" - GV I = 0.005 ml/m³; "Default" - GV II = 0.05 ml/m³
Diethyleneglycol monobutyl ether acetate (Butyl carbitol acetate)	124-17-4	3509	<1	<1.5		
Ethyl 3-ethoxypropionate	763-69-9	644	<2	<2		
2,2,4-trimethyl-1,3-pentanediol diisobutyrate (TXIB)	6846-50-0	2921	<1	3.0	**3.0**	BWG: pGV W II = 1000 µg/m³
Texanol	25265-77-4	3535	<1	2.0	**2.0**	
Dimethyl succinate	106-65-0	2582	<1	<3		
Dimethyl glutarate	1119-40-0	2582	<1	<2.5		
Dimethyl adipate (Hexanedioic acid, dimethyl ester)	627-93-0	2584	<1	<2		
Diisobutyl succinate	925-06-4	855	<2	<2		
Diisobutyl glutarate	71195-64-7	898	<2	<2		
Diisobutyl adipate	141-04-8	1606	<1	<2		
Dibutyl maleate	105-76-0	2840	<1	<2		
Diisobutyl maleate	14234-82-3	628	<1	<1		
Dibutyl fumarate	105-75-9	615	<1	<1		
Dimethyl phthalate	131-11-3	3422	<1	<2		

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Diethyl Phthalate	84-66-2	2198	<1	1.8	**1.8**	
Dibutyl phthalate	84-74-2	2180	<2	<7		
Diisobutyl phthalate	84-69-5	2186	<2	<7		B.A.U.CH. (c): 2.8 µg/m³
1,3-Dioxolan-2-one	96-49-1	619	<1	<1		
Diethyl carbonate	105-58-8	963	<1	<1		
Polyhydric Alcohols and Their Ethers (Glycols and Ethers)						
Ethylene glycol	107-21-1	2745	<1	<6		
Propylene glycol (1,2-Propylene glycol)	57-55-6	3562	2.0	14.4	**14**	
1,4-Butanediol	110-63-4	618	<1	<1		
Hexylene glycol	107-41-5	1244	<5	<5		
Diethylene glycol	111-46-6	1759	<5	<10		
Dipropylene glycol	25265-71-8	729	<1	<5		
Tripropylene glycol	24800-44-0	1224	<1	<3		
Ethylene glycol monomethyl ether (2-Methoxyethanol, Methyl cellosolve)	109-86-4	3486	<3	<5		B.A.U.CH. (a): GV = 30 µg/m³ B.A.U.CH. (a): Summary assessment of different glycol derivatives Ad-hoc-AG: GV I = 0.02 mg/m³; GV II = 0.2 mg/m³
Ethylene glycol monoethyl ether (2-Ethoxyethanol)	110-80-5	3531	<1	<2.5		B.A.U.CH. (a): GV = 90 µg/m³ B.A.U.CH. (a): Summary assessment of different glycol derivatives Ad-hoc-AG: GV I = 0.1 mg/m³; GV II = 1 mg/m³
Ethylene glycol monobutyl ether (n-Butoxyethanol)	111-76-2	3550	1.9	13.4	**13**	B.A.U.CH. (a): GV = 120µg/m³ B.A.U.CH. (a): Summary assessment of different glycol derivatives Ad-hoc-AG: GV I = 0.1 mg/m³; GV II = 1 mg/m³
Ethylene glycol monophenyl ether (2-Phenoxyethanol)	122-99-6	3547	1.0	5.0	**5.0**	B.A.U.CH. (d): GV = 300 µg/m³ (toxicity); GV = 100 µg/m³ (odor) Ad-hoc-AG: "Default" - GV I = 0.005 ml/m³; "Default" - GV II = 0.05 ml/m³
Diethylene glycol monomethyl ether (2-(2-Methoxyethoxy)ethanol, Methoxydiglycol)	111-77-3	2900	<5	<5		Ad-hoc-AG: (p)GV I = 2 mg/m³ ; (p)GV II = 6 mg/m³

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Diethylene glycol monoethyl ether (2-(2-Ethoxyethoxy)ethanol, Ethoxydiglycol)	111-90-0	3361	<1	<7		Ad-hoc-AG: GV I = 0.7 mg/m³; GV II = 2 mg/m³
Diethylene glycol mono-n-butyl ether (2-(2-Butoxyethoxy)ethanol, Butyl diglycol)	112-34-5	3540	<2	8.0	**8.0**	Ad-hoc-AG: (p)GV I = 0.4 mg/m³; (p)GV II = 1 mg/m³
1-Methoxy-2-hydroxypropane (PGME, 1-Methoxy-2-propanol)	107-98-2	3548	2.0	14.0	**14**	Ad-hoc-AG: GV I = 1 mg/m³; GV II = 10 mg/m³
3-Methoxybutanol	2517-43-3	826	<1.5	1.5	**1.5**	
1-Ethoxy-2-propanol	1569-02-4	1715	<2	<2		Ad-hoc-AG: GV I = 0.3 mg/m³; GV II = 3 mg/m³
1-Propoxy-2-propanol	1569-01-3	749	<1	<1		Ad-hoc-AG: "Default" - GV I = 0.005 ml/m³; "Default"- GV II = 0.05 ml/m³
1-Butoxy-2-propanol (1,2-Propylene glycol monobutyl ether)	5131-66-8	2904	<1	3.0	**3.0**	
1-Phenoxypropan-2-ol (Propylene phenoxetol)	770-35-4	2009	<1	<2		
Dipropylene glycol monomethyl ether	34590-94-8	2871	<1	7.0	**7.0**	Ad-hoc-AG: (p)GV I = 2 mg/m³ ; (p)GV II = 7 mg/m³
Dipropylene glycol monobutyl ether (2-Propanol, 1-(2-butoxy-1-methylethoxy)-)	29911-28-2	3526	<1	3.0	**3.0**	Ad-hoc-AG: "Default" - GV I = 0.005ml/m³; "Default"- GV II = 0.05ml/m³
Tripropylene glycol n-butyl ether (Propanol, (2-(2-butoxymethylethoxy) methylethoxy)-)	55934-93-5	2900	<1	<4		
Ethylene glycol dimethyl ether (DME) (1,2-Dimethoxyethane)	110-71-4	1679	<1	<1		Ad-hoc-AG: "Default" - GV I = 0.005ml/m³; "Default"- GV II = 0.05ml/m³
Ethylene glycol diethyl ether	629-14-1	1636	<1	<1		
Diethylene glycol dimethyl ether	111-96-6	1693	<1	<1		Ad-hoc-AG: GV I = 0.03 mg/m³; GV II = 0.3 mg/m³
Dipropylene glycol monopropyl ether (2-Propanol, 1-(1-methyl-2-propoxyethoxy) or 1-(1-Methyl-2-propoxyethoxy)propan-2-ol)	29911-27-1	1295	<2	<2		Ad-hoc-AG: "Default" - GV I = 0.005ml/m³; "Default" - GV II = 0.05 ml/m³
Dipropylene glycol dimethyl ether	111109-77-4	1098	<1.5	<1.5		
Triethylene glycol monobutyl ether	143-22-6	1118	<1	<1		
Diethylene glycol diethyl ether	112-36-7	1076	<1	<1		
Diethylene glycol dibutyl ether	112-73-2	1614	<1	<2.5		
Triethylene glycol dimethyl ether (Triglyme)	112-49-2	1255	<2	<2		Ad-hoc-AG: "Default" - GV I = 0.00ml/m³; "Default" - GV II = 0.0ml/m³
Diethylene glycol hexyl ether	112-59-4	1591	<1	<1		
Ethylene glycol monohexyl ether (2-Hexoxyethanol)	112-25-4	1592	<1	<1		Ad-hoc-AG: GV I = 0.1 mg/m³; GV II = 1 mg/m³

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Dipropylene glycol mono-tert-butyl ether	132739-31-2	615	<1	<1		Ad-hoc-AG: "Default" - GV I = 0.005 ml/m³; "Default" - GV II = 0.05 ml/m³
Tripropyleneglycol monomethyl ether	20324-33-8	615	<1	<1		
1,2-Dimethoxypropane	7778-85-0	619	<1	<1		
2,4,7,9-Tetramethyl-5-decyne-4,7-diol	126-86-3	1105	<1	<1		
Ethylene glycol monopropyl ether (2-Propoxyethanol)	2807-30-9	618	<1	<1		Ad-hoc-AG: "Default" - GV I = 0.005 ml/m³; "Default" - GV II = 0.05 ml/m³
Isopropoxyethanol	109-59-1	615	<1	<1		
Siloxanes						
Hexamethyldisiloxane	107-46-0	974	<1	<1		
Hexamethylcyclotrisiloxane	541-05-9	2682	2.5	16.0	**16**	Ad-hoc-AG: Total sum of cyclic dimethylsiloxanes D3 – D6 0.4 mg/m³ GV II = 4 mg/m³
Octamethylcyclotetrasiloxane	556-67-2	3610	1.0	7.0	**7.0**	
Decamethylcyclopentasiloxane	541-02-6	3168	3.0	22.0	**22**	
Dodecamethylcyclohexasiloxane	540-97-6	816	<3	10.8	**11**	
Alkanoic Acids						
Acetic acid	64-19-7	1863	24.0	87.8	**88**	
Propionic acid	79-09-4	1709	1.0	7.0	**7.0**	
2-Methylpropanoic acid	79-31-2	1706	<1	1.0	**1.0**	
Butyric acid	107-92-6	1890	<1	2.0	**2.0**	
Pentanoic acid	109-52-4	1702	<1	2.0	**2.0**	
2,2-Dimethylpropanoic acid	75-98-9	1692	<1	<1		
Caproic acid	142-62-1	1890	<1	5.0	**5.0**	
Heptanoic acid	111-14-8	1703	<1	1.0	**1.0**	
2-Ethylhexanoic acid	149-57-5	1717	<1	1.0	**1.0**	
Octanoic acid	124-07-2	1885	<1	2.0	**2.0**	

Chemical Compound (Synonym)	**CAS**	**n**	**Normal Value P 50** [in µg/m³]	**Attention Value P 90** [in µg/m³]	**Guidance Value** [in µg/m³]	**Notes (see chapter 6.1)**
Others						
Dibutyl ether	142-96-1	1603	<1	1.8	**1.8**	
Methyl tert-butyl ether (MTBE)	1634-04-4	1797	<2	<2		
Dicaprylyl ether	629-82-3	1620	<1	<1.5		
2-Methylfuran	534-22-5	1682	<1	<1.3		
3-Methylfuran	930-27-8	872	<1	<1.3		
2-Pentylfuran	3777-69-3	1472	<0.8	2.0	**2.0**	
Tetrahydrofuran (THF)	109-99-9	3353	<1	1.0	**1.0**	
gamma-Butyrolactone	96-48-0	621	<1	1.0	**1.0**	
1,4-Dioxane	123-91-1	2380	<1	<3		
2-Butanone oxime	96-29-7	2507	<1	3.6	**3.6**	
Acrylonitrile	107-13-1	1019	<1	1.0	**1.0**	
Caprolactam	105-60-2	2560	<1	2.0	**2.0**	
Methylpyrrolidone	872-50-4	2870	<1	2.0	**2.0**	
Hexamethylentetramine	100-97-0	615	<1	<1		
Triethylamine	121-44-8	462	<1	<1		
Methylchloroisothiazolinone (MCI)	26172-55-4	652	<1	<1		
Methylisothiazolinone (MIT)	2682-20-4	504	<1	<1		
Benzothiazole	95-16-9	2328	<1	1.0	**1.0**	
Triethyl phosphate	78-40-0	646	<1	<1		
Tributyl phosphate	126-73-8	715	<1	<1		Ad-hoc-AG: Sum GV I = 0.005 mg/m³ ; GV II = 0.05 mg/m³
TVOC (total volatile organic compounds)		2505	360.0	1572.0	**1000** [NB 6]	Seifert: TVOC assessment concept [NB 5] Ad-Hoc-AG: Handout [NB 6]

6.1 Abbreviations

Ad-hoc-AG: Ad-hoc Arbeitsgruppe Innenraumrichtwerte der Innenraumlufthygiene-Kommission (UBA) and AG der Obersten Landesbehörden (AOLG) [Ad Hoc Working Group for Indoor Guideline Values of the Indoor Air Hygiene Commission of the Federal Environment Agency and the Indoor Air Working Group of the State-Level Health Authorities in Germany]

In particular: Ad-hoc-Arbeitsgruppe der Innenraumlufthygiene-Kommission des Umweltbundesamtes und der AGLMB [Ad Hoc Working Group of the Indoor Air Hygiene Commission of the Federal Environment Agency and the AGLMB] (1996): Richtwerte für die Innenraumluft: Basisschema [Indoor air guideline values: basic scheme]. Bundesgesundheitsblatt 39, p. 422-426. German
As well as Ad-hoc Arbeitsgruppe "Innenraumrichtwerte" der Innenraumlufthygiene-Kommission (IRK) des Umweltbundesamtes und der Obersten Landesgesundheitsbehörden [Ad Hoc Working Group for Indoor Guideline Values of the Indoor Air Hygiene Commission (IRK) of the Federal Environment Agency and the Indoor Air Working Group of the State-Level Health Authorities in Germany] (2012): Richtwerte für die Innenraumluft: erste Fortschreibung des Basisschemas [Indoor air guideline values: first update of the basic scheme]. Bundesgesundheitsblatt 55, p. 279-290 and the publications regarding the guideline values on the home page of the Federal Environment Agency at http://www.umweltbundesamt.de/en/ad-hoc-working-group-for-indoor-air-guide-values-0

Roßkamp E (1998): Konservierung von Dispersionsfarben [Preservation of water-based paints]. In UBA (ed. by) Umweltmedizinscher Informationsdienst (UMID). 1-98 p. 2-9. Available at: http://www.umweltbundesamt.de/sites/default/files/medien/419/dokumente/umid011998.pdf German

B.A.U.CH.: Beratung und Analyse – Verein für Umweltchemie [Consulting and Analysis – Association for Environmental Chemistry]

a) Sachbericht: Vorkommen von Estern und Ethern mehrwertiger Alkohole in der Raumluft [Technical report: presence of polyvalent esters and ethers in indoor air] (1994) German

b) Sachbericht: Analyse und Bewertung der in Innenräumen vorkommenden Konzentrationen an längerkettigen Aldehyden [Technical report: analysis and assessment of longer-chain aldehyde concentrations in indoor air] (1993) German

c) Sachbericht: Analyse und Bewertung der in Raumluft und Hausstaub vorhandenen Konzentrationen der Weichmacherbestandteile Diethylhexylphthalat (DEHP) und Dibutylphthalat (DBP) [Technical report: analysis and assessment of concentrations of the plasticizer components diethylhexyl phthalate (DEHP) and dibutyl phthalate (DBP) in indoor air and house dust] (1991) German

d) Marchl, D. (1998): Raumluftbelastungen durch Glykolverbindungen [Indoor air pollution due to glycol compounds]. In Diel, Feist, Krieg und Linden: Ökologisches Bauen und Sanieren [Ecological building and remediation]. C.F. Müller Verlag. ISBN 3-7880-9901-1. p. 71-77. German

BGA: Bundesgesundheitsamt [Federal Health Office in Germany];
(in the meantime part of it merged into the Federal Institute for Risk Assessment)

In particular: „Zur Gültigkeit des 0,1-ppm-Wertes für Formaldehyd [On the validity of the 0.1 ppm value for formaldehyde]“. Bundesgesundheitsblatt 35 (1992) p. 482-483. German

BImSchV: Bundesimmissionsschutzverordnung [Ordinances to the Federal Immission Control Act in Germany]

In particular: 2. BImSchV (10 December 1990, last amended by Article 1 of the Ordinance from 2 May 2013): Verordnung zur Emissionsbegrenzung von leichtflüchtigen halogenierten organischen Verbindungen [Ordinance limiting emissions of volatile halogenated organic compounds] German

In particular: 39. BImSchV (2010): Verordnung über Luftqualitätsstandards und Emissionshöchstmengen [Ordinance on air quality standards and emission ceilings] German

BMLFUW: Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft [Federal Ministry for Agriculture, Forestry, Environment and Water Management in Austria]
In particular: Indoor Air Working Group at the BMLFUW and the Austrian Academy of Sciences
Refer to the link: http://www.innenraumanalytik.at/

BUI: Bremer Umweltinstitut [Bremen Environmental Institute]

In particular: ZORN, C.; KÖHLER, M.; WEIS; N.; SCHARENBERG, W (2005): Proposal for assessment of indoor air polycyclic aromatic hydrocarbon (PAH). 10th International Conference on Indoor Air Quality and Climate. Beijing, China

See also www.bremer-umweltinstitut.de

BWG = Hamburger Behörde für Soziales, Familie, Gesundheit und Verbraucherschutz, früher Hamburger Behörde Umwelt und Gesundheit bzw. Gesundheit und Soziales [Hamburg Office for Social Affairs, Family, Health and Consumer Protection, formerly Hamburg Office for Science and Health or Health and Social Affairs, respectively]

In particular: VOC Table 1: http://www.hamburg.de/contentblob/122306/data/voc-tab1.pdf and VOC Table 2: http://www.hamburg.de/contentblob/122308/data/voc-tab2.pdf

GV = guideline value [in German documents: RW = Richtwert]

pGV = provisional guideline value [in German documents: vRW = vorläufiger Richtwert]

WHO: World Health Organization

In particular: WHO Air Quality Guidelines for Europe 2000 (second edition)
http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf

“WHO-Leitlinien zur Raumluftqualität: Ausgewählte Schadstoffe (2010)“ [WHO guidelines for indoor air quality: selected pollutants]
http://www.euro.who.int/en/publications/abstracts/who-guidelines-for-indoor-air-quality-selected-pollutants

WIR = Wirkungsbezogene Innenraumrichtwerte [effect-based indoor guideline values]

6.2 Annotations:

[NB 1]: An exposure to naphthalene can indicate the presence of a more complex exposure to polycyclic aromatic hydrocarbons. It is recommended to check for the latter and to adjust the assessment accordingly.

[NB 2]: To a great degree, formaldehyde concentrations are dependent on the climatic conditions of a given space or emission source, respectively. When formaldehyde concentrations of 60 µg/m³ are exceeded at climatic conditions that are associated with a low rate of emissions from materials, we know from experience that, when the emission sources stay the same but the climatic conditions change, this can result in exposures within the range of WHO or BGA guideline values (e.g. winter/summer effects). This fact can be accounted for by a test value that is meant to encourage retesting formaldehyde exposures at other climatic conditions where applicable.

[NB 3]: Sagunski H (2006): Formaldehyd, eine Innenraum-Geschichte [Formaldehyde, an indoor air history]. In: Bayerisches Landesamt für Gesundheit und Lebensmittelsicherheit Ed. by Materialien zur Umweltmedizin. Aktuelle umweltmedizinische Probleme in Innenräumen, Part. 1 Vol. 13. p. 60-70 German

[NB 4] In a recent statement, the German Federal Institute for Risk Assessment confirmed that formaldehyde is considered carcinogenic when inhaled. However, the effect is said to be dependent on the concentration and in this assessment the currently valid guideline value of 0.1 ppm (124 µg/m³) is reconfirmed, at which virtually no carcinogenic effect is to be expected.

Ad-hoc-AG: Krebserzeugende Wirkung von Formaldehyd - Änderung des Richtwertes für die Innenraumluft von 0,1 ppm nicht erforderlich [Carcinogenic effect of formaldehyde-Changing the threshold level of 0.1 ppm for indoor air not necessary]. Bundesgesundheitsblatt 11 p.1169 Available at: http://www.umweltbundesamt.de/sites/default/files/medien/pdfs/Formaldehyd.pdf German

[NB 5]: The Indoor Air Hygiene Commission of the Federal Environment Agency in Germany (IRK) suggests that in indoor spaces, where humans are intended to spend longer periods of time, the TVOC value between one and three milligrams per cubic meter should not be exceeded in the long term; also see: Seifert, Bernd (1999): Richtwerte für die Innenraumluft. Die Beurteilung der Innenraumluftqualität mit Hilfe der Summe der flüchtigen organischen Verbindungen (TVOC-Wert) [Indoor air guideline values: indoor air quality assessment by means of the sum total of volatile organic compounds (TVOC value)]. In: Bundesgesundheitsblatt - Gesundheitsforschung- Gesundheitsschutz, vol. 42, p. 270-278. German

[NB 6]: Ad-hoc-AG: Beurteilung von Innenraumluftkontaminationen mittels Referenz- und Richtwerten [Ad-hoc-AG: Assessment of indoor air contaminations through reference and guideline values]. Bundesgesundheitsblatt 7 p. 990-1004 (2007) German