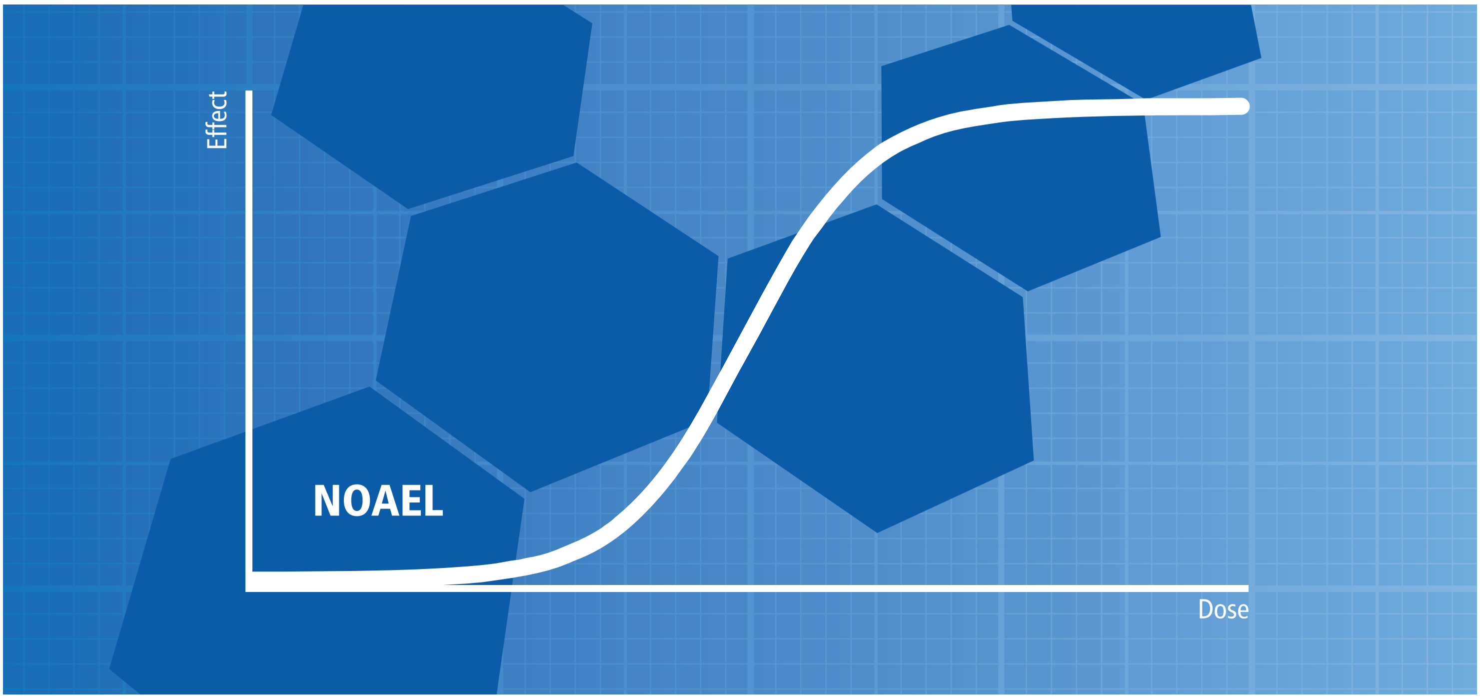

List of MAK and BAT Values 2024

Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area

Report 60

GMS
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List of MAK and BAT Values 2024

Permanent Senate
Commission for the
Investigation of
Health Hazards
of Chemical Compounds
in the Work Area

Report 60

Further publications from the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area:

The MAK Collection for Occupational Health and Safety

These publications are available from the open access publishing platform for life sciences: https://mak-dfg.publisso.de

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List of MAK and BAT Values 2024

Maximum Concentrations at the Workplace
and Assessment Values in Biological Material

Permanent Senate Commission
for the Investigation of Health Hazards
of Chemical Compounds in the Work Area

Report 60

GMS
PUBLISSO
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Lebenswissenschaften
DFG

Report 60 of the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area, of 1 July 2024.
This report replaces Report 59 of 1 July 2023 and supersedes all previous reports of the Commission.

DEUTSCHE FORSCHUNGSGEMEINSCHAFT
authorized and signed by Professor Dr. Andrea Hartwig
Chair of the Permanent Senate Commission
for the Investigation of Health Hazards of Chemical Compounds in the Work Area

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Appendix

★ Indicates a change from the 2023 List of MAK and BAT Values
Details of the new limit values or classifications proposed are listed in the list of MAK values and classifications and assessment values in biological material reviewed in 2023/2024 (appendix page I). The Commission has adopted these proposals but puts them up for discussion until 31. 12. 2024. New data or scientific commentary may be submitted to the Commission's scientific office (Kommissionssekretariat) until this date. This information will be examined and taken into consideration in the final ratification.

Maximum Concentrations at the Workplace

I. Significance, use and derivation of MAK values

Definition

The MAK value (“maximale Arbeitsplatzkonzentration”: maximum workplace concentration) is defined as the maximum concentration of a chemical substance (as gas, vapour or aerosol) in the workplace air which generally does not have known adverse effects on the health of the employee nor cause unreasonable annoyance (e. g. by a nauseous odour) even when the person is repeatedly exposed during long periods, usually for 8 hours daily but assuming on average a 40-hour working week. As the MAK value is intended for a daily exposure period of 8 hours, the permissible concentration should be reduced if exposure regularly exceeds 8 hours1). Certain aspects of occupational hygiene associated with liquid substances, e. g. formation of mist with obscured visibility, dampening of clothing, or condensation on the floor, can not be taken into account in establishing the MAK value. Such effects have a wide range of variation, depending on the industrial process, the procedure, and the physical conditions at the workplace. A suitable instrument for evaluation is not yet available. Regardless of the level of the toxicologically based MAK value, it should be ensured in these cases that safety at the workplace is not placed at risk. This situation is not explicitly mentioned in the documentations because it is not known whether the substance exists as an aerosol at the MAK value. As a rule, the MAK value is given as an average concentration for a period of up to one working day or shift. MAK values are established on the basis of the effects of chemical substances; when possible, practical aspects of the industrial processes and the resulting exposure patterns are also taken into account. Scientific criteria for the prevention of adverse effects on health are decisive, not technical and economic feasibility. Furthermore,

the carcinogenicity (see Section III)
the sensitizing effects (see Section IV)
the contribution to systemic toxicity after percutaneous absorption (see Section VII)
the risks during pregnancy (see Section VIII)
the germ cell mutagenicity (see Section IX)

of a substance are evaluated and the substance classified or designated accordingly. Descriptions of the procedures used by the Commission in the evaluation of these end points may be found in the appropriate sections of the List of MAK and BAT Values, in “The MAK Collection for Occupational Health and Safety”2) and in scientific journals3)4)5)6)7).

In line with the so-called “preferred value approach” also used e. g. in the European Union, MAK values are to be established preferentially as the numerical values 1, 2 or 5 ml/m^3 or, for non-volatile substances, 1, 2 or 5 mg/m^3, multiplied by powers of ten.

In the use of MAK values, the analytical procedures used for sampling and analysis and the sampling strategy are of great importance.

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1) Hartwig A, MAK Commission (2023) Extended work shifts and MAK values. MAK Value Documentation – Translation of the German version from 2022. MAK Collect Occup Health Saf 8(2):Doc039. https://doi.org/10.34865/mb0verlarbegt8_2or

2) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

3) Adler ID, Andrae U, Kreis P, Neumann HG, Thier R, Wild D (1999) Vorschläge zur Einstufung von Keimzellmutagenen. Arbeitsmed Sozialmed Umweltmed 34: 400–403.

4) Drexler H (1998) Assignment of skin notation for MAK values and its legal consequences in Germany. Int Arch Occup Environ Health 71: 503–505. https://doi.org/10.1007/s004200050313

5) Hofmann A (1995) Fundamentals and possibilities of classification of occupational substances as developmental toxicants. Int Arch Occup Environ Health 67: 139–145. https://doi.org/10.1007/BF00626344

6) Neumann HG, Thielmann HW, Filser JG, Gelbke HP, Greim H, Kappus H, Norpoth KH, Reuter U, Vamvakas S, Wardenbach P, Wichmann HE (1998) Changes in the classification of carcinogenic chemicals in the work area. (Section III of the German List of MAK and BAT Values). J Cancer Res Clin Oncol 124: 661–669. https://doi.org/10.1007/s004320050229

7) Neumann HG, Vamvakas S, Thielmann HW, Gelbke HP, Filser JG, Reuter U, Greim H, Kappus H, Norpoth KH, Wardenbach P, Wichmann HE (1998) Changes in the classification of carcinogenic chemicals in the work area. Section III of the German List of MAK and BAT Values. Int Arch Occup Environ Health 71: 566–574. https://doi.org/10.1007/s004200050325

List of MAK and BAT Values 2024. DFG, Deutsche Forschungsgemeinschaft
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Purpose

MAK values promote the protection of health at the workplace. They provide a basis for judgement of the toxic potential or safety of the concentrations of substances in the workplace air. However, they do not provide constants from which the presence or absence of a health hazard after longer or shorter periods of exposure can be determined; nor can proven or suspected damage to health be deduced, in an isolated case, from MAK values or from the classification of a substance as carcinogenic. Such deductions can be made only on the basis of medical findings, taking into consideration all the circumstances of the particular case. On principle, statements in the List of MAK and BAT Values are therefore not to be seen as a priori judgements for individual cases and observation of MAK Values does not eliminate the necessity for regular medical examination of the exposed individuals.

MAK values are not suitable for providing constant conversion factors for deduction of health risks associated with long-term exposure to contaminants in the non-occupational atmosphere, e. g., in the vicinity of industrial plants.

Prerequisites

In principle, the substances are dealt with according to their importance for practical occupational hygiene and the expertise of the members of the Commission. The prerequisite for the establishment of a MAK value is the availability of sufficient data for the substance from the fields of toxicology, occupational medicine or industrial hygiene. Adequate documentation is not always available. The list is revised annually and suggestions for substances to be added and new information on listed substances are welcome[8]).

Derivation of MAK values

MAK values are derived by the "Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area of the DFG" exclusively on the basis of scientific arguments and are published in the List of MAK and BAT Values which is issued annually. For the derivation of MAK values, certain rules of procedure have been developed by the Commission on the basis of established toxicological and occupational medical concepts; answers to at least the more common questions are repeatedly sought in the same way. Therefore, the usual procedures and the general principles for the derivation of MAK values are described below. Essentially, these principles correspond with those published by the European "Scientific Committee on Occupational Exposure Limits, SCOEL"[9]).

First, the most sensitive parameters described in the available data are to be identified, i. e., those effects which appear first during exposure to increasing concentrations of the substance. To be taken into account in this process are both local effects, that is, the results of effects on surfaces of the organism which are in contact with the environment (e. g. mucous membranes of the respiratory tract and the eyes, skin) and also systemic effects, that is, the results of uptake of the substance into the organism. Generally, the concentration-effect relationships for these two kinds of effects are different. The derivation of the MAK value is based on the "no observed adverse effect level" for the most sensitive effect with relevance for health. A NOAEL is not equivalent with a threshold which cannot be scientifically defined. The NOAEL is a concentration determined by experimental conditions at which the given effect is so low that it does not differ from the control value. It must be decided whether or not such effects may be considered to be adverse effects. At present there is no generally accepted definition for an "adverse" effect, at least in part because of the lack of clarity about the still changing definition for the state of being "healthy"[10]) [11]); therefore, this decision must be made anew in every case.

Fundamentally, known effects of a substance in man are given highest priority in the derivation of the MAK value.

In the evaluation of a substance, known effects of structural analogues may also be taken into account.

If no NOAEL may be derived from the available data, a scientifically founded MAK value cannot be established and the substance is listed in Section IIb of the List of MAK and BAT Values.

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[8]) Please contact the Geschäftsstelle der Deutschen Forschungsgemeinschaft, D-53170 Bonn; or the Sekretariat der Kommission: Karlsruher Institut für Technologie (KIT) – Institut für angewandte Biowissenschaften, Abteilung Lebensmittelchemie und Toxikologie, 76131 Karlsruhe.

[9]) European Commission, editor (1999) Methodology for the derivation of occupational exposure limits: Key documentation Cat. No. CENA-19253-EN-C, ISBN 92-828-8106-7, EUR 7. Office for Official Publications of the European Communities, L-2985 Luxembourg.

[10]) DFG (Deutsche Forschungsgemeinschaft), editor (1997) Verhaltenstoxikologie und MAK-Grenzwertfestlegungen. Wissenschaftliche Arbeitspapiere. Weinheim: Wiley-VCH.

[11]) Henschler D (1992) Evaluation of adverse effects in the standard-setting process. Toxicology Letters 64/65: 53–57. https://doi.org/10.1016/0378-4274(92)90172-g

a) Selection of substances and collection of data

For the substances being studied, the epidemiological data published in scientific journals, occupational medical reports, toxicological properties and any other potentially useful information is first assembled by carrying out researches in appropriate databanks. The references found in the literature search are checked for their relevance for the assessment of the substance in question and the original publications of the selected literature are examined. When necessary, unpublished internal company data in the form of complete study reports are also included. These are then identified as such in the reference list at the end of the documentation. The validity of the available information and studies is checked. Whether or not a study is relevant for the current assessment, is decided on a case to case basis. Whenever possible, evaluation of the studies is based on the guidelines of the OECD or similar bodies.

The unabridged reports are made available to the Commission and are filed at the Commission's scientific central office. Information required by a third party about the company reports cited in the Commission's documentation is supplied in writing by the chair of the Commission at own discretion. Access to company reports is not made available to third parties. Copies, even of parts of reports, are not provided.

b) Values based on effects in man

For many substances encountered at the workplace, irritation or central nervous depression is the critical effect. Valuable information – at least for these acute effects of single exposures – may be obtained from studies of volunteers exposed under controlled conditions which yield data for concentration-effect relationships and also for concentrations without effects (NOAEC). A detailed review of the methods required of such studies and of the usefulness of various parameters for the establishment of limit values has been published[12]). Such studies often demonstrate differences in sensitivity between persons who have never been exposed to the test substance and those who have been repeatedly exposed, e. g., at work.

Occupational medical and epidemiological studies provide further information from which the health risks associated with handling particular substances may be evaluated. However, not only the parameters determined in the exposed persons, but also any differences in study design, in the analytical methods and sampling strategies must be considered in evaluating such studies. Various confounders, exposure to mixtures, previous disorders or inadequate exposure records can alter or falsify any detected concentration-effect relationships.

Cross-sectional studies with only single determinations of exposure levels and only single examinations of the exposed persons do not generally permit the association of any observed symptoms with the current exposure situation. This requires information as to past exposure levels.

Therefore, longitudinal studies with repeated determination of the workplace and systemic exposure levels and repeated examination of the exposed persons play a decisive role in the establishment of limit values. Valid epidemiological studies of persons exposed for long periods to concentrations which do not produce adverse effects provide a reliable basis for the establishment of limit values for the workplace, especially when the study design permits statements as to both local and systemic effects.

The diverse sensitivities of individual employees (as determined by age, constitution, nutrition, climate, etc.) are taken into consideration in the establishment of MAK values. It is currently not possible to take sex-specific differences in toxicokinetics and toxicodynamics into account when establishing MAK and BAT values because of the lack of appropriate scientific data.

When the NOAEL has been determined from the effects of the substance in man observed at the workplace, the MAK value is generally established at the level of this NOAEL.

When deriving MAK values for systemic effects and effects on the lungs from studies with volunteers at rest, the results are extrapolated to the increased respiratory minute volume at the workplace. The MAK value is established at half of the concentration used in the volunteer study, which is calculated from the ratio of the respiratory volume of workers to that of persons at rest. Gases and vapours with a blood:air partition coefficient of < 5 represent an exception (see the documentation "Increased respiratory volume at the workplace – Significance for the derivation of the MAK value"[13])). In addition, the results are extrapolated to the longer daily exposure at the workplace, unless there are toxicokinetic data available that show this to be unnecessary.

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[12]) DFG (Deutsche Forschungsgemeinschaft), editor (1997) Verhaltenstoxikologie und MAK-Grenzwertfestlegungen. Wissenschaftliche Arbeitspapiere. Weinheim: Wiley-VCH.

[13]) Hartwig A, MAK Commission (2017) Increased respiratory volume at the workplace – Significance for the derivation of the MAK value. MAK Value Documentation, 2017. MAK Collect Occup Health Saf 2(2): 277–283. https://doi.org/10.1002/3527600418.mbrespivole6217

c) Values based on effects on animals

Because the effects in man are not known for many substances, MAK values are often derived from results obtained with experimental animals. This is carried out in the clear understanding of the problems associated with extrapolation between species and of the much smaller group sizes than is usual in epidemiological studies. On the other hand, animal studies carried out according to modern principles also offer advantages including precise characterization of exposure levels, the wide range of parameters that can be studied, and the possibility of determining dose-response relationships and NOAELs. The minimum database for the derivation of a MAK value is generally considered to be a NOAEL from a valid 90-day inhalation study with experimental animals. Of the results of studies in which substances were administered to experimental animals by the oral or dermal route, mostly only the systemic effects may be considered to be relevant for persons exposed at the workplace. Therefore, in the documentation of a MAK value such results must be accompanied by information about the local effects of the substance, especially the effects on the respiratory tract.

To extrapolate an oral dose from an animal study to a concentration in the air at the workplace, the Commission uses a procedure which in essence corresponds with that described in the document for determination of “Derived No-Effect Levels” (Guidance on Information Requirements and Chemical Safety Assessment, Chapter R.8, ECHA 2008). The only difference is that the Commission assumes 100 % absorption after inhalation and oral administration when there are no substance-specific data. Exceptions to this are the metals and metal compounds, for which 50 % absorption is assumed after oral administration if substance-specific data are not available.

Procedure: If substance-specific data are not available, the oral dose is divided by the following correction factor (ECHA 2008), depending on the species:

mouse: 7; rat: 4; rabbit: 2.4; monkey: 2; dog: 1.4.

The further assumptions (human body weight: 70 kg, breathing volume: 10 m^3 per 8 hours) still apply. The conversion is calculated with the following formula:

Inhaled concentration =

$$\frac{\text{oral dose (mg/kg body weight and day) x oral absorption in the animal (\%) x 70 kg body weight}}{\text{species-specific correction factor x inhalation absorption in humans (\%) x (10 m}^3\text{ per day)}}$$

For example, a dose of 1 mg/kg body weight in the rat, a substance-specific oral absorption of 80 % and unknown inhalation absorption result in the following concentration:

$$\frac{1\ \text{mg/kg}\ \times\ 80\%\ \times\ 70\ \text{kg}}{4\ \times\ 100\%\ \times\ 10\ \text{m}^3} = 1.4\ \text{mg/m}^3$$

Assuming that the same external concentration in the air leads to the same internal exposure in all species at rest, it must be taken into account when extrapolating data from inhalation studies in animals to humans that in the case of systemic effects and effects in the lungs the body burden (related to kg body weight) of the worker at the workplace, with an assumed respiratory volume of 10 m^3 in 8 hours, is about twice as high as that of the experimental animal in the usual 6-hour experiment. The equivalent external concentration at the workplace is, therefore, half of that used in the experiment. This applies only for gases and vapours with a blood:air distribution coefficient of >5 and for aerosols, provided that the effect is the product of c×t. If it can be shown that the critical effect depends more on the concentration than the product of c×t and that the steady state was reached within the duration of the experiment, the equivalent concentration at the workplace is two thirds of the concentration used in the experiment (1 : 1.5), as then extrapolation of the usual 6-hour exposure in animal experiments to the 8-hour exposure at the workplace is no longer necessary (see the documentation “Increased respiratory volume at the workplace – Significance for the derivation of the MAK value”14))). If there are valid PBPK models of exposure with the relevant metabolites in humans and animals these are used for extrapolation from the experimental animal to persons at the workplace. If necessary, the dose in the animal experiment is converted if the frequency of exposure differed from that at the workplace. With continuous exposure (for example, feeding studies) the NOAEL from the animal experiment is therefore multiplied by 7/5 to take into consideration the continuous exposure of the animals compared with the intermittent exposure of the usual 5-day working week. With administration of the substance with the diet or drinking water to rats and

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14) Hartwig A, MAK Commission (2017) Increased respiratory volume at the workplace – Significance for the derivation of the MAK value. MAK Value Documentation, 2017. MAK Collect Occup Health Saf 2(2): 277–283. https://doi.org/10.1002/3527600418.mbrespivole6217

mice, as a rule the factors used by the EFSA[15]) are used to convert the values into a dose per kg body weight, if there are no measured values.

When the NOAEL is based on results with animals in oral or inhalation studies, the MAK value is generally established at the level of half of the concentration in air extrapolated for workers at the workplace. However, in some cases species differences in sensitivity to the substance must be taken into account and here the toxicokinetic data are particularly important.

d) Exceptional workplaces

The concentrations of inhaled gaseous substances in blood and tissues of persons working under hyperbaric pressure have been shown to correlate positively with the pressure. This dependence of the body burden on the workplace conditions must be taken into account in the application of MAK and BAT values.

e) Chemosensory perceptions and effects

Substances present in the workplace air as gas or aerosol are potentially able to induce chemosensory perceptions and thus associated effects relevant to health.

Humans possess very sensitive chemosensory senses which are able to perceive chemicals at the workplace. The sense of smell (nervus olfactorius) is particularly sensitive and perceives both *pleasant* and *unpleasant* odours even at very low concentrations, frequently below the MAK value. The so-called “trigeminal chemoreception” (nervus trigeminus) perceives *burning* and *biting* sensations, above all at higher concentrations of the substance in the workplace air. Both senses serve primarily the perception of volatile chemicals in the ambient air but can also warn the organism against possible dangers. The sense of smell possesses above all a “psychological” warning function, while trigeminal chemoreception can induce defence mechanisms to avoid damage to tissues.

Nevertheless, the mere perception of the chemical is not a health effect; in addition (a) sensory irritation, (b) considerable odour annoyance or (c) in individual cases “odour-associated” symptoms must occur.

Sensory irritation

Trigeminal nerve fibres occur in almost all regions of the nose, but also in the mucous membranes of the eyes, the oral cavity and the throat. Various receptors are found on these fibres of the peripheral nervous system, which can be activated by chemicals. They detect changes in temperature and other changes in the milieu (for example, changes in pH) in their immediate environment. The activation of these chemoreceptors forms the physiological basis of sensory irritation. Sensory irritation is understood to be an acute, more or less concentration-dependent effect, which can be regarded as reversible until the activation of the receptors leads to defence reflexes (for example, an increase in blinking frequency, or the release of neurogenic inflammation markers). This sensory defence reaction takes place without signs of inflammation or histopathological changes yet being evident. The sensory NOAEC can be determined in human studies (subjective/objective symptoms) or estimated from suitable studies with animals (mouse, RD_{10}). At higher concentrations, however, neurogenic inflammation and adverse histopathological changes of the upper respiratory tract (for example, an inflammatory reaction of the tissue, atrophy/degeneration of the olfactory epithelium) may additionally occur. Such effects have been observed in inhalation studies with rodents. A NOAEC can be derived for this, which can decrease with increasing exposure duration. According to an empirical study[16]), if there are no studies in humans for sensory irritation, the long-term NOAEC for histopathological effects of the upper respiratory tract of rodents can be used to estimate a NAEC for sensory irritation (eyes, nose) in humans. If the target tissue is the olfactory epithelium in rodents, no sensory irritation is to be expected at half the value of the long-term NOAEC; for other target tissues of the upper respiratory tract the same is true at a third of the value of the corresponding NOAEC. If there is only a short or medium-term study available, its NOAEC is divided by 6 or 2, respectively, to extrapolate a long-term NAEC[16]), unless the data for the substance or a better-investigated analogous substance suggest that the increasing exposure duration does not lead to an increase in the effects or leads to an increase of different magnitude. If no NOAEC was obtained, with a suitable database the lower confidence interval of a benchmark dose ($BMDL_{05}$ or $BMDL_{SD}$) can be calculated or the NAEC can be estimated by dividing the LOAEC by 2 or 3 depending on the severity of the effects and the gradient of the concentration–effect relationship.

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[15]) EFSA (European Food Safety Authority) (2012) Guidance on selected default values to be used by the EFSA Scientific Committee, scientific panels and units in the absence of actual measured data. EFSA J 10: 2579. https://doi.org/10.2903/j.efsa.2012.2579

[16]) Brüning T, Bartsch R, Bolt HM, Desel H, Drexler H, Gundert-Remy U, Hartwig A, Jäckh R, Leibold E, Pallapies D, Rettenmeier AW, Schlüter G, Stropp G, Sucker K, Triebig G, Westphal G, van Thriel C (2014) Sensory irritation as a basis for setting occupational exposure limits. Arch Toxicol 88: 1855–1879. https://doi.org/10.1007/s00204-014-1346-z

Considerable odour annoyance

The receptors of the sense of smell (nervus olfactorius) are activated even at low concentrations of a chemical and induce action potentials in the olfactory nerve. Initally, this leads to the perception of an odour (perception threshold). The basis for this perception is the characteristic activation pattern of the around 350 different odour receptors in humans, which, however, can change very rapidly depending on the duration and concentration of the exposure. These dynamic processes ultimately lead to the recognition of an odour. For the brain to recognise a particular odour (identification threshold), in some cases the concentrations need to be 10 times as high as those necessary for the perception threshold. The primary criterion by which humans judge unknown odours is their hedonic quality; whether they are *pleasant* or *unpleasant*. These judgements are very subjective and individual as they are learnt during the course of life and are connected with the person's experiences with certain odours.

Chemicals at the workplace often have an *unpleasant* smell. Persistent intensive or nauseous odours may lead to *excessive annoyance*. As a rule, this not only involves the perception of the odour, but also *trigeminal* sensations (biting, burning) and the otherwise very pronounced adaptation/habituation to chemosensory irritation does not take place. From an objective physiological point of view, it is almost impossible to say when *excessive annoyance* has been reached. Indirect indicators are reduced cognitive performance resulting from the diversion caused by the substance when the annoying chemosensory perception can no longer be ignored and hinders the actual task being performed. In controlled studies in humans, such behavioural effects can be determined using standardized neuropsychological test procedures.

"Odour-associated" symptoms

Certain chemical substances can induce immediate "odour-associated" symptoms such as nausea or headaches in some people. As a rule, nothing is known in the scientific literature about the physiological mechanisms behind these symptoms, but it is above all very odour-intensive substances that cause such reactions in certain individuals. Substances which can cause "odour-associated" symptoms even at concentrations below the MAK value are given the footnote *"Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases."*. A substance is designated with this footnote according to the following criteria: (a) a low, psycho-physically determined odour threshold, (b) a very unpleasant odour even in the range of the perception threshold or (c) case reports or observations which describe the increased occurrence of "odour-associated" symptoms[17]).

Habituation

When only the odour is perceived, constant exposure to certain substances (for example, hydrogen sulfide, 2-methyl-2-propanethiol) can lead to habituation and thus also to impairment or the complete loss of the olfactory perception of this substance. Also for this reason, odour perception is not a suitable "warning" against hazardous exposure to such chemicals. At present there is not enough substance-specific knowledge about the underlying mechanisms of very pronounced habituation processes (for example, changes to the odour receptors) and the concentration–effect relationships involved. In the case of such substances, attention must be drawn to this phenomenon of olfactory perception.

Documentation

A detailed scientific documentation of each decision is published in "The MAK Collection for Occupational Health and Safety"[18]). These documents present, clearly and in detail, the scientific data and the reasons for the establishment of a MAK value. Because of this system, it is sufficient to establish only general principles for the derivation of MAK values. The assessment of individual substances on the basis of all the available toxicological and occupational medical data yields a more differentiated and specific evaluation than would the observance of stringently formulated rules.

The published data for the toxicity and effects of a substance in man and animals and all other relevant information are organized according to the kind of effect and presented in the form of a review. This review of the toxicological and epidemiological data for a substance serves initially as a basis for the discussion within the Commission for the derivation of a MAK value and for detailed evaluation of the physicochemical properties, percutaneous absorption, sensitizing effects, carcinogenic effects, prenatal toxicity and germ cell mutagenicity of the substance. When new data become available, the MAK value, classification and designation of the substance are reassessed and, when necessary, altered.

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[17]) van Thriel C, Monsé C, Rettenmeier A, Sucker K, Werner S, Leibold E, Brüning T, Arand M, Käfferlein H, Bartsch R, Kreis P, Hartwig A, MAK Commission (2024) Substances with intense odours: general principles, evaluation and designation MAK Value Documentation – Translation of the German version from 2023. MAK Collect Occup Health Saf 9(1): Doc013. https://doi.org/10.34865/mb0geruchegt9_1or

[18]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

Publication

Prospective changes and new entries are announced one year in advance in the List of MAK and BAT Values, usually on 1st July. In addition, the new entries are published on the homepage of the Commission at the DFG (https://www.dfg.de/download/pdf/dfg_im_profil/gremien/senat/arbeitsstoffe/ankuendigungsliste.pdf). If necessary, in addition to the regular updates each year in July, further announcements of prospective changes and new entries can be made there at any time. Following ratification of the annual List, the organizations listed below are officially informed of the planned changes: "Länderausschuss für Arbeitsschutz und Sicherheitstechnik (LASI)" (Federal Committee for Occupational Safety and Technical Security), the "Bundesverband der deutschen Industrie" (Federation of German Industries), the "Deutsche Gesetzliche Unfallversicherung" (German Statutory Accident Insurance) and the "Deutsche Gewerkschaftsbund" (the German Trade Union Federation). The purpose of this measure is to give these organizations enough time to send to the Commission any available scientific documentation relevant to the planned changes and additions to the List of MAK and BAT Values.

Mixtures of substances

In general, the MAK value is only valid for exposure to a single, pure substance. It cannot be applied unconditionally to one component of a mixture in the workplace air or to a technical product which might contain more toxic impurities. Simultaneous or successive exposure to several substances may be much more or, in isolated cases, even less dangerous than the exposure to one of the substances on its own. A MAK value for a mixture of substances cannot be satisfactorily determined by simple calculation because the components of the mixture generally have very different kinds of effect; MAK values can presently be established for such mixtures only after specific toxicological examination or studies of the particular mixture of substances. Given the inadequacy of the currently available data, the Commission decidedly refrains from calculating MAK values for mixtures, particularly for liquid solvent mixtures. However, it is willing, on the basis of appropriate investigations, to provide values for defined vapour mixtures of practical relevance.

Analytical controls

The compliance with MAK and BAT values (that is, keeping the exposure levels below these values) is intended to protect the health of persons exposed to hazardous substances at work. This objective can be ensured only by regular analytical determination of the concentration of the hazardous substances in the workplace air or of the concentration of the substances, their metabolites or other parameters of intermediary metabolism in the body fluids of exposed persons. For this purpose, it is necessary to use analytical methods which have been tested regarding the analytical reliability and practicability.

The Commission's analytical working groups for air analyses and for analyses in biological materials have developed such methods and published them19)[19]. These collections of methods are supplemented regularly and are published in both German and English. The methods are conceived as so-called standard operating procedures (SOP) which are intended to ensure comparability of the analytical results from laboratory to laboratory and with the corresponding limit values. Thus they contribute to the quality control of the results. In addition, they provide a good basis for the health protection which is the objective of the limit values.

In the development of these analytical methods, the accuracy and reliability of the results is the most important factor. The methods are updated regularly if new scientific and instrumental findings indicate changes. In this respect the methods always reflect the current state of technology and are well-suited for monitoring limit values.

The methods for analyses in biological materials are, whenever possible, designed so that their measurement range includes the background concentration range. In this way it is possible to differentiate between occupational and environmental exposure and to correctly evaluate the analytical results.

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19) Available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019).
The Commission welcomes suggestions for inclusion of new substances as well as analytical methods. Analytical methods for carcinogenic workplace substances are published in cooperation with the analytical chemistry group from the German statutory accident insurance, 'Arbeitsgruppe Analytik im Sachgebiet „Gefahrstoffe" des Fachbereichs „Rohstoffe und chemische Industrie" der Deutschen Gesetzlichen Unfallversicherung' („Von den Unfallversicherungsträgern anerkannte Analysenverfahren zur Feststellung der Konzentrationen krebserzeugender, erbgutverändernder oder fortpflanzungsgefährdender Stoffe in der Luft in Arbeitsbereichen" (DGUV Informationen 213–5xx)), DGUV, D81359 München: https://www.bgrci.de/fachwissen-portal/themenspektrum/gefahrstoffe/gefahrstoffanalytik/inhalte/dguv-informationen-213-5xx/

Substances that can occur simultaneously as vapour and aerosol

Substances in the air at the workplace usually occur either as gas/vapour or as an aerosol in the form of either droplets (mist) or as dust. There are, however, also substances that do not follow this categorisation. These are substances with a low vapour pressure at room temperature, which can therefore occur in relevant amounts as both vapour and aerosol. They can be both liquids and sublimating solids.

When determining the inhalation exposure to substances it must always be considered whether vapour and aerosol mixtures can be formed as a result of the work process. This must be taken into account during the determination and evaluation. In particular, such mixtures occur above all when aerosols are formed during the work process, for example as a result of mechanical processes such as the processing of metals or ceramics, during dipping processes in electroplating or during spraying processes. In addition, there are manufacturing processes in which non-volatile substances evaporate at higher temperatures and then condense again, for example, during the hot processing of bitumen or laser welding, and thus occur in the workplace air simultaneously as a vapour and an aerosol. According to DIN EN 23861[20]), for substances with a vapour pressure at room temperature of less than 100 Pa and more than 0.001 Pa sampling procedures should always be selected which determine vapour and aerosols simultaneously in one sampling system. Liquids with boiling points between around 200 ℃ and 320 ℃ usually fall into this category. The mass transfer between the vapour and condensed phase is a dynamic process which is continually changing as a result of influences such as temperature or air currents. The exact distribution of a substance in the workplace air between the vapour phase and condensed phase is very difficult to determine, and therefore not possible in practice. Systems with which aerosols and vapour can be determined together (the aerosol is determined as the inhalable fraction) are suitable for sampling such substances.

For substances with the physical properties described and for which there is a MAK value for the respirable fraction of the particle phase, at workplaces it is not possible, for analytical reasons, to determine only the respirable aerosol fraction. For these substances it is also recommended that the inhalable fraction is determined to cover the “worst-case” scenario[21]). As a result of the dynamic behaviour of these substances, only the sum of the vapour and particle fractions can be determined reliably as long as the particle fraction is determined in its entirety as the inhalable fraction.

Substances in the list in Section II which can occur simultaneously as a vapour and an aerosol are marked with the following note: *“The substance can occur simultaneously as vapour and aerosol”.*

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[20]) DIN (Deutsches Institut für Normung), editor (2023) DIN EN ISO 23861:2023-02. Workplace air – Chemical agent present as a mixture of airborne particles and vapour – Requirements for evaluation of measuring procedures using samplers (ISO 23861:2022); German version EN ISO 23861:2022. Berlin: DIN Media. https://doi.org/10.31030/3369591

[21]) Breuer D, Dragan GC, Hebisch R, Bartsch R, Giesen Y, Krämer W, Nitschke L, Nitz G, Pannwitz K-H, Tschickardt M, Hartwig A, MAK Commission (2018) Sampling and analysis of substances and substance mixtures which may occur simultaneously as vapours and particles in workplace air. Air Monitoring Methods, 2018. MAK Collect Occup Health Saf 3(3): 1628–1662. https://doi.org/10.1002/3527600418.amsampmixe1918

II. List of Substances

In the following list, maximum concentrations in the workplace air (MAK values) of gases, vapours and aerosols are expressed in ml/m³ (millilitre (ml) of the substance per cubic metre (m³) of air, ppm), a unit which is unaffected by temperature and barometric pressure, as well as in mg/m³ (milligram (mg) of the substance per cubic metre (m³) of air)[22]), a unit which is temperature and pressure dependent and has therefore been adjusted to a temperature of 20 ℃ and barometric pressure of 1013 hPa[23]); the MAK values for **non-volatile aerosols** (dust, smoke, mist) are given in mg/m³ air. Non-volatile aerosols are substances which have such a low vapour pressure that at normal temperatures a dangerously high concentration cannot occur in the gaseous phase.

Since the health hazards associated with handling a substance can be affected by its **volatility**, the **vapour pressure** of a series of highly volatile compounds has been listed for 20 ℃, unless otherwise stated. Knowledge of the vapour pressure makes it possible to estimate whether hazardous concentrations of the substance can accumulate by evaporation under the conditions prevailing at the particular workplace. The listed vapour pressure values are taken from the literature, mainly from the US National Library of Medicine, the ECHA, the SRCPhysprop or the GESTIS database, and have been rounded for practical purposes.

MAK [ml/m³]	MAK value in ml/m³ (ppm)	value or "–"	see Section I
MAK [mg/m³]	MAK value in mg/m³ measured as	value or "–"	see Section I
	the respirable fraction	R	see Section Vd
	the inhalable fraction	I	see Section Vd
Peak lim	peak limitation category (excursion factor)	I/II or "–" (1 to max. 8)	see Section VI
Preg gr	pregnancy risk group	A, B, C, D or "–"	see Section VIII
Perc abs	danger from percutaneous absorption	designated with H	see Section VII
Sens	danger of sensitization	designated with	
	– of the airways	Sa	see Section IV
	– of the skin	Sh	see Section IV
	– of the airways and the skin	Sah	see Section IV
	danger of photocontact sensitization	SP	see Section IV
Carc cat	carcinogen category	1, 2, 3, 4, 5	see Section III
Muta cat	germ cell mutagen category	1, 2, 3 A, 3 B, 5	see Section IX

⋆ indicates a change from the 2023 List of MAK and BAT Values. see Section I

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[22]) "mg/m³" is a measure which means milligram (mg) of the substance per cubic metre (m³) of air

[23]) Under the specified atmospheric conditions (20 ℃, 1013 hPa) the concentration values can be converted according to the following formula:

$$C(\text{mg/m}^3) = \frac{\text{molar mass in g}}{\text{molar volume in l}} \cdot C(\text{ml/m}^3)$$

The molar volume corresponds to 24.1 l at 20 ℃ and 1013 hPa (mbar).
The MAK value is generally established with the units ml/m³; the value in mg/m³ is then calculated with the formula given above. Following a suggestion from users, the calculated values are given correct to two significant figures.

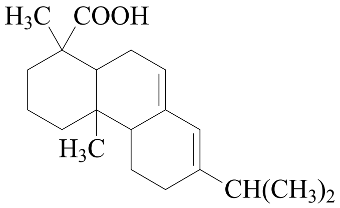
List of MAK and BAT Values 2024. DFG, Deutsche Forschungsgemeinschaft
DOI: 10.34865/mbwl_2024_eng
German Medical Science | PUBLISSO 2024

a) Substances with MAK values and substances listed in Sections IIb, IIc and III to XII

MAK values which were established on the condition that the working week exceeds 40 hours have been retained with no change in the toxicological evaluation.

Abietic acid

[514-10-3]



also includes disproportionation and transposition products
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

An immunological genesis of the asthma often seen in persons working with materials containing abietic acid has not been proved.

Acacia melanoxylon ⟶ Woods

Acetaldehyde

[75-07-0]

$H_3C\text{-}CHO$

MAK[ml/m^3]: 50
MAK[mg/m^3]: 91

see definition of Carcinogen Category 5 and supporting documentation

Peak lim: I(1)

A momentary value of 100 ml/m^3 (180 mg/m^3) should not be exceeded.

Preg gr: C
Carc cat: 5
Muta cat: 5

Acetamide

[60-35-5]

$H_3C\text{-}CO\text{-}NH_2$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Acetic acid

[64-19-7]

$H_3C\text{-}COOH$

MAK[ml/m^3]: 10
MAK[mg/m^3]: 25
Peak lim: I(2)
Preg gr: C

Acetic acid ethyl ester ⟶ Ethyl acetate

Acetic acid methyl ester ⟶ Methyl acetate

Acetic acid 2-propoxyethyl ester ⟶ 2-(Propyloxy)ethyl acetate

Acetic anhydride

[108-24-7]

$H_3C\text{-}CO\text{-}O\text{-}CO\text{-}CH_3$

VP[hPa]: 4

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.42
Peak lim: I(2)
Preg gr: C

Acetoacetic acid ethyl ester

[141-97-9]

$H_3C\text{-}CO\text{-}CH_2\text{-}COO\text{-}CH_2\text{-}CH_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Acetone

[67-64-1]

$H_3C\text{-}CO\text{-}CH_3$

VP[hPa]: 240
see Section XII

MAK[ml/m^3]: 500
MAK[mg/m^3]: 1200
Peak lim: I(2)
Preg gr: B
Note regarding prerequisite for Group C see documentation

Acetonitrile

[75-05-8]

$H_3C\text{-}CN$

VP[hPa]: 96.6

MAK[ml/m^3]: 10
MAK[mg/m^3]: 17
Peak lim: II(2)
Preg gr: C
Perc abs: H

Acetylacetone ⟶ 2,4-Pentanedione

Acetylene black ⟶ Carbon black

Acetylene tetrabromide ⟶ 1,1,2,2-Tetrabromoethane

Acetylene tetrachloride ⟶ 1,1,2,2-Tetrachloroethane

Acetylpropionyl ⟶ 2,3-Pentanedione

Acrolein

[107-02-8]

$H_2C{=}CH\text{-}CHO$

VP[hPa]: 290
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Acrylaldehyde ⟶ Acrolein

Acrylamide

[79-06-1]

$H_2C{=}CH\text{-}CO\text{-}NH_2$

see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 2

Acrylates and methacrylates

see Section IVe

Acrylic acid

[79-10-7]

$H_2C{=}CH\text{-}COOH$

MAK[ml/m^3]: 10
MAK[mg/m^3]: 30
Peak lim: I(1)
Preg gr: C

Acrylic acid n-butyl ester ⟶ n-Butyl acrylate

Acrylic acid tert-butyl ester ⟶ tert-Butyl acrylate

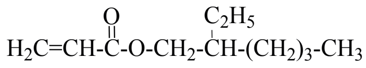
Acrylic acid diester with ethylene glycol ⟶ Triethylene glycol diacrylate

Acrylic acid 2-ethoxyethanol diester ⟶ Diethylene glycol diacrylate

Acrylic acid ethyl ester ⟶ Ethyl acrylate

Acrylic acid 2-ethylhexyl ester

[103-11-7]



$$H_2C{=}CH\text{-}\overset{\overset{\large O}{\|}}{C}\text{-}O\text{-}CH_2\text{-}\overset{\overset{\large C_2H_5}{|}}{C}H\text{-}(CH_2)_3\text{-}CH_3$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.132

MAK[ml/m^3]: 5
MAK[mg/m^3]: 38
Peak lim: I(1)
Preg gr: C
Sens: Sh

Acrylic acid 2-hydroxyethyl ester

[818-61-1]

$H_2C{=}CH\text{-}COO\text{-}C_2H_4OH$

see Section IV
Sens: Sh

Acrylic acid hydroxypropyl ester (all isomers)

[25584-83-2]

$H_2C{=}CH\text{-}COO\text{-}C_3H_6OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.16 at 25℃ (calculated value)
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Acrylic acid isobornyl ester ⟶ Isobornyl acrylate

Acrylic acid methyl ester ⟶ Methyl acrylate

Acrylic acid pentaerythritol triester ⟶ Pentaerythritol triacrylate

Acrylic acid polymer (neutralized, cross-linked)

$(\text{-}CH_2\text{-}CH(COO^-)\text{-})_n$

MAK[mg/m^3]: 0.05 R
Peak lim: I(1)
Preg gr: C
Carc cat: 4

– Sodium polyacrylate

[9003-01-4]

Acrylic acid resin ⟶ Acrylic acid polymer (neutralized, cross-linked)

Acrylic acid tetramethylene ester ⟶ 1,4-Butanediol diacrylate

Acrylic acid 1,1,1-(trihydroxymethyl)propane triester ⟶ Trimethylolpropane triacrylate

Acrylonitrile

[107-13-1]

$$H_2C=CH\text{-}CN$$

VP[hPa]: 116
see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

Actinolite (fibrous dust) ⟶ Asbestos

Adipic acid

[124-04-9]

$$HO_2C\text{-}(CH_2)_4\text{-}CO_2H$$

see Section Xc

MAK[mg/m³]: 2 I
Peak lim: I(2)
Preg gr: C

Aerosols

see Section V

Afara (Terminalia superba) ⟶ Woods

Aflatoxins

[1402-68-2]

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

African blackwood (Dalbergia melanoxylon) ⟶ Woods

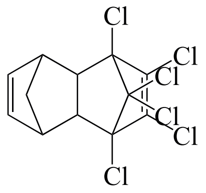
African “cherry” (Tieghemella heckelii) ⟶ Woods

African ebony (Diospyros crassiflora) ⟶ Woods

African whitewood (Triplochiton scleroxylon) ⟶ Woods

Aldrin

[309-00-2]

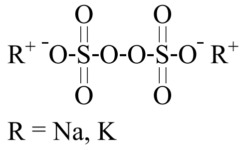


see Section IIc

Alkali chromates ⟶ Chromium(VI) compounds

Alkali citrates ⟶ Citric acid

Alkali persulfates



$$R^+\ {}^-O\text{-}\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}\text{-}O\text{-}O\text{-}\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}\text{-}O^-\ R^+$$

$$R = Na, K$$

see Section IV
Sens: Sah

Alkali salts of benzoic acid ⟶ Benzoic acid alkali salts

(C12–C18)-Alkyl alcohols ⟶ Fatty alcohols, C12–18

Alkyl amines, C11–14-branched, monohexyl and dihexyl phosphates

[80939-62-4]

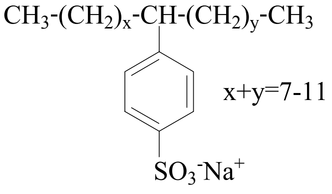
$$H_2N\text{-}C_{11\text{-}14}H_{23\text{-}29} \quad +$$
$$HN(C_{11\text{-}14}H_{23\text{-}29})_2 \quad +$$
$$O=P(OH)_2OC_6H_{13} \quad +$$
$$O=P(OH)(OC_6H_{13})_2$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Alkyl benzenesulfonates C10–C14, linear

[69669-44-9; 85117-50-6]



see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

N-Alkyl-N,N-dimethyl-N-benzylammoniumchloride ⟶ Benzalkonium chloride

Alkyl ether carboxylic acids

$$\mathrm{RO\text{-}(CH_2\text{-}CH_2\text{-}O)_n\text{-}CH_2COOH}$$
$$\mathrm{RO\text{-}(CH(CH_3)\text{-}CH_2\text{-}O)_n\text{-}CH_2COOH}$$
$$\mathrm{R = C_{4\text{-}20},\ n = 2\text{–}10}$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Allyl alcohol

[107-18-6]

$$\mathrm{H_2C{=}CH\text{-}CH_2OH}$$

VP[hPa]: 24

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Allyl chloride

[107-05-1]

$$\mathrm{H_2C{=}CH\text{-}CH_2Cl}$$

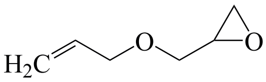
VP[hPa]: 393

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Allyl 2,3-epoxypropyl ether ⟶ Allyl glycidyl ether

Allyl glycidyl ether

[106-92-3]

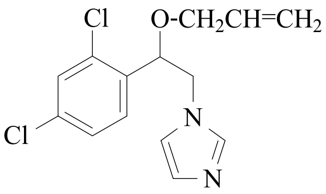


MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

4-Allyl-2-methoxyphenol ⟶ Eugenol

1-(2-Allyloxy)-2-(2,4-dichlorophenyl)ethyl)-1H-imidazole

[35554-44-0]

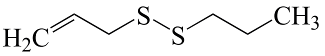


see Section Xc

MAK[mg/m³]: 2 I
Peak lim: II(2)
Preg gr: C
Perc abs: H

★ Allyl propyl disulfide

[2179-59-1]



VP[hPa]: 0.52 at 25℃ (calculated value)
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

★ Aluminium and its poorly soluble compounds

[7429-90-5]
(inhalable fraction)

MAK[mg/m³]: 0.5 I
Peak lim: II(8)
Preg gr: D
Carc cat: 4
Due to particle overload effect in the lungs

★ Aluminium and its poorly soluble compounds

[7429-90-5]
(respirable fraction)

MAK[mg/m³]: 0.05 R
Peak lim: II(8)
Preg gr: D
Carc cat: 4
Due to particle overload effect in the lungs

★ Aluminium compounds, soluble (irritating)

MAK[mg/m³]: 0.0002 I
Peak lim: I(2)
Preg gr: C

★ – Aluminium chloride

[7446-70-0]

$$\mathrm{AlCl_3}$$

★ – Aluminium chloride, basic

[1327-41-9]

$$\mathrm{Al(OH)Cl_2}$$

★ – Aluminum chloride hydroxide sulfate

[39290-78-3]

$Al_2(OH)_2Cl_2SO_4$

★ – Aluminium citrate

[31142-56-0]

$C_6H_5AlO_7$

★ – Aluminium diacetate

[142-03-0]

$Al(CH_3COO)_2(OH)$

★ – Aluminium gluconate

[60007-93-4]

$Al(C_6H_{11}O_7)_3$

★ – Aluminium lactate

[18917-91-4]

$Al(C_3H_5O_3)_3$

★ – Aluminium maltolate

[103616-17-7]

$Al(C_6H_5O_3)_3$

★ – Aluminium nitrate

[13473-90-0]

$Al(NO_3)_3$

★ – Aluminium sulfate

[10043-01-3]

$Al_2(SO_4)_3$

★ Aluminium compounds, soluble (non-irritating)

MAK[mg/m^3]: 0.005 I
Peak lim: II(2)
Preg gr: C

★ – Aluminium ammonium disulfate

[7784-25-0]

$NH_4Al(SO_4)_2$

★ – Aluminium chlorohydrate

[12042-91-0]

$Al_2Cl(OH)_5$

★ – Aluminum potassium sulfate

[10043-67-1]

$AlK(SO_4)_2$

Aluminiumdichloride hydroxide ⟶ Aluminium chloride, basic

α-Aluminium oxide

[1302-74-5]
(corundum)

Al_2O_3

except for aluminium oxide fibres and ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m^3]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

γ-Aluminium oxide ⟶ Aluminium and its poorly soluble compounds

δ-Aluminium oxide ⟶ Aluminium and its poorly soluble compounds

Aluminium oxide

[1344-28-1]
(fibrous dust)

Al_2O_3

see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

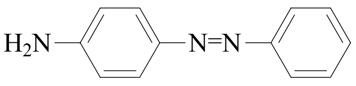
Aluminium silicate fibres

(RCF)
Cristobalite can develop from aluminium silicate fibres used in building materials under thermal load, see documentation.
see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

p-Aminoazobenzene

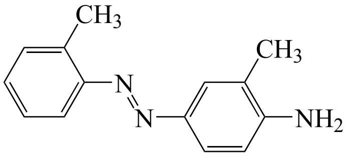
[60-09-3]



see Section IV
Sens: Sh

o-Aminoazotoluene

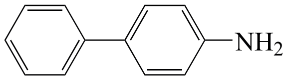
[97-56-3]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 3B

4-Aminobiphenyl

[92-67-1]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.00016 at 25℃ (calculated value)
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

1-Aminobutane ⟶ n-Butylamine

2-Aminobutane ⟶ sec-Butylamine

2-Aminobutanol

[96-20-8]

$HOCH_2\text{-}CH(NH_2)\text{-}CH_2\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.58
see Section Xc

MAK[ml/m^3]: 1
MAK[mg/m^3]: 3.7
Peak lim: II(2)
Preg gr: D
Perc abs: H

1-Amino-4-chlorobenzene ⟶ p-Chloroaniline

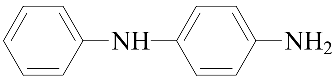
2-Amino-5-chlorotoluene ⟶ 4-Chloro-o-toluidine

Aminocyclohexane ⟶ Cyclohexylamine

1-Amino-3,4-dichlorobenzene ⟶ 3,4-Dichloroaniline

4-Aminodiphenylamine

[101-54-2]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

2-Aminoethanol

[141-43-5]

$H_2NCH_2\text{-}CH_2OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.3

MAK[ml/m^3]: 0.2
MAK[mg/m^3]: 0.51
Peak lim: I(1)
Preg gr: C
Sens: Sh

2-(2-Aminoethoxy)ethanol

[929-06-6]

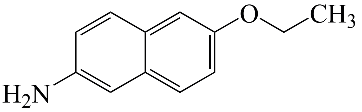
$HO\text{-}(CH_2)_2\text{-}O\text{-}(CH_2)_2\text{-}NH_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.002 at 25℃
see Section Xc

MAK[ml/m^3]: 0.2
MAK[mg/m^3]: 0.87
Peak lim: I(1)
Preg gr: C
Perc abs: H
Sens: Sh

6-Amino-2-ethoxynaphthalene

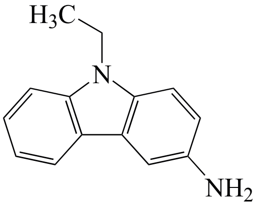
[293733-21-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

3-Amino-9-ethylcarbazole

[132-32-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2-Amino-2-ethyl-1,3-propanediol

[115-70-8]

$(HOCH_2)_2C(C_2H_5)NH_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.6×10^{-3}
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

4-Amino-1-hydroxybenzene ⟶ p-Aminophenol

2-Aminoisobutanol ⟶ 2-Amino-2-methyl-1-propanol

1-Amino-2-methoxy-5-methylbenzene ⟶ 5-Methyl-o-anisidine

3-Amino-4-methoxy-toluene ⟶ 5-Methyl-o-anisidine

4-Amino-1-methylbenzene ⟶ p-Toluidine

1-Amino-2-methylpropane ⟶ Isobutylamine

2-Amino-2-methylpropane ⟶ tert-Butylamine

2-Amino-2-methyl-1-propanol

[124-68-5]

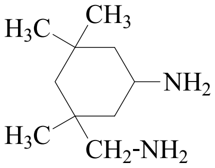
CH_3-C(CH_3)NH_2-CH_2-OH

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.3
see Section Xc

MAK[ml/m^3]: 1
MAK[mg/m^3]: 3.7
Peak lim: II(2)
Preg gr: C
Perc abs: H

3-Aminomethyl-3,5,5-trimethyl-cyclohexylamine (Isophorone diamine)

[2855-13-2]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.02
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

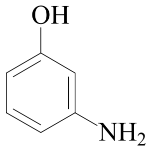
Aminonitrofen ⟶ 4-(2,4-Dichlorophenoxy)benzenamine

4-Amino-2-nitrophenol ⟶ 2-Nitro-4-aminophenol

2-Amino-4-nitrotoluene ⟶ 5-Nitro-o-toluidine

3-Aminophenol

[591-27-5]

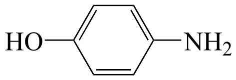


see Section IV
Sens: Sh

4-Aminophenol ⟶ p-Aminophenol

p-Aminophenol

[123-30-8]



see Section IV
Sens: Sh

p-Aminophenol triglycidylether ⟶ Triglycidyl-p-aminophenol

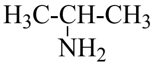
2-[(4-Aminophenyl)-amino]-5-nitrobenzenesulfonic acid ⟶ 4-Nitro-4′-aminodiphenylamine-2-sulfonic acid

4-(4-Aminophenyl)aniline ⟶ Benzidine

2-Aminopropane ⟶ 2-Aminopropane

2-Aminopropane

[75-31-0]



$H_3C\text{-}\underset{NH_2}{CH}\text{-}CH_3$

VP[hPa]: 637

MAK[ml/m³]: 5
MAK[mg/m³]: 12
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 10 ml/m³ (25 mg/m³) should not be exceeded.
Preg gr: C

1-Amino-2-propanol

[78-96-6]

$NH_2\text{-}CH_2\text{-}CHOH\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.6
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine

[2372-82-9]

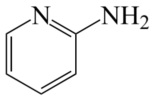
$CH_3\text{-}(CH_2)_{11}\text{-}N((CH_2)_3\text{-}NH_2)_2$

see Section Xc

MAK[mg/m³]: 0.05 I
Peak lim: II(8)
Preg gr: C

2-Aminopyridine

[504-29-0]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13 at 25℃ (calculated value)
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

4-Aminotoluene ⟶ p-Toluidine

3-Amino-p-toluidine ⟶ 2,4-Toluenediamine

5-Amino-o-toluidine ⟶ 2,4-Toluenediamine

3-Amino-1,2,4-triazole ⟶ Amitrole

Aminotris(methylenephosphonic acid)

[6419-19-8]
and its sodium salts

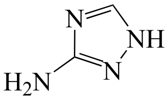
$N(CH_2PO_3R_2)_3$
$R = H, Na$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Amitrole

[61-82-5]



MAK[mg/m³]: 0.2 I
Peak lim: II(8)
Preg gr: C
Perc abs: H
Carc cat: 4

Ammonia

[7664-41-7]

NH_3

VP[hPa]: 8570

MAK[ml/m³]: 20
MAK[mg/m³]: 14
Peak lim: I(2)
Preg gr: C

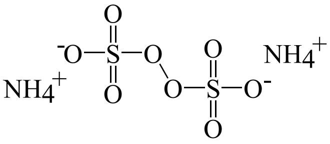
Ammonium molybdate ⟶ Molybdenum

Ammonium perfluorooctanoate ⟶ Perfluorooctanoic acid (PFOA)

Ammonium peroxydisulfate ⟶ Ammonium persulfate

Ammonium persulfate

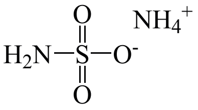
[7727-54-0]



see Section IV
Sens: Sah

Ammonium sulfamate

[7773-06-0]



$H_2N-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-O^- \quad NH_4^+$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Amorphous carbon ⟶ Carbon black

Amosite (fibrous dust) ⟶ Asbestos

Amyl acetate (all isomers)

$H_3C\text{-}COOC_5H_{11}$

VP[hPa]: <10

MAK[ml/m^3]: 50
MAK[mg/m^3]: 270
Peak lim: I(1)

– 1,1-Dimethylpropyl acetate

[625-16-1]

$CH_3COO-C(CH_3)_2CH_2CH_3$

Preg gr: D

– 1-Methylbutyl acetate

[626-38-0]

$CH_3COO-CH(CH_3)(CH_2)_2CH_3$

VP[hPa]: 9.3
Preg gr: D

– 2-Methylbutyl acetate

[624-41-9]

$CH_3COO-CH_2CH(CH_3)CH_2CH_3$

Preg gr: C

– 3-Methylbutyl acetate

[123-92-2]

$CH_3COO-(CH_2)_2CH(CH_3)_2$

VP[hPa]: 5.3
Preg gr: D

– 1-Pentyl acetate

[628-63-7]

$CH_3COO-(CH_2)_4CH_3$

VP[hPa]: 5.3
Preg gr: C

– 3-Pentyl acetate

[620-11-1]

$CH_3COO-CH(CH_2CH_3)_2$

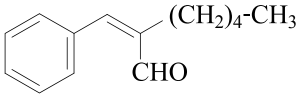
Preg gr: D

Amyl alcohol ⟶ Pentanol (isomers)

α-Amylase
see Section IV
Sens: Sa

α-Amylcinnamaldehyde

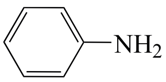
[122-40-7]



The substance can occur simultaneously as vapour and aerosol.
see Section IV
Sens: Sh

★ **Aniline**

[62-53-3]



VP[hPa]: 0.68
see Section XII

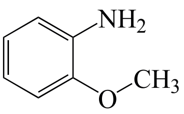
MAK[ml/m^3]: 2
MAK[mg/m^3]: 7.7
Peak lim: II(2)
Preg gr: B
Perc abs: H
Sens: Sh
Carc cat: 4

Aniline yellow ⟶ p-Aminoazobenzene

Animal hair, epithelia and other materials derived from animals
see Section IV
Sens: Sah

o-Anisidine

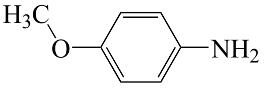
[90-04-0]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

p-Anisidine

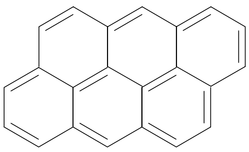
[104-94-9]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Anthanthrene

[191-26-4]



see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Anthophyllite (fibrous dust) ⟶ Asbestos

Anthracite dust ⟶ Coal mine dust

Antibiotics

see Section IVe

Antimony

[7440-36-0]
and its inorganic compounds (except for stibine)

Sb

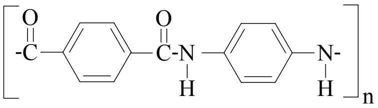
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2
Muta cat: 3A

ANTU ⟶ 1-Naphthylthiourea

p-Aramid

[26125-61-1]
(fibrous dust)



see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Arborvitae (Thuja spp.) ⟶ Woods

Arprocarb ⟶ Propoxur

Arsenic ⟶ Phenyl arsenic compounds

Arsenic

[7440-38-2]
and inorganic arsenic compounds (except for arsine)
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
arsenic and gallium arsenide are not designated with "H"
Carc cat: 1
Muta cat: 3A

– Metallic arsenic

[7440-38-2]

As

– Arsenic trioxide

[1327-53-3]

As_2O_3

– Arsenous acid

[13464-58-9]
and its salts, e.g.

H_3AsO_3

– Sodium arsenite

[7784-46-5]

$NaAsO_2$

– Arsenic pentoxide

[1303-28-2]

As_2O_5

– Arsenic acid

[7778-39-4]
and its salts, e.g.

H_3AsO_4

– Lead arsenate

[3687-31-8]

$Pb_3(AsO_4)_2$

– Calcium arsenate

[7778-44-1]

$Ca_3(AsO_4)_2$

– Gallium arsenide

[1303-00-0]

GaAs

Arsenic(III) oxide ⟶ Arsenic

Arsenic(V) oxide ⟶ Arsenic

Arsine

[7784-42-1]

AsH_3

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Artificial almond oil ⟶ Benzaldehyde

Asbestos

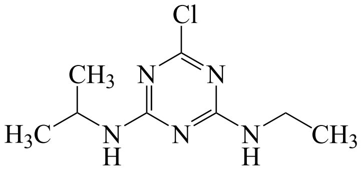
[1332-21-4]
(fibrous dust)
Actinolite, Amosite, Anthophyllite, Chrysotile, Crocidolite and Tremolite
see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 1
Cigarette smokers bear an increased risk of bronchial cancer.

Asphalt ⟶ Bitumen (high-temperature processing, vapours and aerosols)

Atrazine

[1912-24-9]



MAK[mg/m³]: 1 I
Peak lim: II(2)
Preg gr: C

Attapulgite

[12174-11-7]
(fibrous dust)

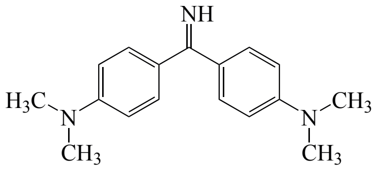
$Mg_5\text{-}Si_8\text{-}O_{20}(OH)_2(H_{20})_4 \cdot 4\ H_2O$

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Auramine

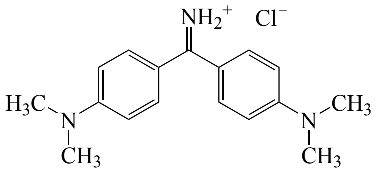
[492-80-8]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Auramine hydrochloride

[2465-27-2]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Australian blackwood (Acacia melanoxylon) ⟶ Woods

Australian silky oak (Grevillea robusta) ⟶ Woods

Ayan (Distemonanthus benthamianus) ⟶ Woods

Azelaic acid

[123-99-9]

$HO_2C\text{-}(CH_2)_7\text{-}CO_2H$

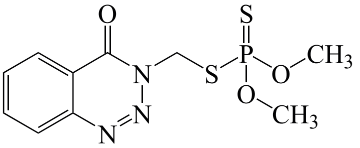
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Azepan-2-one ⟶ ε-Caprolactam

Azinphos-methyl

[86-50-0]



MAK[mg/m^3]: 1 I
Peak lim: II(8)
Preg gr: B
Note regarding prerequisite for Group C see documentation
Perc abs: H
Sens: Sh

Aziridine ⟶ Ethylenimine

Azobiscarbamide ⟶ Azodicarbonamide

Azo colourants

see also Pigment Yellow
see Section III

Azodicarbonamide

[123-77-3]

$H_2N\text{-}CO\text{-}N{=}N\text{-}CO\text{-}NH_2$

MAK[mg/m^3]: 0.02 I
Peak lim: I(1)
Preg gr: D

1,1′-Azodiformamide ⟶ Azodicarbonamide

Azoimide ⟶ Hydrazoic acid

Barium compounds, soluble

(as Ba [7440-39-3])
see Section XII

MAK[mg/m^3]: 0.5 I
Peak lim: II(8)
Preg gr: D

Barium sulfate

[7727-43-7]
(inhalable fraction)

$BaSO_4$

see Section Vf and g

MAK[mg/m^3]: 4 I
Preg gr: C

Barium sulfate

[7727-43-7]
(respirable fraction)

$BaSO_4$

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m^3]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Beech wood dust

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1
Dusts have been shown epidemiologically to be unequivocally carcinogenic. The active carcinogenic principle has not been identified to date.

Behenic acid

[112-85-6]

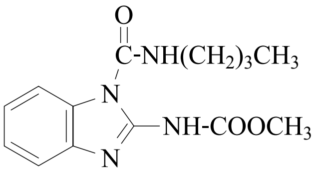
$CH_3(CH_2)_{20}COOH$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Benomyl

[17804-35-2]



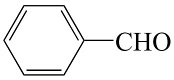
Sens: Sh
Muta cat: 3A

Bentonite ⟶ Montmorillonite

Benzal chloride ⟶ Benzyl dichloride

Benzaldehyde

[100-52-7]

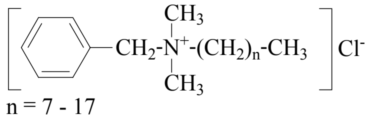


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Benzalkonium chloride

[8001-54-5]

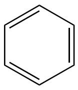


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Benzene

[71-43-2]



VP[hPa]: 101
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

1,2-Benzenedicarboxylic acid ⟶ o-Phthalic acid

1,2-Benzenedicarboxylic acid, diisodecylester ⟶ Diisodecyl phthalate

Benzenedicarboxylic acid dibutyl ester ⟶ Di-n-butyl phthalate

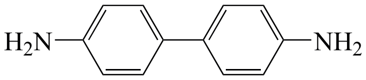
1,2-Benzenedicarboxylic acid di-2-propenyl ester ⟶ Diallyl phthalate

1,3-Benzenediol ⟶ Resorcinol

1,2,4-Benzenetricarboxylic acid 1,2-anhydride ⟶ Trimellitic anhydride

Benzidine

[92-87-5]
and its salts



see Section XII

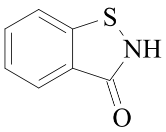
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

Benzilidene chloride ⟶ Benzyl dichloride

1H-Benzimidazole-2-carbamic acid methyl ester ⟶ Carbendazim

1,2-Benzisothiazol-3(2H)-one

[2634-33-5]

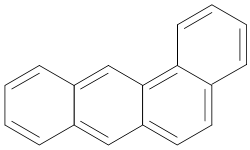


see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Benzo[a]anthracene

[56-55-3]

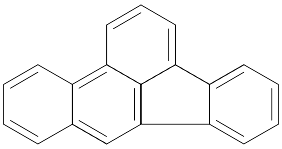


see Section III, "pyrolysis products of organic materials"

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3A

Benzo[b]fluoranthene

[205-99-2]

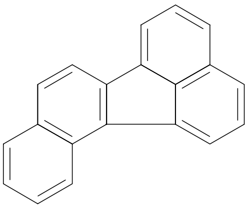


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Benzo[j]fluoranthene

[205-82-3]

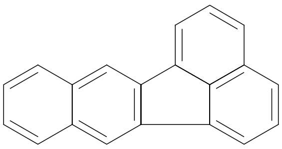


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Benzo[k]fluoranthene

[207-08-9]

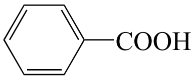


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Benzoic acid

[65-85-0]
(inhalable fraction)
see also Benzoic acid alkali salts

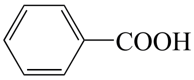


The substance can occur simultaneously as vapour and aerosol.
Causes pseudoallergic reactions, see documentation.
VP[hPa]: 9×10^{-4} at 25°C
see Section Xc

MAK[ml/m^3]: 0.39
MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: C
Perc abs: H

Benzoic acid

[65-85-0]
(respirable fraction)
see also Benzoic acid alkali salts



The substance can occur simultaneously as vapour and aerosol.
Causes pseudoallergic reactions, see documentation.
VP[hPa]: 9×10^{-4} at 25°C
see Section Xc

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.5 R
Peak lim: II(4)
Preg gr: C
Perc abs: H

Benzoic acid alkali salts

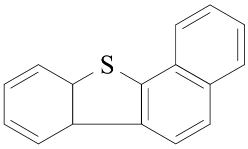
(as benzoate) see also Benzoic acid
Causes pseudoallergic reactions, see documentation.

MAK[mg/m^3]: 10 I
Peak lim: II(2)
Preg gr: C
Perc abs: H

Benzoic aldehyde ⟶ Benzaldehyde

Benzo[b]naphtho[2,1-d]thiophene

[239-35-0]

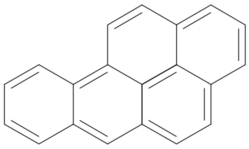


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Benzo[a]pyrene

[50-32-8]



see Section III, “pyrolysis products of organic materials”

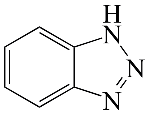
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 2

p-Benzoquinone ⟶ Quinone

3H-1,3-Benzothiazol-2-thione ⟶ 2-Mercaptobenzothiazole

Benzotriazole

[95-14-7]



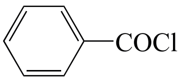
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 6.89×10^{-2} at 25℃
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Benzotrichloride ⟶ Benzyl trichloride

Benzoyl chloride

[98-88-4]
see also α-Chlorinated toluenes



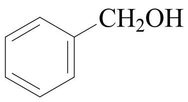
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.5

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Benzoyl peroxide ⟶ Dibenzoyl peroxide

Benzyl alcohol

[100-51-6]

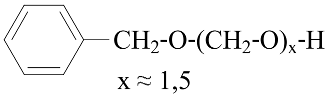


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13 at 25℃ (calculated value)
see Section Xc

MAK[ml/m^3]: 5
MAK[mg/m^3]: 22
Peak lim: I(2)
Preg gr: C
Perc abs: H

Benzyl alcohol mono(poly)hemiformal

[14548-60-8]

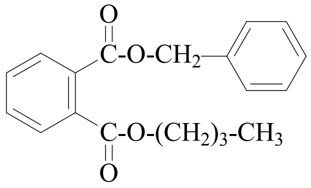


releases formaldehyde
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Benzylbutyl phthalate

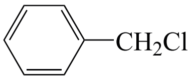
[85-68-7]



MAK[mg/m^3]: 20 I
Peak lim: II(2)
Preg gr: C

Benzyl chloride

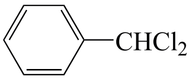
[100-44-7]
see also α-Chlorinated toluenes



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Benzyl dichloride

[98-87-3]
see also α-Chlorinated toluenes

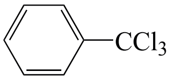


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.5

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

Benzyl trichloride

[98-07-7]
see also α-Chlorinated toluenes



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.2

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

Beryllium

[7440-41-7]
and its inorganic compounds

Be

see Section XII

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Sens:	Sah
Carc cat:	1

Bété (Mansonia altissima) ⟶ Woods

Bethabara (Tabebuia serratifolia) ⟶ Woods

BHT ⟶ Butylated hydroxytoluene

Biacetyl ⟶ Diacetyl

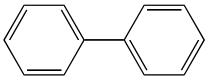
N,N′-Bianiline ⟶ Hydrazobenzene

Biformyl ⟶ Glyoxal

2,2′-Bioxirane ⟶ Diepoxybutane

Biphenyl

[92-52-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.012 at 25℃

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	3

3,3′,4,4′-Biphenyltetramine ⟶ 3,3′-Diaminobenzidine and its tetrahydrochloride

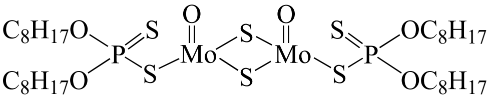
Bis(2-aminoethyl)amine ⟶ Diethylenetriamine

N,N′-Bis(2-aminoethyl)-1,2-ethanediamine ⟶ Triethylenetetramine

1,3-Bis(aminomethyl)benzene ⟶ m-Xylylenediamine

Bis[O,O-bis(2-ethylhexyl) dithiophosphorato-S,S′]-dioxodi-μ-thioxodimolybdenum

[68958-92-9; 72030-25-2]



VP[hPa]: $<1.5\times10^{-5}$
see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Bis[O,O-bis(2-ethylhexyl)phosphorodithioato-S,S′]-zinc ⟶ Zinc, O,O′-di-2-ethylhexyl dithiophosphate

Bis(2-chloroethyl)ether ⟶ 2,2′-Dichlorodiethyl ether

Bis(2-chloroethyl)sulfide ⟶ Bis(β-chloroethyl)sulfide (mustard gas)

Bis(β-chloroethyl)sulfide (mustard gas)

[505-60-2]

$ClCH_2\text{-}CH_2\text{-}S\text{-}CH_2\text{-}CH_2Cl$

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	1

Bischloromethyl ether

(Dichlorodimethylether)
[542-88-1]

$$ClCH_2\text{-}O\text{-}CH_2Cl$$

not to be confused with the asymmetric (Dichloromethyl)methyl ether

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 1

4,4′-Bis(dimethylamino)benzophenone → Michler's ketone

3,5-Bis(1,1-dimethylethyl)-4-hydroxybenzenepropanoic acid octadecyl ester → 3,5-Di-tert-butyl-4-hydroxyphenylpropionic acid octadecyl ester

3,5-Bis(1,1-dimethylethyl)-4-hydroxybenzenepropanoic acid thiodi-2,1-ethanediyl ester → 2,2′-Thiodiethylene Bis[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate]

Bis[dimethyltin(isooctylmercaptoacetate)]sulfide → Methyltin compounds

Bis[dimethyltin(2-mercaptoethyloleate)]sulfide → Methyltin compounds

1,3-Bis(2,3-epoxypropoxy)benzene → Diglycidyl resorcinol ether

1,4-Bis(2,3-epoxypropoxy)butane → 1,4-Butanediol diglycidyl ether

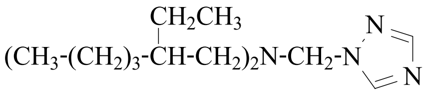
2,2-Bis(4-(2,3-epoxypropyloxy)phenyl)propane → Bisphenol A diglycidyl ether

S-1,2-Bis(ethoxycarbonyl)ethyl-O,O-dimethyl thiophosphate → Malathion

Bis(2-ethylhexoxy)-sulfanylidene-sulfido-λ5-phosphane;molybdenum → Bis[O,O-bis(2-ethylhexyl) dithiophosphorato-S,S′]dioxodi-μ-thioxodimolybdenum

N,N-Bis(2-ethylhexyl)-(1,2,4-triazole-1-yl)methanamine

[91273-04-0]



releases formaldehyde
The substance can occur simultaneously as vapour and aerosol.
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh

2,2-Bis(p-glycidyloxyphenyl)propane → Bisphenol A diglycidyl ether

1,2-Bis(2-hydroxyethoxy)ethane → Triethylene glycol

Bis(2-hydroxyethyl)ether → Diethylene glycol

2-[3,5-Bis(2-hydroxyethyl)-1,3,5-triazinan-1-yl]ethanol → N,N′,N″-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine

Bis(hydroxymethyl)acetylene → Butynediol

1,3-Bis(hydroxymethyl)-5,5-dimethyl-2,4-imidazolidinedione → 1,3-Dimethylol-5,5-dimethyl hydantoin

★ 1,3-Bis(hydroxymethyl)urea

[140-95-4]

$$(HOCH_2\text{-}NH)_2CO$$

releases formaldehyde
VP[hPa]: $<1\times10^{-6}$
see Section Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

2,2-Bis(4-hydroxyphenyl)propane → Bisphenol A

1-[3,5-Bis(2-hydroxypropyl)-1,3,5-triazinan-1-yl]propan-2-ol → N,N′,N″-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine

Bis(1-hydroxy-2(1H)-pyridinthionato)zinc → Zinc pyrithione

1,2-Bis(2-(methacryloyloxy)ethoxy)ethane → Triethylene glycol dimethacrylate

Bis(2-methoxyethyl)ether → Diethylene glycol dimethyl ether

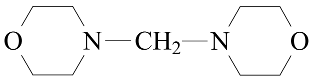
Bis(2-methoxypropyl)ether → Dipropylene glycol monomethyl ether

Bis[methyltin di(isooctylmercaptoacetate)]sulfide → Methyltin compounds

Bis[methyltin di(2-mercaptoethyloleate)]sulfide → Methyltin compounds

★ Bismorpholino methane

[5625-90-1]

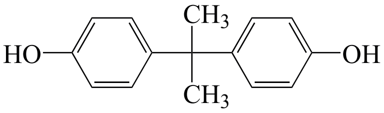


releases formaldehyde
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.00625 at 25℃ (calculated value)
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

Bisphenol A

(4,4′-Isopropylidenediphenol)
[80-05-7]

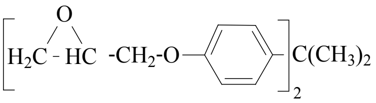


see Section XII

MAK[mg/m^3]: 5 I
Peak lim: I(1)
Preg gr: C
Sens: SP

Bisphenol A diglycidyl ether

[1675-54-3]

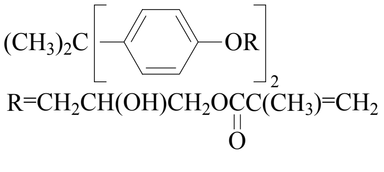


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Bisphenol A diglycidyl methacrylate

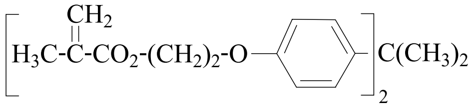
[1565-94-2]



see Section IV
Sens: Sh

Bisphenol A ethoxylate dimethacrylate

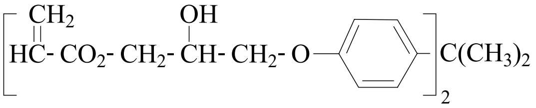
[24448-20-2]



see Section IV
Sens: Sh

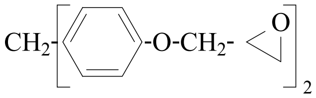
Bisphenol A glycerolate

[4687-94-9]



see Section IV
Sens: Sh

Bisphenol F diglycidyl ether



see Section IV
Sens: Sh

– o,o′-Bisphenol F diglycidylether

[54208-63-8]

– o,p′-Bisphenol F diglycidylether

[57469-07-5]

– p,p′-Bisphenol F diglycidyl ether

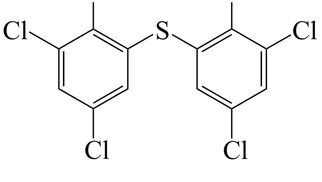
[2095-03-6]

1,4-Bis(phenylamino)benzene ⟶ N,N-Diphenyl-p-phenylenediamine

Bis(1-piperidylthiocarboxyl) disulfide ⟶ Dipentamethylenethiuram disulfide

Bithionol

[97-18-7]



see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: SP

Bitumen (high-temperature processing, vapours and aerosols)

[8052-42-4; 64741-56-6/64742-93-4]
(straight-run bitumen, air-rectified bitumen)
can occur simultaneously as vapour and aerosol
VP[hPa]: <1

MAK[ml/m^3]: –
MAK[mg/m^3]: 1.5
Sum of vapour and inhalable fraction based on bitumen condensate standard
Peak lim: II(2)
Preg gr: D
Perc abs: H
Carc cat: 3

Bitumen (high-temperature processing, vapours and aerosols)

[64742-93-4]
(bitumen, oxidized)
can occur simultaneously as vapour and aerosol

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Black coal dust ⟶ Coal mine dust

Bombay blackwood (Dalbergia latifolia) ⟶ Woods

Borax ⟶ Boric acid

Boric acid

[10043-35-3]
and tetraborates

– Boric acid

[10043-35-3]

$B(OH)_3$

see Section Xc

MAK[mg/m^3]: 10 I
when boric acid and tetraborates are present together, the MAK value is 0.75 mg boron/m^3
Peak lim: I(1)
Preg gr: B

– Sodium tetraborate pentahydrate

[12179-04-3]

MAK[mg/m^3]: 5 I
Peak lim: I(1)
Preg gr: C

– Tetraborates

as Boron [7440-42-8]

MAK[mg/m^3]: 0.75 I
Peak lim: I(1)
Preg gr: C

Boron oxide

[1303-86-2]

B_2O_3

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Boron trifluoride

[7637-07-2]

BF_3

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Bowdichia nitida ⟶ Woods

Brazilian rosewood (Dalbergia nigra) ⟶ Woods

Bromelain

[9001-00-7]
see Section IV
Sens: Sa

Bromine

[7726-95-6]

Br_2

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2-Bromo-2-(bromomethyl)glutaronitrile ⟶ 1,2-Dibromo-2,4-dicyanobutane

2-Bromo-2-(bromomethyl)pentanedinitrile ⟶ 1,2-Dibromo-2,4-dicyanobutane

Bromochloromethane

[74-97-5]

CH_2BrCl

VP[hPa]: 147

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

2-Bromo-2-chloro-1,1,1-trifluoroethane ⟶ Halothane

Bromodichloromethane

[75-27-4]

$CHBrCl_2$

Perc abs: H
Carc cat: 2
Muta cat: 3B

Bromoethane

[74-96-4]

$H_3C\text{-}CH_2Br$

VP[hPa]: 507

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Bromoform ⟶ Tribromomethane

Bromomethane

(Methyl bromide)
[74-83-9]

CH_3Br

see Section XII

MAK[ml/m^3]: 1
MAK[mg/m^3]: 3.9
Peak lim: I(2)
Preg gr: C
Carc cat: 3

2-Bromo-2-nitro-1,3-propanediol

[52-51-7]

$HOCH_2\text{-}CBr(NO_2)\text{-}CH_2OH$

releases formaldehyde
use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh

1-Bromopropane

[106-94-5]

$BrCH_2\text{-}CH_2\text{-}CH_3$

see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Bromotrifluoromethane

[75-63-8]

$BrCF_3$

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 6200
Peak lim: II(8)
Preg gr: C

Brown coal tars

(soft coal tars)
see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1

Brucite (fibrous dust) ⟶ Nemalite

Brya ebenus ⟶ Woods

1,3-Butadiene

[106-99-0]

$H_2C{=}CH\text{-}CH{=}CH_2$

VP[hPa]: 2477
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1
Muta cat: 2

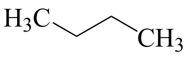
1,3-Butadiene diepoxide ⟶ Diepoxybutane

Butane (both isomers)

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 2400
Peak lim: II(4)
Preg gr: D

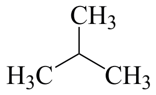
– n-Butane

[106-97-8]



– Isobutane

[75-28-5]



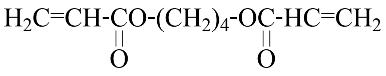
1,4-Butanedicarboxylic acid ⟶ Adipic acid

1,4-Butane diglycidyl ether ⟶ 1,4-Butanediol diglycidyl ether

Butanedioic acid ⟶ Succinic acid

1,4-Butanediol diacrylate

[1070-70-8]

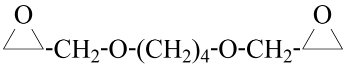


$$H_2C{=}CH\text{-}\underset{\underset{O}{\|}}{C}O\text{-}(CH_2)_4\text{-}O\underset{\underset{O}{\|}}{C}\text{-}HC{=}CH_2$$

see Section IV
Sens: Sh

1,4-Butanediol diglycidyl ether

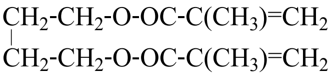
[2425-79-8]



see Section IV
Sens: Sh

1,4-Butanediol dimethacrylate

[2082-81-7]



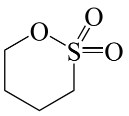
$$\begin{array}{l} CH_2\text{-}CH_2\text{-}O\text{-}OC\text{-}C(CH_3){=}CH_2 \\ | \\ CH_2\text{-}CH_2\text{-}O\text{-}OC\text{-}C(CH_3){=}CH_2 \end{array}$$

see Section IV
Sens: Sh

2,3-Butanedione ⟶ Diacetyl

1,4-Butane sultone

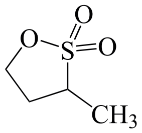
[1633-83-6]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2,4-Butane sultone

[1121-03-5]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Butane sultone ⟶ 1,4-Butane sultone

1-Butanethiol

[109-79-5]

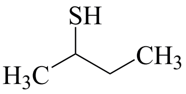
$H_3C\text{-}(CH_2)_2\text{-}CH_2SH$

VP[hPa]: 40

MAK[ml/m^3]: 1
MAK[mg/m^3]: 3.7
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: II(2)
Preg gr: C
Perc abs: H
Sens: Sh

2-Butanethiol

[513-53-1]



VP[hPa]: 108 at 25°C

MAK[ml/m^3]: 2
MAK[mg/m^3]: 7.5
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: II(2)
Preg gr: D
Perc abs: H

tert-Butanol

[75-65-0]

$(H_3C)_3COH$

VP[hPa]: 40.8

MAK[ml/m^3]: 20
MAK[mg/m^3]: 62
Peak lim: II(4)
Preg gr: C

1-Butanol

[71-36-3]

$H_3C-(CH_2)_2-CH_2OH$

VP[hPa]: 6.3
see Section XII

MAK[ml/m^3]: 100
MAK[mg/m^3]: 310
Peak lim: I(1)
Preg gr: C

2-Butanol

[78-92-2]

$H_3C-CH_2-CHOH-CH_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Butanol-2-amine ⟶ 2-Aminobutanol

2-Butanone

(Methyl ethyl ketone)
[78-93-3]

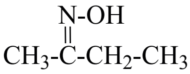
$H_3C-CH_2-CO-CH_3$

VP[hPa]: 105
see Section XII

MAK[ml/m^3]: 200
MAK[mg/m^3]: 600
Peak lim: I(1)
Preg gr: C
Perc abs: H

Butanone oxime

[96-29-7]



$$\underset{CH_3-C-CH_2-CH_3}{\overset{N-OH}{\|}}$$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

2-Butanone peroxide ⟶ Methyl ethyl ketone peroxide

δ-Butan sultone ⟶ 1,4-Butane sultone

2-Butenal (trans-) ⟶ Crotonaldehyde

1,2-Butene oxide ⟶ 1,2-Butylene oxide

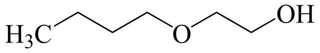
Butoxydiglycol ⟶ Diethylene glycol monobutyl ether

1-n-Butoxy-2,3-epoxypropane ⟶ n-Butyl glycidyl ether (BGE)

1-tert-Butoxy-2,3-epoxypropane ⟶ tert-Butyl glycidyl ether

2-Butoxyethanol

[111-76-2]



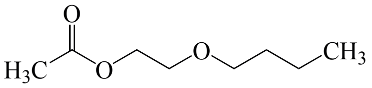
VP[hPa]: 0.8
see Section XII

MAK[ml/m^3]: 10
MAK[mg/m^3]: 49
MAK value applies for the sum of the concentrations of 2-butoxyethanol and 2-butoxyethyl acetate in the air.
Peak lim: I(2)
Preg gr: C
Perc abs: H

2-(2-Butoxyethoxy)-ethanol ⟶ Diethylene glycol monobutyl ether

2-Butoxyethyl acetate

[112-07-2]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.4
see Section XII

MAK[ml/m^3]: 10
MAK[mg/m^3]: 66
MAK value applies for the sum of the concentrations of 2-butoxyethanol and 2-butoxyethyl acetate in the air.
Peak lim: I(2)
Preg gr: C
Perc abs: H

n-Butyl acetate

[123-86-4]

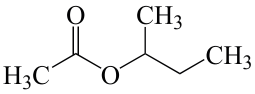
$H_3C-COOCH_2-(CH_2)_2-CH_3$

VP[hPa]: 13.3

MAK[ml/m^3]: 100
MAK[mg/m^3]: 480
Peak lim: I(2)
Preg gr: C

sec-Butyl acetate

[105-46-4]



see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

tert-Butyl acetate

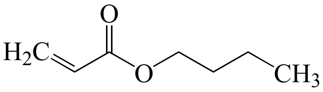
[540-88-5]

$H_3C\text{-}COOC(CH_3)_3$

MAK[ml/m^3]: 20
MAK[mg/m^3]: 96
Peak lim: II(2)
Preg gr: C

n-Butyl acrylate

[141-32-2]

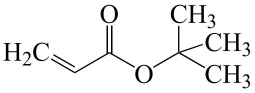


VP[hPa]: 5 at 22.2℃

MAK[ml/m^3]: 2
MAK[mg/m^3]: 11
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
Preg gr: C
Perc abs: H
Sens: Sh

tert-Butyl acrylate

[1663-39-4]



see Section IV
Sens: Sh

n-Butyl alcohol ⟶ 1-Butanol

sec-Butyl alcohol ⟶ 2-Butanol

tert-Butyl alcohol ⟶ tert-Butanol

n-Butylamine

[109-73-9]

$H_3C\text{-}(CH_2)_2\text{-}CH_2NH_2$

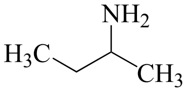
VP[hPa]: 122-128 at 25℃

MAK[ml/m^3]: 2
MAK[mg/m^3]: 6.1
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m^3 (15 mg/m^3) should not be exceeded.
Preg gr: C

2-Butylamine ⟶ sec-Butylamine

sec-Butylamine

[13952-84-6]



MAK[ml/m^3]: 2
MAK[mg/m^3]: 6.1
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m^3 (15 mg/m^3) should not be exceeded.
Preg gr: D

tert-Butylamine

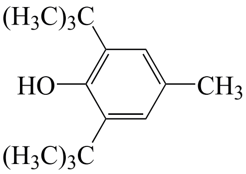
[75-64-9]

$(H_3C)_3CNH_2$

MAK[ml/m^3]: 2
MAK[mg/m^3]: 6.1
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m^3 (15 mg/m^3) should not be exceeded.
Preg gr: D

Butylated hydroxytoluene

(BHT)
[128-37-0]

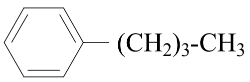


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.9×10^{-3} at 25℃
see Section Xc

MAK[mg/m^3]: 10 I
Peak lim: II(4)
Preg gr: C
Carc cat: 4

n-Butylbenzene

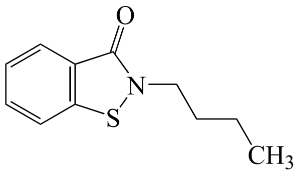
[104-51-8]



MAK[ml/m^3]: 10
MAK[mg/m^3]: 56
Peak lim: II(2)
Preg gr: D
Perc abs: H

2-Butyl-1,2-benzisothiazolin-3-one

[4299-07-4]

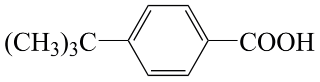


VP[hPa]: 0.00015 at 25℃
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

p-tert-Butylbenzoic acid

[98-73-7]



see Section Xc

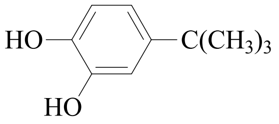
MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: D
Perc abs: H

Butylcarbamic acid 3-iodo-2-propynyl ester ⟶ 3-Iodo-2-propynyl butylcarbamate

1-(Butylcarbamoyl)-2-benzimidazolecarbamic acid methyl ester ⟶ Benomyl

p-tert-Butylcatechol

[98-29-3; 27213-78-1]

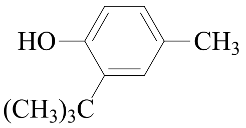


see Section IV
Sens: Sh

n-Butyl chloroformate ⟶ Chloroformic acid butyl ester

2-tert-Butyl-p-cresol

[2409-55-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.02
see Section IIb

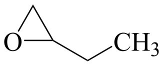
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Butyldiglycol ⟶ Diethylene glycol monobutyl ether

1,4-Butylene glycol diacrylate ⟶ 1,4-Butanediol diacrylate

1,2-Butylene oxide

[106-88-7]

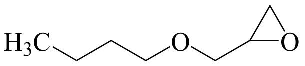


VP[hPa]: 188

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

n-Butyl glycidyl ether (BGE)

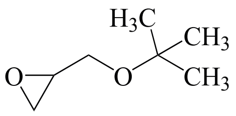
[2426-08-6]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3
Muta cat: 2

tert-Butyl glycidyl ether

[7665-72-7]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

Butyl glycol acetate ⟶ 2-Butoxyethyl acetate

Butyl glycolate ⟶ Hydroxyacetic acid butyl ester

tert-Butyl hydroperoxide

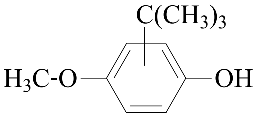
[75-91-2]

$(H_3C)_3C\text{-}OOH$

see Section Xa

tert-Butyl-4-hydroxyanisole (BHA)

[25013-16-5]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.3×10^{-3} at 25℃
see Section Xc

MAK[mg/m³]: 20 I
Peak lim: II(1)
Preg gr: C
Carc cat: 3

Butyl mercaptan ⟶ 1-Butanethiol

n-Butyl methacrylate

[97-88-1]

$CH_3\text{-}(CH_2)_3\text{-}O\text{-}OC\text{-}C(CH_3)\text{=}CH_2$

see Section IV
Sens: Sh

tert-Butyl methyl

ether ⟶ Methyl tert-butyl ether

tert-Butyl peracetate

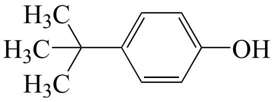
[107-71-1]

$H_3C\text{-}CO\text{-}OO\text{-}C(CH_3)_3$

see Section Xa

p-tert-Butylphenol

[98-54-4]



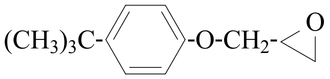
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.051 at 25℃
see Section XII

MAK[ml/m³]: 0.080
MAK[mg/m³]: 0.5
Peak lim: II(2)
Preg gr: D
Perc abs: H
Sens: Sh

p-tert-Butylphenol ⟶ Formaldehyde condensation products with p-tert-butylphenol

p-tert-Butylphenyl glycidyl ether

[3101-60-8]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 2.5×10^{-4}
see Section IV
Sens: Sh

p-tert-Butylphenyl-1-(2,3-epoxy)propyl ether ⟶ p-tert-Butylphenyl glycidyl ether

2-tert-Butyl-6-(3-tert-butyl-2-hydroxy-5-methylphenyl) sulfanyl-4-methylphenol ⟶ 2,2′-Thiobis(4-methyl-6-tert-butylphenol)

n-Butyltin compounds

(as Sn [7440-31-5])
The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m³]: 0.004
MAK[mg/m³]: 0.02
Peak lim: I(1)
Sens: –
For butyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.
Carc cat: 4

– Mono-n-butyltin compounds

Preg gr: C

– Di-n-butyltin compounds

Preg gr: B

– Tri-n-butyltin compounds

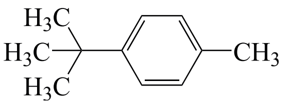
Preg gr: B

– Tetra-n-butyltin

[1461-25-2]
Preg gr: C

p-tert-Butyl toluene

[98-51-1]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.87
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Butynediol

[110-65-6]

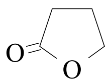
$HO\text{-}CH_2\text{-}C\equiv C\text{-}CH_2\text{-}OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.7×10^{-3}

MAK[ml/m³]: 0.1
MAK[mg/m³]: 0.36
Peak lim: I(1)
Preg gr: C
Perc abs: H
Sens: Sh

γ-Butyrolactone

[96-48-0]



see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Cadmium

[7440-43-9]
and its inorganic compounds (inhalable fraction)

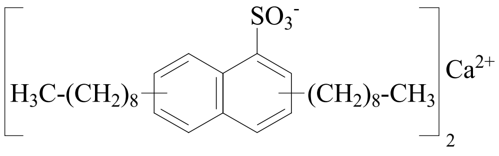
Cd

see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

Calcium bis(dinonylnaphthalenesulphonate)

[57855-77-3]



see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Calcium hydroxide

[1305-62-0]

$Ca(OH)_2$

see Section Xc

MAK[mg/m³]: 1 I
Peak lim: I(2)
Preg gr: C

Calcium arsenate → Arsenic

Calcium carbimide → Calcium cyanamide

Calcium chromate → Chromium(VI) compounds

Calcium cyanamide

[156-62-7]

$CaCN_2$

MAK[mg/m³]: 1 I
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H

Calcium molybdate → Molybdenum

Calcium oxide

[1305-78-8]

CaO

MAK[mg/m³]: 1 I
Peak lim: I(2)
Preg gr: C

Calcium petroleum sulfonates → Petroleum sulfonates, calcium salts (technical mixture in mineral oil)

Calcium sodium metaphosphate

[23209-59-8]
(fibrous dust)

$x\ CaO \cdot x\ Na_2O \cdot P_2O_5$

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Calcium sulfate

(inhalable fraction)
Anhydrite [7778-18-9]
Hemihydrate [10034-76-1]
Dihydrate [10101-41-4]
Gypsum [13397-24-5]

$CaSO_4$

see Section Vf and g

MAK[mg/m^3]: 4 I
Preg gr: C

Calcium sulfate

(respirable fraction)
Anhydrite [7778-18-9]
Hemihydrate [10034-76-1]
Dihydrate [10101-41-4]
Gypsum [13397-24-5]

$CaSO_4$

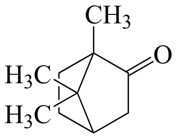
see Section IIb

MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Calocedrus decurrens ⟶ Woods

Camphor

[76-22-2]

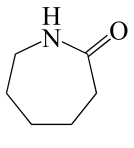


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.027
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

ε-Caprolactam

[105-60-2]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.0013

MAK[ml/m^3]: 0.42
MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: C
Perc abs: H

Carbamic acid ethyl ester

[51-79-6]

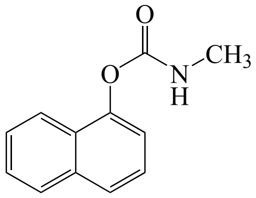
$H_2N\text{-}CO\text{-}O\text{-}CH_2\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 13 at 78℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3A

Carbaryl (1-Naphthyl methylcarbamate)

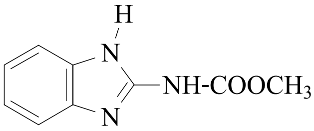
[63-25-2]



BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc

Carbendazim

[10605-21-7]



MAK[mg/m^3]: 10 I
Peak lim: II(4)
Preg gr: B
Muta cat: 5

Carbodicyclohexylimide ⟶ Dicyclohexylcarbodiimide

Carbon black

(inhalable fraction)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Carbon dioxide

[124-38-9]

CO_2

MAK[ml/m^3]: 5000
MAK[mg/m^3]: 9100
Peak lim: II(2)

Carbon disulfide

[75-15-0]

CS_2

VP[hPa]: 400
see Section XII

MAK[ml/m³]: 5
MAK[mg/m³]: 16
Peak lim: II(2)
Preg gr: B
Perc abs: H

Carbon monoxide

[630-08-0]

CO

see Section XII

MAK[ml/m³]: 30
MAK[mg/m³]: 35
Peak lim: II(2)
Preg gr: B

Carbon silicide ⟶ Silicon carbide

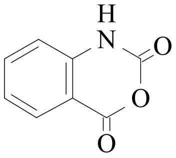
Carbon tetrachloride ⟶ Tetrachloromethane

Carbonyl chloride ⟶ Phosgene

Carborundum ⟶ Silicon carbide

N-Carboxyanthranilic anhydride

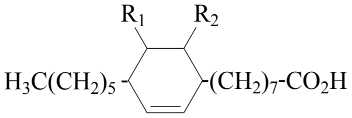
[118-48-9]



see Section IV
Sens: Sh

5(or 6)-Carboxy-4-hexylcyclohex-2-ene-1-octanoic acid

[53980-88-4]



R_1=H, R_2=CO_2H; R_1=CO_2H, R_2=H

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Cedar (Thuja spp., Calocedrus spp.) ⟶ Woods

Cellulases

see Section IV
Sens: Sa

Cement ⟶ Portland cement dust

Ceramic fibres ⟶ Aluminium silicate fibres

Cereal flour dusts

Rye, Wheat
see Section IV
Sens: Sa

Cerium dioxide

[1306-38-3]

CeO_2

MAK[mg/m³]: 0.002 R
Peak lim: II(8)
Preg gr: D
Muta cat: 5

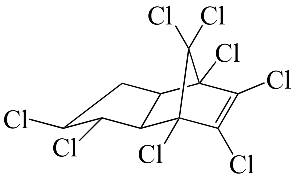
Ceylon ebony (Diospyros ebenum) ⟶ Woods

Cherry mahogany (Tieghemella heckelii) ⟶ Woods

Chloramine ⟶ N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard)

Chlordane

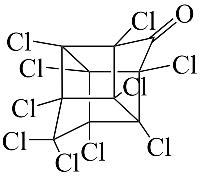
[57-74-9]



see Section IIc

Chlordecone

[143-50-0]

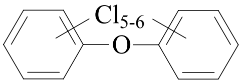


MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

2-Chloro-2-(difluoromethoxy)-1,1,1-trifluoroethane ⟶ Isoflurane

Chlorinated biphenyl oxides

several CAS Nos, e.g.
[55720-99-5]

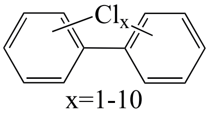


Chlorinated biphenyl oxides form a group of compounds with different degrees and positions of chlorine substitution. Chlorinated biphenyl oxides with low chlorine content can occur as a particle-vapour mixture, whereas chlorinated biphenyl oxides with a large quantity of chlorine occur only as particles.
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

★ Chlorinated biphenyls

[1336-36-3]

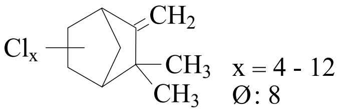


Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.
see Section XII

MAK[mg/m³]: 0.003 I
(PCB 28 + PCB 52 + PCB 101 + PCB 138 + PCB 153 + PCB 180) × 5
Peak lim: II(8)
Preg gr: B
Note regarding prerequisite for Group C see documentation
Perc abs: H
Carc cat: 4
Muta cat: 5

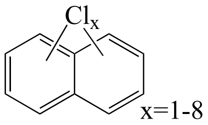
Chlorinated camphene

[8001-35-2]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Chlorinated naphthalenes



Chlorinated naphthalenes form a group of compounds with different degrees and positions of chlorine substitution. Chlorinated naphthalenes with low chlorine content can occur as a particle-vapour mixture, whereas chlorinated naphthalenes with a large quantity of chlorine occur only as particles.
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Chlorinated paraffins

unbranched chains, several CAS Nos, e.g.
[63449-39-8]

$C_{10}H_{22-n}Cl_n$ – $C_{30}H_{62-n}Cl_n$

$n = 1–28$
20–70% Cl

Chlorinated paraffins form a group of compounds with different degrees and positions of chlorine substitution. Chlorinated paraffins with low chlorine content and short chain length can occur as a particle-vapour mixture, whereas chlorinated paraffins with a large quantity of chlorine or with long alkyl chains occur only as particles.

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

α-Chlorinated toluenes: mixture of Benzoyl chloride [98-88-4], Benzyl chloride [100-44-7], Benzyl dichloride [98-87-3], Benzyl trichloride [98-07-7]

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1

Chlorine

[7782-50-5]

Cl_2

MAK[ml/m³]: 0.5
MAK[mg/m³]: 1.5
Peak lim: I(1)
Preg gr: C

Chlorine dioxide

[10049-04-4]

ClO_2

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.28
Peak lim: I(1)
Preg gr: D

Chlorine trifluoride

[7790-91-2]

ClF_3

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Chlorite ⟶ Talc

Chloroacetaldehyde

[107-20-0]

$ClCH_2\text{-}CHO$

VP[hPa]: 133

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

2-Chloroacetamide

[79-07-2]

$Cl\text{-}CH_2\text{-}CO\text{-}NH_2$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh

Chloroacetamide-N-methylol ⟶ N-Methylolchloroacetamide

Chlororacetic acid ⟶ Monochloroacetic acid

Chloroacetic acid methyl ester

[96-34-4]

$Cl\text{-}CH_2\text{-}CO\text{-}OCH_3$

VP[hPa]: ~7

MAK[ml/m^3]: 1
MAK[mg/m^3]: 4.5
Peak lim: I(1)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H
Sens: Sh

Chloroacetyl chloride

[79-04-9]

$ClCH_2\text{-}COCl$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

2-Chloroacrylonitrile

[920-37-6]

$H_2C{=}CClCN$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

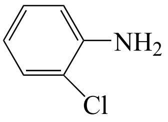
γ-Chloroallyl chloride ⟶ 1,3-Dichloropropene

1-(3-Chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride ⟶ Methenamine 3-chloroallylchloride

4-Chloroaniline ⟶ p-Chloroaniline

o-Chloroaniline

[95-51-2]

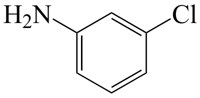


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

m-Chloroaniline

[108-42-9]

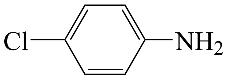


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.031
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh

p-Chloroaniline

[106-47-8]

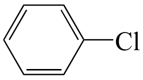


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.036 at 26℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

Chlorobenzene

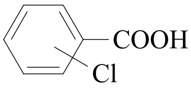
[108-90-7]



VP[hPa]: 12
see Section XII

MAK[ml/m^3]: 5
MAK[mg/m^3]: 23
Peak lim: II(2)
Preg gr: C

Chlorobenzoic acid (all isomers)



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.0031 at 25℃ (calculated value)
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

– o-Chlorobenzoic acid

[118-91-2]

– m-Chlorobenzoic acid

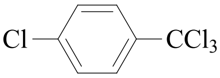
[535-80-8]

– p-Chlorobenzoic acid

[74-11-3]

p-Chlorobenzotrichloride

[5216-25-1]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.2

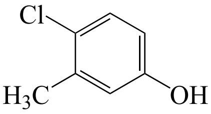
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Chlorobromomethane ⟶ Bromochloromethane

2-Chloro-1,3-butadiene ⟶ Chloroprene

p-Chloro-m-cresol

[59-50-7]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.067
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

1-Chloro-1,1-difluoroethane

[75-68-3]

$ClF_2C\text{-}CH_3$

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 4200
Peak lim: II(8)
Preg gr: D

Chlorodifluoromethane

[75-45-6]

$CHClF_2$

applies only to the pure substance; for samples contaminated with chlorofluoromethane [593-70-4] see documentation

MAK[ml/m^3]: 500
MAK[mg/m^3]: 1800
Peak lim: II(8)
Preg gr: C

2-Chloro-1-(difluoromethoxy)-1,1,2-trifluoroethane ⟶ Enflurane

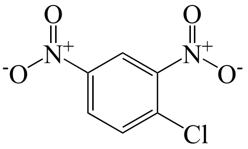
(R)-N-[(5-Chloro-3,4-dihydro-8-hydroxy-3-methyl-1-oxo-1H-2-benzopyran-7-yl)carbonyl]-L-phenylalanine ⟶ Ochratoxin A

2-Chloro-10-(3-dimethylaminopropyl)phenothiazine ⟶ Chlorpromazine (2-Chloro-10-(3-dimethylaminopropyl) phenothiazine)

Chlorodimethyl ether ⟶ Monochlorodimethyl ether

1-Chloro-2,4-dinitrobenzene

[97-00-7]

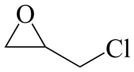


see Section IV

Sens:	Sh

1-Chloro-2,3-epoxypropane

(Epichlorohydrin)
[106-89-8]



see Section XII

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Sens:	Sh
Carc cat:	2
Muta cat:	3B

Chloroethane

[75-00-3]

$H_3C\text{-}CH_2Cl$

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	3

Chloroethanoic acid ⟶ Monochloroacetic acid

2-Chloroethanol

[107-07-3]

$ClCH_2\text{-}CH_2OH$

VP[hPa]: 7

MAK[ml/m³]:	2
MAK[mg/m³]:	6.7
Peak lim:	II(1)
Preg gr:	C
Perc abs:	H

Chlorofluoromethane (FC-31)

[593-70-4]

CH_2ClF

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	2

Chloroform (Trichloromethane)

[67-66-3]

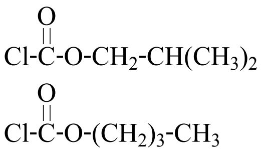
$CHCl_3$

VP[hPa]: 211

MAK[ml/m³]:	0.5
MAK[mg/m³]:	2.5
Peak lim:	II(2)
Preg gr:	C
Perc abs:	H
Carc cat:	4

Chloroformic acid butyl ester

[543-27-1; 592-34-7]



$$\mathrm{Cl{-}\overset{O}{\overset{\|}{C}}{-}O{-}CH_2{-}CH(CH_3)_2}$$

$$\mathrm{Cl{-}\overset{O}{\overset{\|}{C}}{-}O{-}(CH_2)_3{-}CH_3}$$

VP[hPa]: 7

MAK[ml/m³]:	0.2
MAK[mg/m³]:	1.1
Peak lim:	I(2)
Preg gr:	C

Chloroformic acid ethyl ester

[541-41-3]

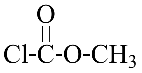
$Cl\text{-}COO\text{-}CH_2\text{-}CH_3$

VP[hPa]: 54

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	3

Chloroformic acid methyl ester

[79-22-1]



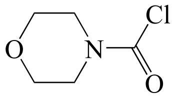
$Cl\text{-}\overset{O}{\overset{\|}{C}}\text{-}O\text{-}CH_3$

VP[hPa]: 137

MAK[ml/m³]:	0.2
MAK[mg/m³]:	0.78
Peak lim:	I(2)
Preg gr:	C

N-Chloroformylmorpholine

[15159-40-7]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.4

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	2

2-Chloro-N-hydroxymethylacetamide ⟶ N-Methylolchloroacetamide

N-(((3R)-5-Chloro-8-hydroxy-3-methyl-1-oxo-7-isochromanyl)carbonyl)-3-phenyl-L-alanine ⟶ Ochratoxin A

Chloromethane

[74-87-3]

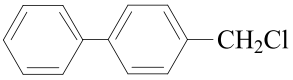
CH_3Cl

VP[hPa]: 5733 at 25℃

MAK[ml/m³]:	10
MAK[mg/m³]:	21
Peak lim:	II(1)
Preg gr:	D

4-Chloromethyl-biphenyl

[1667-11-4]

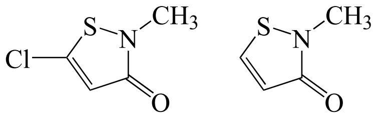


The substance can occur simultaneously as vapour and aerosol.
see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-dihydroisothiazol-3-one

[26172-55-4; 2682-20-4]
mixture in ratio 3:1



see Section Xc

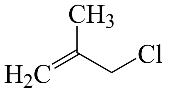
MAK[mg/m³]:	0.2 I
Peak lim:	I(2)
Preg gr:	C

Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

Sens:	Sh

3-Chloro-2-methylpropene

[563-47-3]



VP[hPa]: 140

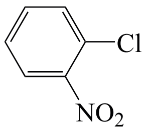
MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	3

1-Chloro-2-nitrobenzene ⟶ o-Chloronitrobenzene

1-Chloro-4-nitrobenzene ⟶ p-Chloronitrobenzene

o-Chloronitrobenzene

[88-73-3]

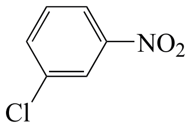


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.43

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	3

m-Chloronitrobenzene

[121-73-3]

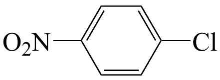


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.129 at 25℃
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

p-Chloronitrobenzene

[100-00-5]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.085

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

1-Chloro-1-nitropropane

[600-25-9]

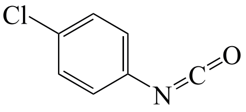
$H_3C\text{-}CH_2\text{-}CHClNO_2$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

4-Chlorophenyl isocyanate

[104-12-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Chlorophora excelsa ⟶ Woods

Chloropicrin ⟶ Trichloronitromethane

Chloroprene

[126-99-8]

$H_2C\text{=}CCl\text{-}CH\text{=}CH_2$

VP[hPa]: 267
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

3-Chloro-1,2-propanediol (α-Chlorohydrin)

[96-24-2]

$HOCH_2\text{-}CHOH\text{-}CH_2Cl$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.27

MAK[ml/m^3]: 0.005
MAK[mg/m^3]: 0.023
Peak lim: II(8)
Preg gr: D
Perc abs: H
Carc cat: 3

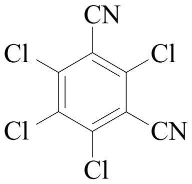
3-Chloro-1-propene ⟶ Allyl chloride

2-Chloro-2-propene nitrile ⟶ 2-Chloroacrylonitrile

1-[(E)-3-chloroprop-2-enyl]-3,5,7-triaza-1-azoniatricyclo[3.3.1.13,7]decane;chloride ⟶ Methenamine 3-chloroallylchloride

Chlorothalonil

[1897-45-6]

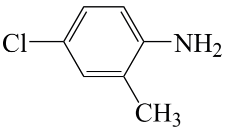


VP[hPa]: <0.013 at 40℃
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

4-Chloro-o-toluidine

[95-69-2]

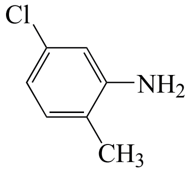


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.055 at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

5-Chloro-o-toluidine

[95-79-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.45

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

1-Chloro-4-(trichloromethyl)benzene ⟶ p-Chlorobenzotrichloride

1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether ⟶ Isoflurane

2-Chloro-1,1,2-trifluoroethyl difluoromethyl ether ⟶ Enflurane

Chlorotrifluoromethane (FC-13)

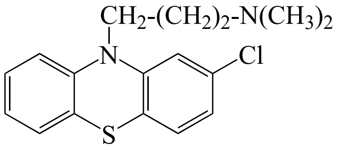
[75-72-9]

$CClF_3$

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 4300
Peak lim: II(8)
Preg gr: D

Chlorpromazine (2-Chloro-10-(3-dimethylamino-propyl)phenothiazine)

[50-53-3]



see Section IV
Sens: SP

Chrome yellow ⟶ Lead chromate

Chromium carbonyl

[13007-92-6]

$Cr(CO)_6$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Chromium(III) compounds

see Section IIb and XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
does not apply for chromium(III) oxide and similar poorly soluble chromium(III) compounds

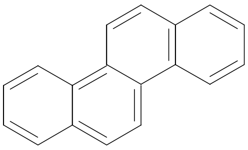
Chromium(VI) compounds

(inhalable fraction)
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
the chromates of barium, lead, strontium and zinc are not designated with “H”
Sens: Sh
barium chromate and lead chromate are not designated with “Sh”
Carc cat: 1
Muta cat: 2

Chrysene

[218-01-9]



see Section III, "pyrolysis products of organic materials"

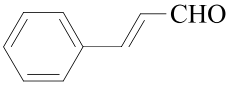
MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Chrysotile (fibrous dust) ⟶ Asbestos

Chymotrypsin ⟶ Trypsin and Chymotrypsin

Cinnamaldehyde

[104-55-2]



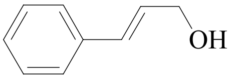
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.029
see Section IV
Sens: Sh

Cinnamic alcohol ⟶ Cinnamyl alcohol

Cinnamic aldehyde ⟶ Cinnamaldehyde

Cinnamyl alcohol

[104-54-1]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.012 at 25℃
see Section IV
Sens: Sh

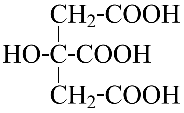
C.I. Pigment Red 104 ⟶ Lead chromate

C.I. Pigment Yellow 34 ⟶ Lead chromate

Citrates ⟶ Citric acid

Citric acid

[77-92-9]



$$\begin{array}{c} CH_2\text{-}COOH \\ | \\ HO\text{-}C\text{-}COOH \\ | \\ CH_2\text{-}COOH \end{array}$$

see Section Xc

MAK[mg/m³]: 2 I
Peak lim: I(2)
Preg gr: C

Citric acid alkali metal salts

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
The MAK value for citric acid (2 mg/m³) protects from irritation, a higher value for alkali metal salts is not justifiable.
Peak lim: –
Preg gr: –

Coal mine dust

(respirable fraction)

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Coal tars, coal tar pitches, coal tar oils

see Section III, "pyrolysis products of organic materials"

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 1

Cobalt

[7440-48-4]
and cobalt compounds (inhalable fraction)
see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sah
Carc cat: 2
Muta cat: 3A

– Metallic cobalt

[7440-48-4]

Co

– Cobalt(II) carbonate

[513-79-1]

$CoCO_3$

– Cobalt(II) oxide

[1307-96-6]

CoO

– Cobalt(II,III) oxide

[1308-06-1]

Co_3O_4

– Cobalt(II) sulfate·7 H_2O

[10026-24-1]
and similar soluble salts

$CoSO_4 \cdot 7\,H_2O$

– Cobalt(II) sulfide

[1317-42-6]

CoS

Cobalt ⟶ Hard metal containing tungsten carbide and cobalt

Cobalt alloys

Sens: –
For cobalt alloys containing bio-available cobalt see Cobalt and cobalt compounds.

Cocobolo (Dalbergia retusa) ⟶ Woods

Coconut oil

[8001-31-8]
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C

Cocus wood (Brya ebenus) ⟶ Woods

Coke oven emissions

see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1

Colophony ⟶ Rosin (colophony)

Copper

[7440-50-8]
and its inorganic compounds

Cu

MAK[mg/m^3]: 0.01 R
Peak lim: II(2)
Preg gr: C

Copra oil ⟶ Coconut oil

Coromandel (Diospyros celebica) ⟶ Woods

Corundum ⟶ α-Aluminium oxide

Cotton dust

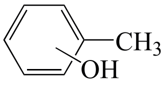
applies only to raw cotton
see Section V

MAK[mg/m^3]: 1.5 I
Peak lim: I(1)
Preg gr: C

p-Cresidine ⟶ 5-Methyl-o-anisidine

Cresol (all isomers)

[1319-77-3]



see Section XII

MAK[ml/m^3]: 1
MAK[mg/m^3]: 4.5
Peak lim: I(1)
Preg gr: C
Perc abs: H

– o-Cresol

[95-48-7]

– m-Cresol

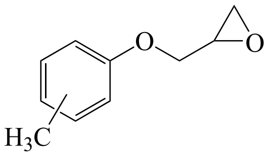
[108-39-4]

– p-Cresol

[106-44-5]

Cresyl glycidyl ethers

mixture of isomers
[26447-14-3]
o-isomer [2210-79-9]



The substance can occur simultaneously as vapour and aerosol.

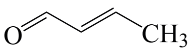
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 3

Cristobalite ⟶ Silica, crystalline

Crocidolite (fibrous dust) ⟶ Asbestos

Crotonaldehyde

[123-73-9; 4170-30-3]



VP[hPa]: 25

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3
Muta cat: 3A

Cu-HDO ⟶ N-Cyclohexylhydroxy-diazen-1-oxide, copper salt

Cumene ⟶ Isopropylbenzene (cumene)

Cumene hydroperoxide ⟶ α,α-Dimethylbenzyl hydroperoxide

Cyanamide

[420-04-2]

$H_2N\text{-}CN$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.005

MAK[ml/m^3]: 0.2
MAK[mg/m^3]: 0.35
Peak lim: II(1)
Preg gr: C
Perc abs: H
Sens: Sh

Cyanides

(as CN)

MAK[mg/m^3]: 2 I
Peak lim: II(1)
Preg gr: C
Perc abs: H

2-Cyanoacrylic acid methyl ester ⟶ Methyl 2-cyanoacrylate

2-Cyano-2,2-dibromoacetamide ⟶ 2,2-Dibromo-2-cyanacetamide

Cyano(4-fluoro-3-phenoxyphenyl)methyl-3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylate ⟶ Cyfluthrin

Cyanogen ⟶ Oxalonitrile

Cyanogen chloride

[506-77-4]

CNCl

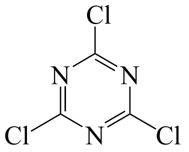
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Cyanoguanidine ⟶ Dicyanodiamide

Cyanuric chloride

[108-77-0]

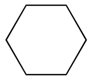


The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: 0.001
MAK[mg/m^3]: 0.0076
Peak lim: I(2)
Preg gr: C
Sens: Sh

Cyclohexane

[110-82-7]

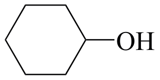


VP[hPa]: 104
see Section XII

MAK[ml/m^3]: 200
MAK[mg/m^3]: 700
Peak lim: II(4)
Preg gr: D

Cyclohexanol

[108-93-0]

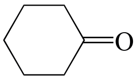


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Cyclohexanone

[108-94-1]



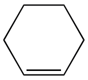
VP[hPa]: 5
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Cyclohexanone peroxide ⟶ 1-Hydroxy-1′-hydroperoxydicyclohexyl peroxide

Cyclohexene

[110-83-8]

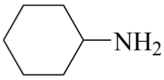


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Cyclohexylamine

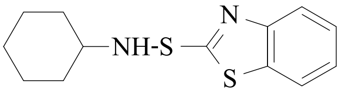
[108-91-8]



MAK[ml/m^3]: 2
MAK[mg/m^3]: 8.2
Peak lim: I(2)
A momentary value of 5 ml/m^3 (21 mg/m^3) should not be exceeded.
Preg gr: C

N-Cyclohexyl-2-benzothiazolesulfenamide

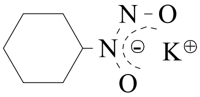
[95-33-0]



see Section IV
Sens: Sh

Cyclohexylhydroxydiazene-1-oxide, potassium salt

[66603-10-9]

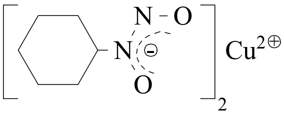


see Section Xc

MAK[mg/m^3]: 10 I
Peak lim: II(2)
Preg gr: D
Perc abs: H

N-Cyclohexylhydroxy-diazen-1-oxide, copper salt

[15627-09-5]



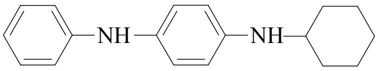
see Section Xc

MAK[mg/m^3]: 0.05 R
corresponding to 0.01 mg Cu/m^3
Peak lim: II(2)
Preg gr: C
Perc abs: H

N-Cyclohexyl-N′-phenyl-1,4-benzenediamine ⟶ N-Cyclohexyl-N′-phenyl-p-phenylendiamine

N-Cyclohexyl-N′-phenyl-p-phenylendiamine

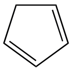
[101-87-1]



see Section IV
Sens: Sh

Cyclopentadiene

[542-92-7]

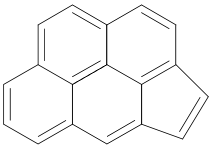


VP[hPa]: 451
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Cyclopenta[cd]pyrene

[27208-37-3]



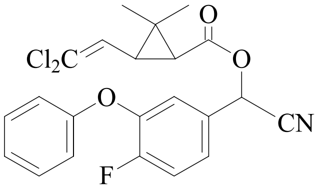
see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Cyclotetramethylene oxide ⟶ Tetrahydrofuran

Cyfluthrin

[68359-37-5]



MAK[mg/m^3]: 0.01 I
Peak lim: I(1)
Preg gr: C

β-Cyfluthrin ⟶ Cyfluthrin

2,4-D ⟶ 2,4-Dichlorophenoxyacetic acid

Dalapon ⟶ 2,2-Dichloropropionic acid

Dalbergia spp. ⟶ Woods

Dawsonite

[12011-76-6]
(fibrous dust)

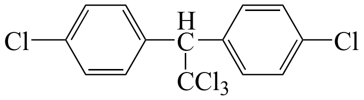
$NaAl(CO_3)(OH)_2$

see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

DDT (Dichlorodiphenyltrichloroethane)

[50-29-3]



see Section IIc

DDVP ⟶ Dichlorvos

Decaborane

[17702-41-9]

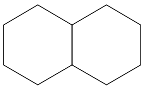
$B_{10}H_{14}$

MAK[ml/m^3]: 0.05
MAK[mg/m^3]: 0.25
Peak lim: II(2)
Perc abs: H

Decachlorotetracyclodecanone ⟶ Chlordecone

Decahydronaphthalene

[91-17-8]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.07

MAK[ml/m^3]: 5
MAK[mg/m^3]: 29
Peak lim: II(2)
Preg gr: D

Decalin ⟶ Decahydronaphthalene

1,10-Decanedioic acid ⟶ Sebacic acid

1-Decanol

[112-30-1]

$H_3C\text{-}(CH_2)_9\text{-}OH$

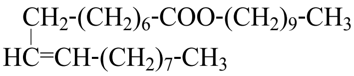
The substance can occur simultaneously as vapour and aerosol.
see Section Xc

MAK[ml/m^3]: 10
MAK[mg/m^3]: 66
Peak lim: I(1)
Preg gr: C

Decyl 9-octadecenoat ⟶ n-Decyl oleate

n-Decyl oleate

[3687-46-5]



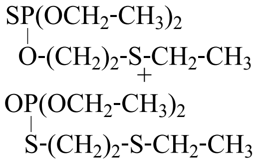
$$\begin{array}{l} CH_2\text{-}(CH_2)_6\text{-}COO\text{-}(CH_2)_9\text{-}CH_3 \\ | \\ HC{=}CH\text{-}(CH_2)_7\text{-}CH_3 \end{array}$$

see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: D

Demeton

[8065-48-3]



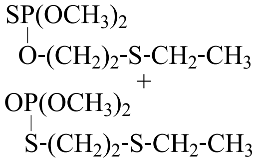
$$\begin{array}{l} \mathrm{SP(OCH_2\text{-}CH_3)_2} \\ \quad | \\ \quad \mathrm{O\text{-}(CH_2)_2\text{-}S\text{-}CH_2\text{-}CH_3} \\ \qquad\qquad + \\ \mathrm{OP(OCH_2\text{-}CH_3)_2} \\ \quad | \\ \quad \mathrm{S\text{-}(CH_2)_2\text{-}S\text{-}CH_2\text{-}CH_3} \end{array}$$

see Section XII, Acetylcholinesterase inhibitors
see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H

Demeton-methyl

[8022-00-2]



$$\begin{array}{l} \mathrm{SP(OCH_3)_2} \\ \quad | \\ \quad \mathrm{O\text{-}(CH_2)_2\text{-}S\text{-}CH_2\text{-}CH_3} \\ \qquad\qquad + \\ \mathrm{OP(OCH_3)_2} \\ \quad | \\ \quad \mathrm{S\text{-}(CH_2)_2\text{-}S\text{-}CH_2\text{-}CH_3} \end{array}$$

BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc

Desflurane

[57041-67-5]

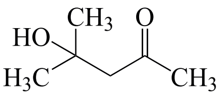
$CF_3\text{-}CHF\text{-}O\text{-}CHF_2$

see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Diacetone alcohol

[123-42-2]



MAK[ml/m³]:	20
MAK[mg/m³]:	96
Peak lim:	I(2)
Preg gr:	D
Perc abs:	H

Diacetyl

[431-03-8]

$H_3C\text{-}CO\text{-}OC\text{-}CH_3$

MAK[ml/m³]:	0.02
MAK[mg/m³]:	0.071
Peak lim:	II(1)
Preg gr:	C
Perc abs:	H
Sens:	Sh
Carc cat:	3

Diacetyl peroxide

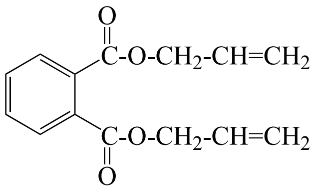
[110-22-5]

$H_3C\text{-}CO\text{-}OO\text{-}CO\text{-}CH_3$

see Section Xa

Diallyl phthalate

[131-17-9]



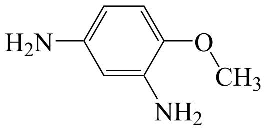
see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Dialuminumchloride pentahydroxide ⟶ Aluminium chlorohydrate

2,4-Diaminoanisole

[615-05-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.063 (calculated value)

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

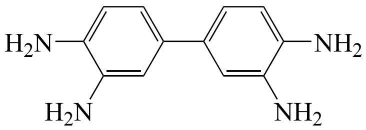
1,2-Diaminobenzene ⟶ o-Phenylenediamine

1,3-Diaminobenzene ⟶ m-Phenylenediamine

1,4-Diaminobenzene ⟶ p-Phenylenediamine

3,3′-Diaminobenzidine and its tetrahydrochloride

[91-95-2; 7411-49-6]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

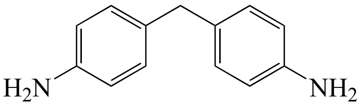
4,4′-Diamino-3,3′-dichlorodiphenylmethane ⟶ 4,4′-Methylenebis(2-chloroaniline)

2,2′-Diaminodiethylamine ⟶ Diethylenetriamine

4,4′-Diaminodiphenyl ⟶ Benzidine

4,4′-Diaminodiphenylmethane

[101-77-9]



see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

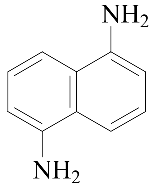
4,4′-Diaminodiphenyl sulfide ⟶ 4,4′-Thiodianiline

1,2-Diaminoethane ⟶ Ethylenediamine

3,8-Diamino-5-ethyl-6-phenylphenanthridinium bromide ⟶ Ethidium bromide

1,5-Diaminonaphthalene

[2243-62-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

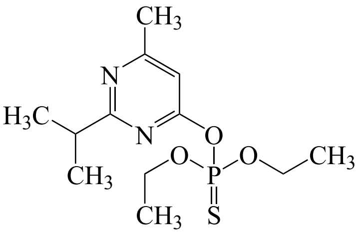
o-Dianisidine ⟶ 3,3′-Dimethoxybenzidine

Diatomaceous earth ⟶ Silica, amorphous: a) synthetic amorphous silica [7631-86-9]

Diazenedicarboxamide ⟶ Azodicarbonamide

Diazinon

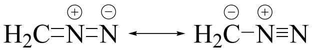
[333-41-5]



MAK[mg/m^3]: 0.1 I
Peak lim: II(2)
Preg gr: C
Perc abs: H

Diazomethane

[334-88-3]

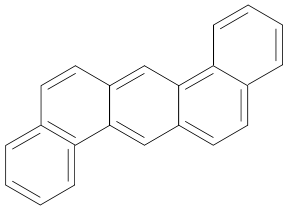


$$H_2C{=}\overset{\oplus}{N}{=}\overset{\ominus}{N} \longleftrightarrow H_2\overset{\ominus}{C}{-}\overset{\oplus}{N}{\equiv}N$$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Dibenzo[a,h]anthracene

[53-70-3]

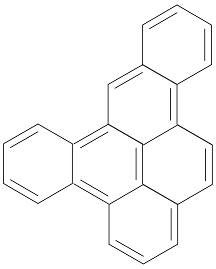


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3A

Dibenzo[a,e]pyrene

[192-65-4]

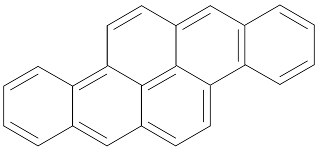


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Dibenzo[a,h]pyrene

[189-64-0]

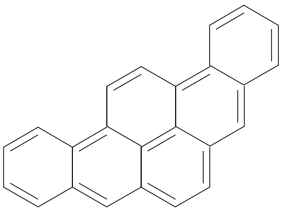


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Dibenzo[a,i]pyrene

[189-55-9]

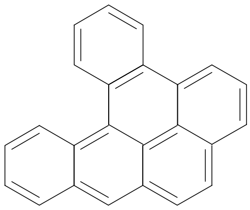


see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Dibenzo[a,l]pyrene

[191-30-0]



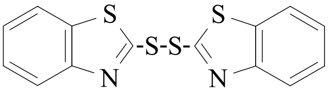
see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Dibenzo-1,4-thiazine → Phenothiazine

2,2′-Dibenzothiazyl disulfide

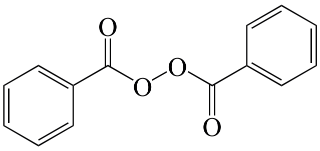
[120-78-5]



see Section IV
Sens: Sh

Dibenzoyl peroxide

[94-36-0]
(inhalable fraction)

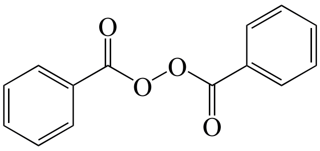


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 9×10^{-5} at 25℃ (calculated value)
see Section Xa

MAK[mg/m^3]: 4 I
Peak lim: I(2)
Preg gr: C

Dibenzoyl peroxide

[94-36-0]
(respirable fraction)

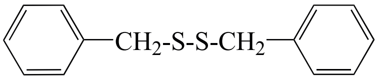


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 9×10^{-5} at 25℃ (calculated value)
see Section Xa

MAK[mg/m^3]: 1 R
Peak lim: II(4)
Preg gr: C

Dibenzyl disulfide

[150-60-7]



see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Diborane

[19287-45-7]

$H_3B\text{-}BH_3$

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

1,2-Dibromo-3-chloropropane

[96-12-8]

$H_2CCl\text{-}CHBr\text{-}CH_2Br$

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 2

2,2-Dibromo-2-cyanacetamide

[10222-01-2]

$H_2N\text{-}CO\text{-}CBr_2\text{-}C\equiv N$

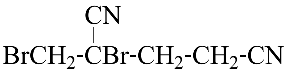
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh

2,6-Dibromo-4-[2-(3,5-dibromo-4-hydroxyphenyl)propan-2-yl]phenol ⟶ Tetrabromobisphenol A

1,2-Dibromo-2,4-dicyanobutane

[35691-65-7]



$BrCH_2\text{-}\overset{\overset{\displaystyle CN}{|}}{C}Br\text{-}CH_2\text{-}CH_2\text{-}CN$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh

Dibromodifluoromethane

[75-61-6]

CBr_2F_2

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

1,2-Dibromoethane

[106-93-4]

$BrH_2CH\text{-}CH_3Br$

VP[hPa]: 15

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

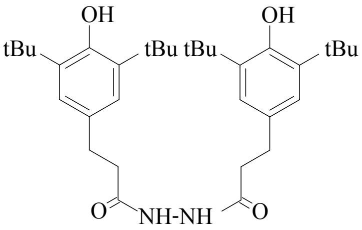
Dibromohydroxymercurifluorescein disodium salt ⟶ Merbromin

Dibutyl phosphite ⟶ Di-n-butyl phosphonate

2,6-Di-tert-butyl-p-cresol ⟶ Butylated hydroxytoluene

3-(3,5-Di-tert-butyl-4-hydroxyphenyl)-N′-[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propanoyl]-propanehydrazide

[32687-78-8]

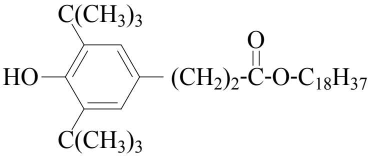


see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

3,5-Di-tert-butyl-4-hydroxyphenylpropionic acid octadecyl ester

[2082-79-3]



VP[hPa]: 2.5×10^{-9}
see Section Xc

MAK[mg/m^3]: 20 I
Peak lim: II(2)
Preg gr: C

3,5-Di-tert-butyl-4-hydroxytoluene → Butylated hydroxytoluene

N,N-Di-n-butylnitrosoamine → N-Nitrosodi-n-butylamine

Di-tert-butyl peroxide

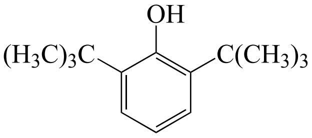
[110-05-4]

$(H_3C)_3C\text{-}OO\text{-}C(CH_3)_3$

see Section Xa

2,6-Di-tert-butylphenol

[128-39-2]

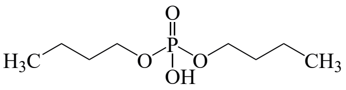


see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Di-n-butyl phosphate

[107-66-4]
and its technical mixtures

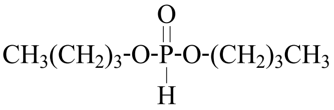


VP[hPa]: 7.4×10^{-5}
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Di-n-butyl phosphonate

[1809-19-4]
see also Di-n-octyl phosphonate



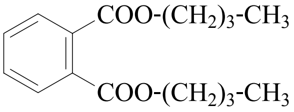
$$CH_3(CH_2)_3\text{-}O\text{-}\underset{H}{\overset{O}{\overset{\|}{P}}}\text{-}O\text{-}(CH_2)_3CH_3$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.03 at 25℃ (calculated value)
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Di-n-butyl phthalate

[84-74-2]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.6×10^{-4}
see Section Xc

MAK[ml/m^3]: 0.05
MAK[mg/m^3]: 0.58
Peak lim: I(2)
Preg gr: C
Carc cat: 3

6,6′-Di-tert-butyl-2,2′-thiodi-p-cresol → 2,2′-Thiobis(4-methyl-6-tert-butylphenol)

Dicarbamoyldiimide → Azodicarbonamide

Dicarboxylic acid anhydrides

see Section IVe

Dicarboxylic acid (C4–C6) dimethylester, mixture

[95481-62-2]
16.5% Dimethyl adipate,
16.9% Dimethyl succinate,
66.6% Dimethyl glutarate
(purity > 99.5%)

MAK[ml/m^3]: 0.75
MAK[mg/m^3]: 5
Peak lim: I(1)
Preg gr: C

Dichloroacetic acid

[79-43-6]
and its salts

$HOOC\text{-}CHCl_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.19

MAK[ml/m^3]: 0.2
MAK[mg/m^3]: 1.1
salts: 1.1 mg/m^3 as acid
Peak lim: I(1)
Preg gr: D
Perc abs: H
Designation with an H does not apply for the acid
Carc cat: 4

Dichloroacetylene

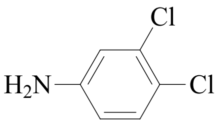
[7572-29-4]

$ClC{\equiv}CCl$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

3,4-Dichloroaniline

[95-76-1]



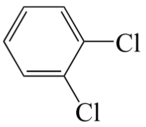
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.84×10^{-3}
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh

3,4-Dichlorobenzenamine ⟶ 3,4-Dichloroaniline

1,2-Dichlorobenzene

[95-50-1]

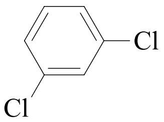


VP[hPa]: 1.33
see Section XII

MAK[ml/m^3]: 10
MAK[mg/m^3]: 61
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H

1,3-Dichlorobenzene

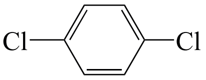
[541-73-1]



MAK[ml/m^3]: 2
MAK[mg/m^3]: 12
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

1,4-Dichlorobenzene

[106-46-7]

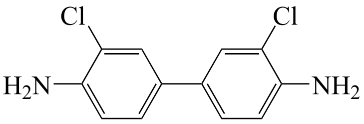


VP[hPa]: 2.3 at 25℃
see Section XII

MAK[ml/m^3]: 2
MAK[mg/m^3]: 12
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

3,3′-Dichlorobenzidine

[91-94-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

1,4-Dichloro-2-butene

[764-41-0]

$ClCH_2\text{-}CH{=}CH\text{-}CH_2Cl$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3A

2,2′-Dichlorodiethyl ether

[111-44-4]

$ClCH_2$-CH_2-O-CH_2-CH_2Cl

VP[hPa]: 2.66 at 30℃

MAK[ml/m^3]: 0.5
MAK[mg/m^3]: 3.0
Peak lim: II(2)
Preg gr: D
Perc abs: H

Dichlorodifluoromethane

[75-71-8]

CCl_2F_2

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 5000
Peak lim: II(2)
Preg gr: C

Dichlorodimethyl ether → Bischloromethyl ether

1,1-Dichloroethane

[75-34-3]

H_3C-$CHCl_2$

VP[hPa]: 240

MAK[ml/m^3]: 50
MAK[mg/m^3]: 210
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 3

1,2-Dichloroethane

[107-06-2]

ClH_2C-CH_2Cl

VP[hPa]: 87

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

1,2-Dichloroethene → 1,2-Dichloroethylene sym

★ 1,1-Dichloroethene

[75-35-4]

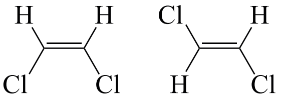
H_2C=CCl_2

VP[hPa]: 667

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

1,2-Dichloroethylene sym

[540-59-0]
(cis [156-59-2] and trans [156-60-5])



VP[hPa]: 220

MAK[ml/m^3]: 200
MAK[mg/m^3]: 800
Peak lim: II(2)

1,2-Dichloroethyl methyl ether → 1,2-Dichloromethoxyethane

Di-(2-chloroethyl)sulfide → Bis(β-chloroethyl)sulfide (mustard gas)

2,2′-Dichloroethyl sulfide → Bis(β-chloroethyl)sulfide (mustard gas)

Dichlorofluoromethane

[75-43-4]

$CHCl_2F$

see Section IIc

Dichlorohydrin → 1,3-Dichloro-2-propanol

Dichloromethane

[75-09-2]

CH_2Cl_2

VP[hPa]: 475
see Section XII

MAK[ml/m^3]: 50
MAK[mg/m^3]: 180
see definition of Carcinogen Category 5 and supporting documentation
Peak lim: II(2)
Preg gr: B
Perc abs: H
Carc cat: 5

1,2-Dichloromethoxyethane

[41683-62-9]

H_2CCl-$CHCl$-OCH_3

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

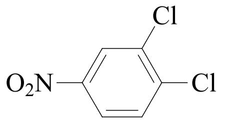
2,2′-Dichloro-N-methyldiethylamine → N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard)

2,2′-Dichloro-4,4′-methylene dianiline → 4,4′-Methylenebis(2-chloroaniline)

Dichloronaphthalenes ⟶ Chlorinated naphthalenes

3,4-Dichloronitrobenzene

[99-54-7]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.02 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

1,1-Dichloro-1-nitroethane

[594-72-9]

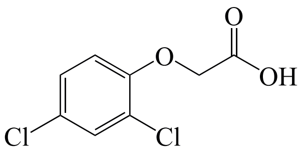
$H_3C\text{-}CCl_2NO_2$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2,4-Dichlorophenoxyacetic acid

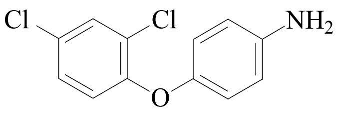
[94-75-7]
(including salts and esters)



MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Perc abs: H

4-(2,4-Dichlorophenoxy)benzenamine

[14861-17-7]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

1,2-Dichloropropane

[78-87-5]

$H_3C\text{-}CHCl\text{-}CH_2Cl$

VP[hPa]: 66.2 at 25℃
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1

1,3-Dichloro-2-propanol

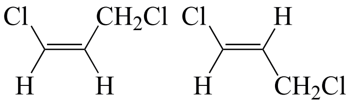
[96-23-1]

$ClH_2C\text{-}CH_2OH\text{-}CH_3Cl$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

1,3-Dichloropropene

(cis and trans)
[542-75-6]



VP[hPa]: 40

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

2,2-Dichloropropionic acid

[75-99-0]

$H_3C\text{-}CCl_2\text{-}COOH$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2,2-Dichloropropionic acid, sodium salt

[127-20-8]

$H_3C\text{-}CCl_2\text{-}COO^- \; Na^+$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

1,2-Dichloro-1,1,2,2-tetrafluoroethane

[76-14-2]

$ClF_2C\text{-}CClF_2$

see Section IIc

α,α-Dichlorotoluene ⟶ Benzyl dichloride

2,2-Dichloro-1,1,1-trifluoroethane

[306-83-2]

$F_3C\text{-}CHCl_2$

VP[hPa]: 13.2

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Dichlorvos

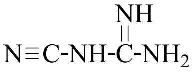
[62-73-7]

$Cl_2C{=}CH\text{-}O\text{-}PO(OCH_3)_2$

MAK[ml/m³]: 0.11
MAK[mg/m³]: 1
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H

Dicyanodiamide

[461-58-5]



$N\equiv C\text{-}NH\text{-}\overset{\overset{NH}{\|}}{C}\text{-}NH_2$

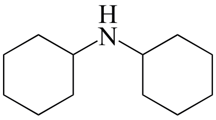
VP[hPa]: 2.3×10⁻³
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

1,3-Dicyanotetrachlorobenzene ⟶ Chlorothalonil

Dicyclohexylamine

[101-83-7]

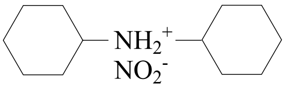


The substance can occur simultaneously as vapour and aerosol. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodicyclohexylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 0.04 at 25°C
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Dicyclohexylamine nitrite

[3129-91-7]

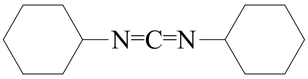


see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Dicyclohexylcarbodiimide

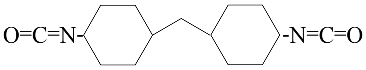
[538-75-0]



see Section IV
Sens: Sh

Dicyclohexyl methane 4,4′-diisocyanate

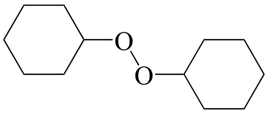
[5124-30-1]



see Section IV
Sens: Sh

Dicyclohexyl peroxide

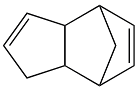
[1758-61-8]



see Section Xa

Dicyclopentadiene

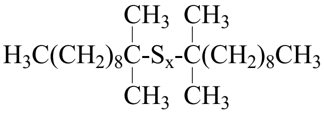
[77-73-6]



MAK[ml/m³]:	0.5
MAK[mg/m³]:	2.7
Peak lim:	I(1)
Preg gr:	D

Di-tert-dodecyl pentasulfide and Di-tert-dodecyl polysulfide

[31565-23-8; 68583-56-2; 68425-15-0]



$$H_3C(CH_2)_8\underset{CH_3}{\overset{CH_3}{C}}\text{-}S_x\text{-}\underset{CH_3}{\overset{CH_3}{C}}(CH_2)_8CH_3$$

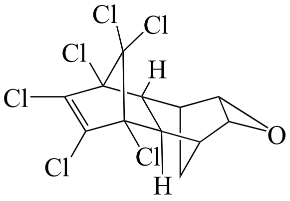
1) 31565-23-8: $x = 5$
2) 68583-56-2: $x = 2\text{-}8$

see Section Xc

MAK[mg/m³]:	5 R
Peak lim:	II(4)
Preg gr:	C

Dieldrin

[60-57-1]



see Section IIc

Diepoxybutane

[1464-53-5]

$$H_2\overset{O}{C}\text{-}CH\text{-}H\overset{O}{C}\text{-}CH_2$$

Muta cat:	2

Diesel engine emissions

Because of the new diesel engine technology the emissions have changed significantly in quality and quantity. Since it must be assumed that these new diesel engines were introduced at the end of the 1990s, all the available epidemiological studies which were evaluated in 2007 are based on exposures to emissions from older diesel engines. The emissions from the new diesel engines can not be evaluated until appropriate studies become available. see Section III, “pyrolysis products of organic materials”

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	2

Diethanolamine

[111-42-2]

$HO\text{-}(CH_2)_2\text{-}NH\text{-}(CH_2)_2\text{-}OH$

The substance can occur simultaneously as vapour and aerosol. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethanolamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 2×10^{-4}

MAK[mg/m³]:	1 I
Peak lim:	I(1)
Preg gr:	C
Perc abs:	H
Sens:	Sh
Carc cat:	3

N,N-Diethanolnitrosoamine → N-Nitrosodiethanolamine

Diethylamine

[109-89-7]

$(H_3C\text{-}CH_2)_2NH$

Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 253

MAK[ml/m³]: 2
MAK[mg/m³]: 6.1
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m³ (15 mg/m³) should not be exceeded.
Preg gr: D
Perc abs: H

2-Diethylaminoethanol

[100-37-8]

$(H_3C\text{-}CH_2)_2N\text{-}CH_2\text{-}CH_2OH$

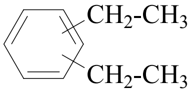
VP[hPa]: 2

MAK[ml/m^3]: 2
MAK[mg/m^3]: 9.7
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(1)
A momentary value of 5 ml/m^3 (24 mg/m^3) should not be exceeded.
Preg gr: C

Diethylbenzene

(all isomers)

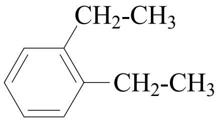
– Diethylbenzene, Mixture [25340-17-4]
1,3-Diethylbenzene [141-93-5]
1,4-Diethylbenzene [105-05-5]



MAK[ml/m^3]: 5
MAK[mg/m^3]: 28
When exposed to the mixture the MAK value for 1,2-diethylbenzene should be observed.
Peak lim: II(2)
Preg gr: C
Perc abs: H

– 1,2-Diethylbenzene

[135-01-3]



MAK[ml/m^3]: 1
MAK[mg/m^3]: 5.6
Peak lim: II(8)
Preg gr: C
Perc abs: H

Diethylcarbamoyl chloride

[88-10-8]

$(H_3C\text{-}CH_2)_2N\text{-}CO\text{-}Cl$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.96 at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Diethyldithiocarbamate sodium ⟶ Sodium diethyldithiocarbamate

Diethylene dioxide ⟶ 1,4-Dioxane

Diethylene glycol

[111-46-6]

$HO\text{-}(CH_2)_2\text{-}O\text{-}(CH_2)_2\text{-}OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.027

MAK[ml/m^3]: 10
MAK[mg/m^3]: 44
Peak lim: II(4)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

Diethylene glycol diacrylate

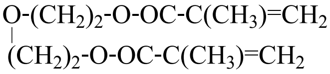
[4074-88-8]

$(CH_2C{=}CH\text{-}COO\text{-}(CH_2)_2)_2O$

see Section IV
Sens: Sh

Diethylene glycol dimethacrylate

[2358-84-1]



$$\begin{array}{l}O\text{-}(CH_2)_2\text{-}O\text{-}OC\text{-}C(CH_3){=}CH_2\\ |\\ (CH_2)_2\text{-}O\text{-}OC\text{-}C(CH_3){=}CH_2\end{array}$$

see Section IV
Sens: Sh

Diethylene glycol dimethyl ether

[111-96-6]

$H_3C\text{-}O\text{-}[(CH_2)_2\text{-}O]_2\text{-}CH_3$

VP[hPa]: 0.6

MAK[ml/m^3]: 1
MAK[mg/m^3]: 5.6
Peak lim: II(8)
Preg gr: B
Perc abs: H

Diethylene glycol dinitrate

[693-21-0]

$O((CH_2)_2\text{-}ONO_2)_2$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Diethylene glycol monobutyl ether

[112-34-5]

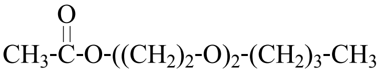
$$CH_3\text{-}(CH_2)_3\text{-}[O\text{-}(CH_2)_2]_2\text{-}OH$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.027

MAK[ml/m^3]: 10
MAK[mg/m^3]: 67
MAK value applies for the sum of the concentrations of diethylene glycol monobutyl ether and its acetate in the air.
Peak lim: I(1.5)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

Diethylene glycol monobutyl ether acetate

[124-17-4]



$$CH_3\text{-}\overset{\overset{\displaystyle O}{||}}{C}\text{-}O\text{-}((CH_2)_2\text{-}O)_2\text{-}(CH_2)_3\text{-}CH_3$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.053

MAK[ml/m^3]: 10
MAK[mg/m^3]: 85
MAK value applies for the sum of the concentrations of diethylene glycol monobutyl ether and its acetate in the air.
Peak lim: I(1.5)
Preg gr: C

Diethylene glycol monoethyl ether

[111-90-0]

$$CH_3\text{-}(C\text{-}O\text{-}CH_2)_2\text{-}CH_2OH$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13

MAK[mg/m^3]: 50 I
Peak lim: I(2)
Preg gr: C

Diethylene glycol monomethyl ether

[111-77-3]

$$H_3C\text{-}O\text{-}[(CH_2)_2\text{-}O]_2\text{-}H$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.33 at 25℃

MAK[ml/m^3]: 10
MAK[mg/m^3]: 50
Peak lim: II(8)
Preg gr: B
Perc abs: H

Diethylenetriamine

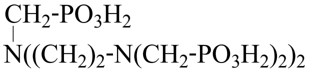
[111-40-0]

$$(H_2N\text{-}CH_2\text{-}CH_2)_2NH$$

see Section IV
Sens: Sh

Diethylenetriaminepenta(methylenephosphonic acid)

[15827-60-8]
and its sodium salts [22042-96-2]



$$\overset{\overset{\displaystyle CH_2\text{-}PO_3H_2}{|}}{N}((CH_2)_2\text{-}N(CH_2\text{-}PO_3H_2)_2)_2$$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Diethylenoxide → Tetrahydrofuran

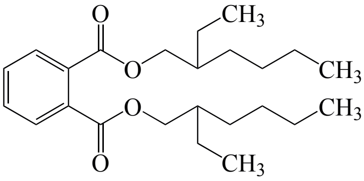
Diethylene oximide → Morpholine

N,N-Diethylethanolamine → 2-Diethylaminoethanol

Diethyl ether → Ethyl ether

Di(2-ethylhexyl)phthalate (DEHP)

[117-81-7]



VP[hPa]: 8.6×10^{-6}

MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

O,O-Diethyl O-(4-nitrophenyl) thiophosphate → Parathion

N,N-Diethylnitrosoamine → N-Nitrosodiethylamine

Diethyl sulfate

[64-67-5]

$$(H_3C\text{-}CH_2\text{-}O)_2SO_2$$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 2

Difluorodibromomethane → Dibromodifluoromethane

1,1-Difluoroethylene

[75-38-7]

$H_2C{=}CF_2$

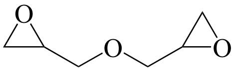
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2-Difluoromethyl 1,2,2,2-tetrafluoroethyl ether ⟶ Desflurane

Diformyl ⟶ Glyoxal

Diglycidyl ether (DGE)

[2238-07-5]



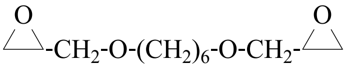
The substance can occur simultaneously as vapour and aerosol. VP[hPa]: 0.12

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Diglycidyl hexahydrophthalate ⟶ Hexahydrophthalic acid diglycidylester

Diglycidyl hexanediol

[16096-31-4]



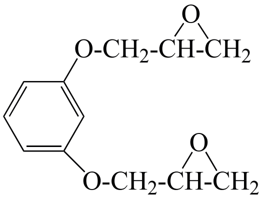
$\text{-}CH_2\text{-}O\text{-}(CH_2)_6\text{-}O\text{-}CH_2\text{-}$

see Section IV
Sens: Sh

1,3-Diglycidyloxybenzene ⟶ Diglycidyl resorcinol ether

Diglycidyl resorcinol ether

[101-90-6]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

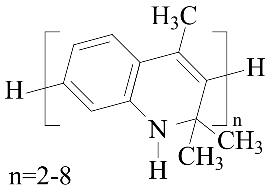
Diglycolamine ⟶ 2-(2-Aminoethoxy)ethanol

Dihydro-2(3H)-furanone ⟶ γ-Butyrolactone

1,2-Dihydro-5-nitroacenaphthylene ⟶ 5-Nitroacenaphthene

1,2-Dihydro-2,2,4-trimethyl-quinoline polymer

[26780-96-1]



see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

1,4-Dihydroxybenzene ⟶ Hydroquinone

4,4′-Dihydroxydiphenylpropane ⟶ Bisphenol A

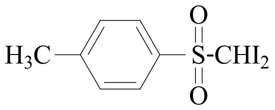
1,2-Dihydroxyethane ⟶ Ethylene glycol

2,2′-Dihydroxyethyl ether ⟶ Diethylene glycol

1,2-Dihydroxypropane ⟶ Propylene glycol

4-(Diiodomethylsulfonyl)-toluene

[20018-09-1]

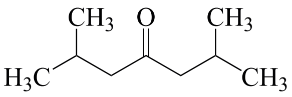


see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Diisobutyl ketone

[108-83-8]



see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

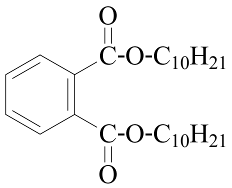
Diisocyanates

see Section IVe

4,4′-Diisocyanato-methylenedicyclohexane ⟶ Dicyclohexyl methane 4,4′-diisocyanate

Diisodecyl phthalate

[26761-40-0]



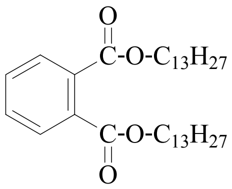
VP[hPa]: 3×10^{-7}
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

N,N-Diisopropylnitrosoamine ⟶ N-Nitrosodiisopropylamine

Diisotridecyl phthalate

[27253-26-5]

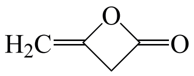


see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Diketene

[674-82-8]



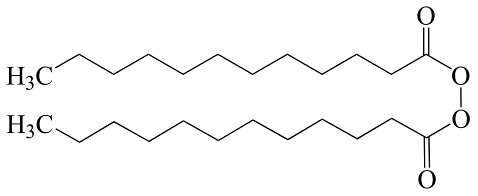
see documentation “Ketene”
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2,3-Diketobutane ⟶ Diacetyl

Dilauroyl peroxide

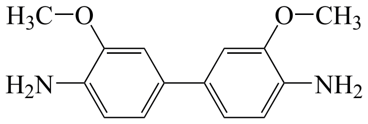
[105-74-8]



see Section Xa

3,3′-Dimethoxybenzidine

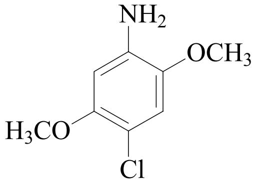
[119-90-4]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

2,5-Dimethoxy-4-chloroaniline

[6358-64-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Dimethoxymethane

[109-87-5]

$H_3CO\text{-}CH_2\text{-}OCH_3$

VP[hPa]: 440

MAK[ml/m^3]: 500
MAK[mg/m^3]: 1600
Peak lim: II(2)
Preg gr: C

N,N-Dimethylacetamide

[127-19-5]

$H_3C\text{-}CO\text{-}N(CH_3)_2$

VP[hPa]: 1.3
see Section XII

MAK[ml/m^3]: 5
MAK[mg/m^3]: 18
Peak lim: II(2)
Preg gr: C
Perc abs: H

Dimethyl adipate

[627-93-0]
see also Dicarboxylic acid (C4–C6) dimethylester

$CH_3\text{-}OOC\text{-}(CH_2)_4\text{-}COO\text{-}CH_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dimethylamine

[124-40-3]

$HN(CH_3)_2$

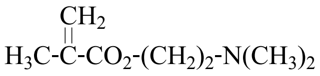
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodimethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

MAK[ml/m^3]: 2
MAK[mg/m^3]: 3.7
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
Preg gr: D

1,1-Dimethylaminoethane ⟶ tert-Butylamine

N,N′-(Dimethylamino)ethyl methacrylate

[2867-47-2]



$$H_3C\text{-}\overset{\overset{\displaystyle CH_2}{||}}{C}\text{-}CO_2\text{-}(CH_2)_2\text{-}N(CH_3)_2$$

see Section IV
Sens: Sh

Dimethylaminopropionitrile

[1738-25-6]

$(H_3C)_2N\text{-}CH_2\text{-}CH_2\text{-}CN$

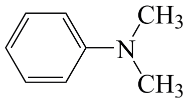
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dimethylaminosulfochloride ⟶ Dimethylsulfamoyl chloride

N,N-Dimethylaniline

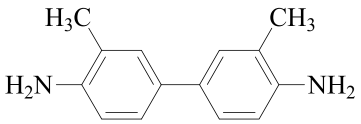
[121-69-7]



MAK[ml/m^3]: 5
MAK[mg/m^3]: 25
Peak lim: II(2)
Preg gr: D
Perc abs: H
Carc cat: 3

3,3′-Dimethylbenzidine

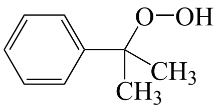
[119-93-7]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

α,α-Dimethylbenzyl hydroperoxide

[80-15-9]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4.4×10^{-3} at 25°C
see Section Xa

1,1′-Dimethyl-4,4′-bipyridinium ⟶ Paraquat dichloride

2,2-Dimethylbutane ⟶ Hexane (all isomers except n-Hexane) and Methylcyclopentane

2,3-Dimethylbutane ⟶ Hexane (all isomers except n-Hexane) and Methylcyclopentane

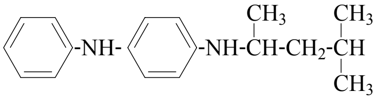
Dimethyl butanedioate ⟶ Dimethyl succinate

1,3-Dimethylbutyl acetate ⟶ sec-Hexyl acetate

N-(1,3-Dimethylbutyl)-N′-phenyl-1,4-benzenediamine ⟶ N-(1,3-Dimethylbutyl)-N′-phenyl-p-phenylenediamine

N-(1,3-Dimethylbutyl)-N′-phenyl-p-phenylenediamine

[793-24-8]



MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Sens: Sh

Dimethylcarbamoyl chloride

[79-44-7]

$Cl\text{-}CO\text{-}N(CH_3)_2$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

3,3′-Dimethyl-4,4′-diaminodiphenylmethane ⟶ 4,4′-Methylenebis(2-methylaniline)

Dimethyl diketone ⟶ Diacetyl

Dimethyl ether

[115-10-6]

$H_3C\text{-}O\text{-}CH_3$

VP[hPa]: 5200

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 1900
Peak lim: II(8)
Preg gr: D

N,N-Dimethylethylamine

[598-56-1]

$H_3C\text{-}CH_2\text{-}N(CH_3)_2$

Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodimethylamine and N-nitrosomethylethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 527-580

MAK[ml/m^3]: 2
MAK[mg/m^3]: 6.1
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m^3 (15 mg/m^3) should not be exceeded.
Preg gr: D

4-(1,1-Dimethylethyl)-1,2-benzenediol ⟶ p-tert-Butylcatechol

2-(4-(1,1-Dimethylethyl)phenoxy)methyloxirane ⟶ p-tert-Butylphenyl glycidyl ether

N,N-Dimethylformamide

[68-12-2]

$HCO\text{-}N(CH_3)_2$

see Section XII

MAK[ml/m^3]: 5
MAK[mg/m^3]: 15
Peak lim: II(2)
Preg gr: B
Note regarding prerequisite for Group C see documentation
Perc abs: H
Carc cat: 4

Dimethyl glutarate

[1119-40-0]
see also Dicarboxylic acid (C4–C6) dimethylester

$CH_3\text{-}OOC\text{-}(CH_2)_3\text{-}COO\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dimethyl glyoxal ⟶ Diacetyl

2,6-Dimethyl-4-heptanone ⟶ Diisobutyl ketone

Dimethyl hexanedioate ⟶ Dimethyl adipate

1,1-Dimethylhydrazine

[57-14-7]

$H_2N\text{-}N(CH_3)_2$

VP[hPa]: 209 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 3A

1,2-Dimethylhydrazine

[540-73-8]

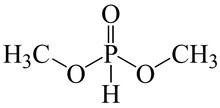
$H_3C\text{-}NH\text{-}NH\text{-}CH_3$

VP[hPa]: 93 at 25℃

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 3A

Dimethyl hydrogen phosphite

[868-85-9]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

3,7-Dimethyl-7-hydroxyoctanal ⟶ 7-Hydroxycitronellal

N,N-Dimethylisopropylamine

[996-35-0]

$(CH_3)_2CH\text{-}N(CH_3)_2$

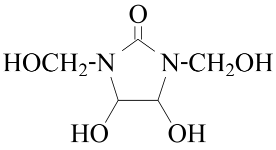
VP[hPa]: 170

MAK[ml/m³]: 1
MAK[mg/m³]: 3.6
Peak lim: I(2)
Preg gr: D

N,N-Dimethylnitrosoamine ⟶ N-Nitrosodimethylamine

Dimethylol dihydroxyethyleneurea

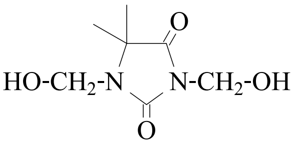
[1854-26-8]



see Section IV
Sens: Sh

1,3-Dimethylol-5,5-dimethyl hydantoin

[6440-58-0]



releases formaldehyde
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh

Dimethylolurea ⟶ 1,3-Bis(hydroxymethyl)urea

Dimethyl pentanedioate ⟶ Dimethyl glutarate

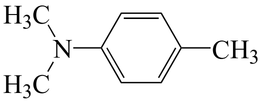
Dimethyl phosphonate ⟶ Dimethyl hydrogen phosphite

N,N-Dimethyl-2-propanamine ⟶ N,N-Dimethylisopropylamine

1,1-Dimethylpropyl acetate ⟶ Amyl acetate (all isomers)

N,N-Dimethyl-p-toluidine

[99-97-8]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.1

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Dimethyl succinate

[106-65-0]
see also Dicarboxylic acid (C4–C6) dimethylester

$CH_3\text{-}OOC\text{-}(CH_2)_2\text{-}COO\text{-}CH_3$

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Dimethylsulfamoyl chloride

[13360-57-1]

$(H_3C)_2N\text{-}SO_2\text{-}Cl$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3 at 44℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Dimethyl sulfate

[77-78-1]

$(H_3CO)_2SO_2$

see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Dimethyl sulfide

[75-18-3]

$H_3C\text{-}S\text{-}CH_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dimethyl sulfoxide

[67-68-5]

$H_3C\text{-}SO\text{-}CH_3$

MAK[ml/m^3]: 50
MAK[mg/m^3]: 160
Peak lim: I(2)
Preg gr: B
Note regarding prerequisite for Group C see documentation
Perc abs: H

Dimethyltin compounds → Methyltin compounds

Dimethyltin bis(2-ethylhexylmercaptoacetate) [DMT(2-EHMA)$_2$] → Methyltin compounds

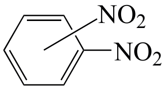
Dimethyltin bis(isooctylmercaptoacetate) [DMT(IOMA)$_2$] → Methyltin compounds

Dimorpholinomethane → Bismorpholino methane

Dinickel trioxide → Nickel and nickel compounds

Dinitrobenzene (all isomers)

[25154-54-5]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.0013 at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

– 1,2-Dinitrobenzene

[528-29-0]

– 1,3-Dinitrobenzene

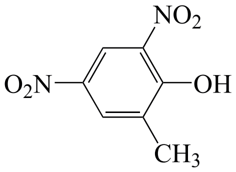
[99-65-0]

– 1,4-Dinitrobenzene

[100-25-4]

4,6-Dinitro-o-cresol

[534-52-1]



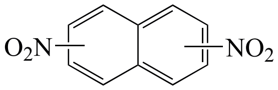
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.6×10^{-4} at 25℃
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Dinitrogen monoxide → Nitrous oxide

Dinitronaphthalene (all isomers)

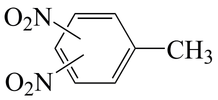
[27478-34-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Dinitrotoluene (mixtures of isomers)

[25321-14-6]



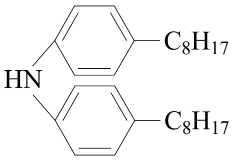
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 5.3×10^{-4} at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Dinonyl-naphthalenesulfonic acid calcium salt ⟶ Calcium bis(dinonylnaphthalenesulphonate)

4,4′-Dioctyldiphenylamine

[101-67-7]



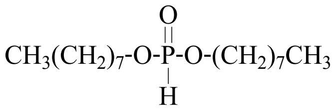
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dioctyl phosphite ⟶ Di-n-octyl phosphonate

Di-n-octyl phosphonate

[1809-14-9]
see also Di-n-butyl phosphonate



$$CH_3(CH_2)_7\text{-}O\text{-}\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle H}{|}}{P}}\text{-}O\text{-}(CH_2)_7CH_3$$

VP[hPa]: 2.1×10^{-7} at 25℃
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Di-sec-octyl phthalate ⟶ Di(2-ethylhexyl)phthalate (DEHP)

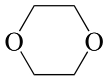
Di-n-octyltin compounds ⟶ n-Octyltin compounds

Diospyros spp. ⟶ Woods

Dioxacyclopentane ⟶ 1,3-Dioxolane

1,4-Dioxane

[123-91-1]



VP[hPa]: 41
see Section XII

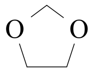
MAK[ml/m^3]: 10
MAK[mg/m^3]: 37
Peak lim: I(2)
Preg gr: C
Perc abs: H
Carc cat: 4

Dioxane ⟶ 1,4-Dioxane

1,3-Dioxo-2-benzofuran-5-carboxylic acid ⟶ Trimellitic anhydride

1,3-Dioxolane

[646-06-0]



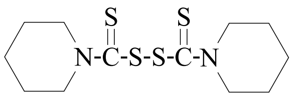
VP[hPa]: 105

MAK[ml/m^3]: 50
MAK[mg/m^3]: 150
Peak lim: II(2)
Preg gr: B
Perc abs: H

3,6-Dioxyoctane-1,8-diyl dimethacrylate ⟶ Triethylene glycol dimethacrylate

Dipentamethylenethiuram disulfide

[94-37-1]



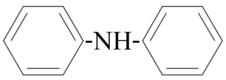
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Diphenyl ⟶ Biphenyl

Diphenylamine

[122-39-4]

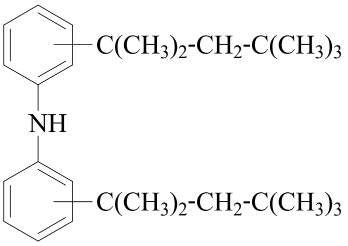


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.33
see Section Xc

MAK[mg/m³]:	5 I
Peak lim:	II(2)
Preg gr:	C
Perc abs:	H
Carc cat:	3

Diphenylamine, octylated (Benzenamine, N-phenyl-, reaction products with 2,4,4-trimethylpentene)

[68411-46-1]



see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

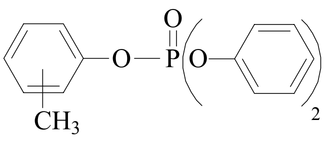
Diphenylamine, reaction products with styrene and 2,4,4-trimethylpentene

[68921-45-9]
see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Diphenyl cresyl phosphate

[26444-49-5]

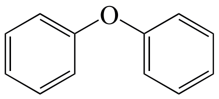


VP[hPa]: <0.01
see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Diphenyl ether

[101-84-8]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.027 at 25℃

MAK[ml/m³]:	1
MAK[mg/m³]:	7.1
Peak lim:	I(1)
Preg gr:	C

Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

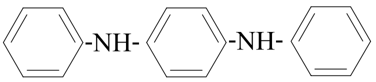
1,2-Diphenylhydrazine ⟶ Hydrazobenzene

Diphenylmethane-4,4′-diisocyanate ⟶ 4,4′-Methylene diphenyl diisocyanate (MDI)

N,N-Diphenylnitrosamine ⟶ N-Nitrosodiphenylamine

N,N-Diphenyl-p-phenylenediamine

[74-31-7]



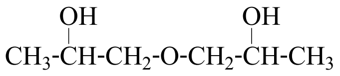
see Section IV

Sens:	Sh

Diphosphorus pentoxide ⟶ Phosphorus pentoxide

Dipropylene glycol

[25265-71-8]



$$CH_3\text{-}\underset{}{\overset{OH}{CH}}\text{-}CH_2\text{-}O\text{-}CH_2\text{-}\overset{OH}{CH}\text{-}CH_3$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.043 at 25℃
see Section Xc

MAK[mg/m³]:	100 I
Peak lim:	II(2)
Preg gr:	C

Dipropylene glycol monomethyl ether

[34590-94-8]
(mixture of isomers)

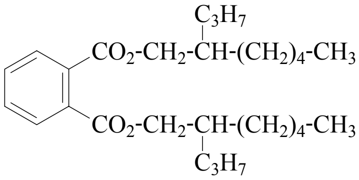
$$H_3CO\text{-}C_3H_6\text{-}O\text{-}C_3H_6\text{-}OH$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.7 at 25℃

MAK[ml/m³]:	50
MAK[mg/m³]:	310
Peak lim:	I(1)
Preg gr:	D

Di(2-propylheptyl) phthalate (DPHP)

[53306-54-0]



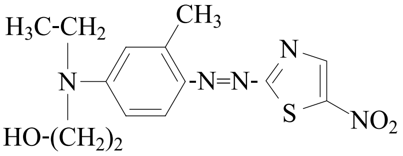
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

N,N-Di-n-propylnitrosoamine ⟶ N-Nitrosodi-n-propylamine

Disodium 2′,7′-dibromo-4′-(hydroxymercury) fluorescein ⟶ Merbromin

Disperse blue 106/124

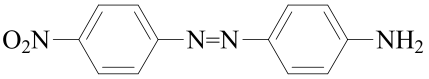
[68516-81-4; 15141-18-1]



see Section IV
Sens: Sh

Disperse Orange 3

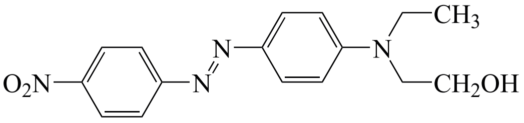
[730-40-5]



see Section IV
Sens: Sh

Disperse Red 1

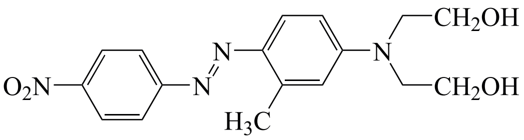
[2872-52-8]



see Section IV
Sens: Sh

Disperse Red 17

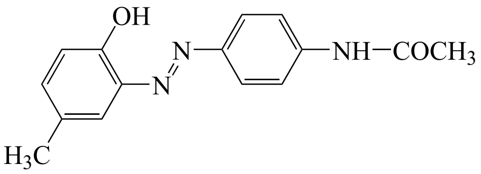
[3179-89-3]



see Section IV
Sens: Sh

Disperse Yellow 3

[2832-40-8]



see Section IV
Sens: Sh

Distemonanthus benthamianus ⟶ Woods

Distillates (petroleum)

[64742-47-8]
hydrotreated light (aerosol)
VP[hPa]: 0.6
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C
Carc cat: 3

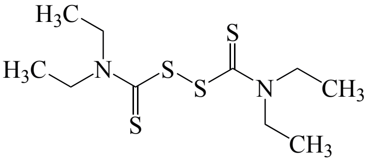
Distillates (petroleum)

[64742-47-8]
hydrotreated light (vapour)
VP[hPa]: 0.6
see Section Xc

MAK[ml/m^3]: 50
MAK[mg/m^3]: 350
Peak lim: II(2)
Preg gr: C
Carc cat: 3

Disulfiram

[97-77-8]



Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".

MAK[mg/m^3]: 2 I
Peak lim: II(8)
Preg gr: D
Sens: Sh

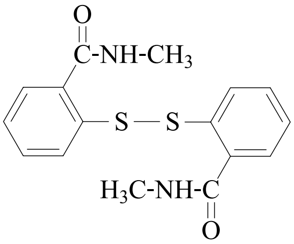
Disulfur chloride ⟶ Sulfur monochloride

Disulfur decafluoride ⟶ Sulfur pentafluoride

2,2′-Dithiobisbenzothiazole ⟶ 2,2′-Dibenzothiazyl disulfide

2,2′-Dithiobis(N-methylbenzamide)

[2527-58-4]



see Section IIb and Xc

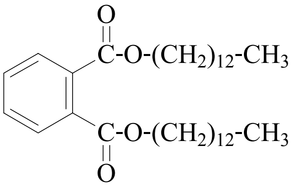
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Dithiocarb ⟶ Sodium diethyldithiocarbamate

Dithiocarb sodium ⟶ Sodium diethyldithiocarbamate

Ditridecyl phthalate

[119-06-2]

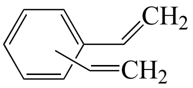


see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Divinylbenzene (all isomers)

[1321-74-0]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.9 at 25°C
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Docosanoic acid ⟶ Behenic acid

Dodecanedioic acid

[693-23-2]

$HOOC(CH_2)_{10}COOH$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dodecanoic acid ⟶ Lauric acid

1-Dodecanol

[112-53-8]

$CH_3\text{-}(CH_2)_{10}\text{-}CH_2OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.1×10^{-3}
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Dodecyl alcohol ⟶ 1-Dodecanol

DOP ⟶ Di(2-ethylhexyl)phthalate (DEHP)

Douka (Tieghemella africana) ⟶ Woods

DPHP ⟶ Di(2-propylheptyl) phthalate (DPHP)

Dust, general limit value (inhalable fraction)

see Section Vf and g
MAK[mg/m^3]: 4 I

Dust, general limit value (respirable fraction)

(biopersistent granular dusts)
except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m^3]: 0.3
for dusts with a density of 1 g/cm^3
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Dusts

see Section V

Dusts containing enzymes

see Section IVe

East Indian rosewood (Dalbergia latifolia) ⟶ Woods

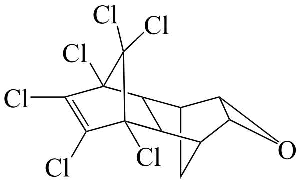
Ebony (Diospyros spp.) ⟶ Woods

EDTA ⟶ Ethylenediaminetetraacetic acid (EDTA)

Endothiapepsin ⟶ Microbial rennets: endothiapepsin and mucorpepsin

Endrin

[72-20-8]



MAK[mg/m^3]: 0.05 I
Peak lim: II(8)
Preg gr: C
Perc abs: H

Enflurane

[13838-16-9]

$HF_2C\text{-}O\text{-}CF_2\text{-}CHFCl$

VP[hPa]: 232

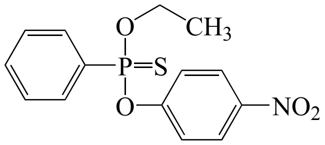
MAK[ml/m^3]: 20
MAK[mg/m^3]: 150
Peak lim: II(8)
Preg gr: C

Entandrophragma spp. ⟶ Woods

Epichlorohydrin ⟶ 1-Chloro-2,3-epoxypropane

EPN (O-Ethyl O-(4-nitrophenyl)-phenylthiophosphonate)

[2104-64-5]



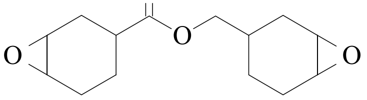
BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc

1,2-Epoxy-3-allyloxypropane ⟶ Allyl glycidyl ether

1,2-Epoxybutane ⟶ 1,2-Butylene oxide

3,4-Epoxycyclohexane carboxylic acid (3,4-epoxycyclohexylmethyl) ester

[2386-87-0]



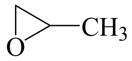
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

1,2-Epoxy-4-(epoxyethyl)cyclohexane ⟶ 4-Vinyl-1-cyclohexene dioxide

1,2-Epoxy-3-isopropoxypropane ⟶ Isopropyl glycidyl ether (IGE)

1,2-Epoxypropane

[75-56-9]



see Section XII

MAK[ml/m^3]: 2
MAK[mg/m^3]: 4.8
Peak lim: I(2)
Preg gr: C
Sens: Sh
Carc cat: 4

2,3-Epoxy-1-propanol ⟶ Glycidol

2,3-Epoxypropyl methacrylate ⟶ Glycidyl methacrylate

2,3-Epoxypropyl-o-tolylether ⟶ Cresyl glycidyl ethers

(2,3-Epoxypropyl)trimethylammonium chloride ⟶ Glycidyl trimethylammonium chloride

Erionite

[12510-42-8]
(fibrous dust)

$(Ca,Na,K)_2[Al_3Si_9O_{24}] \cdot 9\ H_2O$

see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1

Ethanedial ⟶ Glyoxal

1,2-Ethanediol ⟶ Ethylene glycol

N,N′-1,2-Ethanediylbis[N-(carboxymethyl)glycine] ⟶ Ethylenediaminetetraacetic acid (EDTA)

Ethanethiol

[75-08-1]

$H_3C\text{-}CH_2SH$

VP[hPa]: 590

MAK[ml/m^3]: 0.5
MAK[mg/m^3]: 1.3
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: II(2)
Preg gr: D
Perc abs: H

Ethanol

[64-17-5]

$H_3C\text{-}CH_2OH$

VP[hPa]: 59

MAK[ml/m^3]: 200
MAK[mg/m^3]: 380
see definition of Carcinogen Category 5 and supporting documentation
Peak lim: II(4)
Preg gr: C
Carc cat: 5
Muta cat: 5

Ethanolamine ⟶ 2-Aminoethanol

Ethene ⟶ Ethylene

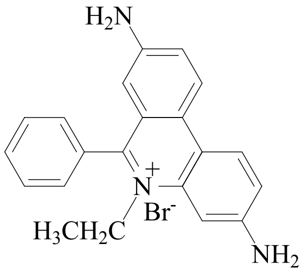
N-Ethenylcarbazole ⟶ Vinylcarbazole

4-Ethenylcyclohexene ⟶ 4-Vinylcyclohexene

1-(Ethenyloxy)-2-methylpropane ⟶ Isobutyl vinyl ether

Ethidium bromide

[1239-45-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3
Muta cat: 3B

2-Ethoxy-6-amino-naphthalene ⟶ 6-Amino-2-ethoxynaphthalene

2-Ethoxyethanol

[110-80-5]

$H_3C\text{-}CH_2O\text{-}CH_2\text{-}CH_2OH$

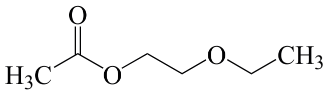
VP[hPa]: ~ 5
see Section XII

MAK[ml/m^3]: 2
MAK[mg/m^3]: 7.5
MAK value applies for the sum of the concentrations of 2-ethoxyethanol and 2-ethoxyethyl acetate in the air.
Peak lim: II(8)
Preg gr: B
Perc abs: H

2-(2-Ethoxyethoxy)ethanol ⟶ Diethylene glycol monoethyl ether

2-Ethoxyethyl acetate

[111-15-9]



see Section XII

MAK[ml/m^3]: 2
MAK[mg/m^3]: 11
MAK value applies for the sum of the concentrations of 2-ethoxyethanol and 2-ethoxyethyl acetate in the air.
Peak lim: II(8)
Preg gr: B
Perc abs: H

1-Ethoxy-2-propanol

[1569-02-4]

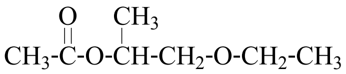
$CH_3\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH(OH)\text{-}CH_3$

VP[hPa]: 10
see Section XII

MAK[ml/m^3]: 20
MAK[mg/m^3]: 86
MAK value applies for the sum of the concentrations of 1-ethoxy-2-propanol and 1-ethoxy-2-propyl acetate in the air.
Peak lim: II(2)
Preg gr: C
Perc abs: H

1-Ethoxy-2-propyl acetate

[54839-24-6]



$$CH_3\text{-}\overset{\overset{\displaystyle O}{||}}{C}\text{-}O\text{-}\overset{\overset{\displaystyle CH_3}{|}}{CH}\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_3$$

VP[hPa]: 2
see Section XII

MAK[ml/m^3]: 20
MAK[mg/m^3]: 120
MAK value applies for the sum of the concentrations of 1-ethoxy-2-propanol and 1-ethoxy-2-propyl acetate in the air.
Peak lim: II(2)
Preg gr: C
Perc abs: H

Ethyl acetate

[141-78-6]

$H_3C\text{-}COOCH_2\text{-}CH_3$

VP[hPa]: 97

MAK[ml/m^3]: 200
MAK[mg/m^3]: 750
Peak lim: I(2)
Preg gr: C

Ethyl acrylate

[140-88-5]

$H_2C=CH\text{-}COOCH_2\text{-}CH_3$

VP[hPa]: 39

MAK[ml/m^3]: 2
MAK[mg/m^3]: 8.3
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
Preg gr: C
Perc abs: H
Sens: Sh

Ethyl alcohol ⟶ Ethanol

Ethylamine

[75-04-7]

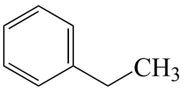
$H_3C\text{-}CH_2NH_2$

VP[hPa]: 990

MAK[ml/m^3]: 5
MAK[mg/m^3]: 9.4
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 10 ml/m^3 (19 mg/m^3) should not be exceeded.
Preg gr: D

Ethylbenzene

[100-41-4]



VP[hPa]: 9
see Section XII

MAK[ml/m^3]: 20
MAK[mg/m^3]: 88
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

Ethyl bromide ⟶ Bromoethane

Ethyl carbamate ⟶ Carbamic acid ethyl ester

Ethyl chloride ⟶ Chloroethane

Ethyl 2-cyanoacrylate

[7085-85-0]

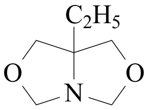
$H_2C=CCN\text{-}CO\text{-}OCH_2\text{-}CH_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

★ 5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO)

[7747-35-5]



releases formaldehyde
VP[hPa]: 0.376
see Section Xc

MAK[ml/m^3]: 0.15
MAK[mg/m^3]: 0.89
Peak lim: I(2)
Preg gr: C
Sens: Sh
Carc cat: 4
Muta cat: 5

Ethylene

[74-85-1]

$H_2C=CH_2$

see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Ethylenebis(oxyethylene)methacrylate ⟶ Triethylene glycol dimethacrylate

Ethylene chlorohydrin ⟶ 2-Chloroethanol

Ethylenediamine

[107-15-3]

$H_2NCH_2\text{-}CH_2NH_2$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sah

Ethylenediaminetetraacetic acid (EDTA)

[60-00-4]

$(HO_2C\text{-}\ CH_2)_2N\text{-}\ CH_2\text{-}\ CH_2\text{-}\ N(CH_2\text{-}\ CO_2H)_2$

Avoid exposure to mixtures with iron compounds (formation of FeEDTA).
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Ethylene dibromide ⟶ 1,2-Dibromoethane

Ethylene dichloride ⟶ 1,2-Dichloroethane

(Ethylenedioxy)dimethanol

[3586-55-8]

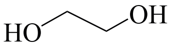
$$HO\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_2\text{-}O\text{-}CH_2\text{-}OH$$

releases formaldehyde
VP[hPa]: 13.2 (calculated value)
see Section Xc

MAK[ml/m^3]: 0.15
MAK[mg/m^3]: 0.76
Peak lim: I(2)
Preg gr: C
Carc cat: 4
Muta cat: 5

Ethylene glycol

[107-21-1]

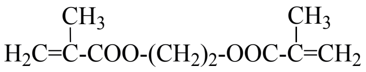


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.053

MAK[ml/m^3]: 10
MAK[mg/m^3]: 26
Peak lim: I(2)
Preg gr: C
Perc abs: H

Ethylene glycol dimethacrylate

[97-90-5]



$$H_2C{=}\overset{\overset{\displaystyle CH_3}{|}}{C}\text{-}COO\text{-}(CH_2)_2\text{-}OOC\text{-}\overset{\overset{\displaystyle CH_3}{|}}{C}{=}CH_2$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.25 at 25℃ (calculated value)
see Section IV
Sens: Sh

Ethylene glycol dinitrate

[628-96-6]

$$O_2NH\text{-}O\text{-}(CH_3)_2\text{-}OH\text{-}NO_2$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.096 at 25℃
see Section XII

MAK[ml/m^3]: 0.01
MAK[mg/m^3]: 0.063
MAK value applies for the sum of the concentrations of ethylene glycol dinitrate, nitroglycerin and propylene glycol dinitrate in the air.
Peak lim: II(1)
Preg gr: C
Perc abs: H

Ethylene glycol isopropyl ether ⟶ 2-Isopropoxyethanol

Ethylene glycol methacrylate ⟶ 2-Hydroxyethyl methacrylate

Ethylene glycol monoacrylate ⟶ Acrylic acid 2-hydroxyethyl ester

Ethylene glycol monobutyl ether ⟶ 2-Butoxyethanol

Ethylene glycol monobutyl ether acetate ⟶ 2-Butoxyethyl acetate

Ethylene glycol monoethyl ether ⟶ 2-Ethoxyethanol

Ethylene glycol monoethyl ether acetate ⟶ 2-Ethoxyethyl acetate

Ethylene glycol monomethyl ether ⟶ 2-Methoxyethanol

Ethylene glycol monomethyl ether acetate ⟶ 2-Methoxyethyl acetate

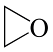
Ethylene glycol monophenyl ether ⟶ 2-Phenoxyethanol

Ethylene glycol mono-n-propyl ether ⟶ 2-Propyloxyethanol

Ethylene glycol monopropyl ether acetate ⟶ 2-(Propyloxy)ethyl acetate

Ethylene oxide

[75-21-8]

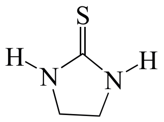


see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 2

Ethylene thiourea (Imidazoline-2-thione)

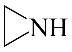
[96-45-7]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Ethylenimine

[151-56-4]



VP[hPa]: 214

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 2

Ethyl ether

[60-29-7]

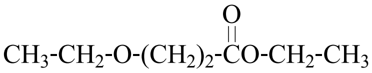
$H_3C\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_3$

VP[hPa]: 587

MAK[ml/m^3]: 400
MAK[mg/m^3]: 1200
Peak lim: I(1)
Preg gr: D

Ethyl-3-ethoxypropionate

[763-69-9]



$CH_3\text{-}CH_2\text{-}O\text{-}(CH_2)_2\text{-}\overset{\overset{\displaystyle O}{||}}{C}O\text{-}CH_2\text{-}CH_3$

MAK[ml/m^3]: 100
MAK[mg/m^3]: 610
Peak lim: I(1)
Preg gr: C
Perc abs: H

★ Ethyl formate

[109-94-4]

$HCOOCH_2\text{-}CH_3$

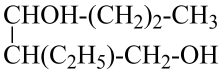
VP[hPa]: 266

MAK[ml/m^3]: 100
MAK[mg/m^3]: 310
Peak lim: I(1)
Preg gr: C
Perc abs: H

Ethyl glycol ⟶ 2-Ethoxyethanol

2-Ethyl-1,3-hexanediol

[94-96-2]



$$\begin{array}{l} CHOH\text{-}(CH_2)_2\text{-}CH_3 \\ | \\ CH(C_2H_5)\text{-}CH_2\text{-}OH \end{array}$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: <0.01
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2-Ethylhexanoic acid

[149-57-5]

$CH_3\text{-}(CH_2)_3\text{-}CH(C_2H_5)\text{-}COOH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.04
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2-Ethylhexanol

[104-76-7]

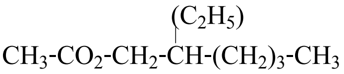
$CH_3(CH_2)_3CH(C_2H_5)CH_2OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.18 at 25℃

MAK[ml/m^3]: 10
MAK[mg/m^3]: 54
Peak lim: I(1)
Preg gr: C

2-Ethylhexyl acetate

[103-09-3]



$CH_3\text{-}CO_2\text{-}CH_2\text{-}\overset{\overset{\displaystyle (C_2H_5)}{|}}{C}H\text{-}(CH_2)_3\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.31 at 25℃

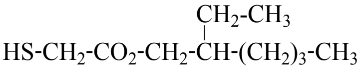
MAK[ml/m^3]: 10
MAK[mg/m^3]: 71
Peak lim: I(1)
Preg gr: C

2-Ethylhexyl acrylate ⟶ Acrylic acid 2-ethylhexyl ester

2-Ethylhexyl alcohol ⟶ 2-Ethylhexanol

2-Ethylhexyl mercaptoacetate

[7659-86-1]



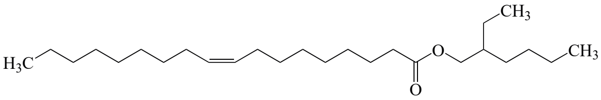
$HS\text{-}CH_2\text{-}CO_2\text{-}CH_2\text{-}\overset{\overset{\displaystyle CH_2\text{-}CH_3}{|}}{C}H\text{-}(CH_2)_3\text{-}CH_3$

see Section IV
Sens: Sh

2-Ethylhexyl (Z)-octadec-9-enoate ⟶ 2-Ethylhexyl oleate

2-Ethylhexyl oleate

[26399-02-0]



VP[hPa]: 2.4×10^{-5} (calculated value)
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: D

2-Ethylhexyl thioglycolate ⟶ 2-Ethylhexyl mercaptoacetate

2-Ethyl-2-(hydroxymethyl)-1,3-propanediol triacrylate ⟶ Trimethylolpropane triacrylate

Ethylidene chloride ⟶ 1,1-Dichloroethane

Ethyl mercaptan ⟶ Ethanethiol

Ethyl(2-mercaptobenzoato-S)mercury sodium salt ⟶ Thimerosal

Ethyl mercury ⟶ Mercury, organic compounds

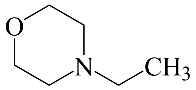
Ethyl methacrylate ⟶ Methacrylic acid ethyl ester

Ethyl methyl ketoxime ⟶ Butanone oxime

Ethyl 2-methyl-2-propenoate ⟶ Methacrylic acid ethyl ester

N-Ethylmorpholine

[100-74-3]



see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

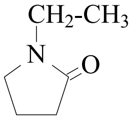
O-Ethyl O-(4-nitrophenyl)phenylthiophosphonate ⟶ EPN (O-Ethyl O-(4-nitrophenyl)phenylthiophosphonate)

4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine ⟶ 4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w)

N-Ethyl-N-nitrosoaniline ⟶ N-Nitrosoethylphenylamine

N-Ethyl-2-pyrrolidone

[2687-91-4]
(vapour)



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.18

MAK[ml/m^3]: 5
MAK[mg/m^3]: 23
Peak lim: I(2)
Preg gr: C
Perc abs: H

Ethyl silicate ⟶ Silicic acid tetraethyl ester

Ethyltin compounds

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: –
For ethyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.

Ethyl vinyl ether

[109-92-2]

$$H_2C{=}CH\text{-}O\text{-}CH_2CH_3$$

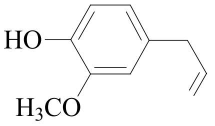
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Etidronic acid ⟶ 1-Hydroxyethylidene-1,1-diphosphonic acid

Eugenol

[97-53-0]

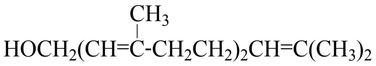


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: <0.1
see Section IV
Sens: Sh

F 134a ⟶ 1,1,1,2-Tetrafluoroethane

Farnesol

[4602-84-0]



$$HOCH_2(CH{=}\overset{\overset{\displaystyle CH_3}{|}}{C}\text{-}CH_2CH_2)_2CH{=}C(CH_3)_2$$

see Section IV
Sens: Sh

Fatty acids, C14–18 saturated and C16–18-unsaturated

[67701-06-8]
VP[hPa]: $<1.87 \times 10^{-6}$ at 25°C
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Fatty alcohol ethoxylates, C16–18 and C18-unsaturated

[68920-66-1]

$$HO(\text{-}CH_2CH_2\text{-}O)_n\text{-}R$$
$$R1\text{: -}(CH_2)_{15\text{-}17}\text{-}CH_3$$
$$R2\text{: -}(CH_2)_x\text{-}CH{=}CH\text{-}(CH_2)_y\text{-}CH_3$$
$$x+y=15$$

VP[hPa]: 5.5×10^{-5} (calculated value)
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Fatty alcohols, C12–18

[67762-25-8]

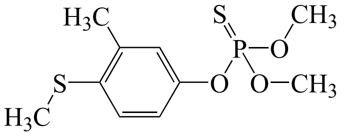
$HO\text{-}(CH_2)_{11\text{-}17}\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Fenthion

[55-38-9]



BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc

Ferbam

[14484-64-1]

$Fe[S\text{-}CS\text{-}N(CH_3)_2]_3$

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Ferrovanadium

[12604-58-9]
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Fibrous dust, inorganic

see Section III

Fluorides

[16984-48-8]
(as Fluoride)
see Section XII

MAK[mg/m³]: 1 I
Peak lim: II(4)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H

Fluorine

[7782-41-4]

F_2

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Fluorocarbon 134a ⟶ 1,1,1,2-Tetrafluoroethane

Fluorotrichloromethane ⟶ Trichlorofluoromethane

Formaldehyde

[50-00-0]

$HCHO$

MAK[ml/m³]: 0.3
MAK[mg/m³]: 0.37
During exposure to mixtures it should be ensured that irritant effects do not occur.
Peak lim: I(2)
A momentary value of 1 ml/m³ (1.2 mg/m³) should not be exceeded.
Preg gr: C
Sens: Sh
Carc cat: 4
Muta cat: 5

Formaldehyde condensation products with p-tert-butylphenol

(low molecular)
see Section IV
Sens: Sh

Formaldehyde condensation products with phenol (low-molecular)

see Section IV
Sens: Sh

Formamide

[75-12-7]

$NH_2\text{-}CHO$

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Formic acid

[64-18-6]

$HCOOH$

VP[hPa]: 42

MAK[ml/m³]: 5
MAK[mg/m³]: 9.5
Peak lim: I(2)
Preg gr: C

Formic acid ethyl ester ⟶ Ethyl formate

Formic acid methyl ester ⟶ Methyl formate

Fragrance components
see Section IVe

Fraké (Terminalia superba) ⟶ Woods

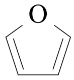
Framiré (Terminalia ivorensis) ⟶ Woods

Fumes
see Section V

2-Furaldehyde ⟶ Furfural

Furan

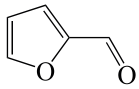
[110-00-9]



MAK[ml/m^3]: 0.02
MAK[mg/m^3]: 0.056
Peak lim: II(2)
Preg gr: D
Perc abs: H
Carc cat: 4

Furfural

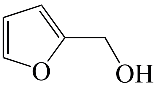
[98-01-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Furfuryl alcohol

[98-00-0]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

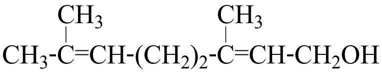
Gallium arsenide ⟶ Arsenic

Gasolines
see Section Xb

Gedu nohor (Entandrophragma angolense) ⟶ Woods

Geraniol

[106-24-1]



$$CH_3\text{-}\overset{CH_3}{\overset{|}{C}}\text{=}CH\text{-}(CH_2)_2\text{-}\overset{CH_3}{\overset{|}{C}}\text{=}CH\text{-}CH_2OH$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.3
see Section IV
Sens: Sh

Germanium tetrahydride

[7782-65-2]

GeH_4

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Glass fibres, biopersistent (fibrous dust)
see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

⋆ Glass wool, half-life < 40 days (fibrous and granular components)

MAK[mg/m^3]: 0.1 R
Peak lim: II(8)
Preg gr: D
Carc cat: 4

Glutaraldehyde

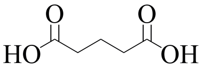
[111-30-8]

$OCH\text{-}(CH_2)_3\text{-}CHO$

MAK[ml/m^3]: 0.05
MAK[mg/m^3]: 0.21
Peak lim: I(2)
A momentary value of 0.2 ml/m^3 (0.83 mg/m^3) should not be exceeded.
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Sens: Sah
Carc cat: 4

Glutaric acid

[110-94-1]



MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: C

Glutaric acid, dimethyl ester ⟶ Dimethyl glutarate

Glycerol

[56-81-5]

$$HOCH_2\text{-}CH(OH)\text{-}CH_2OH$$

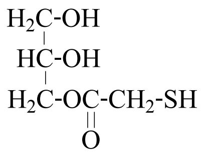
see Section Xc

MAK[mg/m³]:	200 I
Peak lim:	I(2)
Preg gr:	C

Glycerol trinitrate ⟶ Nitroglycerin

Glyceryl monothioglycolate

[30618-84-9]



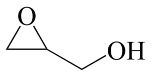
$$\begin{array}{l} H_2C\text{-}OH \\ \quad | \\ HC\text{-}OH \\ \quad | \\ H_2C\text{-}OC\text{-}CH_2\text{-}SH \\ \qquad \| \\ \qquad O \end{array}$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.2×10^{-5} at 25°C
see Section IV

Sens:	Sh

Glycidol

[556-52-5]



see Section XII

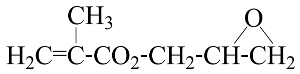
MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2
Muta cat:	3A

Glycidyl compounds (epoxides)

see Section IVe

Glycidyl methacrylate

[106-91-2]



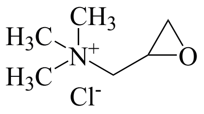
$$H_2C\text{=}\overset{\overset{CH_3}{|}}{C}\text{-}CO_2\text{-}CH_2\text{-}\overset{O}{\overbrace{CH\text{-}CH_2}}$$

see Section IV

Sens:	Sh

Glycidyl trimethylammonium chloride

[3033-77-0]



MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Sens:	Sh
Carc cat:	2

Glycol ⟶ Ethylene glycol

Glycol dinitrate ⟶ Ethylene glycol dinitrate

Glycolic acid n-butylester ⟶ Hydroxyacetic acid butyl ester

Glyoxal

[107-22-2]

$$OHC\text{-}CHO$$

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Sens:	Sh
Carc cat:	3

Gold

[7440-57-5]
and its inorganic compounds

$$Au$$

see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Sens:	Sh

only soluble gold compounds

Gonystylus bancanus ⟶ Woods

Granular biopersistent dusts ⟶ Dust, general limit value (respirable fraction)

Graphite

[7782-42-5]
(inhalable fraction)

$$C$$

see Section Vf and g

MAK[mg/m³]:	4 I
Preg gr:	C

Graphite

[7782-42-5]
(respirable fraction)

C

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m^3]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Grevillea robusta ⟶ Woods

Hafnium

[7440-58-6]
and its compounds

Hf

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Halloysite

[12298-43-0]
(fibrous dust)

$Al_2(Si_2O_7) \cdot x\ H_2O$

see Section III

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Halothane

[151-67-7]

$BrClHC\text{-}CF_3$

VP[hPa]: 242
see Section XII

MAK[ml/m^3]: 5
MAK[mg/m^3]: 41
Peak lim: II(8)
Preg gr: B

Hard coal dust ⟶ Coal mine dust

Hard metal containing tungsten carbide and cobalt

(inhalable fraction)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sah
Carc cat: 1
Muta cat: 3A

HDDA ⟶ 1,6-Hexanediol diacrylate

Hemicellulases ⟶ Xylanases

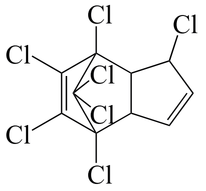
Hemimellitene (1,2,3-Trimethylbenzene) ⟶ Trimethylbenzene (all isomers)

Hempa ⟶ Hexamethylphosphoric acid triamide

HEOD ⟶ Dieldrin

Heptachlor

[76-44-8]



MAK[mg/m^3]: 0.05 I
Peak lim: II(8)
Preg gr: D
Perc abs: H
Carc cat: 4

Heptadecafluoro-1-octanesulfonic acid ⟶ Perfluorooctanesulfonic acid (PFOS)

n-Heptane

[142-82-5]

$H_3C\text{-}C_5H_{10}\text{-}CH_3$

VP[hPa]: 48
see Section XII

MAK[ml/m^3]: 500
MAK[mg/m^3]: 2100
Peak lim: I(1)
Preg gr: D

1,7-Heptanedicarbonic acid ⟶ Azelaic acid

3-Heptanone

[106-35-4]

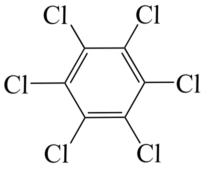
$CH_3\text{-}CH_2\text{-}CO\text{-}(CH_2)_3\text{-}CH_3$

VP[hPa]: 1.5

MAK[ml/m^3]: 10
MAK[mg/m^3]: 47
Peak lim: I(2)
Preg gr: D

Hexachlorobenzene

[118-74-1]



see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: D
Perc abs: H
Carc cat: 4

Hexachloro-1,3-butadiene

[87-68-3]

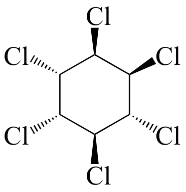
$Cl_2C=CCl-CCl=CCl_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.29 at 25℃

MAK[ml/m^3]: 0.02
MAK[mg/m^3]: 0.22
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

α-Hexachlorocyclohexane

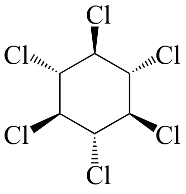
[319-84-6]



MAK[mg/m^3]: 0.5 I
Peak lim: II(8)
Preg gr: D
Perc abs: H
Carc cat: 4

β-Hexachlorocyclohexane

[319-85-7]



MAK[mg/m^3]: 0.1 I
Peak lim: II(8)
Preg gr: D
Perc abs: H
Carc cat: 4

γ-Hexachlorocyclohexane ⟶ Lindane

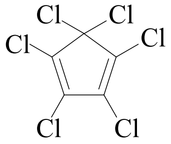
1,2,3,4,5,6-Hexachlorocyclohexane

techn. mixture of α-HCH [319-84-6] and β-HCH [319-85-7]

MAK[mg/m^3]: 0.1 I
(Conc. α-HCH divided by 5) + Conc. β-HCH = 0.1
Peak lim: II(8)
Preg gr: D
Perc abs: H
Carc cat: 4

Hexachlorocyclopentadiene

[77-47-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.1 at 25℃
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Hexachloroethane

[67-72-1]

Cl_3C-CCl_3

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.4

MAK[ml/m^3]: 1
MAK[mg/m^3]: 9.8
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 3

Hexachloronaphthalenes ⟶ Chlorinated naphthalenes

Hexadecanoic acid ⟶ Palmitic acid

1-Hexadecanol

[36653-82-4]

$HO-(CH_2)_{15}-CH_3$

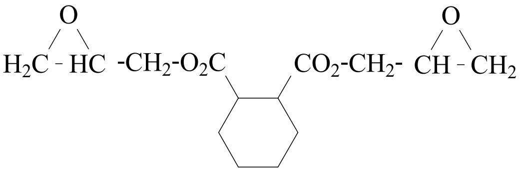
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: <0.01
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

1,1,1,3,3,3-Hexafluoro-2-(fluoromethoxy) propane ⟶ Sevoflurane

Hexahydrophthalic acid diglycidylester

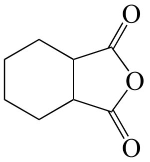
[5493-45-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

Hexahydrophthalic anhydride

[85-42-7]



The substance can occur simultaneously as vapour and aerosol.
see Section IV
Sens: Sa

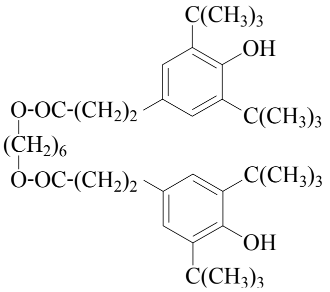
Hexahydro-1,3,5-triethyl-s-triazine ⟶ 1,3,5-Triethylhexahydro-1,3,5-triazine

Hexahydro-1,3,5-tris(hydroxyethyl)-s-triazine ⟶ N,N′,N′′-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine

Hexahydro-1,3,5-tris(2-hydroxypropyl)-s-triazine ⟶ N,N′,N′′-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine

Hexamethylene bis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate)

[35074-77-2]



see Section Xc

MAK[mg/m^3]: 10 I
Peak lim: II(2)
Preg gr: C

1,6-Hexamethylene diacrylate ⟶ 1,6-Hexanediol diacrylate

1,6-Hexamethylene diisocyanate

[822-06-0]

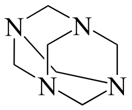
$OCN\text{-}(CH_2)_6\text{-}NCO$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.007

MAK[ml/m^3]: 0.005
MAK[mg/m^3]: 0.035
Peak lim: I(1)
A momentary value of 0.01 ml/m^3 (0.070 mg/m^3) should not be exceeded.
Preg gr: D
Sens: Sah

Hexamethylenetetramine

[100-97-0]



releases formaldehyde
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Hexamethylentetramine-3-chloroallyl chloride ⟶ Methenamine 3-chloroallylchloride

Hexamethylphosphoric acid triamide

[680-31-9]

$OP[N(CH_3)_2]_3$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 2

n-Hexane

[110-54-3]

$H_3C\text{-}(CH_2)_4\text{-}CH_3$

VP[hPa]: 160
see Section XII

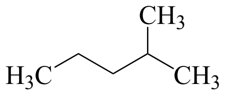
MAK[ml/m^3]: 50
MAK[mg/m^3]: 180
Peak lim: II(8)
Preg gr: C

Hexane (all isomers except n-Hexane) and Methylcyclopentane

MAK[ml/m^3]: 500
MAK[mg/m^3]: 1800
Peak lim: II(2)
Preg gr: D

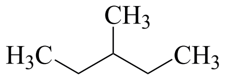
– 2-Methylpentane

[107-83-5]



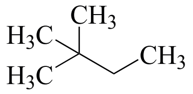
– 3-Methylpentane

[96-14-0]



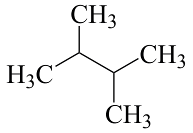
– 2,2-Dimethylbutane

[75-83-2]



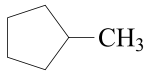
– 2,3-Dimethylbutane

[79-29-8]



– Methylcyclopentane

[96-37-7]



1,6-Hexanedioic acid ⟶ Adipic acid

1,6-Hexanediol diacrylate

[13048-33-4]

$H_2C{=}CH\text{-}COO\text{-}(CH_2)_6\text{-}OOC\text{-}CH{=}CH_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.014 at 50℃
see Section IV
Sens: Sh

1,6-Hexanediol diglycidylether ⟶ Diglycidyl hexanediol

2,2′-[1,6-Hexanediylbis(oxymethylene)]bisoxirane ⟶ Diglycidyl hexanediol

1-Hexanol

[111-27-3]

$H_3C\text{-}(CH_2)_4\text{-}CH_2OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.93
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

2-Hexanone

[591-78-6]

$H_3C\text{-}(CH_2)_3\text{-}CO\text{-}CH_3$

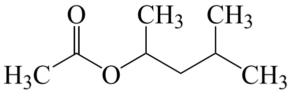
see Section XII

MAK[ml/m³]: 5
MAK[mg/m³]: 21
Peak lim: II(8)
Perc abs: H

Hexone ⟶ 4-Methyl-2-pentanone

sec-Hexyl acetate

[108-84-9]



see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

2-Hexyl-1-decanol

[2425-77-6]

$HO\text{-}CH_2\text{-}CH(C_6H_{13})\text{-}(CH_2)_7\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.004 at 38℃
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Hexylene glycol

[107-41-5]

$H_3C\text{-}CH(OH)\text{-}CH_2\text{-}C(OH)(CH_3)_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.07
see Section Xc

MAK[ml/m^3]: 10
MAK[mg/m^3]: 49
Peak lim: I(2)
Preg gr: D

HFC 134a ⟶ 1,1,1,2-Tetrafluoroethane

HMPA ⟶ Hexamethylphosphoric acid triamide

Honduras rosewood (Dalbergia stevensonii) ⟶ Woods

Hydraulic fluids
see Section Xc

Hydrazine

[302-01-2]

$H_2N\text{-}NH_2$

VP[hPa]: 13
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

Hydrazine hydrate

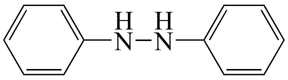
[7803-57-8]
and hydrazine salts

$H_2N\text{-}NH_2 \cdot H_2O$

see Section IV
Sens: Sh

Hydrazobenzene

[122-66-7]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Hydrazoic acid

[7782-79-8]

HN_3

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.18
Peak lim: I(2)

Hydrocarbon solvent C6–C13 dearomatised ⟶ Naphtha (petroleum)

Hydrochloric acid ⟶ Hydrogen chloride

Hydrocyanic acid ⟶ Hydrogen cyanide

Hydrogen bromide

[10035-10-6]

HBr

MAK[ml/m^3]: 2
MAK[mg/m^3]: 6.7
Peak lim: I(1)
Preg gr: D

Hydrogen chloride

[7647-01-0]

HCl

MAK[ml/m^3]: 2
MAK[mg/m^3]: 3.0
Peak lim: I(2)
Preg gr: C

Hydrogen cyanide

[74-90-8]

HCN

VP[hPa]: 800

MAK[ml/m^3]: 1.9
MAK[mg/m^3]: 2.1
Peak lim: II(2)
Preg gr: C
Perc abs: H

Hydrogen fluoride

[7664-39-3]

HF

VP[hPa]: 1033
see Section XII

MAK[ml/m^3]: 1
MAK[mg/m^3]: 0.83
Peak lim: I(2)
Preg gr: C

Hydrogen peroxide

[7722-84-1]

H_2O_2

MAK[ml/m³]:	0.5
MAK[mg/m³]:	0.71
Peak lim:	I(1)
Preg gr:	C
Carc cat:	4

Hydrogen selenide

[7783-07-5]

H_2Se

MAK[ml/m³]:	0.006
MAK[mg/m³]:	0.02

Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.

Peak lim:	II(8)
Preg gr:	C
Carc cat:	3

Hydrogen sulfide

[7783-06-4]

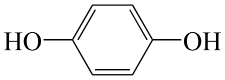
H_2S

MAK[ml/m³]:	5
MAK[mg/m³]:	7.1
Peak lim:	I(2)
Preg gr:	C

α-Hydro-ω-hydroxy-poly[oxy(methyl-1,2-ethandiyl)] ⟶ Polypropylene glycol (PPG)

Hydroquinone

[123-31-9]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.015

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Sens:	Sh
Carc cat:	2
Muta cat:	3A

Hydroxyacetic acid butyl ester

[7397-62-8]

$HO\text{-}CH_2\text{-}CO\text{-}O\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$

see Section IIb

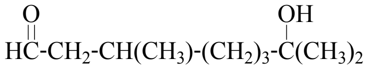
MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

3-Hydroxyaniline ⟶ 3-Aminophenol

p-Hydroxyaniline ⟶ p-Aminophenol

7-Hydroxycitronellal

[107-75-5]



$$H\overset{\overset{O}{\|}}{C}\text{-}CH_2\text{-}CH(CH_3)\text{-}(CH_2)_3\text{-}\overset{\overset{OH}{|}}{C}(CH_3)_2$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: <1
see Section IV

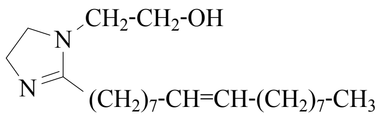
Sens:	Sh

2-(2-Hydroxyethoxy)-ethylamine ⟶ 2-(2-Aminoethoxy) ethanol

2-Hydroxyethyl acrylate ⟶ Acrylic acid 2-hydroxyethyl ester

1-Hydroxyethyl-2-heptadecenyl-imidazoline

[21652-27-7]

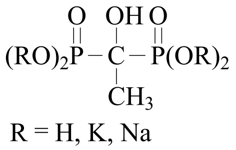


see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

1-Hydroxyethylidene-1,1-diphosphonic acid

[2809-21-4]
and its sodium and potassium salts



$$(RO)_2\overset{\overset{O}{\|}}{P}-\underset{\underset{CH_3}{|}}{\overset{\overset{OH}{|}}{C}}-\overset{\overset{O}{\|}}{P}(OR)_2$$

R = H, K, Na

see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

2-Hydroxyethyl methacrylate

[868-77-9]

$$H_2C{=}\overset{\overset{CH_3}{|}}{C}\text{-}COO\text{-}CH_2\text{-}CH_2OH$$

see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Sens:	Sh

2-[2-Hydroxyethyl(methyl)amino]ethanol ⟶ Methyldiethanolamine

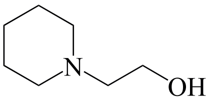
N-(2-Hydroxyethyl)-3-methyl-2-quinoxalinecarboxamide 1,4-dioxide ⟶ Olaquindox (N-(2-Hydroxyethyl)-3-methyl-2-quinoxalinecarboxamide 1,4-dioxide)

β-Hydroxyethyl phenylether ⟶ 2-Phenoxyethanol

1-(2-Hydroxyethyl)piperidine ⟶ N-(2-Hydroxyethyl) piperidine

N-(2-Hydroxyethyl)piperidine

[3040-44-6]

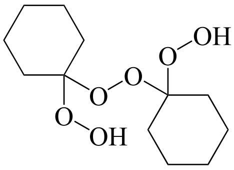


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.217
see Section Xc

MAK[ml/m^3]: 2
MAK[mg/m^3]: 11
Peak lim: I(1)
A momentary value of 5 ml/m^3 (27 mg/m^3) should not be exceeded.
Preg gr: D
Sens: Sh

1-Hydroxy-1′-hydroperoxydicyclohexyl peroxide

[78-18-2]



see Section Xa

Hydroxylamine

[7803-49-8]
and its salts

NH_2-OH

see Section IV
Sens: Sh

2-(Hydroxymethoxy)ethoxymethanol ⟶ (Ethylenedioxy) dimethanol

1-Hydroxy-2-methoxy-4-(1-propenyl)benzene ⟶ Isoeugenol

N-Hydroxymethylchloroacetamide ⟶ N-Methylolchloroacetamide

2-Hydroxymethyl-2-nitro-1,3-propanediol

[126-11-4]

$C(CH_2\text{-}OH)_3(NO_2)$

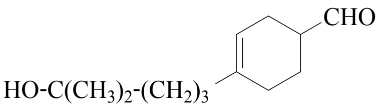
use forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4"
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

4-Hydroxy-4-methylpentan-2-one ⟶ Diacetone alcohol

4-(4-Hydroxy-4-methyl pentyl)-3-cyclohexene-1-carboxaldehyde (Lyral)

[31906-04-4]



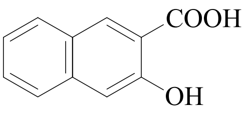
see Section IV
Sens: Sh

N-(4-((2-Hydroxy-5-methylphenyl)azo)phenyl)acetamide ⟶ Disperse Yellow 3

1-(Hydroxymethyl)propylamine ⟶ 2-Aminobutanol

3-Hydroxy-2-naphthalenecarboxylic acid

[92-70-6]



see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

3-Hydroxy-2-naphthoic acid ⟶ 3-Hydroxy-2-naphthalenecarboxylic acid

4-Hydroxy-3-nitroaniline ⟶ 2-Nitro-4-aminophenol

12-Hydroxyoctadecanoic acid ⟶ 12-Hydroxystearic acid

3-Hydroxyphenol ⟶ Resorcinol

1-Hydroxy-2-phenoxyethane ⟶ 2-Phenoxyethanol

2-Hydroxy-1,2,3-propanetricarboxylic acid ⟶ Citric acid

Hydroxypropyl acrylate ⟶ Acrylic acid hydroxypropyl ester (all isomers)

2-Hydroxypropylamine ⟶ 1-Amino-2-propanol

2-Hydroxypropyl methacrylate ⟶ Methacrylic acid 2-hydroxypropyl ester

2-Hydroxypropyl 2-methyl-2-propenoate ⟶ Methacrylic acid 2-hydroxypropyl ester

1-Hydroxy-2(1H)-pyridinethione sodium salt ⟶ Sodium pyrithione

12-Hydroxystearic acid

[106-14-9]

$$H_3C(CH_2)_5CH(OH)(CH_2)_{10}CO_2H$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Hydroxytoluene ⟶ Benzyl alcohol

1-Hydroxy-2,4,5-trichlorobenzene ⟶ 2,4,5-Trichlorophenol

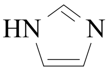
IBOA ⟶ Isobornyl acrylate

Idigbo (Terminalia ivorensis) ⟶ Woods

Imazalil ⟶ 1-(2-Allyloxy)-2-(2,4-dichlorophenyl)ethyl)-1H-imidazole

Imidazole

[288-32-4]



VP[hPa]: 3.3×10^{-3}
see Section IIb

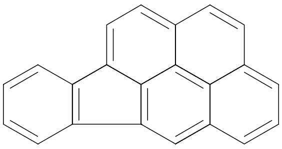
MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

2-Imidazolidinethione ⟶ Ethylene thiourea (Imidazoline-2-thione)

Incense cedar (Calocedrus decurrens) ⟶ Woods

Indeno[1,2,3-cd]pyrene

[193-39-5]



see Section III, "pyrolysis products of organic materials"

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Indian ebony (Diospyros ebenum) ⟶ Woods

Indium

[7440-74-6]
and its inorganic compounds

$$In$$

see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Indium phosphide ⟶ Indium

Iodine

[7553-56-2]
and inorganic iodides

$$I_2$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.31 at 25℃
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Iodomethane

[74-88-4]

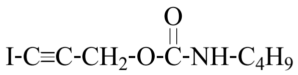
$$H_3C\ I$$

VP[hPa]: 438

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

3-Iodo-2-propynyl butylcarbamate

[55406-53-6]



$$I-C\equiv C-CH_2-O-\overset{\overset{O}{\|}}{C}-NH-C_4H_9$$

The substance can occur simultaneously as vapour and aerosol.
see Section Xc

MAK[ml/m^3]: 0.005
MAK[mg/m^3]: 0.058
Peak lim: I(2)
Preg gr: C
Sens: Sh

Ipe (Tabebuia spp.) ⟶ Woods

Ipe peroba (Paratecoma peroba) ⟶ Woods

IPPD ⟶ N-Isopropyl-N′-phenyl-p-phenylenediamine

Iroko (Chlorophora excelsa) ⟶ Woods

Iron oxides

(inhalable fraction)
[1345-25-1; 1309-37-1; 1309-38-2; 1317-61-9]

$$FeO; Fe_2O_3$$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3
with the exception of iron oxides which are not biologically available

Iron pentacarbonyl

[13463-40-6]

$$Fe(CO)_5$$

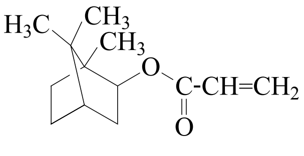
MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.81
Peak lim: I(2)
Preg gr: D
Perc abs: H

Isatoic anhydride ⟶ N-Carboxyanthranilic anhydride

Isoamyl alcohol (3-Methyl-1-butanol) ⟶ Pentanol (isomers)

Isobornyl acrylate

[5888-33-5]



see Section IV
Sens: Sh

Isobutane ⟶ Butane (both isomers)

Isobutenyl chloride ⟶ 3-Chloro-2-methylpropene

Isobutyl acetate

[110-19-0]

$$H_3C-COOCH_2-CH(CH_3)_2$$

VP[hPa]: 18

MAK[ml/m^3]: 100
MAK[mg/m^3]: 480
Peak lim: I(2)
Preg gr: C

Isobutanol

[78-83-1]

$$(H_3C)_2CH-CH_2OH$$

VP[hPa]: 11.7

MAK[ml/m^3]: 100
MAK[mg/m^3]: 310
Peak lim: I(1)
Preg gr: C

Isobutylamine

[78-81-9]

$$(H_3C)_2CH-CH_2NH_2$$

MAK[ml/m^3]: 2
MAK[mg/m^3]: 6.1
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m^3 (15 mg/m^3) should not be exceeded.
Preg gr: D

Isobutyl chloroformate ⟶ Chloroformic acid butyl ester

Isobutyl phosphate ⟶ Triisobutyl phosphate

Isobutyl vinyl ether

[109-53-5]

$$H_2C=CH-O-CH_2-CH(CH_3)-CH_3$$

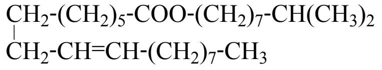
MAK[ml/m^3]: 20
MAK[mg/m^3]: 83
Peak lim: I(1)
Preg gr: D

Isocyanatobenzene ⟶ Phenyl isocyanate

Isocyanic acid p-chlorophenyl ester ⟶ 4-Chlorophenyl isocyanate

Isodecyl oleate

[59231-34-4]



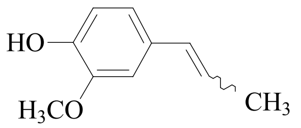
$$\begin{array}{l} CH_2\text{-}(CH_2)_5\text{-}COO\text{-}(CH_2)_7\text{-}CH(CH_3)_2 \\ | \\ CH_2\text{-}CH{=}CH\text{-}(CH_2)_7\text{-}CH_3 \end{array}$$

see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: D

Isoeugenol

[97-54-1]



The substance can occur simultaneously as vapour and aerosol.
see Section IV
Sens: Sh

– trans-Isoeugenol

[5932-68-3]

– cis-Isoeugenol

[5912-86-7]

Isoflurane

[26675-46-7]

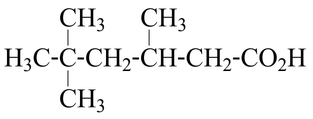
$F_3C\text{-}CHCl\text{-}O\text{-}CHF_2$

VP[hPa]: 320

MAK[ml/m^3]: 2
MAK[mg/m^3]: 15
Peak lim: II(8)
Preg gr: D

Isononanoic acid

[3302-10-1; 26896-18-4]



$$H_3C\text{-}\overset{CH_3}{\underset{CH_3}{C}}\text{-}CH_2\text{-}\overset{CH_3}{CH}\text{-}CH_2\text{-}CO_2H$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.04
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Isooctadecanol

[27458-93-1]

$HO\text{-}(CH_2)_{15}\text{-}CH(CH_3)_2$

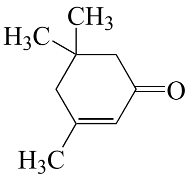
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Isopentane ⟶ Pentane (all isomers)

Isophorone

[78-59-1]



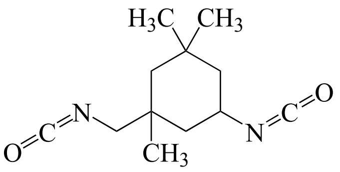
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.33

MAK[ml/m^3]: 2
MAK[mg/m^3]: 11
Peak lim: I(2)
Preg gr: C
Carc cat: 3

Isophorone diamine ⟶ 3-Aminomethyl-3,5,5-trimethylcyclohexylamine (Isophorone diamine)

Isophorone diisocyanate

[4098-71-9]

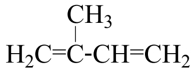


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4×10^{-4}

MAK[ml/m^3]: 0.005
MAK[mg/m^3]: 0.046
Peak lim: I(1)
A momentary value of 0.01 ml/m^3 (0.092 mg/m^3) should not be exceeded.
Preg gr: D
Sens: Sah

Isoprene (2-Methyl-1,3-butadiene)

[78-79-5]



$$H_2C{=}\overset{\displaystyle CH_3}{C}\text{-}CH{=}CH_2$$

VP[hPa]: 733

MAK[ml/m³]: 3
MAK[mg/m³]: 8.5
see definition of Carcinogen Category 5 and supporting documentation
Peak lim: II(8)
Preg gr: C
Carc cat: 5
Muta cat: 5

Isopropanolamine ⟶ 1-Amino-2-propanol

Isopropenyl acetate

[108-22-5]

$H_3C\text{-}COO\text{-}CH_2\text{-}CH{=}CH_2$

MAK[ml/m³]: 10
MAK[mg/m³]: 46
Peak lim: I(2)
Preg gr: D

Isopropenylbenzene ⟶ α-Methyl styrene

2-Isopropoxyethanol

[109-59-1]

$(CH_3)_2CH\text{-}O\text{-}CH_2\text{-}CH_2OH$

MAK[ml/m³]: 10
MAK[mg/m³]: 43
Peak lim: I(2)
Preg gr: C
Perc abs: H

2-Isopropoxyphenyl N-methylcarbamate ⟶ Propoxur

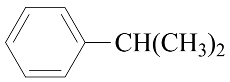
Isopropyl acetate ⟶ Propylacetate

Isopropyl alcohol ⟶ 2-Propanol

Isopropylated triphenyl phosphate ⟶ Triphenyl phosphate, isopropylated

Isopropylbenzene (cumene)

[98-82-8]



VP[hPa]: 4
see Section XII

MAK[ml/m³]: 10
MAK[mg/m³]: 50
Peak lim: II(4)
Preg gr: C
Perc abs: H
Carc cat: 3

Isopropyl ether

[108-20-3]

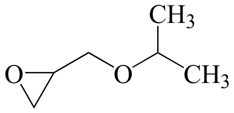
$(H_3C)_2CH\text{-}O\text{-}CH(CH_3)_2$

VP[hPa]: 180

MAK[ml/m³]: 200
MAK[mg/m³]: 850
Peak lim: I(2)
Preg gr: C

Isopropyl glycidyl ether (IGE)

[4016-14-2]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

4,4′-Isopropylidenediphenol ⟶ Bisphenol A

4,4′-Isopropylidenediphenol diglycidyl ether ⟶ Bisphenol A diglycidyl ether

4-Isopropylnitrobenzene ⟶ p-Nitrocumene

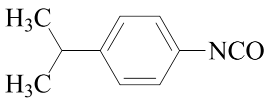
Isopropyl oil

residue of isopropyl alcohol production

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

4-Isopropylphenyl isocyanate

[31027-31-3]

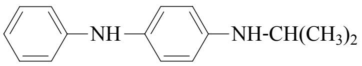


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.1
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh

N-Isopropyl-N′-phenyl-p-phenylenediamine

[101-72-4]



MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Sens: Sh

Isostearyl alcohol ⟶ Isooctadecanol

Isotridecanol

[27458-92-0]
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Isotridecyl alcohol ⟶ Isotridecanol

Kambala (Chlorophora excelsa) ⟶ Woods

Kaolinite

[1332-58-7]

$Al_4[(OH)_8Si_4O_{10}]$

quartz content must be considered separately

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Kepone ⟶ Chlordecone

Kerosine (petroleum)

(aerosol)
[8008-20-6]
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C
Carc cat: 3
applies to skin contact

Kerosine (petroleum)

(vapour)
[8008-20-6]
see Section Xc

MAK[ml/m^3]: 50
MAK[mg/m^3]: 350
Peak lim: II(2)
Preg gr: C
Carc cat: 3
applies to skin contact

Ketene

[463-51-4]

$H_2C=CO$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Khaya spp. ⟶ Woods

Lapacho (Tabebuia avellanedae) ⟶ Woods

Laughing gas ⟶ Nitrous oxide

Lauric acid

[143-07-7]

$CH_3\text{-}(CH_2)_{10}\text{-}COOH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 2.3×10^{-5} at 25℃
see Section Xc

MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: D

Lauryl alcohol ⟶ 1-Dodecanol

Laurylamine dipropylenediamine ⟶ N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine

Lead acetate ⟶ Lead and its inorganic compounds

Lead

[7439-92-1]
and its inorganic compounds (inhalable fraction)

Pb

except lead arsenate and lead chromate
see Section XII

MAK[mg/m^3]: 0.004 I
Peak lim: II(8)
Preg gr: A
Carc cat: 4
Muta cat: 3A

Lead arsenate ⟶ Arsenic

Lead chromate ⟶ Chromium(VI) compounds

Lead compounds, organic

MAK[mg/m^3]: 0.004
Peak lim: II(1)
Preg gr: A
Perc abs: H
Carc cat: 4
Muta cat: 3A

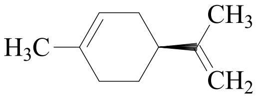
Lead tetraethyl ⟶ Lead compounds, organic

Lead tetramethyl ⟶ Lead compounds, organic

Limba (Terminalia superba) ⟶ Woods

D-Limonene

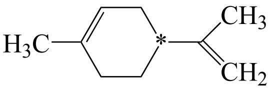
[5989-27-5]



MAK[ml/m^3]:	5
MAK[mg/m^3]:	28
Peak lim:	II(4)
Preg gr:	C
Perc abs:	H
Sens:	Sh

D,L-Limonene

[138-86-3]
and similar mixtures

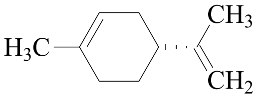


see Section IIb

MAK[ml/m^3]:	–
MAK[mg/m^3]:	–
Peak lim:	–
Preg gr:	–
Sens:	Sh

L-Limonene

[5989-54-8]

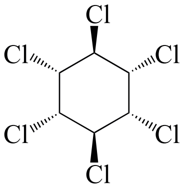


see Section IIb

MAK[ml/m^3]:	–
MAK[mg/m^3]:	–
Peak lim:	–
Preg gr:	–
Sens:	Sh

Lindane

(γ-1,2,3,4,5,6-Hexachlorocyclohexane)
[58-89-9]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 5.6×10^{-5}
see Section XII

MAK[mg/m^3]:	0.1 I
Peak lim:	II(8)
Preg gr:	C
Perc abs:	H
Carc cat:	4

Lithium

[7439-93-2]
and highly irritating lithium compounds (as lithium amide, hydride, hydroxide, nitride, oxide, tetrahydroaluminate, tetrahydroborate)

Li

see Section IIb

MAK[ml/m^3]:	–
MAK[mg/m^3]:	–
Peak lim:	–
Preg gr:	–

Lithium compounds, inorganic

(as Li [7439-93-2]) except for lithium and highly irritating lithium compounds (as lithium amide, hydride, hydroxide, nitride, oxide, tetrahydroaluminate, tetrahydroborate)

MAK[mg/m^3]:	0.2 I
Peak lim:	I(1)
Preg gr:	C

Lithium-12-hydroxystearate

[7620-77-1]

$LiO_2C\text{-}(CH_2)_{10}\text{-}CH(OH)\text{-}(CH2)_5\text{-}CH_3$

see Section IIb and Xc

MAK[ml/m^3]:	–
MAK[mg/m^3]:	–
Peak lim:	–
Preg gr:	–

Lithium stearate

[4485-12-5]

$LiO_2C\text{-}(CH_2)_{16}\text{-}CH_3$

see Section IIb and Xc

MAK[ml/m^3]:	–
MAK[mg/m^3]:	–
Peak lim:	–
Preg gr:	–

Lubricants

Lubricants contain mixtures of hydrocarbons which can occur as particle-vapour mixtures because of their composition.
see Section Xc

Lyral ⟶ 4-(4-Hydroxy-4-methyl pentyl)-3-cyclohexene-1-carboxaldehyde (Lyral)

Macassar ebony (Diospyros celebica) ⟶ Woods

Machaerium scleroxylon ⟶ Woods

Magnesium oxide

[1309-48-4]
(inhalable fraction)

MgO

see Section Vf and g

MAK[mg/m³]: 4 I
Preg gr: C

Magnesium oxide

[1309-48-4]
(respirable fraction)

MgO

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m³]: 0.3
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Magnesium oxide sulfate

[12286-12-3]
(fibrous dust)

$MgSO_4 \cdot 5\ MgO \cdot 8\ H_2O$

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Magnesium oxide fume

[1309-48-4]

MgO

see Section IIb and Vh

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

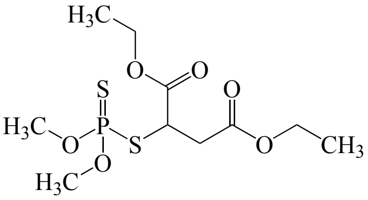
Mahogany, African (Khaya spp.) ⟶ Woods

Mahogany, American (Swietenia spp.) ⟶ Woods

Makoré (Tieghemella heckelii) ⟶ Woods

Malathion

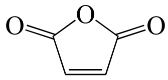
[121-75-5]



BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc

Maleic anhydride

[108-31-6]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.151

MAK[ml/m³]: 0.02
MAK[mg/m³]: 0.081
Peak lim: I(1)
A momentary value of 0.05 ml/m³ (0.20 mg/m³) should not be exceeded.
Preg gr: C
Sens: Sah

Manganese

[7439-96-5]
and its inorganic compounds (inhalable fraction)

Mn

see Section XII

MAK[mg/m³]: 0.2 I
Peak lim: II(8)
Permanganates: Peak limitation category II(1)
Preg gr: C

Manganese(II,III) oxide ⟶ Manganese

Manganese

[7439-96-5]
and its inorganic compounds (respirable fraction)

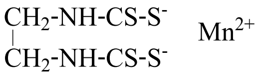
Mn

see Section XII

MAK[mg/m³]: 0.02 R
Peak lim: II(8)
Permanganates: Peak limitation category II(1)
Preg gr: C

Manganese ethylenebis(dithiocarbamate) (Maneb)

[12427-38-2]



$$\begin{array}{l} CH_2\text{-NH-CS-S}^- \\ | \\ CH_2\text{-NH-CS-S}^- \end{array} \quad Mn^{2+}$$

see Section IV
Sens: Sh

Manganous-manganic oxide → Manganese

Man-made mineral fibres (fibrous dust)

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Mansonia altissima → Woods

Mastic asphalt → Bitumen (high-temperature processing, vapours and aerosols)

MBT → 2-Mercaptobenzothiazole

MDI → 4,4′-Methylene diphenyl diisocyanate (MDI)

MDI oligomers → “polymeric MDI”

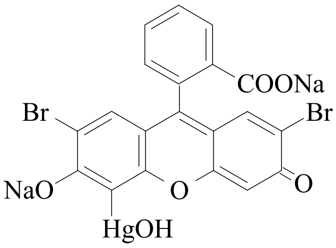
Mechlorethamine → N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard)

Medicines, carcinogenic

see Section III

Merbromin

[129-16-8]



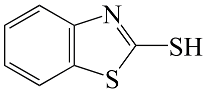
see Section IV
Sens: Sh

2-Mercaptoacetates → Thioglycolates

Mercaptoacetic acid → Thioglycolic acid

2-Mercaptobenzothiazole

[149-30-4]



VP[hPa]: $<2.53\times10^{-6}$ at 25℃
see Section Xc

MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 3

2-Mercaptobenzothiazole disulfide → 2,2′-Dibenzothiazyl disulfide

2-Mercaptoimidazoline → Ethylene thiourea (Imidazoline-2-thione)

Mercury

[7439-97-6]
and its inorganic compounds (as Hg)

Hg

see Section XII

MAK[mg/m³]: 0.02 I
Peak lim: II(8)
Preg gr: D
Perc abs: H
Sens: Sh
Carc cat: 3

Mercury, organic compounds

see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

Mesitylene (1,3,5-Trimethylbenzene) → Trimethylbenzene (all isomers)

Mesityl oxide → 4-Methyl-3-penten-2-one

Metal-working fluids

Metal-working fluids contain mixtures of hydrocarbons which can occur as particle-vapour mixtures as a result of their composition.
see Section Xc

Metal-working fluids which contain nitrite or nitrite-forming compounds and substances which react with nitrite to yield nitrosamines

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Methacrylic acid

[79-41-4]

$H_2C{=}C(CH_3)\text{-}COOH$

VP[hPa]: 0.9

MAK[ml/m³]: 50
MAK[mg/m³]: 180
Peak lim: I(2)
Preg gr: C

Methacrylic acid ethyl ester

[97-63-2]

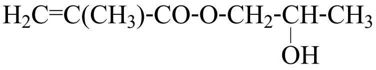
$H_2C{=}C(CH_3)\text{-}COOCH_2\text{-}CH_3$

see Section IV
Sens: Sh

Methacrylic acid 2-hydroxyethyl ester ⟶ 2-Hydroxyethyl methacrylate

Methacrylic acid 2-hydroxypropyl ester

[923-26-2]



$$H_2C{=}C(CH_3)\text{-}CO\text{-}O\text{-}CH_2\text{-}\underset{\displaystyle OH}{\underset{|}{C}}H\text{-}CH_3$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.096 at 25℃ (calculated value)
see Section IV
Sens: Sh

Methacrylic acid methyl ester

[80-62-6]

$H_2C{=}C(CH_3)\text{-}COOCH_3$

VP[hPa]: 47

MAK[ml/m³]: 50
MAK[mg/m³]: 210
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
Preg gr: C
Sens: Sh

N,N′-Methanetetraylbiscyclohexanamine ⟶ Dicyclohexylcarbodiimide

Methanethiol

[74-93-1]

H_3CSH

VP[hPa]: 1710

MAK[ml/m³]: 0.5
MAK[mg/m³]: 1.0
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(1)
Preg gr: D

Methanol

[67-56-1]

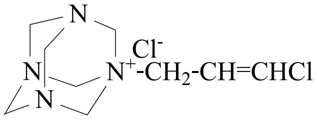
H_3COH

VP[hPa]: 128
see Section XII

MAK[ml/m³]: 100
MAK[mg/m³]: 130
Peak lim: II(2)
Preg gr: C
Perc abs: H

★ Methenamine 3-chloroallylchloride

[4080-31-3; 51229-78-8]



releases formaldehyde
VP[hPa]: 1.33×10^{-7} at 25℃
see Section Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

Methoxyacetic acid

[625-45-6]

$H_3C\text{-}O\text{-}CH_2\text{-}COOH$

VP[hPa]: 1.8

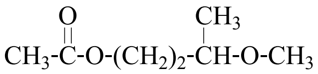
MAK[ml/m³]: 1
MAK[mg/m³]: 3.7
Peak lim: II(2)
Preg gr: B
Perc abs: H

2-Methoxyaniline ⟶ o-Anisidine

4-Methoxyaniline ⟶ p-Anisidine

3-Methoxy-n-butyl acetate

[4435-53-4]



$$CH_3\text{-}\overset{\displaystyle O}{\overset{||}{C}}\text{-}O\text{-}(CH_2)_2\text{-}\overset{\displaystyle CH_3}{\overset{|}{C}}H\text{-}O\text{-}CH_3$$

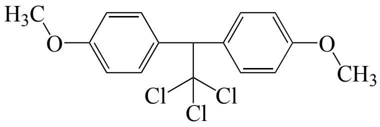
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

2-Methoxycarbonyl-1-methylvinyl dimethyl phosphate ⟶ Mevinphos

Methoxychlor (DMDT)

[72-43-5]



MAK[mg/m^3]: 1 I
Peak lim: II(8)
Preg gr: B
Perc abs: H

★ 2-Methoxyethanol

[109-86-4]

$H_3CO\text{-}CH_2\text{-}CH_2OH$

VP[hPa]: 8,5
see Section XII

MAK[ml/m^3]: 1
MAK[mg/m^3]: 3.2
MAK value applies for the sum of the concentrations of 2-methoxyethanol and 2-methoxyethyl acetate in the air.
Peak lim: II(8)
Preg gr: B
Note regarding prerequisite for Group C see documentation
Perc abs: H

2-(2-Methoxyethoxy)ethanol ⟶ Diethylene glycol monomethyl ether

2-[2-(2-Methoxyethoxy)ethoxy]ethanol ⟶ Triethylene glycol monomethyl ether

2-Methoxyethyl acetate

[110-49-6]

$H_3CO\text{-}CH_2\text{-}CH_2OOC\text{-}CH_3$

VP[hPa]: 9
see Section XII

MAK[ml/m^3]: 1
MAK[mg/m^3]: 4.9
MAK value applies for the sum of the concentrations of 2-methoxyethanol and 2-methoxyethyl acetate in the air.
Peak lim: II(8)
Preg gr: B
Perc abs: H

1-Methoxy-2-(2-methoxyethoxy)ethane ⟶ Diethylene glycol dimethyl ether

2-Methoxy-5-methylaniline ⟶ 5-Methyl-o-anisidine

2-Methoxy-2-methylpropane ⟶ Methyl tert-butyl ether

1-Methoxy-2-nitrobenzene ⟶ 2-Nitroanisole

1-Methoxy-2-propanol

[107-98-2]

$H_3C\text{-}CHOH\text{-}CH_2OCH_3$

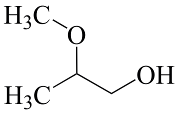
VP[hPa]: 12
see Section XII

MAK[ml/m^3]: 100
MAK[mg/m^3]: 370
Peak lim: I(2)
Preg gr: C

2-Methoxy-1-propanol ⟶ 2-Methoxypropanol-1

2-Methoxypropanol-1

[1589-47-5]



VP[hPa]: 6

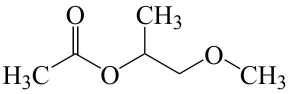
MAK[ml/m^3]: 5
MAK[mg/m^3]: 19
MAK value applies for the sum of the concentrations of 2-methoxypropanol-1 and 2-methoxypropylacetate-1 in the air.
Peak lim: I(2)
Preg gr: B
Perc abs: H

2-Methoxy-4-(2-propenyl)phenol ⟶ Eugenol

2-Methoxy-4-(1-propenyl)phenol ⟶ Isoeugenol

1-Methoxypropyl-2-acetate

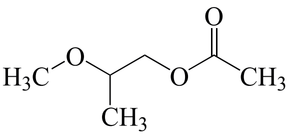
[108-65-6]



MAK[ml/m^3]: 50
MAK[mg/m^3]: 270
Peak lim: I(1)
Preg gr: C

2-Methoxypropylacetate-1

[70657-70-4]



VP[hPa]: 4.17 at 25℃

MAK[ml/m^3]: 5
MAK[mg/m^3]: 27
MAK value applies for the sum of the concentrations of 2-methoxypropanol-1 and 2-methoxypropylacetate-1 in the air.
Peak lim: I(2)
Preg gr: B
Perc abs: H

2-Methoxypropyl-1-acetate ⟶ 2-Methoxypropylacetate-1

2-Methyl-2,4-pentanediol ⟶ Hexylene glycol

Methyl acetate

[79-20-9]

$H_3C\text{-}COOCH_3$

VP[hPa]: 220

MAK[ml/m³]:	100
MAK[mg/m³]:	310
Peak lim:	I(4)
Preg gr:	C

Methyl acetylene

[74-99-7]

$H_3C\text{-}C{\equiv}CH$

see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Methyl acrylate

[96-33-3]

$H_2C{=}CH\text{-}COOCH_3$

VP[hPa]: 89

MAK[ml/m³]:	2
MAK[mg/m³]:	7.1

Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.

Peak lim:	I(2)
Preg gr:	C
Perc abs:	H
Sens:	Sh

Methylal ⟶ Dimethoxymethane

Methyl alcohol ⟶ Methanol

2-Methylallyl chloride ⟶ 3-Chloro-2-methylpropene

Methylamine

[74-89-5]

$H_3C\text{-}NH_2$

MAK[ml/m³]:	5
MAK[mg/m³]:	6.4

Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.

Peak lim:	I(2)

A momentary value of 10 ml/m³ (13 mg/m³) should not be exceeded.

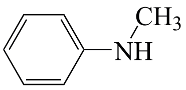
Preg gr:	C

1-Methyl-2-amino-5-chlorobenzene ⟶ 4-Chloro-o-toluidine

4-Methylanilin ⟶ p-Toluidine

N-Methylaniline

[100-61-8]

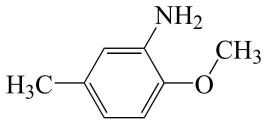


Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosomethylaniline, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

MAK[ml/m³]:	0.5
MAK[mg/m³]:	2.2
Peak lim:	II(2)
Preg gr:	D
Perc abs:	H
Carc cat:	3

5-Methyl-o-anisidine

[120-71-8]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.033 at 25℃ (calculated value)

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	2

Methylarsenic compounds

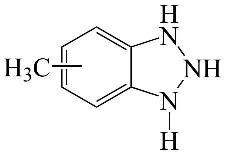
MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	1
Muta cat:	3A

Methylbenzene ⟶ Toluene

Methyl benzimidazol-2-ylcarbamate ⟶ Carbendazim

Methyl-1H-benzotriazole

[29385-43-1]



see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard)

[51-75-2]

$(ClH_2C\text{-}CH_2)_2N\text{-}CH_3$

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Sens:	Sh
Carc cat:	1
Muta cat:	2

Methyl bromide ⟶ Bromomethane

2-Methyl-1,3-butadiene ⟶ Isoprene (2-Methyl-1,3-butadiene)

1-Methylbutyl acetate ⟶ Amyl acetate (all isomers)

2-Methylbutyl acetate ⟶ Amyl acetate (all isomers)

3-Methylbutyl acetate ⟶ Amyl acetate (all isomers)

Methyl tert-butyl ether

[1634-04-4]

$(CH_3)_3C\text{-}O\text{-}CH_3$

VP[hPa]: ~ 300
see Section XII

MAK[ml/m³]:	50
MAK[mg/m³]:	180
Peak lim:	I(1.5)
Preg gr:	C
Carc cat:	3

Methyl butyl ketone ⟶ 2-Hexanone

Methyl chloride ⟶ Chloromethane

Methyl chloroacetate ⟶ Chloroacetic acid methyl ester

Methyl chloroform ⟶ 1,1,1-Trichloroethane

Methyl chloroformate ⟶ Chloroformic acid methyl ester

Methyl 2-cyanoacrylate

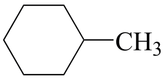
[137-05-3]

$H_2C{=}CCN\text{-}CO\text{-}OCH_3$

MAK[ml/m³]:	2
MAK[mg/m³]:	9.2
Peak lim:	I(1)
Preg gr:	D

Methylcyclohexane

[108-87-2]

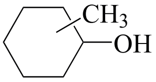


VP[hPa]: 48

MAK[ml/m³]:	200
MAK[mg/m³]:	810
Peak lim:	II(2)
Preg gr:	D

Methylcyclohexanol (all isomers)

[25639-42-3]

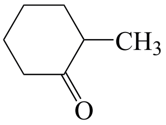


see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

1-Methylcyclohexan-2-one

[583-60-8]



see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Methylcyclopentane ⟶ Hexane (all isomers except n-Hexane) and Methylcyclopentane

Methyl demeton ⟶ Demeton-methyl

Methyldiethanolamine

[105-59-9]

$H_3C\text{-}N(CH_2\text{-}CH_2OH)_2$

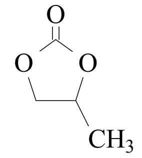
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.0031
see Section Xc

MAK[ml/m³]:	0.4
MAK[mg/m³]:	2
Peak lim:	I(1)
Preg gr:	D
Perc abs:	H
Carc cat:	3

Methyldiglycol ⟶ Diethylene glycol monomethyl ether

4-Methyl-1,3-dioxolan-2-one

[108-32-7]

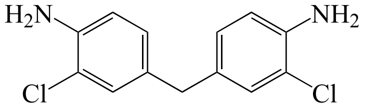


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.04
see Section Xc

MAK[ml/m^3]: 2
MAK[mg/m^3]: 8.5
Peak lim: I(1)
Preg gr: C

4,4′-Methylenebis(2-chloroaniline)

(MOCA)
[101-14-4]

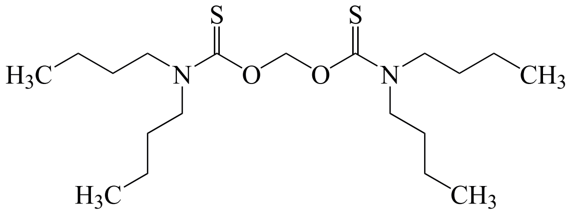


MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Methylene bis(4-cyclohexylisocyanate) ⟶ 4,4′-Diisocyanato-methylenedicyclohexane

Methylene bis(dibutyldithiocarbamate)

[10254-57-6]
(inhalable fraction)

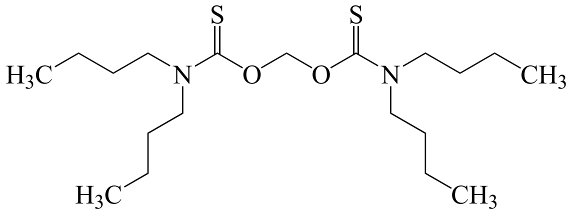


see Section Xc

MAK[mg/m^3]: 20 I
Peak lim: II(8)
Preg gr: D

Methylene bis(dibutyldithiocarbamate)

[10254-57-6]
(respirable fraction)

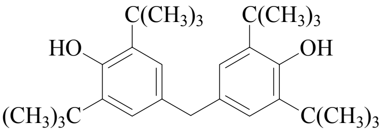


see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: D

4,4′-Methylenebis(2,6-di-tert-butylphenol)

[118-82-1]



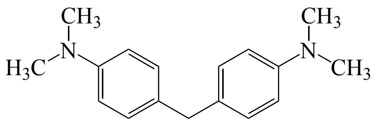
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

4,4′-Methylenebis(N,N-diglycidylaniline) ⟶ Tetraglycidyl-4,4′-methylenedianiline

4,4′-Methylenebis(N,N-dimethylaniline)

[101-61-1]

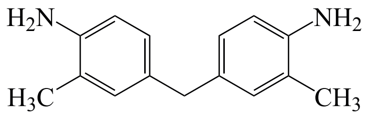


MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

4,4′-Methylenebis(N,N-dimethyl)benzenamine ⟶ 4,4′-Methylenebis(N,N-dimethylaniline)

4,4′-Methylenebis(2-methylaniline)

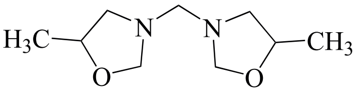
[838-88-0]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

N,N′-Methylenebis(5-methyloxazolidine)

[66204-44-2]



see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

Methylenebismorpholine ⟶ Bismorpholino methane

2,2′-(Methylenebis(p-phenyleneoxymethylene))bisoxirane ⟶ Bisphenol F diglycidyl ether

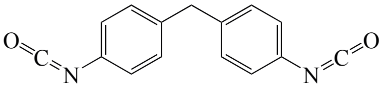
Methylene chloride ⟶ Dichloromethane

4,4′-Methylene dianiline ⟶ 4,4′-Diaminodiphenylmethane

4,4′-Methylenedimorpholine ⟶ Bismorpholino methane

4,4′-Methylene diphenyl diisocyanate (MDI)

[101-68-8]
(inhalable fraction) see also “polymeric MDI”



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 7×10^{-6}
see Section XII

MAK[mg/m^3]: 0.05 I
Peak lim: I(1)
A momentary value of 0.1 mg/m^3 should not be exceeded.
Preg gr: C
Perc abs: H
Sens: Sah
Carc cat: 4

Methyl ether ⟶ Dimethyl ether

2-(1-Methylethoxy)ethanol ⟶ 2-Isopropoxyethanol

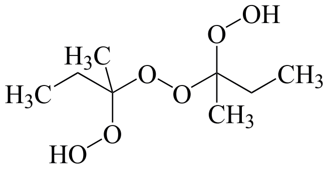
4,4′-(1-Methylethylidene)bisphenol ⟶ Bisphenol A

2,2′-[(1-Methylethylidene) bis(4,1-phenyleneoxymethylene)]bisoxirane ⟶ Bisphenol A diglycidyl ether

Methyl ethyl ketone ⟶ 2-Butanone

Methyl ethyl ketone peroxide

[1338-23-4]



see Section Xa

Methyl ethyl ketoxime ⟶ Butanone oxime

1-(1-Methylethyl)-4-nitrobenzene ⟶ p-Nitrocumene

N,N-Methylethylnitrosoamine ⟶ N-Nitrosomethylethylamine

N-(1-Methylethyl)-N′-phenyl-1,4-benzenediamine ⟶ N-Isopropyl-N′-phenyl-p-phenylenediamine

Methyl formate

[107-31-3]

$HCO\text{-}OCH_3$

VP[hPa]: 640
see Section XII

MAK[ml/m^3]: 50
MAK[mg/m^3]: 120
Peak lim: II(2)
Preg gr: C
Perc abs: H

Methyl glycol ⟶ 2-Methoxyethanol

Methyl glycol acetate ⟶ 2-Methoxyethyl acetate

5-Methyl-3-heptanone

[541-85-5]

$CH_3\text{-}CH_2\text{-}CO\text{-}CH_2\text{-}CH(CH_3)\text{-}CH_2\text{-}CH_3$

VP[hPa]: 2.4

MAK[ml/m^3]: 10
MAK[mg/m^3]: 53
Peak lim: I(2)
Preg gr: D

Methyl-2-hexanone

[110-12-3]

$CH_3\text{-}CO\text{-}CH_2\text{-}CH_2\text{-}CH_2(CH_3)_2$

VP[hPa]: 6

MAK[ml/m^3]: 10
MAK[mg/m^3]: 47
Peak lim: I(2)
Preg gr: D

Methyl isobutyl carbinol ⟶ 4-Methyl-2-pentanol

Methyl isobutyl ketone ⟶ 4-Methyl-2-pentanone

Methyl isocyanate

[624-83-9]

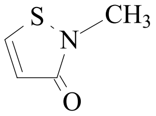
H_3C-NCO

VP[hPa]: 513

MAK[ml/m^3]: 0.01
MAK[mg/m^3]: 0.024
Peak lim: I(1)
Preg gr: D

2-Methyl-4-isothiazolin-3-one

[2682-20-4]



see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

2-Methyl-4-isothiazolin-3-one ⟶ 5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-dihydroisothiazol-3-one

2-Methylisothiazolone ⟶ 2-Methyl-4-isothiazolin-3-one

Methyl mercaptan ⟶ Methanethiol

Methyl mercury ⟶ Mercury, organic compounds

Methyl methacrylate ⟶ Methacrylic acid methyl ester

2-Methyl-4-[(2-methylphenyl)azo]benzenamine ⟶ o-Aminoazotoluene

N-Methyl-1-naphthyl carbamate ⟶ Carbaryl (1-Naphthyl methylcarbamate)

1-Methyl-3-nitrobenzene ⟶ 3-Nitrotoluene

1-Methyl-4-nitrobenzene ⟶ 4-Nitrotoluene

2,2′-[[3-Methyl-4-[(4-nitrophenyl)azo]phenyl]imino] bisethanol ⟶ Disperse Red 17

N-Methyl-N-nitrosoaniline ⟶ N-Nitrosomethylphenylamine

⋆ N-Methylolchloroacetamide

[2832-19-1]

H_2CCl-CO-NH-CH_2OH

releases formaldehyde
VP[hPa]: <0.002 (calculated value)
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

(Z)-N-Methyl-N-(1-oxo-9-octadecenyl)glycine ⟶ Oleyl sarcosine

2-Methylpentane ⟶ Hexane (all isomers except n-Hexane) and Methylcyclopentane

3-Methylpentane ⟶ Hexane (all isomers except n-Hexane) and Methylcyclopentane

2-Methyl-2,4-pentanediol ⟶ Hexylene glycol

4-Methyl-2-pentanol

[108-11-2]

$(H_3C)_2CH$-CH_2-CHOH-CH_3

VP[hPa]: 7

MAK[ml/m^3]: 20
MAK[mg/m^3]: 85
Peak lim: I(1)
Preg gr: D

4-Methyl-2-pentanone

[108-10-1]

$(H_3C)_2CH$-CH_2-CO-CH_3

VP[hPa]: 21
see Section XII

MAK[ml/m^3]: 20
MAK[mg/m^3]: 83
Peak lim: I(2)
Preg gr: C
Perc abs: H

2-Methyl-2-penten-4-one ⟶ 4-Methyl-3-penten-2-one

4-Methyl-3-penten-2-one

[141-79-7]

$(H_3C)_2C{=}CH\text{-}CO\text{-}CH_3$

VP[hPa]: 19 at 25℃

MAK[ml/m³]:	2
MAK[mg/m³]:	8.1
Peak lim:	I(2)
Preg gr:	D
Perc abs:	H

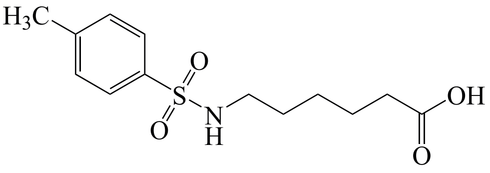
2-[(2-Methylphenoxy)-methyl]oxirane ⟶ Cresyl glycidyl ethers

4-Methylphenyl diiodomethyl sulfone ⟶ 4-(Diiodomethylsulfonyl)-toluene

Methylphenyl diphenyl phosphate ⟶ Diphenyl cresyl phosphate

6-[(4-Methylphenyl)sulfonylamino]hexanoic acid

[78521-39-8]



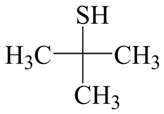
VP[hPa]: 3.98×10^{-9}
see Section IIb and Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

2-Methyl-1-propanamine ⟶ Isobutylamine

2-Methyl-2-propanethiol

[75-66-1]



$H_3C\text{-}C(SH)(CH_3)\text{-}CH_3$

VP[hPa]: 241

MAK[ml/m³]:	1
MAK[mg/m³]:	3.7

Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.

Peak lim:	II(2)
Preg gr:	C
Perc abs:	H
Sens:	Sh

2-Methyl-2-propenoic acid 1,2-ethanediyl ester ⟶ Ethylene glycol dimethacrylate

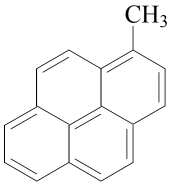
2-Methyl-2-propenoic acid 2-hydroxyethyl ester ⟶ 2-Hydroxyethyl methacrylate

2-Methyl-2-propenoic acid 2-hydroxypropyl ester ⟶ Methacrylic acid 2-hydroxypropyl ester

Methyl propyl ketone ⟶ 2-Pentanone

1-Methylpyrene

[2381-21-7]

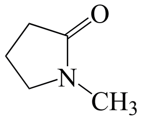


see Section III, “pyrolysis products of organic materials”

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

N-Methyl-2-pyrrolidone

[872-50-4]
(vapour)

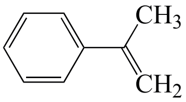


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.32
see Section XII

MAK[ml/m³]:	20
MAK[mg/m³]:	82
Peak lim:	I(2)
Preg gr:	C
Perc abs:	H

α-Methyl styrene

[98-83-9]

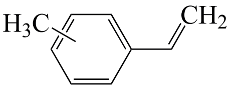


VP[hPa]: 3

MAK[ml/m³]:	50
MAK[mg/m³]:	250
Peak lim:	I(2)
Preg gr:	D

Methyl styrene (all isomers)

[25013-15-4]
2-Methylstyrene [611-15-4]
3-Methylstyrene [100-80-1]
4-Methylstyrene [622-97-9]

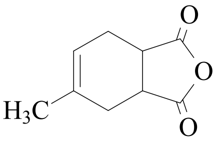


VP[hPa]: 1.5-2

MAK[ml/m^3]: 20
MAK[mg/m^3]: 98
Peak lim: I(2)
Preg gr: D

Methyltetrahydrophthalic anhydride

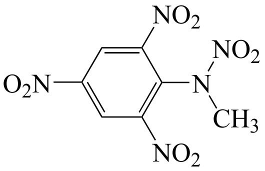
[11070-44-3]



see Section IV
Sens: Sa

N-Methyl-N,2,4,6-tetranitroaniline

[479-45-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

Methyltin compounds

(as Sn [7440-31-5])

– Monomethyltin compounds

The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: 0.004
MAK[mg/m^3]: 0.02
Peak lim: I(1)
Preg gr: C
Sens: –

For methyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.

– except
– Methyltin tris(isooctylmercatoacetate) (MMT(IOMA)$_3$)

[54849-38-6]
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.02 at 25°C

MAK[ml/m^3]: 0.2
MAK[mg/m^3]: 1
Peak lim: II(2)
Preg gr: B
Sens: –

For methyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.

– and
– Bis[methyltin di(isooctylmercaptoacetate)]sulfide
– and
– Bis[methyltin di(2-mercaptoethyloleate)]sulfide

[59118-99-9]

– Dimethyltin compounds

The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: 0.004
MAK[mg/m^3]: 0.02
Peak lim: I(1)
Preg gr: C
Sens: –

For methyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.

– except
– Dimethyltin bis(isooctylmercaptoacetate) (DMT(IOMA)$_2$)

[26636-01-1]
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4.4×10^{-3} at 25°C

MAK[ml/m^3]: 0.01
MAK[mg/m^3]: 0.05
Peak lim: II(2)
Preg gr: C
Sens: –

For methyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.

– and
– Dimethyltin bis(2-ethylhexylmercaptoacetate) (DMT(2-EHMA)$_2$)

[57583-35-4]
VP[hPa]: 4.4×10^{-3} at 25°C

– and
– Bis[dimethyltin(isooctylmercaptoacetate)]sulfide
– and
– Bis[dimethyltin(2-mercaptoethyloleate)]sulfide

– Trimethyltin compounds

The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: 0.001
MAK[mg/m^3]: 0.005
Peak lim: II(4)
Preg gr: D
Perc abs: H
Sens: –
For methyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.

– Tetramethyltin

[594-27-4]

$(CH_3)_4Sn$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 147 at 25℃

MAK[ml/m^3]: 0.001
MAK[mg/m^3]: 0.005
Peak lim: II(4)
Preg gr: D
Perc abs: H

Methyl tribromide ⟶ Tribromomethane

Methyltriglycol ⟶ Triethylene glycol monomethyl ether

Methyl vinyl ether

[107-25-5]

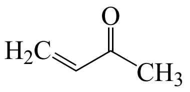
$H_2C=CH-O-CH_3$

VP[hPa]: 1756

MAK[ml/m^3]: 200
MAK[mg/m^3]: 480
Peak lim: II(2)
Preg gr: C

Methyl vinyl ketone

[78-94-4]

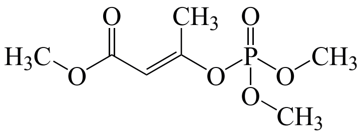


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh

Mevinphos

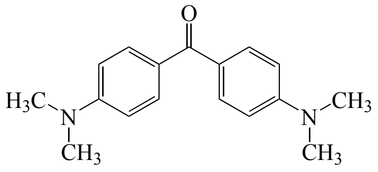
[7786-34-7]



see documentation "Phosdrin". The substance can occur simultaneously as vapour and aerosol.
BLW for acetylcholinesterase inhibitors still valid; see section XII.
VP[hPa]: 1.7×10^{-4}
see Section IIc

Michler's ketone

[90-94-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Microbial rennets: endothiapepsin and mucorpepsin

see Section IV
Sens: Sa

Mineral oils (petroleum), severely refined

[92062-35-6; 72623-83-7; 92045-44-8; 92045-45-9]

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C

Mist

see Section V

Molybdocene dichloride ⟶ Molybdenum

Molybdenum

[7439-98-7]
and its compounds apart from molybdenum trioxide

Mo

see Section IIb and XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Molybdenum(VI) oxide ⟶ Molybdenum trioxide

Molybdenum trioxide

[1313-27-5]

MoO_3

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Molybdic anhydride ⟶ Molybdenum trioxide

Molybdic trioxide ⟶ Molybdenum trioxide

Monochloroacetic acid

[79-11-8]
see also Sodium monochloroacetate

$ClCH_2\text{-}COOH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.021

MAK[ml/m³]: 0.5
MAK[mg/m³]: 2.0
Peak lim: I(2)
Preg gr: C

Monochlorodifluoromethane ⟶ Chlorodifluoromethane

Monochlorodimethyl ether

[107-30-2]

$H_3C\text{-}O\text{-}CH_2Cl$

The classification in Category 1 applies to technical monochlorodimethyl ether which can be contaminated with up to 7% bischloromethyl ether.
VP[hPa]: 213

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 1

Monochloronaphthalenes ⟶ Chlorinated naphthalenes

Monocyclic aromatic amino and nitro compounds

see Section III

Monoisopropanolamine ⟶ 1-Amino-2-propanol

Monomethylhydrazine

[60-34-4]

$H_3C\text{-}NH\text{-}NH_2$

VP[hPa]: 67 at 25℃

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 3B

Monomethyltin compounds ⟶ Methyltin compounds

Mono-n-octyltin compounds ⟶ n-Octyltin compounds

Montmorillonite

[1318-93-0]
and Bentonite [1302-78-9]

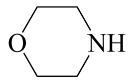
$Na_{0,33}\{(Al_{1,67}Mg_{0,33})(OH)_2[Si_4O_{10}]\} \times nH_2O$

quartz content must be considered separately
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Morpholine

[110-91-8]



Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosomorpholine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 9.8

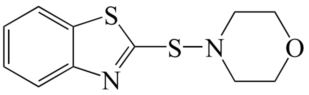
MAK[ml/m³]: 5
MAK[mg/m³]: 18
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(1)
A momentary value of 10 ml/m³ (36 mg/m³) should not be exceeded.
Preg gr: C

2-(Morpholinothio)benzothiazole ⟶ 2-(4-Morpholinylmercapto)benzothiazole

Morpholinyl carbonyl chloride ⟶ N-Chloroformylmorpholine

2-(4-Morpholinylmercapto)benzothiazole

[102-77-2]



see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh

4-(Morpholin-4-ylmethyl)morpholine ⟶ Bismorpholino methane

4-[2-(Morpholin-4-ylmethyl)-2-nitrobutyl]morpholine ⟶ 4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w)

Mucorpepsin ⟶ Microbial rennets: endothiapepsin and mucorpepsin

Myristic acid

[544-63-8]

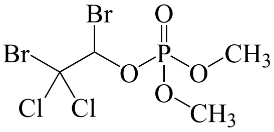
$CH_3\text{-}(CH_2)_{12}\text{-}COOH$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Naled

[300-76-5]



MAK[mg/m^3]: 0.5 I
Peak lim: II(2)
Preg gr: C
Perc abs: H
Sens: Sh

Naphtha (petroleum)

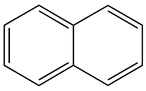
hydrotreated, heavy
[64742-48-9]
see Section Xc

MAK[ml/m^3]: 50
MAK[mg/m^3]: 300
Peak lim: II(2)
Preg gr: D

Naphthalane ⟶ Decahydronaphthalene

Naphthalene

[91-20-3]

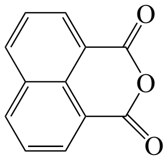


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.072
see Section III, “pyrolysis products of organic materials”

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

1,8-Naphthalic anhydride

[81-84-5]



see Section IV
Sens: Sh

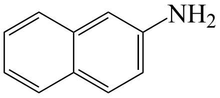
Naphthenic acids and sodium, calcium, potassium napthenates

[1338-24-5; 61790-13-4; 61789-36-4; 66072-08-0]
(technical mixtures)
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2-Naphthylamine

[91-59-8]

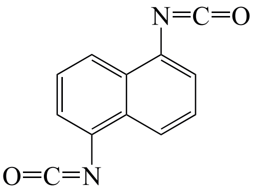


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.4×10^{-4} at 25°C
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

1,5-Naphthylene diisocyanate

[3173-72-6]

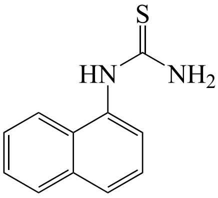


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 8×10^{-6} at 25℃
see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sa
Carc cat: 3

1-Naphthylthiourea

[86-88-4]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

Natural latex ⟶ Natural rubber latex

Natural rubber ⟶ Natural rubber latex

Natural rubber latex

[9006-04-6]
see Section IV
Sens: Sah

Nemalite

[1317-43-7]
(fibrous dust)

$Mg(OH)_2$

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Nickel and nickel compounds

(inhalable fraction)
Regarding compounds which have been found to be unequivocally carcinogenic in man, see documentation.
see Section XII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sah
There is sufficient evidence of sensitizing effects on the respiratory tract only for water-soluble nickel compounds.
Carc cat: 1

– Metallic nickel

[7440-02-0]

Ni

– Nickel acetate

[373-02-4]
and similar soluble salts

$Ni(OOC-CH_3)_2$

– Nickel carbonate

[3333-67-3]

$NiCO_3$

– Nickel chloride

[7718-54-9]

$NiCl_2$

– Nickel monoxide

[1313-99-1]

NiO

– Nickel dioxide

[12035-36-8]

NiO_2

– Nickel sesquioxide

[1314-06-3]

Ni_2O_3

– Nickel hydroxide

[12054-48-7]

$Ni(OH)_2$

– Nickel sulfide

[16812-54-7]

NiS

– Nickel sulbsulfide

[12035-72-2]

Ni_3S_2

– Nickel sulfate

[7786-81-4]

$NiSO_4$

Nickel alloys

Sens: –
For nickel alloys containing bio-available nickel see Nickel and nickel compounds.

Nickel titanic yellow pigment

[8007-18-9]

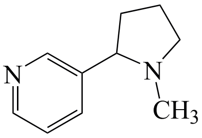
$(Ti,Sb,Ni)O_2$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Nicotine

[54-11-5]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.056
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Nitric acid

[7697-37-2]

HNO_3

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Nitrilotriacetic acid

[139-13-9]
and its sodium salts

$N(CH_2OOH)_3$

Avoid simultaneous exposure to iron compounds (formation of FeNTA).

MAK[mg/m^3]: 2
as acid
Peak lim: II(4)
Preg gr: C
Carc cat: 4

– Monosodium nitrilotriacetate

[18994-66-6]

– Disodium nitrilotriacetate

[15467-20-6]

– Disodium nitrilotriacetate monohydrate

[23255-03-0]

– Trisodium nitrilotriacetate

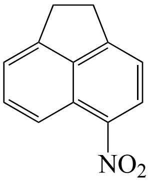
[5064-31-3]

– Trisodium nitrilotriacetate monohydrate

[18662-53-8]

5-Nitroacenaphthene

[602-87-9]

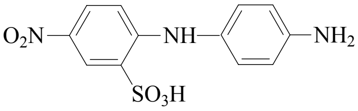


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.6×10^{-5} at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

4-Nitro-4′-aminodiphenylamine-2-sulfonic acid

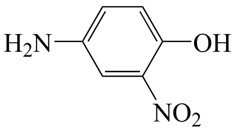
[91-29-2]



see Section IV
Sens: Sh

2-Nitro-4-aminophenol

[119-34-6]

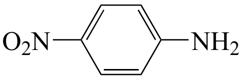


MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

4-Nitro-2-aminotoluene ⟶ 5-Nitro-o-toluidine

4-Nitroaniline

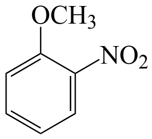
[100-01-6]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

2-Nitroanisole

[91-23-6]

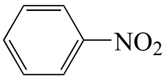


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4.8×10^{-3} at 25°C

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Nitrobenzene

[98-95-3]



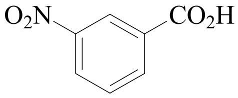
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.3
see Section XII

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.51
Peak lim: II(4)
Preg gr: C
Perc abs: H
Carc cat: 4

2-Nitro-1,4-benzenediamine ⟶ 2-Nitro-p-phenylenediamine

3-Nitrobenzoic acid

[121-92-6]

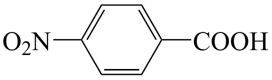


VP[hPa]: 5×10^{-5} at 25°C (calculated value)
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

4-Nitrobenzoic acid

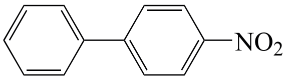
[62-23-7]



MAK[mg/m^3]: 1 I
Peak lim: I(2)
Preg gr: D
Carc cat: 3

4-Nitrobiphenyl

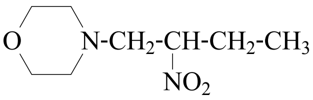
[92-93-3]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

★ 4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w)

[2224-44-4; 1854-23-5]
(mixture)



$O\ N\text{-}CH_2\text{-}\underset{NO_2}{CH}\text{-}CH_2\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.
VP[hPa]: 0.0104
see Section Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

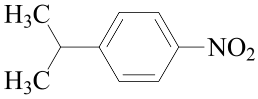
o-Nitrochlorobenzene ⟶ o-Chloronitrobenzene

m-Nitrochlorobenzene ⟶ m-Chloronitrobenzene

p-Nitrochlorobenzene ⟶ p-Chloronitrobenzene

p-Nitrocumene

[1817-47-6]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.02 at 25℃ (calculated value)
see Section IV
Sens: Sh

4-Nitrodiphenyl ⟶ 4-Nitrobiphenyl

Nitroethane

[79-24-3]

$H_3C\text{-}CH_2\text{-}NO_2$

VP[hPa]: 20.8

MAK[ml/m³]: 10
MAK[mg/m³]: 31
Peak lim: II(4)
Preg gr: D
Perc abs: H

4-Nitro-4′-[N-ethyl-N-(2-hydroxyethyl)-amino]azobenzene ⟶ Disperse Red 1

Nitrogen dioxide

[10102-44-0]

NO_2

VP[hPa]: 960

MAK[ml/m³]: 0.5
MAK[mg/m³]: 0.95
Peak lim: I(1)
Preg gr: D
Carc cat: 3

Nitrogen monoxide

[10102-43-9]

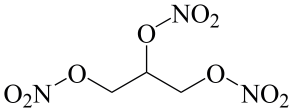
NO

MAK[ml/m³]: 0.5
MAK[mg/m³]: 0.63
Peak lim: I(2)
Preg gr: D

Nitrogen oxide ⟶ Nitrous oxide

Nitroglycerin

[55-63-0]



see Section XII

MAK[ml/m³]: 0.01
MAK[mg/m³]: 0.094
MAK value applies for the sum of the concentrations of ethylene glycol dinitrate, nitroglycerin and propylene glycol dinitrate in the air.
Peak lim: II(1)
Preg gr: C
Perc abs: H
Carc cat: 3

Nitroglycol ⟶ Ethylene glycol dinitrate

Nitromethane

[75-52-5]

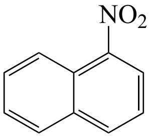
$H_3C\text{-}NO_2$

VP[hPa]: 37

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

1-Nitronaphthalene

[86-57-7]

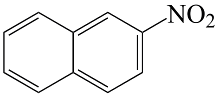


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.002 at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2-Nitronaphthalene

[581-89-5]



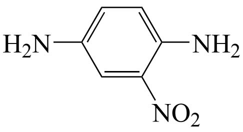
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.5×10^{-4} at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

4-(4-Nitrophenylazo)aniline ⟶ Disperse Orange 3

2-Nitro-p-phenylenediamine

[5307-14-2]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

1-Nitropropane

[108-03-2]

$H_3C\text{-}(CH_2)_2\text{-}NO_2$

Technical products measurably contaminated with 2-nitropropane, see 2-Nitropropane.

MAK[ml/m^3]: 2
MAK[mg/m^3]: 7.4
Peak lim: I(8)
Preg gr: D
Perc abs: H

2-Nitropropane

[79-46-9]

$(H_3C)_2CH\text{-}NO_2$

VP[hPa]: 17

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Nitropyrenes (Mono-, Di-, Tri-, Tetra-) (isomers)

$C_{16}H_{10\text{-}n}(NO_2)_n$; n = 1 - 4

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Nitrosamines (formed from amines)

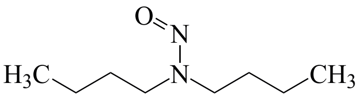
see Section III

N-Nitroso-bis(2-hydroxyethyl)amine ⟶
N-Nitrosodiethanolamine

N-Nitroso-cyclohexylhydroxylamine, potassium salt ⟶
Cyclohexylhydroxydiazene-1-oxide, potassium salt

N-Nitrosodi-n-butylamine

[924-16-3]

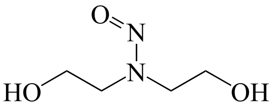


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.06 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

N-Nitrosodiethanolamine

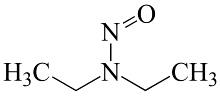
[1116-54-7]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

N-Nitrosodiethylamine

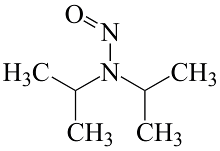
[55-18-5]



MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

N-Nitrosodiisopropylamine

[601-77-4]

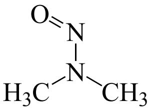


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.35 at 25℃ (calculated value)

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

N-Nitrosodimethylamine

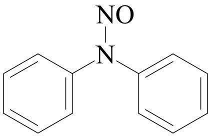
[62-75-9]



MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

N-Nitrosodiphenylamine

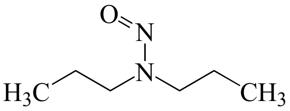
[86-30-6]



MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	3

N-Nitrosodi-n-propylamine

[621-64-7]



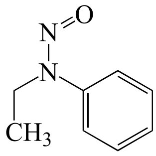
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.12 at 25℃ (calculated value)

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

Nitrosoethylaniline → N-Nitrosoethylphenylamine

N-Nitrosoethylphenylamine

[612-64-6]

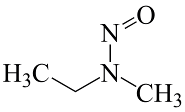


MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

Nitrosomethylaniline → N-Nitrosomethylphenylamine

N-Nitrosomethylethylamine

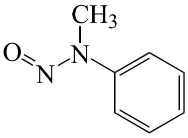
[10595-95-6]



MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H
Carc cat:	2

N-Nitrosomethylphenylamine

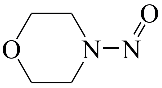
[614-00-6]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

N-Nitrosomorpholine

[59-89-2]

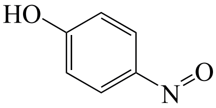


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.05 at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

4-Nitrosophenol

[104-91-6]



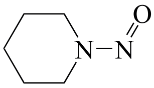
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.20 at 25℃ (calculated value)
see Section IV

p-Nitrosophenol ⟶ 4-Nitrosophenol

N-Nitroso-N-phenylaniline ⟶ N-Nitrosodiphenylamine

N-Nitrosopiperidine

[100-75-4]

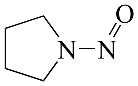


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.12 at 25℃ (calculated value)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

N-Nitrosopyrrolidine

[930-55-2]

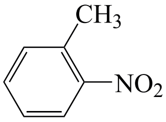


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.08

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

2-Nitrotoluene

[88-72-2]

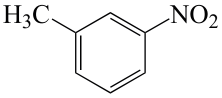


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.20

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

3-Nitrotoluene

[99-08-1]

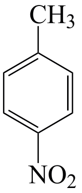


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.20

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

4-Nitrotoluene

[99-99-0]

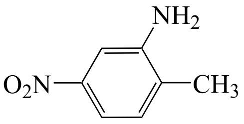


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.22 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

5-Nitro-o-toluidine

[99-55-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Nitrous oxide

[10024-97-2]

N_2O

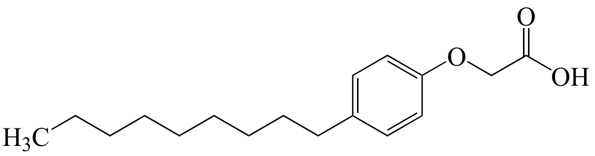
MAK[ml/m^3]: 100
MAK[mg/m^3]: 180
Peak lim: II(2)
Preg gr: C

3,3,4,4,5,5,6,6,6-Nonafluoro-1-hexene ⟶ 1H,1H,2H-Perfluorohexene

Nonanedionic acid ⟶ Azelaic acid

(4-Nonylphenoxy)acetic acid

[3115-49-9]



see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Oak (Quercus spp.) ⟶ Woods

Oakmoss extracts

see Section IV
Sens: Sh

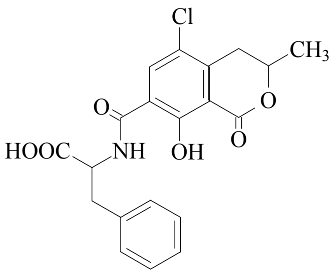
Oak wood dust

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1
Dusts have been shown epidemiologically to be unequivocally carcinogenic. The active carcinogenic principle has not been identified to date.

Obeche (Triplochiton scleroxylon) ⟶ Woods

Ochratoxin A

[303-47-9]



VP[hPa]: 4.4×10^{-16}

Carc cat: 2
Muta cat: 3B

Octadecanoic acid ⟶ Stearic acid

1-Octadecanol

[112-92-5]

$HO\text{-}(CH_2)_{17}\text{-}CH_3$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

9-Octadecenoic acid ⟶ Oleic acid

9-Octadecenoic acid decyl ester ⟶ n-Decyl oleate

Octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate ⟶ 3,5-Di-tert-butyl-4-hydroxyphenylpropionic acid octadecyl ester

Octane (all isomers except trimethylpentane isomers)

$H_3C\text{-}C_6H_{12}\text{-}CH_3$

VP[hPa]: 15

MAK[ml/m^3]: 500
MAK[mg/m^3]: 2400
Peak lim: II(2)
Preg gr: D

1,8-Octanedicarboxylic acid ⟶ Sebacic acid

1-Octanol

[111-87-5]

$$CH_3\text{-}(CH_2)_6\text{-}CH_2OH$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.1 at 25℃
see Section Xc

MAK[ml/m^3]: 10
MAK[mg/m^3]: 54
Peak lim: I(1)
Preg gr: C

n-Octanol ⟶ 1-Octanol

Octyl acetate ⟶ 2-Ethylhexyl acetate

Octyl alcohol ⟶ 1-Octanol

2-Octyl-1-dodecanol

[5333-42-6]

$$CH_3\text{-}(CH_2)_9\text{-}CH(C_8H_{17})\text{-}CH_2OH$$

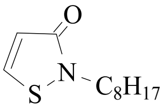
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2-Octyldodecyl alcohol ⟶ 2-Octyl-1-dodecanol

2-Octyl-4-isothiazolin-3-one

[26530-20-1]



see Section Xc

MAK[mg/m^3]: 0.05 I
Peak lim: I(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H
Sens: Sh

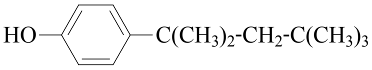
2-Octyl-4-isothiazolin-3-one ⟶ 2-Octyl-4-isothiazolin-3-one

2-Octyl-3(2H)-isothiazolone ⟶ 2-Octyl-4-isothiazolin-3-one

4-Octyl-N-(4-octylphenyl)benzenamine ⟶ 4,4′-Dioctyldiphenylamine

4-tert-Octylphenol

[140-66-9]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.01
see Section Xc

MAK[ml/m^3]: 0.5
MAK[mg/m^3]: 4.3
Peak lim: I(1)
Preg gr: D

n-Octyltin compounds

(as Sn [7440-31-5])
The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: 0.002
MAK[mg/m^3]: 0.0098
Peak lim: II(2)
Perc abs: H
Sens: –
For octyltin compounds whose organic ligands were already designated with “Sa” or “Sh”, these designations also apply.
Carc cat: 4

– Mono-n-octyltin compounds

Preg gr: C

– Di-n-octyltin compounds

Preg gr: B

– Tri-n-octyltin compounds

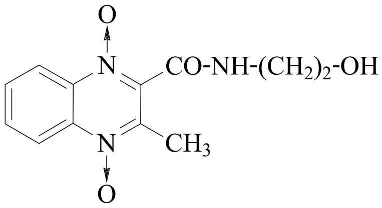
Preg gr: B

– Tetra-n-octyltin

Preg gr: D

Olaquindox (N-(2-Hydroxyethyl)-3-methyl-2-quinoxalinecarboxamide 1,4-dioxide)

[23696-28-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: SP
Carc cat: 3
Muta cat: 2

Oleic acid

[112-80-1]

$CH_3\text{-}(CH_2)_7\text{-}CH{=}CH\text{-}(CH_2)_7\text{-}COOH$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Oleic acid decyl ester ⟶ n-Decyl oleate

Oleyl alcohol

[143-28-2]

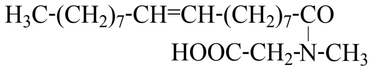
$HO\text{-}(CH_2)_8\text{-}CH{=}CH\text{-}(CH_2)_7\text{-}CH_3$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Oleyl sarcosine

[110-25-8]



$$\begin{array}{r} H_3C\text{-}(CH_2)_7\text{-}CH{=}CH\text{-}(CH_2)_7\text{-}CO \\ | \\ HOOC\text{-}CH_2\text{-}N\text{-}CH_3 \end{array}$$

VP[hPa]: 4×10^{-7}
see Section Xc

MAK[mg/m^3]: 0.05 I
Peak lim: II(2)
Preg gr: D

Organic lead compounds ⟶ Lead compounds, organic

Organomercury compounds ⟶ Mercury, organic compounds

Organotin compounds ⟶ Tin compounds, organic (n-Butyl-)

Orthoarsenic acid ⟶ Arsenic

Orthophosphoric acid ⟶ Phosphoric acid

Osmium tetroxide

[20816-12-0]

OsO_4

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

1-Oxa-4-azacyclohexane ⟶ Morpholine

Oxacyclopentadiene ⟶ Furan

Oxalonitrile

[460-19-5]

$NC\text{-}CN$

MAK[ml/m^3]: 5
MAK[mg/m^3]: 11
Peak lim: II(2)
Preg gr: D
Perc abs: H

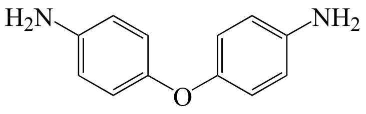
3-Oxapentane-1,5-diol ⟶ Diethylene glycol

Oxirane ⟶ Ethylene oxide

Oxybispropanol ⟶ Dipropylene glycol

4,4′-Oxydianiline

[101-80-4]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

2,2′-Oxydiethanol ⟶ Diethylene glycol

N-Oxydiethylenebenzothiazole-2-sulfenamide ⟶ 2-(4-Morpholinylmercapto)benzothiazole

Ozone

[10028-15-6]

O_3

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

PAH ⟶ Polycyclic aromatic hydrocarbons (PAH)

Palladium

[7440-05-3]
and palladium compounds
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

– Metallic palladium

[7440-05-3]

Pd

Sens: –

– Palladium chloride

[7647-10-1]

$PdCl_2$

Sens: Sh

– bioavailable palladium(II) compounds

Sens: Sh

Palmitic acid

[57-10-3]

$CH_3\text{-}(CH_2)_{14}\text{-}COOH$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

⋆ Palm kernel oil

[8023-79-8]
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C
Carc cat: –
Muta cat: –

Palygorskite (fibrous dust) ⟶ Attapulgite

Pao ferro (Machaerium scleroxylon) ⟶ Woods

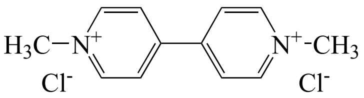
Papain

[9001-73-4]
see Section IV
Sens: Sa

Paraffin oil ⟶ White mineral oil (pharmaceutical)

Paraquat dichloride

[1910-42-5]

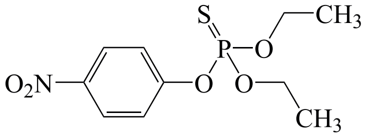


see Section IIc

Paratecoma peroba ⟶ Woods

Parathion

[56-38-2]



BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc and XII

Passive smoking ⟶ Sidestream smoke (passive smoking at the workplace)

PCBs ⟶ Chlorinated biphenyls

PCP ⟶ Pentachlorophenol

PEG ⟶ Polyethylene glycol (average molecular weight 200–600)

Pencil cedar (Calocedrus decurrens) ⟶ Woods

Pentaborane

[19624-22-7]

B_5H_9

VP[hPa]: 213
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Pentachloroethane

[76-01-7]

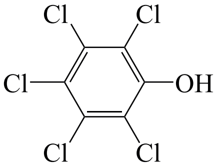
$Cl_2HC\text{-}CCl_3$

MAK[ml/m^3]: 2
MAK[mg/m^3]: 17
Peak lim: II(2)
Preg gr: D
Perc abs: H
Carc cat: 3

Pentachloronaphthalenes ⟶ Chlorinated naphthalenes

Pentachlorophenol

[87-86-5]



see Section XIII

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Pentadecafluorooctanoic acid ⟶ Perfluorooctanoic acid (PFOA)

Pentaerythritol triacrylate

[3524-68-3]

$HO\text{-}CH_2\text{-}C(CH_2\text{-}O\text{-}OC\text{-}CH{=}CH_2)_3$

see Section IV
Sens: Sh

Pentane (all isomers)

VP[hPa]: 573

MAK[ml/m³]: 1000
MAK[mg/m³]: 3000
Peak lim: II(2)
Preg gr: C

– n-Pentane

[109-66-0]

$H_3C\text{-}(CH_2)_3\text{-}CH_3$

– Isopentane

[78-78-4]

$(H_3C)_2CH\text{-}CH_2\text{-}CH_3$

– tert-Pentane

[463-82-1]

$C(CH_3)_4$

1,5-Pentanedial ⟶ Glutaraldehyde

2,3-Pentanedione

[600-14-6]

$CH_3\text{-}CH_2\text{-}CO\text{-}CO\text{-}CH_3$

MAK[ml/m³]: 0.02
MAK[mg/m³]: 0.083
Peak lim: II(1)
Preg gr: D
Perc abs: H
Sens: Sh

2,4-Pentanedione

[123-54-6]

$CH_3\text{-}CO\text{-}CH_2\text{-}CO\text{-}CH_3$

MAK[ml/m³]: 20
MAK[mg/m³]: 83
Peak lim: II(2)
Preg gr: C
Perc abs: H

Pentanol (isomers)

$C_5H_{11}OH$

MAK[ml/m³]: 20
MAK[mg/m³]: 73
Peak lim: I(2)
Preg gr: C

– 1-Pentanol

[71-41-0]
VP[hPa]: 2.93 at 25℃

– 2-Pentanol

[6032-29-7]
VP[hPa]: 8.13 at 25℃

– 3-Pentanol

[584-02-1]
VP[hPa]: 11.7 at 25℃

– 2-Methyl-1-butanol

[137-32-6]
VP[hPa]: 4.15 at 25℃

– 2-Methyl-2-butanol

[75-85-4]
VP[hPa]: 19 at 25℃

– 3-Methyl-1-butanol

[123-51-3]
VP[hPa]: 3.15 at 25℃

– 3-Methyl-2-butanol

[598-75-4]
VP[hPa]: 12.17 at 25℃

– 2,2-Dimethyl-1-propanol

[75-84-3]
VP[hPa]: 21.28

– Mixture of isomers, Pentanol

[30899-19-5; 94624-12-1]

2-Pentanone

[107-87-9]

$H_3C\text{-}(CH_2)_2\text{-}CO\text{-}CH_3$

VP[hPa]: 16
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

1-Pentyl acetate → Amyl acetate (all isomers)

3-Pentyl acetate → Amyl acetate (all isomers)

Pentyl acetate → Amyl acetate (all isomers)

2-Pentyl-3-phenylpropenoic aldehyde → α-Amylcinnamaldehyde

Pepsin

[9001-75-6]
see Section IV
Sens: Sa

Peracetic acid

[79-21-0]

$H_3C\text{-}CO\text{-}OOH$

VP[hPa]: 19.3 at 25℃
see Section Xa

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.32
Peak lim: I(1)
Preg gr: C
Carc cat: 4

Perchloroethylene → Tetrachloroethene

Tetrarchloroethylene → Tetrachloroethene

Perchloromethyl mercaptan

[594-42-3]

$Cl_3C\text{-}S\text{-}Cl$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

1H,1H,2H-Perfluorohexene

[19430-93-4]

$H_2C{=}CH\text{-}(CF_2)_3\text{-}CF_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Perfluorooctanesulfonic acid (PFOS)

[1763-23-1]
and its salts

$CF_3(CF_2)_7SO_3H$

VP[hPa]: 0.69
see Section XII

MAK[mg/m^3]: 0.01 I
Peak lim: II(8)
Preg gr: B
Perc abs: H
Carc cat: 3

Perfluorooctanoic acid (PFOA)

[335-67-1]
and its salts

$F_3C(CF_2)_6COOR$
$R = Ag, H, K, NH_4, Na$

VP[hPa]: 0.69
see Section XII

MAK[mg/m^3]: 0.005 I
Peak lim: II(8)
Preg gr: B
Perc abs: H
Carc cat: 4

Perhydronaphthalene → Decahydronaphthalene

Peroxydisulfuric acid diammonium salt → Ammonium persulfate

Petroleum, distillates → Distillates (petroleum)

Petroleum sulfonates, calcium salts (technical mixture in mineral oil)

[61789-86-4]
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: D

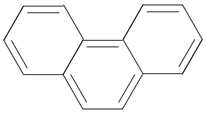
Petroleum sulfonates, sodium salts

[68608-26-4]
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Phenanthrene

[85-01-8]



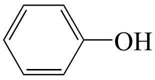
see documentation “Polycyclic Aromatic Hydrocarbons (PAH)”
see Section III, “pyrolysis products of organic materials”

Peak lim: –
Preg gr: –
Perc abs: H

Phenethyl alcohol ⟶ 2-Phenyl-1-ethanol

Phenol

[108-95-2]



The substance can occur simultaneously as vapour and aerosol.
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3
Muta cat: 3B

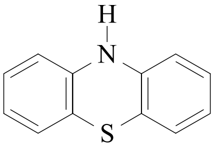
Phenol ⟶ Formaldehyde condensation products with phenol (low-molecular)

Phenol, 2(or 4)-C9–10-branched alkyl derivs., phosphorothioates ⟶ Tris[(2- or 4-)C9–C10-isoalkylphenyl]phosphorothioate

Phenol, isopropylated, phosphate ⟶ Triphenyl phosphate, isopropylated

Phenothiazine

[92-84-2]

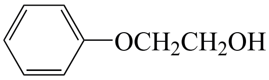


phototoxic effect
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2-Phenoxyethanol

[122-99-6]

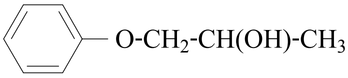


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.01 at 25℃
see Section Xc

MAK[ml/m^3]: 1
MAK[mg/m^3]: 5.7
Peak lim: I(1)
Preg gr: C

1-Phenoxy-2-propanol

[770-35-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.03 at 25℃
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Phenylacrolein ⟶ Cinnamaldehyde

γ-Phenylallyl alcohol ⟶ Cinnamyl alcohol

N-Phenyl aniline ⟶ Diphenylamine

Phenyl arsenic compounds

[637-03-6]

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

p-Phenylazoaniline ⟶ p-Aminoazobenzene

Phenylbenzene ⟶ Biphenyl

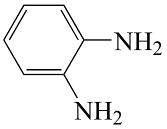
N-Phenylbenzene amin ⟶ Diphenylamine

N-Phenyl-1,4-benzenediamine ⟶ 4-Aminodiphenylamine

Phenyl Cellosolve ⟶ 2-Phenoxyethanol

o-Phenylenediamine

[95-54-5]

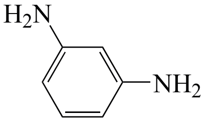


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.1×10^{-3}

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 3

m-Phenylenediamine

[108-45-2]

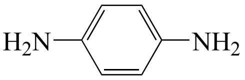


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.8×10^{-4}

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

p-Phenylenediamine

[106-50-3]

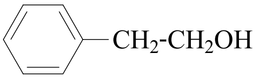


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.01

MAK[mg/m^3]: 0.1 I
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H
Sens: Sh
The "Ursol-Asthma" which used to be observed frequently, especially in persons dyeing furs with p-phenylenediamine, has not been demonstrated unequivocally to involve respiratory allergy to p-phenylenediamine; see documentation.
Carc cat: 3

2-Phenyl-1-ethanol

[60-12-8]



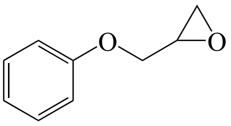
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.08
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Phenyl ether → Diphenyl ether

Phenyl glycidyl ether (PGE)

[122-60-1]

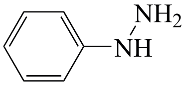


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.013 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2

Phenylhydrazine

[100-63-0]

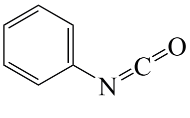


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.035 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

Phenyl isocyanate

[103-71-9]



see Section IV
Sens: Sah

Phenyl mercury → Mercury, organic compounds

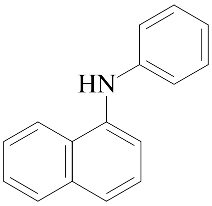
Phenylmethanal → Benzaldehyde

Phenylmethane ⟶ Toluene

2-(Phenylmethylene)-heptanal ⟶ α-Amylcinnamaldehyde

N-Phenyl-1-naphthylamine

[90-30-2]

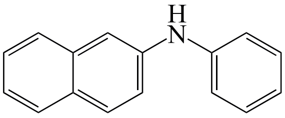


VP[hPa]: 0.000011
see Section Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Sens: Sh

N-Phenyl-2-naphthylamine

[135-88-6]



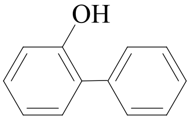
VP[hPa]: <0.000011 (calculated value)
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 1
Muta cat: 3A

4-Phenylnitrobenzene ⟶ 4-Nitrobiphenyl

o-Phenylphenol

[90-43-7]
see also Sodium o-phenylphenol



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4.7×10^{-3}
see Section Xc

MAK[mg/m^3]: 5 I
Peak lim: I(1)
Preg gr: C
Carc cat: 4

N-Phenyl-p-phenylenediamine ⟶ 4-Aminodiphenylamine

N-Phenyl-p-phenylenediamine ⟶ 4-Aminodiphenylamine

3-Phenyl-2-propenal ⟶ Cinnamaldehyde

2-Phenylpropene ⟶ α-Methyl styrene

3-Phenyl-2-propen-1-ol ⟶ Cinnamyl alcohol

Phenyltin compounds

(as Sn [7440-31-5])
The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: 0.0004
MAK[mg/m^3]: 0.002
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

Phosdrin ⟶ Mevinphos

Phosgene

[75-44-5]

$COCl_2$

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.41
Peak lim: I(2)
Preg gr: C

Phosphine

[7803-51-2]

PH_3

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.14
Peak lim: II(2)
Preg gr: C

Phosphomolybdic acid ⟶ Molybdenum

Phosphoric acid

[7664-38-2]

H_3PO_4

MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: C

Phosphoric acid methylphenyl diphenyl ester ⟶ Diphenyl cresyl phosphate

Phosphoric acid tributyl ester ⟶ Tributyl phosphate

Phosphorus, red

[7723-14-0]

P_n

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Phosphorus, white/yellow

[7723-14-0; 12185-10-3]

P_4

MAK[mg/m^3]: 0.01 I
Peak lim: II(2)
Preg gr: C

Phosphorus oxychloride

[10025-87-3]

$POCl_3$

VP[hPa]: 36

MAK[ml/m^3]: 0.02
MAK[mg/m^3]: 0.13
Peak lim: I(1)
Preg gr: C

Phosphorus pentachloride

[10026-13-8]

PCl_5

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.016

MAK[mg/m^3]: 1 I
Peak lim: I(1)
Preg gr: C

Phosphorus pentasulfide

[1314-80-3]

P_2S_5

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Phosphorus pentoxide

[1314-56-3]

P_2O_5

MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: C

Phosphorus trichloride

[7719-12-2]

PCl_3

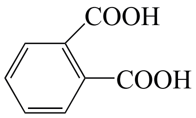
VP[hPa]: 130

MAK[ml/m^3]: 0.1
MAK[mg/m^3]: 0.57
Peak lim: I(1)
Preg gr: C

Phosphoryl chloride ⟶ Phosphorus oxychloride

o-Phthalic acid

[88-99-3]

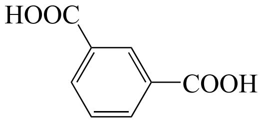


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

m-Phthalic acid

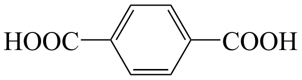
[121-91-5]



MAK[mg/m^3]: 5 I
Peak lim: I(2)
Preg gr: C

p-Phthalic acid

[100-21-0]



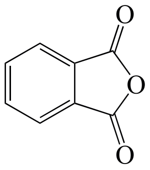
MAK[mg/m^3]: 5 I
Peak lim: I(2)
Preg gr: C

Phthalic acid diallyl ester ⟶ Diallyl phthalate

Phthalic acid diisodecyl ester ⟶ Diisodecyl phthalate

Phthalic anhydride

[85-44-9]



see Section IIb

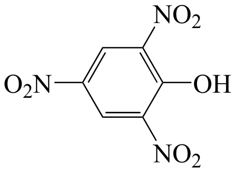
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sa

Phytases

see Section IV
Sens: Sa

Picric acid

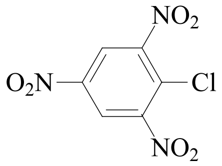
[88-89-1]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

Picryl chloride

[88-88-0]



see Section IV
Sens: Sh

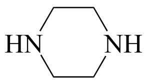
Pigment Yellow 12, Pigment Yellow 13, Pigment Yellow 83

[6358-85-6; 5102-83-0; 5567-15-7]
(respirable fraction)

MAK[mg/m^3]: 0.3 R
multiplied with the material density × 0.5;
corresponds to an assumed agglomerate density at a packing factor of 50%, see documentation
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Piperazine

[110-85-0]



The substance can occur simultaneously as vapour and aerosol. Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N,N′-dinitrosopiperazine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 0.21
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sah

1-Piperidineethanol → N-(2-Hydroxyethyl)piperidine

2-Piperidinoethanol → N-(2-Hydroxyethyl)piperidine

2-Piperidin-1-ylethanol → N-(2-Hydroxyethyl)piperidine

Plant or animal proteins

see Section IVe

Plants containing sesquiterpene lactones → Sesquiterpene lactones

Platinum compounds (Chloroplatinates)

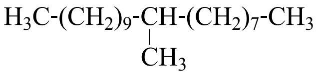
A peak concentration of 2 µg/m^3 should not be exceeded.
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sah

pMDI → “polymeric MDI”

Polyalphaolefins

several CAS Nos, e. g.
[68649-11-6]



$$H_3C\text{-}(CH_2)_9\text{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}\text{-}(CH_2)_7\text{-}CH_3$$

VP[hPa]: 0.019
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C

Polyaluminium chloride → Aluminium chloride, basic

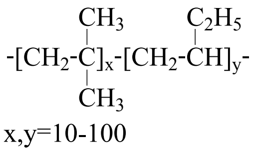
Polybutenes and Polyisobutenes

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

– Polybutenes

[9003-29-6]

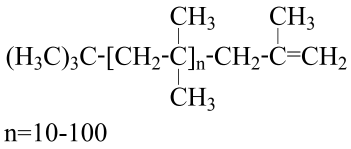


$$\text{-}[CH_2\text{-}\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}]_x\text{-}[CH_2\text{-}\overset{\displaystyle C_2H_5}{CH}]_y\text{-}$$

x,y=10-100

– Polyisobutenes

[9003-27-4]



$$(H_3C)_3C\text{-}[CH_2\text{-}\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}]_n\text{-}CH_2\text{-}\overset{\displaystyle CH_3}{C}\text{=}CH_2$$

n=10-100

Polychlorinated biphenyls → Chlorinated biphenyls

Polycyclic aromatic hydrocarbons (PAH)

see Section III, “pyrolysis products of organic materials” and section XII

Perc abs: H

Poly(1,2-dihydro-2,2,4-trimethyl-quinoline) ⟶ 1,2-Dihydro-2,2,4-trimethyl-quinoline polymer

Polydimethyl siloxanes, linear

[63148-62-9; 9006-65-9; 9016-00-6]

$$(CH_3)_3Si\text{-}[O\text{-}Si(CH_3)_2]_n\text{-}O\text{-}Si(CH_3)_3$$
$$n > 14$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Polyethylene glycol (average molecular weight 200–600)

[25322-68-3]

$$HO\text{-}(CH_2\text{-}CH_2\text{-}O)_x\text{-}H \quad x > 4$$

Because formation of a mist is possible, exposure should be minimized for reasons of occupational safety and hygiene.
VP[hPa]: <0.1
see Section Xc

MAK[mg/m³]: 250 I
Peak lim: II(2)
Preg gr: C

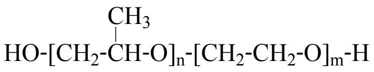
Polyethylene glycol (average molecular weight > 600)

[25322-68-3]
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Polyethylenepolypropylene glycol

[9003-11-6]



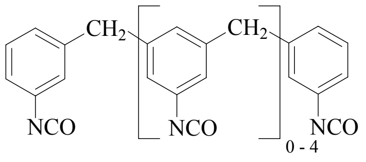
$$HO\text{-}[CH_2\text{-}\underset{}{\overset{CH_3}{C}}H\text{-}O]_n\text{-}[CH_2\text{-}CH_2\text{-}O]_m\text{-}H$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

“polymeric MDI”

[9016-87-9]
(inhalable fraction) see also 4,4′-Methylene diphenyl diisocyanate (MDI)



“polymeric MDI” (pMDI) is a technical grade MDI, containing 30–80% w/w 4,4′-methylene diphenyl isocyanate (MDI); the remainder consists of MDI oligomers and MDI homologues.

MAK[mg/m³]: 0.05 I
Peak lim: I(1)
A momentary value of 0.1 mg/m³ should not be exceeded.
Preg gr: C
Perc abs: H
Sens: Sah
Carc cat: 4

Poly(oxy-1,2-ethanediyl)-ω-alkoxy-α-acetic acid ⟶ Alkyl ether carboxylic acids

Polyoxyethylene oleyl ether

[9004-98-2]

$$CH_3(CH_2)_7CH{=}CH(CH_2)_8\text{-}(O(CH_2)_2)_n\text{-}OH$$
$$n = 2\text{-}55$$

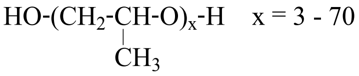
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Poly(oxy-1,2-propanediyl)-ω-alkoxy-α-acetic acid ⟶ Alkyl ether carboxylic acids

Polypropylene glycol (PPG)

[25322-69-4]



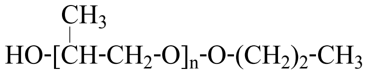
$$HO\text{-}(CH_2\text{-}\underset{CH_3}{C}H\text{-}O)_x\text{-}H \quad x = 3 - 70$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Poly(propylene glycol) n-butyl ether

[9003-13-8]



$$HO\text{-}[CH(CH_3)\text{-}CH_2\text{-}O]_n\text{-}O\text{-}(CH_2)_2\text{-}CH_3$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.7×10^{-3} at 30℃
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Polytetrafluoroethene

[9002-84-0]
(inhalable fraction)

$-[CF_2\text{-}CF_2]_n-$

see Section Vf and g and Xc

MAK[mg/m³]: 4 I
Preg gr: C

Polytetrafluoroethene

[9002-84-0]
(respirable fraction)

$-[CF_2\text{-}CF_2]_n-$

except for ultrafine particles; see Section Vh
see Section Vf and Xc

MAK[mg/m³]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Polyvinyl chloride

[9002-86-2]

$(-CH_2\text{-}CHCl-)_n$
$n=500\text{-}2000$

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m³]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Portland cement dust

[65997-15-1]
Cr(VI) content and quartz level to be assessed separately

MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: –
Is valid only for low-chromate cement containing less than 2 ppm (2 mg/kg) of chromium(VI). Refer to the chromium(VI) compounds for cement with a higher chromium(VI) content.
Carc cat: 3

Potassium benzoate ⟶ Benzoic acid alkali salts

Potassium citrate ⟶ Citric acid

Potassium citrate ⟶ Citric acid alkali metal salts

Potassium cyanide

[151-50-8]

KCN

MAK[mg/m³]: 5.0 I
Peak lim: II(1)
Preg gr: C
Perc abs: H

Potassium dichloroacetate ⟶ Dichloroacetic acid

Potassium metabisulfite ⟶ Sulfites

Potassium perfluorooctanoate ⟶ Perfluorooctanoic acid (PFOA)

Potassium persulfate ⟶ Alkali persulfates

Potassium titanates (fibrous dust)

several CAS Nos and formulas, e.g.
see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 2

– Potassium titanate

[12030-97-6]

K_2TiO_3

– Potassium titanate

[12056-46-1]

$K_2Ti_2O_5$

– Potassium titanate

[12056-49-4]

$K_2Ti_4O_9$

– Potassium titanate

[12056-51-8]

$K_2Ti_6O_{13}$

– Potassium titanate

[59766-31-3]

$K_2Ti_8O_{17}$

Propane

[74-98-6]

$H_3C\text{-}CH_2\text{-}CH_3$

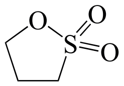
MAK[ml/m^3]: 1000
MAK[mg/m^3]: 1800
Peak lim: II(4)
Preg gr: D

1,3-Propanedicarboxylic acid ⟶ Glutaric acid

1,2-Propanediol ⟶ Propylene glycol

1,3-Propane sultone

[1120-71-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.48

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

1,2,3-Propanetriol ⟶ Glycerol

2-Propanol

[67-63-0]

$(H_3C)_2CHOH$

VP[hPa]: 44
see Section XII

MAK[ml/m^3]: 200
MAK[mg/m^3]: 500
Peak lim: II(2)
Preg gr: C

Propargyl alcohol

[107-19-7]

$HC{\equiv}C\text{-}CH_2OH$

VP[hPa]: 11.6

MAK[ml/m^3]: 2
MAK[mg/m^3]: 4.7
Peak lim: I(2)
Preg gr: D
Perc abs: H

2-Propenal ⟶ Acrolein

2-Propenoic acid 1,4-butanediyl ester ⟶ 1,4-Butanediol diacrylate

2-Propenoic acid 1,2-ethanediylbis(oxy-2,1-ethanediyl) ester ⟶ Triethylene glycol diacrylate

2-Propenoic acid 2-hydroxyethyl ester ⟶ Acrylic acid 2-hydroxyethyl ester

2-Propenoic acid 2-(hydroxymethyl)-2-(((1-oxo-2-propenyl)oxy)-methyl)-1,3-propanediyl ester ⟶ Pentaerythritol triacrylate

2-Propenoic acid hydroxypropyl ester ⟶ Acrylic acid hydroxypropyl ester (all isomers)

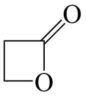
2-Propenoic acid oxydi-2,1-ethanediyl ester ⟶ Diethylene glycol diacrylate

2-Propen-1-ol ⟶ Allyl alcohol

4-Propenyl-2-methoxyphenol ⟶ Isoeugenol

β-Propiolactone

[57-57-8]



MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Propionic acid

[79-09-4]

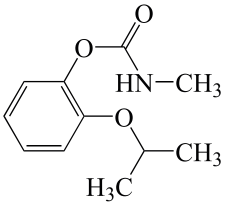
$H_3C\text{-}CH_2\text{-}COOH$

VP[hPa]: 4

MAK[ml/m^3]: 10
MAK[mg/m^3]: 31
Peak lim: I(2)
Preg gr: C

Propoxur

[114-26-1]



BLW for acetylcholinesterase inhibitors still valid; see section XII.
see Section IIc

2-Propoxyethanol ⟶ 2-Propyloxyethanol

2-Propoxyethanol acetate ⟶ 2-(Propyloxy)ethyl acetate

Propylacetate

VP[hPa]: 33

MAK[ml/m³]: 100
MAK[mg/m³]: 420
Peak lim: I(2)

– n-Propyl acetate

[109-60-4]

$H_3C\text{-}COOCH_2\text{-}CH_2\text{-}CH_3$

Preg gr: D

– Isopropyl acetate

[108-21-4]

$H_3C\text{-}COOCH(CH_3)_2$

Preg gr: C

Propyl allyl disulfide ⟶ Allyl propyl disulfide

n-Propyl bromide ⟶ 1-Bromopropane

Propyl Cellosolve ⟶ 2-Propyloxyethanol

Propylene carbonate ⟶ 4-Methyl-1,3-dioxolan-2-one

Propylene dichloride ⟶ 1,2-Dichloropropane

Propylene glycol

[57-55-6]

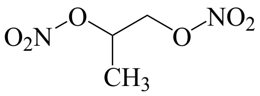
$CH_3\text{-}CH(OH)\text{-}CH_2OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.11
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Propylene glycol dinitrate

[6423-43-4]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.084

MAK[ml/m³]: 0.01
MAK[mg/m³]: 0.069
MAK value applies for the sum of the concentrations of ethylene glycol dinitrate, nitroglycerin and propylene glycol dinitrate in the air.
Peak lim: II(1)
Preg gr: C
Perc abs: H

Propylene glycol 1-methyl ether ⟶ 1-Methoxy-2-propanol

Propylene glycol 2-methyl ether ⟶ 2-Methoxypropanol-1

Propylene glycol 1-methyl ether-2-acetate ⟶ 1-Methoxypropyl-2-acetate

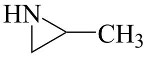
Propylene glycol 2-methyl ether-1-acetate ⟶ 2-Methoxypropylacetate-1

Propylene glycol monoacrylate ⟶ Acrylic acid hydroxypropyl ester (all isomers)

Propylene glycol monoethyl ether ⟶ 1-Ethoxy-2-propanol

Propylene imine

[75-55-8]



MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3B

Propylene oxide ⟶ 1,2-Epoxypropane

n-Propylglycol acetate ⟶ 2-(Propyloxy)ethyl acetate

n-Propyl nitrate

[627-13-4]

$H_3C\text{-}(CH_2)_2\text{-}ONO_2$

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

2-Propyloxyethanol

[2807-30-9]

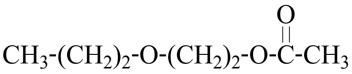
$CH_3\text{-}(CH_2)_2\text{-}O\text{-}(CH_2)_2\text{-}OH$

VP[hPa]: 6.4 at 25℃

MAK[ml/m³]: 10
MAK[mg/m³]: 43
MAK value applies for the sum of the concentrations of 2-propyloxyethanol and 2-propyloxyethyl acetate in the air.
Peak lim: I(2)
Preg gr: C
Perc abs: H

2-(Propyloxy)ethyl acetate

[20706-25-6]



$CH_3\text{-}(CH_2)_2\text{-}O\text{-}(CH_2)_2\text{-}O\text{-}\overset{\overset{O}{\|}}{C}\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.67

MAK[ml/m^3]: 10
MAK[mg/m^3]: 61
MAK value applies for the sum of the concentrations of 2-propyloxyethanol and 2-propyloxyethyl acetate in the air.
Peak lim: I(2)
Preg gr: C
Perc abs: H

Propyne → Methyl acetylene

Pruno (Mansonia altissima) → Woods

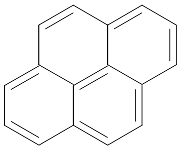
Pseudocumene (1,2,4-Trimethylbenzene) → Trimethylbenzene (all isomers)

PTBBA → p-tert-Butylbenzoic acid

PVC → Polyvinyl chloride

Pyrene

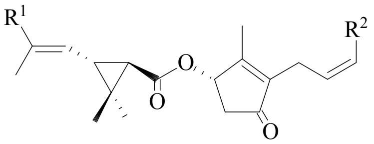
[129-00-0]



see documentation "Polycyclic Aromatic Hydrocarbons (PAH)"
see Section III, "pyrolysis products of organic materials"
Perc abs: H

Pyrethrum

[8003-34-7]

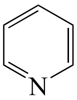


see Section IIb and XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
does not apply for the constituents of insecticides (pyrethrins and cinerins) or for synthetic derivatives (pyrethroids) but only for the constituents of the plant drug and its crude extracts, including α-methylene sesquiterpene lactones (e.g. pyrethrosin)

Pyridine

[110-86-1]



VP[hPa]: 20

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3

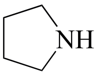
Pyrolysis products of organic materials

see Section III, "pyrolysis products of organic materials"

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Pyrrolidine

[123-75-1]



Use in metal-working fluids is not permitted: see TRGS 611.
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosopyrrolidine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

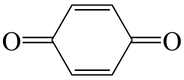
Quartz → Silica, crystalline

Quartz glass → Silica, amorphous: b) quartz glass [60676-86-0], fused silica [60676-86-0], silica fume (calcined) [69012-64-2], diatomaceous earth [68855-54-9]

Quercus spp. → Woods

Quinone

[106-51-4]



VP[hPa]: 0.12

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 3
Muta cat: 3B

Quinone oxime → 4-Nitrosophenol

Ramin (Gonystylus bancanus) → Woods

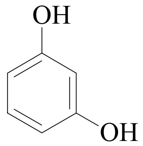
Reaction products of ethylene glycol with paraformaldehyde ⟶ (Ethylenedioxy)dimethanol

Refrigerant 134a ⟶ 1,1,1,2-Tetrafluoroethane

rennets, microbial ⟶ Microbial rennets: endothiapepsin and mucorpepsin

Resorcinol

[108-46-3]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3×10^{-4} at 25℃
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh

Resorcinol bis(2,3-epoxypropyl)ether ⟶ Diglycidyl resorcinol ether

Resorcinol diglycidyl ether ⟶ Diglycidyl resorcinol ether

Rhodium

[7440-16-6]
and its inorganic compounds

Rh

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Ricinus protein

see Section IV
Sens: Sa

Rock wool (fibrous dust)

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 2

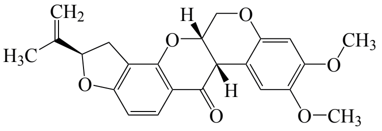
Rosewood (Dalbergia spp.) ⟶ Woods

Rosin (colophony)

[8050-09-7]
see Section IV
Sens: Sh
An immunological genesis of the asthma often seen in persons working with materials containing rosin has not been proved.

Rotenone

[83-79-4]



see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Rubber components

see Section IV

– Dithiocarbamates

Sens: Sh

– Thiazoles

Sens: Sh

– p-Phenylenediamine compounds

Sens: Sh

– Thiurams

Sens: Sh

Rye ⟶ Cereal flour dusts

Santos rosewood (Machaerium scleroxylon) ⟶ Woods

Sapele (Entandrophragma spp.) ⟶ Woods

Sapupira, (black) sucupira (Bowdichia nitida) ⟶ Woods

Sebacic acid

[111-20-6]

$HO_2C\text{-}(CH_2)_8\text{-}CO_2H$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Selenium

[7782-49-2]
and its inorganic compounds (as Se)

Se

see Section XII

MAK[mg/m³]: 0.02 I
Peak lim: II(8)
Preg gr: C
Perc abs: H
Carc cat: 3

Sepiolite (fibrous dust)

several CAS Nos and formulas, e.g.
see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

– Sepiolite

[18307-23-8]

$Mg_9H_6(SiO_3)_{12} \cdot 10\ H_2O$

– Sepiolite

[15501-74-3]

$Mg_2H_2(SiO_3)_3 \cdot H_2O$

Sesquiterpene lactones

see Section IV
Sens: Sh

– Alantolactone

[546-43-0]

– Anthecotulide

[23971-84-8]

– Arteglasin A

[33204-39-6]

– Carabrone

[1748-81-8]

– Costunolide

[553-21-9]

– Dehydrocostus lactone

[477-43-0]

– (+)-Frullanolide and (-)-Frullanolide

[40776-40-7; 27579-97-1]

– Helenalin

[6754-13-8]

– Isoalantolactone

[470-17-7]

– Lactucin

[1891-29-8]

– Laurenobiolide

[35001-25-3]

– Parthenin

[508-59-8]

– Parthenolide

[20554-84-1]

– α-Peroxyachifolide

[134954-21-5]

– Pyrethrosin

[28272-18-6]

Sevoflurane

[28523-86-6]

$(CF_3)_2CH\text{-}O\text{-}CH_2F$

VP[hPa]: 1570
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Sidestream smoke (passive smoking at the workplace)

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 1

Silica, amorphous: a) synthetic amorphous silica [7631-86-9]

including pyrogenic [112945-52-5] and wet process synthetic silica (precipitated silica, silica gel) [112926-00-8] and diatomaceous earth (uncalcined) [61790-53-2]
see Section V

MAK[mg/m³]: 0.02 R
Peak lim: II(8)
Preg gr: C

Silica, amorphous: b) quartz glass [60676-86-0], fused silica [60676-86-0], silica fume (calcined) [69012-64-2], diatomaceous earth [68855-54-9]

see Section V

MAK[mg/m³]: 0.3 R
Preg gr: C

Silica, crystalline

(respirable fraction)

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 1

– Quartz

[14808-60-7]

– Cristobalite

[14464-46-1]

– Tridymite

[15468-32-3]

Silicic acid tetraethyl ester

[78-10-4]

$Si(OCH_2\text{-}CH_3)_4$

VP[hPa]: ~2

MAK[ml/m³]: 10
MAK[mg/m³]: 86
Peak lim: I(1)
Preg gr: D

Silicon carbide

[409-21-2]
(fibrous dust)

SiC

see Section III

MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 2

Silicon carbide

[409-21-2]
(without fibres)

SiC

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Silicon dioxide ⟶ Silica, crystalline

Silicone ⟶ Polydimethyl siloxanes, linear

Silicone oil ⟶ Polydimethyl siloxanes, linear

Silver

[7440-22-4]

Ag

MAK[mg/m³]: 0.1 I
Peak lim: II(8)
Preg gr: D

Silver perfluorooctanoate ⟶ Perfluorooctanoic acid (PFOA)

Silver salts

(as Ag [7440-22-4])

MAK[mg/m³]: 0.01 I
Peak lim: I(2)
Preg gr: D

Slag wool (fibrous dust)

see Section III

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Sodium citrate ⟶ Citric acid

Sodium azide

[26628-22-8]

N_3Na

MAK[mg/m³]: 0.2 I
Peak lim: I(2)
Preg gr: D

Sodium benzoate ⟶ Benzoic acid alkali salts

Sodium bisulfite ⟶ Sulfites

Sodium cyanide

[143-33-9]

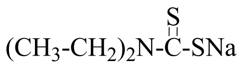
NaCN

MAK[mg/m³]: 3.8 I
Peak lim: II(1)
Preg gr: C
Perc abs: H

Sodium dichloroacetate ⟶ Dichloroacetic acid

Sodium diethyldithiocarbamate

[148-18-5]



$(CH_3\text{-}CH_2)_2N\text{-}\overset{\overset{S}{\|}}{C}\text{-}SNa$

Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
see Section Xc

MAK[mg/m³]: 2 I
Peak lim: II(2)
Preg gr: D
Sens: Sh

Sodium ethylmercurithiosalicylate ⟶ Thimerosal

Sodium fluoroacetate

[62-74-8]

$FCH_2COO^- Na^+$

MAK[mg/m³]: 0.05 I
Peak lim: II(4)
Preg gr: B
Perc abs: H

Sodium hydroxide

[1310-73-2]

$NaOH$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Sodium metabisulfite ⟶ Sulfites

Sodium molybdate ⟶ Molybdenum

Sodium monochloroacetate

[3926-62-3]

$ClCH_2\text{-}COONa$

MAK[mg/m^3]: 2 I
as monochloroacetic acid
Peak lim: II(2)
Preg gr: C
Perc abs: H

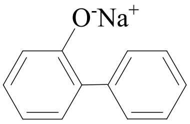
Sodium perfluorooctanoate ⟶ Perfluorooctanoic acid (PFOA)

Sodium persulfate ⟶ Alkali persulfates

Sodium petroleum sulfonates ⟶ Petroleum sulfonates, sodium salts

Sodium o-phenylphenol

[132-27-4]



see Section Xc

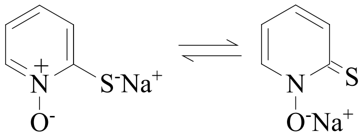
MAK[mg/m^3]: 2 I
Peak lim: I(1)
Preg gr: C
Carc cat: 4

Sodium polyacrylate ⟶ Acrylic acid polymer (neutralized, cross-linked)

Sodium pyridinethione ⟶ Sodium pyrithione

Sodium pyrithione

[3811-73-2; 15922-78-8]



see Section Xc

MAK[mg/m^3]: 0.2 I
Peak lim: II(2)
Preg gr: C
Perc abs: H

Sodium tetraborate pentahydrate ⟶ Boric acid

Sodium trichloroacetate

[650-51-1]
see also Trichloroacetic acid

$Cl_3C\text{-}COONa$

MAK[mg/m^3]: 2 I
Peak lim: I(1)
Preg gr: C
Perc abs: H

Sodium warfarin ⟶ Warfarin

Soot ⟶ Carbon black

Soya bean constituents
see Section IV
Sens: Sa

Stearic acid

[57-11-4]

$CH_3\text{-}(CH_2)_{16}\text{-}COOH$

see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Stibine

[7803-52-3]

SbH_3

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Stoddard solvent ⟶ Naphtha (petroleum)

Strontium

[7440-24-6]
and its inorganic compounds

Sr

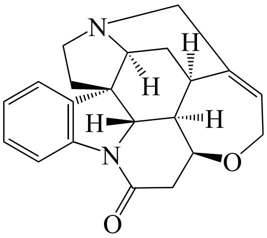
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Strontium chromate ⟶ Chromium(VI) compounds

Strychnine

[57-24-9]

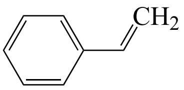


see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Styrene

[100-42-5]



VP[hPa]: 6
see Section XII

MAK[ml/m^3]: 20
MAK[mg/m^3]: 86
see definition of Carcinogen Category 5 and supporting documentation
Peak lim: II(2)
Preg gr: C
Carc cat: 5

Subtilisins

see Section IV
Sens: Sa

Succinic acid

[110-15-6]

$HO_2C\text{-}(CH_2)_2\text{-}CO_2H$

see Section Xc

MAK[mg/m^3]: 2 I
Peak lim: I(2)
Preg gr: C

Sulfites

[14265-45-3]
Causes pseudoallergic reactions, see documentation.
see Section IV

Sulfonic acid, petroleum, sodium salts ⟶ Petroleum sulfonates, sodium salts

Sulfonic acids, petroleum, calcium salts ⟶ Petroleum sulfonates, calcium salts (technical mixture in mineral oil)

Sulfotep ⟶ TEDP

Sulfur dioxide

[7446-09-5]

SO_2

MAK[ml/m^3]: 1
MAK[mg/m^3]: 2.7
Peak lim: I(1)
A momentary value of 1 ml/m^3 (2.7 mg/m^3) should not be exceeded.
Preg gr: C

Sulfur hexafluoride

[2551-62-4]

SF_6

The evaluation refers to the pure substance; with very high energy input (e.g. electrical discharges or temperatures above 500℃), very toxic decomposition and reaction products can form from sulfur hexafluoride.
VP[hPa]: 23670 at 25℃

MAK[ml/m^3]: 5000
MAK[mg/m^3]: 30000
Peak lim: II(8)
Preg gr: C

Sulfuric acid

[7664-93-9]

H_2SO_4

MAK[mg/m^3]: 0.1 I
Peak lim: I(1)
A momentary value of 0.2 mg/m^3 should not be exceeded.
Preg gr: C
Carc cat: 4

Sulfur monochloride

[10025-67-9]

S_2Cl_2

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Sulfur pentafluoride

[5714-22-7]

S_2F_{10}

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Swietenia spp. ⟶ Woods

Sylvic acid ⟶ Abietic acid

2,4,5-T ⟶ 2,4,5-Trichlorophenoxyacetic acid

Tabebuia avellanedae ⟶ Woods

Tabebuia serratifolia ⟶ Woods

Tabebuia spp. ⟶ Woods

Talc

[14807-96-6]
(without asbestos fibres) (respirable fraction)

$Mg_3(OH)_2Si_4O_{10}$

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Talleol ⟶ Tall oil, distilled

Tall oil derivates (abietic acid) ⟶ Abietic acid

Tall oil derivatives (oleic acid) ⟶ Oleic acid

Tall oil, distilled

[8002-26-4]
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh
only applies to tall oil distillates containing abietic acid, see also documentation

Tall oil rosin and fatty acids ⟶ Tall oil, distilled

Tantalum

[7440-25-7]
(inhalable fraction)

Ta

see Section Vf and g

MAK[mg/m³]: 4 I
Preg gr: C

Tantalum

[7440-25-7]
(respirable fraction)

Ta

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m³]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

Tartaric acid

[87-69-4]

$HO_2C\text{-}CHOH\text{-}CHOH\text{-}CO_2H$

see Section Xc

MAK[mg/m³]: 2 I
Peak lim: I(2)
Preg gr: C

TBTO ⟶ n-Butyltin compounds

TCDD ⟶ 2,3,7,8-Tetrachlorodibenzo-p-dioxin

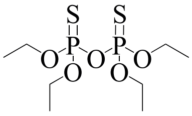
TDI ⟶ Toluene diisocyanates

Teak (Tectona grandis) ⟶ Woods

Tectona grandis ⟶ Woods

TEDP

[3689-24-5]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 2.2×10^{-4}

MAK[ml/m³]: 0.01
MAK[mg/m³]: 0.13
Peak lim: II(2)
Preg gr: C
Perc abs: H

Tellurium

[13494-80-9]
and its inorganic compounds

Te

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

TEPP

[107-49-3]

$[(H_3C\text{-}CH_2\text{-}O)_2PO]_2O$

The substance can occur simultaneously as vapour and aerosol.
BLW for acetylcholinesterase inhibitors still valid; see
Section XII.
VP[hPa]: 0.03
see Section IIc

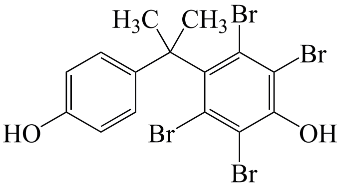
Terephthalic acid → p-Phthalic acid

Terminalia spp. → Woods

3,3′,4,4′-Tetraminobiphenyl → 3,3′-Diaminobenzidine and its tetrahydrochloride

Tetrabromobisphenol A

[79-94-7]



VP[hPa]: 1.19×10^{-7}

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

1,1,2,2-Tetrabromoethane

[79-27-6]

$Br_2HC\text{-}CHBr_2$

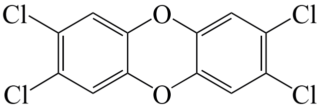
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2,4,5,6-Tetrachloro-1,3-benzenedicarbonitrile → Chlorothalonil

2,3,7,8-Tetrachlorodibenzo-p-dioxin

[1746-01-6]



MAK[mg/m^3]: 1.0E−8 I
Peak lim: II(8)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Perc abs: H
Carc cat: 4

1,1,1,2-Tetrachloro-2,2-difluoroethane

[76-11-9]

$ClF_2C\text{-}CCl_3$

MAK[ml/m^3]: 200
MAK[mg/m^3]: 1700
Peak lim: II(2)
Preg gr: D

1,1,2,2-Tetrachloro-1,2-difluoroethane

[76-12-0]

$Cl_2FC\text{-}CCl_2F$

MAK[ml/m^3]: 200
MAK[mg/m^3]: 1700
Peak lim: II(2)
Preg gr: D

1,1,2,2-Tetrachloroethane

[79-34-5]

$Cl_2HC\text{-}CHCl_2$

VP[hPa]: 6.4

MAK[ml/m^3]: 2
MAK[mg/m^3]: 14
Peak lim: II(2)
Preg gr: D
Perc abs: H
Carc cat: 4

Tetrachloroethene

[127-18-4]

$Cl_2C{=}CCl_2$

VP[hPa]: 19
see Section XII

MAK[ml/m^3]: 10
MAK[mg/m^3]: 69
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 3

Tetrachloroisophthalonitrile → Chlorothalonil

Tetrachloromethane

[56-23-5]

CCl_4

VP[hPa]: 120
see Section XII

MAK[ml/m^3]: 0.5
MAK[mg/m^3]: 3.2
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

Tetrachloronaphthalenes ⟶ Chlorinated naphthalenes

α,α,α,4-Tetrachlorotoluene ⟶ p-Chlorobenzotrichloride

Tetradecanoic acid ⟶ Myristic acid

1-Tetradecanol

[112-72-1]

$HO\text{-}(CH_2)_{13}\text{-}CH_3$

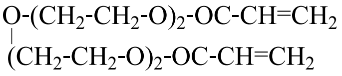
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.5×10^{-4} at 25°C (calculated value)
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Tetraethyl diphosphate ⟶ TEPP

Tetraethylene glycol diacrylate

[17831-71-9]

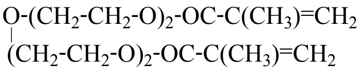


$$\begin{array}{l} O\text{-}(CH_2\text{-}CH_2\text{-}O)_2\text{-}OC\text{-}CH{=}CH_2 \\ | \\ (CH_2\text{-}CH_2\text{-}O)_2\text{-}OC\text{-}CH{=}CH_2 \end{array}$$

see Section IV
Sens: Sh

Tetraethylene glycol dimethacrylate

[109-17-1]



$$\begin{array}{l} O\text{-}(CH_2\text{-}CH_2\text{-}O)_2\text{-}OC\text{-}C(CH_3){=}CH_2 \\ | \\ (CH_2\text{-}CH_2\text{-}O)_2\text{-}OC\text{-}C(CH_3){=}CH_2 \end{array}$$

see Section IV
Sens: Sh

Tetraethyllead ⟶ Lead compounds, organic

Tetraethyl silicate ⟶ Silicic acid tetraethyl ester

1,1,1,2-Tetrafluoroethane

[811-97-2]

$F_3C\text{-}CH_2F$

VP[hPa]: 5700

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 4200
Peak lim: II(8)
Preg gr: C

Tetrafluoroethene

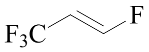
[116-14-3]

$F_2C{=}CF_2$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

trans-1,3,3,3-Tetrafluoropropene

[29118-24-9]



MAK[ml/m^3]: 1000
MAK[mg/m^3]: 4700
Peak lim: II(2)
Preg gr: C

2,3,3,3-Tetrafluoropropene

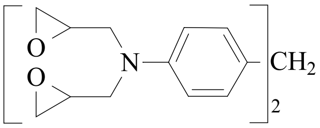
[754-12-1]

$H_2C{=}CF{-}CF_3$

MAK[ml/m^3]: 200
MAK[mg/m^3]: 950
Peak lim: II(2)
Preg gr: C

Tetraglycidyl-4,4′-methylenedianiline

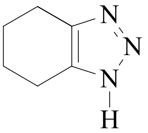
[28768-32-3]



see Section IV
Sens: Sh

Tetrahydrobenzotriazole

[6789-99-7]

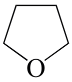


see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Tetrahydrofuran

[109-99-9]

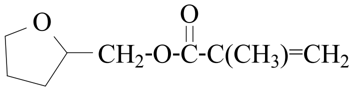


VP[hPa]: 170
see Section XII

MAK[ml/m³]: 20
MAK[mg/m³]: 60
Peak lim: I(2)
Preg gr: C
Perc abs: H

Tetrahydrofurfuryl methacrylate

[2455-24-5]



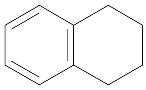
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 9.4×10^{-3}
see Section IV
Sens: Sh

3a,4,7,7a-Tetrahydro-4,7-methanoindene ⟶ Dicyclopentadiene

Tetrahydromethyl-1,3-isobenzofurandione ⟶ Methyltetrahydrophthalic anhydride

Tetrahydronaphthalene

[119-64-2]



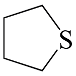
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.24

MAK[ml/m³]: 2
MAK[mg/m³]: 11
Peak lim: I(1)
Preg gr: C

Tetrahydro-1,4-oxazine ⟶ Morpholine

Tetrahydrothiophene (THT)

[110-01-0]



MAK[ml/m³]: 50
MAK[mg/m³]: 183
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(1)
Preg gr: C

1,3,4,6-Tetra(hydroxymethyl)-1,3,4,6-tetraazabicyclooctan-2,5-dione ⟶ Tetramethylol acetylenediurea

1,3,4,6-Tetrakis(hydroxymethyl)-3a,6a-dihydroimidazo[4,5-d]imidazole-2,5-dione ⟶ Tetramethylol acetylenediurea

Tetralene ⟶ Tetrahydronaphthalene

4-(1,1,3,3-Tetramethylbutyl)phenol ⟶ 4-tert-Octylphenol

Tetramethyl diaminobenzophenon ⟶ Michler's ketone

Tetramethyl diaminodiphenylacetimine ⟶ Auramine

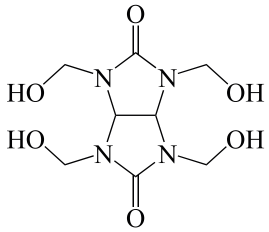
Tetramethyl diaminodiphenylacetimine hydrochloride ⟶ Auramine

N,N,N′,N′-Tetramethyl-4,4′-diaminodiphenylmethane ⟶ 4,4′-Methylenebis(N,N-dimethylaniline)

Tetramethyllead ⟶ Lead compounds, organic

Tetramethylol acetylenediurea

[5395-50-6]



releases formaldehyde
VP[hPa]: 7.6×10^{-10} at 25℃ (calculated value)
see Section Xc

MAK[mg/m³]: 0.5 I
Peak lim: I(2)
Preg gr: C
Sens: Sh
Carc cat: 4
Muta cat: 5

Tetramethyl succinonitrile

[3333-52-6]

$$NC\text{-}C(CH_3)_2\text{-}C(CH_3)_2\text{-}CN$$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 9.8×10^{-3}
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H

Tetramethylthiuram disulfide ⟶ Thiram

Tetramethyltin ⟶ Methyltin compounds

Tetramethyl urea (TMU)

[632-22-4]

$$((CH_3)_2N)_2CO$$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Tetranitromethane

[509-14-8]

$$C(NO_2)_4$$

VP[hPa]: 11

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Tetryl ⟶ N-Methyl-N,2,4,6-tetranitroaniline

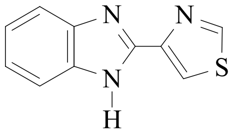
Thallium, soluble compounds

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Thiabendazole

[148-79-8]



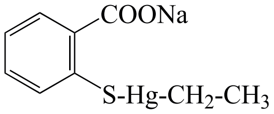
see Section Xc

MAK[mg/m^3]: 20 I
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Muta cat: 5

2-(4′-Thiazolyl)benzimidazole ⟶ Thiabendazole

Thimerosal

[54-64-8]



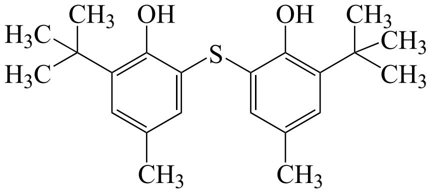
see Section IV
Sens: Sh

2,2′-Thiobis(6-tert-butyl-p-cresol) ⟶
2,2′-Thiobis(4-methyl-6-tert-butylphenol)

2,2′-Thiobis(4,6-dichlorophenol) ⟶ Bithionol

2,2′-Thiobis(4-methyl-6-tert-butylphenol)

[90-66-4]



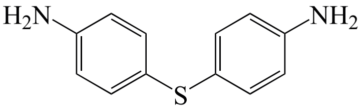
VP[hPa]: 1×10^{-5}
see Section Vf and g and Xc

MAK[mg/m^3]: 4 I
Preg gr: D

Thiocarbamide ⟶ Thiourea

4,4′-Thiodianiline

[139-65-1]

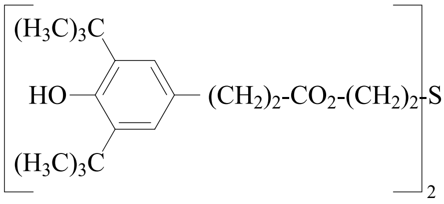


MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 2

p,p′-Thiodianiline ⟶ 4,4′-Thiodianiline

2,2′-Thiodiethylene Bis[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate]

[41484-35-9]



see Section Xc

MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: D

Thioglycolates

MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Perc abs: H
Sens: Sh

Thioglycolic acid

[68-11-1]

$HS\text{-}CH_2\text{-}COOH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.1
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh

Thioglycolic acid monoglyceryl ester ⟶ Glyceryl monothioglycolate

Thiomersal ⟶ Thimerosal

Thiomersalate ⟶ Thimerosal

Thiourea

[62-56-6]

$H_2N\text{-}CS\text{-}NH_2$

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Sens: Sh SP
Carc cat: 3

Thiram

[137-26-8]

$[(H_3C)_2N\text{-}CS]_2S_2$

Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodimethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

MAK[mg/m^3]: 1 I
Peak lim: II(2)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.
Sens: Sh

THU ⟶ Thiourea

Thuja spp. ⟶ Woods

Tieghemella spp. ⟶ Woods

Tin

[7440-31-5]
and its inorganic compounds

Sn

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Tin compounds, organic (n-Butyl-) ⟶ n-Butyltin compounds

Tin compounds, organic (Ethyl-) ⟶ Ethyltin compounds

Tin compounds, organic (Methyl-) ⟶ Methyltin compounds

Tin compounds, organic (n-Octyl-) ⟶ n-Octyltin compounds

Tin compounds, organic (Phenyl-) ⟶ Phenyltin compounds

Titanium dioxide

[13463-67-7]
(respirable fraction)

TiO_2

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m^3]: 0.3 R
multiplied with the material density
Peak lim: II(8)
Preg gr: C
Carc cat: 4

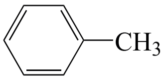
TMAD ⟶ Tetramethylol acetylenediurea

TNT ⟶ 2,4,6-Trinitrotoluene

o-Tolidine → 3,3′-Dimethylbenzidine

Toluene

[108-88-3]

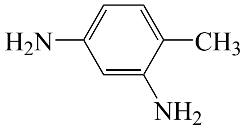


VP[hPa]: 37.9 at 25℃
see Section XII

MAK[ml/m^3]: 50
MAK[mg/m^3]: 190
Peak lim: II(2)
Preg gr: C
Perc abs: H

2,4-Toluenediamine

[95-80-7]

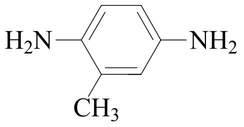


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 2.3×10^{-4} at 25℃
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 3B

2,5-Toluenediamine

[95-70-5]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4.5×10^{-3} at 25℃
see Section IV
Sens: Sh

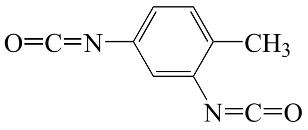
Toluene diisocyanates

The substance can occur simultaneously as vapour and aerosol.
see Section XII

MAK[ml/m^3]: 0.001
MAK[mg/m^3]: 0.007
Peak lim: I(1)
A momentary value of 0.005 ml/m^3 (0.035 mg/m^3) should not be exceeded.
Preg gr: C
Sens: Sah

– 2,4-Toluene diisocyanate

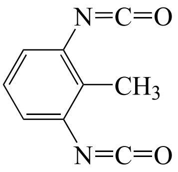
[584-84-9]



VP[hPa]: 0.011

– 2,6-Toluene diisocyanate

[91-08-7]



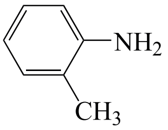
VP[hPa]: 0.028 at 25℃

– Toluene diisocyanates, mixture

[26471-62-5]

o-Toluidine

[95-53-4]

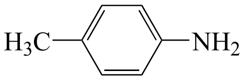


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.18
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3A

p-Toluidine

[106-49-0]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.38 at 25℃

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 3

2,4-Toluylenediamine → 2,4-Toluenediamine

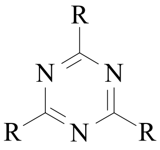
Tolyl diiodomethyl sulfone → 4-(Diiodomethylsulfonyl)-toluene

N-Tosyl-6-aminocaproic acid ⟶ 6-[(4-Methylphenyl) sulfonylamino]hexanoic acid

Tremolite (fibrous dust) ⟶ Asbestos

Triazinetriyltriiminotrishexanoic acid

[80584-91-4]



R = NH-$C_5H_{10}COOH$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Tribromomethane

[75-25-2]

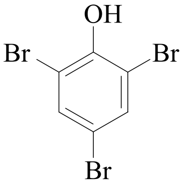
$CHBr_3$

VP[hPa]: 7

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2,4,6-Tribromophenol

[118-79-6]



The substance can occur simultaneously as vapour and aerosol.
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Tri-n-butylamine

[102-82-9]

$N(CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3)_3$

The substance can occur simultaneously as vapour and aerosol. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodi-n-butylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 0.12 at 25℃
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Tributyl phosphate

[126-73-8]

$O{=}P(O\text{-}(CH_2)_3\text{-}CH_3)_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 1.5×10^{-3} at 25℃

MAK[ml/m³]: 1
MAK[mg/m³]: 11
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

Tri-n-butyltin compounds ⟶ n-Butyltin compounds

Trichloroacetic acid

[76-03-9]
see also Sodium trichloroacetate

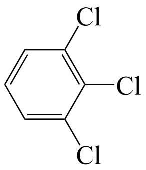
$Cl_3C\text{-}COOH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.1

MAK[ml/m³]: 0.2
MAK[mg/m³]: 1.4
Peak lim: I(1)
Preg gr: C

1,2,3-Trichlorobenzene

[87-61-6]

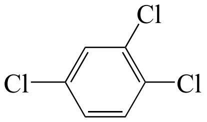


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.28 at 25℃

MAK[ml/m³]: 0.5
MAK[mg/m³]: 3.8
Peak lim: II(2)
Preg gr: C
Perc abs: H
Sens: Sh

1,2,4-Trichlorobenzene

[120-82-1]

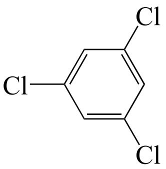


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.61 at 25℃

MAK[ml/m^3]: 0.5
MAK[mg/m^3]: 3.8
Peak lim: II(2)
Preg gr: C
Perc abs: H

1,3,5-Trichlorobenzene

[108-70-3]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.32 at 25℃

MAK[ml/m^3]: 0.5
MAK[mg/m^3]: 3.8
Peak lim: II(2)
Preg gr: C
Perc abs: H

1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane ⟶ DDT (Dichlorodiphenyltrichloroethane)

2,3,4-Trichloro-1-butene

[2431-50-7]

$ClCH_2$-CHCl-CCl=CH_2

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

1,1,1-Trichloroethane

[71-55-6]

H_3C-CCl_3

VP[hPa]: 133
see Section XII

MAK[ml/m^3]: 100
MAK[mg/m^3]: 550
Peak lim: II(1)
Preg gr: C
Perc abs: H

1,1,2-Trichloroethane

[79-00-5]

ClH_2C-$CHCl_2$

VP[hPa]: 25

MAK[ml/m^3]: 1
MAK[mg/m^3]: 5.5
Peak lim: I(2)
Preg gr: D
Perc abs: H
Carc cat: 3

Trichloroethene

[79-01-6]

ClHC=CCl_2

VP[hPa]: 77
see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 1
Muta cat: 3B

Trichloroethylene ⟶ Trichloroethene

Trichlorofluoromethane

[75-69-4]

CCl_3F

VP[hPa]: 889

MAK[ml/m^3]: 1000
MAK[mg/m^3]: 5700
Peak lim: II(2)
Preg gr: C

Trichloromethane ⟶ Chloroform (Trichloromethane)

1-Trichloromethylbenzene ⟶ Benzyl trichloride

Trichloronaphthalenes ⟶ Chlorinated naphthalenes

Trichloronitromethane

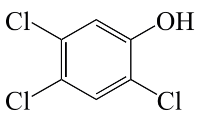
[76-06-2]

Cl_3CNO_2

VP[hPa]: 25
see Section IIc

2,4,5-Trichlorophenol

[95-95-4]

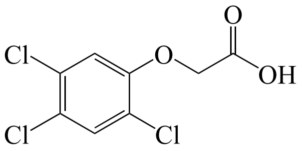


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 8×10^{-3} at 25℃
see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

2,4,5-Trichlorophenoxyacetic acid

[93-76-5]
including salts and esters



MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: C
Perc abs: H

1,2,3-Trichloropropane

[96-18-4]

$ClCH_2$-CHCl-CH_2Cl

VP[hPa]: 4.5

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

α,α,α-Trichlorotoluene ⟶ Benzyl trichloride

2,4,6-Trichloro-1,3,5-triazine ⟶ Cyanuric chloride

1,1,2-Trichloro-1,2,2-trifluoroethane

[76-13-1]

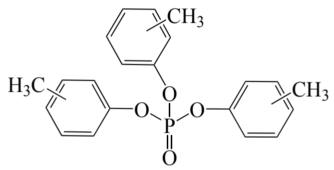
ClF_2C-CCl_2F

VP[hPa]: 360

MAK[ml/m^3]: 500
MAK[mg/m^3]: 3900
Peak lim: II(2)
Preg gr: D

Tricresyl phosphate, sum of all o-isomers

[78-30-8]



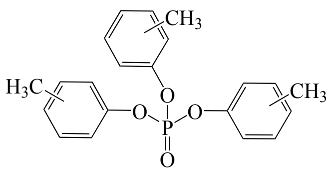
o-o-o, o-o-m, o-o-p, o-m-m, o-m-p, o-p-p

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 2.6×10^{-6} at 25℃
see Section XII

MAK[ml/m^3]: 0.001
MAK[mg/m^3]: 0.015
Peak lim: II(8)
Preg gr: D
Perc abs: H
Carc cat: 3

Tricresyl phosphate, isomers, “free of o-isomers”

[1330-78-5; 563-04-2; 78-32-0]



m-m-m, m-m-p, m-p-p, p-p-p

VP[hPa]: 8×10^{-7} at 25℃
see Section Xc

MAK[mg/m^3]: 5 I
Peak lim: II(2)
Preg gr: C

Tridymite ⟶ Silica, crystalline

Triethanolamine

[102-71-6]

$N(CH_2$-$CH_2OH)_3$

VP[hPa]: 4.8×10^{-6} at 25℃
see Section Xc

MAK[mg/m^3]: 1 I
Peak lim: I(1)
Preg gr: C

Triethylamine

[121-44-8]

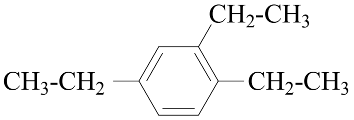
$(H_3C\text{-}CH_2)_3N$

Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".
VP[hPa]: 72

MAK[ml/m^3]: 1
MAK[mg/m^3]: 4.2
Even if the MAK value is observed, "odour-associated" symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
Preg gr: D

1,2,4-Triethylbenzene

[877-44-1]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.19 at 25℃ (calculated value)

MAK[ml/m^3]: 5
MAK[mg/m^3]: 34
Peak lim: II(2)
Preg gr: D
Perc abs: H

Triethylene glycol

[112-27-6]

$HOCH_2\text{-}(CH_2\text{-}O\text{-}CH_2)_2\text{-}CH_2OH$

The substance can occur simultaneously as vapour and aerosol. Because formation of a mist is possible, exposure should be minimized for reasons of occupational safety and hygiene.
VP[hPa]: 0.003

MAK[mg/m^3]: 1000 I
Peak lim: II(2)
Preg gr: B

Triethylene glycol n-butyl ether

[143-22-6]

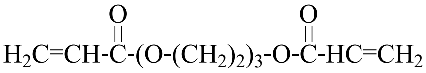
$HO\text{-}((CH_2)_2O)_3\text{-}(CH_2)_3\text{-}CH_3$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 3.3×10^{-3} at 25℃
see Section IIb and Xc

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Triethylene glycol diacrylate

[1680-21-3]

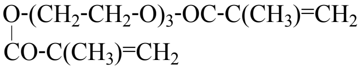


$$H_2C{=}CH\text{-}\overset{\displaystyle O}{\overset{||}{C}}\text{-}(O\text{-}(CH_2)_2)_3\text{-}O\text{-}\overset{\displaystyle O}{\overset{||}{C}}\text{-}HC{=}CH_2$$

see Section IV
Sens: Sh

Triethylene glycol dimethacrylate

[109-16-0]



$$\begin{array}{l}O\text{-}(CH_2\text{-}CH_2\text{-}O)_3\text{-}OC\text{-}C(CH_3){=}CH_2\\ |\\ CO\text{-}C(CH_3){=}CH_2\end{array}$$

see Section IV
Sens: Sh

Triethylene glycol monomethyl ether

[112-35-6]

$CH_3\text{-}(O\text{-}CH_2\text{-}CH_2)_3\text{-}OH$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 4.7×10^{-3} at 25℃ (calculated value)
see Section Xc

MAK[mg/m^3]: 50 I
Peak lim: II(2)
Preg gr: C

Triethylenetetramine

[112-24-3]

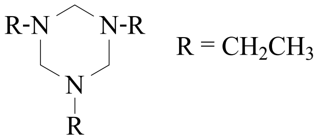
$NH_2\text{-}[(CH_2)_2\text{-}NH]_2\text{-}(CH_2)_2\text{-}NH_2$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 5.5×10^{-4} at 25℃
see Section IV
Sens: Sh

1,3,5-Triethylhexahydro-s-triazine ⟶
1,3,5-Triethylhexahydro-1,3,5-triazine

★ 1,3,5-Triethylhexahydro-1,3,5-triazine

[7779-27-3]



releases formaldehyde
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.114 at 25℃ (calculated value)
see Section Xc

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Carc cat:	2

Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

Muta cat:	3B

1,3,5-Triethyl-1,3,5-triazinane ⟶ 1,3,5-Triethylhexahydro-1,3,5-triazine

Trifluoromonobromomethane ⟶ Bromotrifluoromethane

Trifluoromonochloromethane ⟶ Chlorotrifluoromethane (FC-13)

1,1,1-Trifuoro-2,2-dichloroethane ⟶ 2,2-Dichloro-1,1,1-trifluoroethane

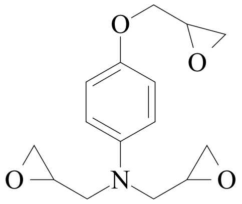
Triglycerides

(lard oil, palm oil, rapeseed oil, soybean oil) see also coconut oil
see Section Xc

MAK[mg/m³]:	5 R
Peak lim:	II(4)
Preg gr:	C

Triglycidyl-p-aminophenol

[5026-74-4]

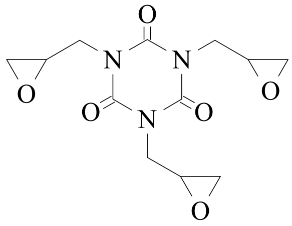


see Section IV

Sens:	Sh

1,3,5-Triglycidyl isocyanurate (mixture of isomers)

[2451-62-9]
α-isomer [59653-73-5]
β-isomer [59653-74-6]



see Section IV

Sens:	Sah

Triisobutyl phosphate

[126-71-6]

$O{=}P(O\text{-}CH_2\text{-}CH(CH_3)_2)_3$

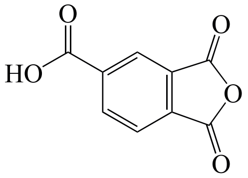
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.02
see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Sens:	Sh

Trimanganese tetroxide ⟶ Manganese

★ Trimellitic anhydride

[552-30-7]



VP[hPa]: 7.4×10^{-7} at 25℃

MAK[mg/m³]:	0.0005 I
Peak lim:	I(1)
Preg gr:	D
Sens:	Sa

Trimethylamine

[75-50-3]

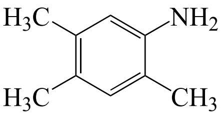
$N(CH_3)_3$

Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodimethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.
VP[hPa]: 1900

MAK[ml/m³]: 2
MAK[mg/m³]: 4.9
Even if the MAK value is observed, “odour-associated” symptoms cannot be ruled out in individual cases, see Section Ie.
Peak lim: I(2)
A momentary value of 5 ml/m³ (12 mg/m³) should not be exceeded.
Preg gr: C

2,4,5-Trimethylaniline

[137-17-7]



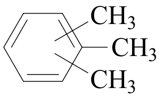
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.057 at 25℃

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

N,N,4-Trimethylaniline ⟶ N,N-Dimethyl-p-toluidine

Trimethylbenzene (all isomers)

[25551-13-7]



VP[hPa]: 2-6
see Section XII

MAK[ml/m³]: 20
MAK[mg/m³]: 100
Peak lim: II(2)
Preg gr: C

– 1,2,3-Trimethylbenzene

[526-73-8]

– 1,2,4-Trimethylbenzene

[95-63-6]

– 1,3,5-Trimethylbenzene

[108-67-8]

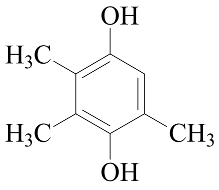
3,5,5-Trimethyl-2-cyclo-1-hexenone ⟶ Isophorone

3,7,11-Trimethyl-2,6,10-dodecatrien-1-ol ⟶ Farnesol

3,5,5-Trimethylhexanoic acid ⟶ Isononanoic acid

Trimethylhydroquinone

[700-13-0]



see Section IV
Sens: Sh

Trimethylolpropane triacrylate

[15625-89-5]

$H_3C\text{-}CH_2\text{-}C(CH_2\text{-}O\text{-}OC\text{-}CH{=}CH_2)_3$

see Section IV
Sens: Sh

Trimethylpentane (all isomers)

[29222-48-8]

$H_3C\text{-}C_6H_{12}\text{-}CH_3$

MAK[ml/m³]: 100
MAK[mg/m³]: 470
Peak lim: II(2)
Preg gr: D

Trimethyl phosphate

[512-56-1]

$(H_3CO)_3PO$

The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.59

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3
Muta cat: 2

Trimethylphosphite

[121-45-9]

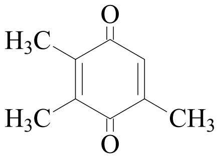
$(H_3CO)_3P$

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H

Trimethylquinone

[935-92-2]

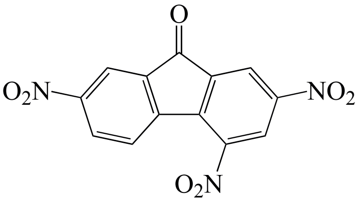


see Section IV
Sens: Sh

Trimethyltin compounds ⟶ Methyltin compounds

2,4,7-Trinitrofluorenone

[129-79-3]



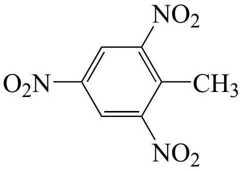
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

2,4,6-Trinitrophenol ⟶ Picric acid

2,4,6-Trinitrophenylmethylnitramine ⟶ N-Methyl-N,2,4,6-tetranitroaniline

2,4,6-Trinitrotoluene

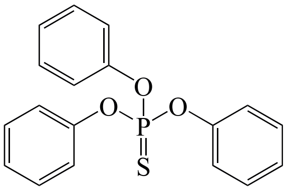
[118-96-7]



see Section XII
MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Sens: Sh
Carc cat: 2
Muta cat: 3B

O,O,O-Triphenyl monothiophosphate

[597-82-0]



VP[hPa]: <0.00001
see Section Xc
MAK[mg/m^3]: 20 I
Peak lim: II(2)
Preg gr: D

Triphenylphosphane ⟶ Triphenylphosphine

Triphenyl phosphate

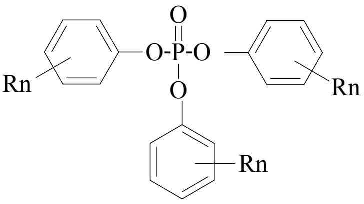
[115-86-6]

$(C_6H_5O)_3PO$

VP[hPa]: 1×10^{-5} at 25℃ (calculated value)
see Section Xc
MAK[ml/m^3]: –
MAK[mg/m^3]: 10 I
Peak lim: II(2)
Preg gr: C

Triphenyl phosphate, isopropylated

[68937-41-7]



VP[hPa]: 1×10^{-7} at 25℃ (calculated value)
see Section Xc
MAK[mg/m^3]: 1 I
Peak lim: II(2)
Preg gr: C

Triphenylphosphine

[603-35-0]

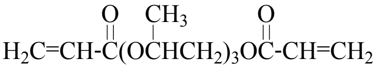
$P(C_6H_5)_3$

VP[hPa]: 1.2×10^{-6} at 20℃ (extrapolated)
MAK[mg/m^3]: 2 I
Peak lim: II(2)
Preg gr: D
Sens: Sh

Triplochiton scleroxylon ⟶ Woods

Tripropylene glycol diacrylate

[42978-66-5]

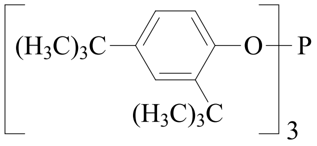


$H_2C{=}CH\text{-}\overset{\overset{O}{\|}}{C}(O\overset{\overset{CH_3}{|}}{C}HCH_2)_3O\overset{\overset{O}{\|}}{C}\text{-}CH{=}CH_2$

see Section IV
Sens: Sh

Tris(2,4-ditert-butylphenyl) phosphite

[31570-04-4]

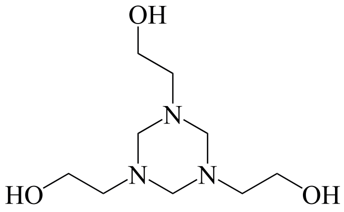


see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

N,N′,N′′-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine

[4719-04-4]

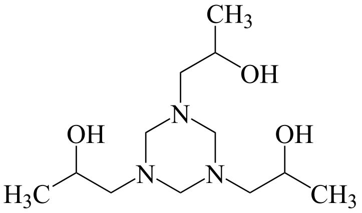


releases formaldehyde
VP[hPa]: 5×10^{-8} at 25°C (calculated value)
see Section Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

N,N′,N′′-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine

[25254-50-6]



releases formaldehyde
VP[hPa]: 1.7×10^{-8} (calculated value)
see Section Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Sens: Sh
Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Muta cat: 3B

Tris[(2- or 4-)C9–C10-isoalkylphenyl]-phosphorothioate

[126019-82-7]

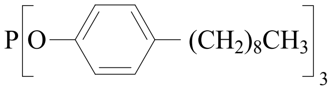
$S{=}P(O\text{-}C_6H_4\text{-}C_{9\text{-}10}H_{19\text{-}21})_3$

VP[hPa]: 2.8×10^{-10} at 25°C (extrapolated)
see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Tris(nonylphenyl) phosphite

[26523-78-4]



see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Tritolyl phosphate, isomers, “free of o-isomers” ⟶ Tricresyl phosphate, isomers, „free of o-isomers”

Trypsin and Chymotrypsin

[9002-07-7; 9004-07-3]
see Section IV
Sens: Sa

Tungsten

[7440-33-7]
and its compounds (as W)

W

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Tungsten carbide ⟶ Hard metal containing tungsten carbide and cobalt

Turpentine

[8006-64-2]
VP[hPa]: 6.6

MAK[ml/m^3]: 5
MAK[mg/m^3]: 28
Peak lim: II(2)
Preg gr: D
Perc abs: H
Sens: Sh

Uranium

[7440-61-1]
and its hardly soluble inorganic compounds

U

see Section XII

MAK[mg/m^3]: –
The limit value of the 'Strahlenschutzkommission' (Commission on Radiological Protection) of 20 mSv per year or 400 mSv per working lifetime corresponds to about 25 µg uranium/m^3 for poorly soluble uranium compounds and 250 µg uranium/m^3 for soluble compounds (MMAD of 5 µm). The value for soluble uranium compounds does not provide protection against nephrotoxicity.
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2
Muta cat: 3A

Uranium compounds, soluble inorganic

see Section XII

MAK[mg/m^3]: –
The limit value of the 'Strahlenschutzkommission' (Commission on Radiological Protection) of 20 mSv per year or 400 mSv per working lifetime corresponds to about 25 µg uranium/m^3 for poorly soluble uranium compounds and 250 µg uranium/m^3 for soluble compounds (MMAD of 5 µm). The value for soluble uranium compounds does not provide protection against nephrotoxicity.
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3
Muta cat: 3A

Urethane ⟶ Carbamic acid ethyl ester

Utile (Entandrophragma utile) ⟶ Woods

Vanadium

[7440-62-2]
and its inorganic compounds (inhalable fraction)

V

see Section XII

MAK[mg/m^3]: 0.005 I
Peak lim: II(2)
Preg gr: D
Carc cat: 4
Muta cat: 5

Vanadium pentoxide ⟶ Vanadium

Vinyl acetate

[108-05-4]

$H_2C{=}CHOOCH_2\text{-}CH_3$

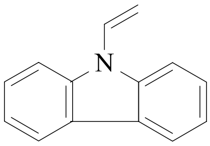
VP[hPa]: 120

MAK[ml/m^3]: 10
MAK[mg/m^3]: 36
Peak lim: I(1)
A momentary value of 20 ml/m^3 (71 mg/m^3) should not be exceeded.
Preg gr: C
Perc abs: H
Carc cat: 4

Vinylbutyrolactam ⟶ N-Vinyl-2-pyrrolidone

Vinylcarbazole

[1484-13-5]



see Section IV
Sens: Sh

Vinyl chloride

[75-01-4]

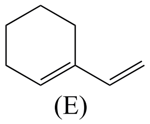
$H_2C{=}CHCl$

see Section XII

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 1

4-Vinylcyclohexene

[100-40-3]



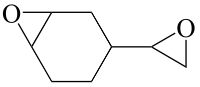
VP[hPa]: 20

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

4-Vinyl-1,2-cyclohexene diepoxide ⟶ 4-Vinyl-1-cyclohexene dioxide

4-Vinyl-1-cyclohexene dioxide

[106-87-6]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

Vinyl ethyl ether ⟶ Ethyl vinyl ether

Vinylidene chloride ⟶ 1,1-Dichloroethene

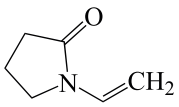
Vinylidene fluoride ⟶ 1,1-Difluoroethylene

Vinyl isobutyl ether ⟶ Isobutyl vinyl ether

Vinyl methyl ether ⟶ Methyl vinyl ether

N-Vinyl-2-pyrrolidone

[88-12-0]



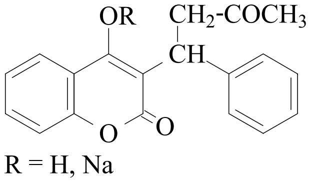
The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.15 at 25℃

MAK[ml/m^3]: 0.01
MAK[mg/m^3]: 0.047
Peak lim: II(2)
Preg gr: C
Perc abs: H
Carc cat: 4

Vinyl toluene ⟶ Methyl styrene (all isomers)

Warfarin

[81-81-2]
and sodium warfarin [129-06-6]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.09

MAK[ml/m^3]: 0.0016
MAK[mg/m^3]: 0.02
MAK value for sodium warfarin 0.02 mg/m^3 I
Peak lim: II(8)
Preg gr: B
Perc abs: H

Western red cedar (Thuja plicata) ⟶ Woods

Wheat ⟶ Cereal flour dusts

White mineral oil (pharmaceutical)

[8042-47-5]
see Section Xc

MAK[mg/m^3]: 5 R
Peak lim: II(4)
Preg gr: C

White spirit, dearomatised ⟶ Naphtha (petroleum)

Wollastonite

[13983-17-0]
(fibrous dust)

$CaSiO_3$

see Section IIb

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –

Wood dust (beech) ⟶ Beech wood dust

Wood dust (oak) ⟶ Oak wood dust

Wood dust (except beech and oak wood dust)

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Carc cat: 3

Wood ether ⟶ Dimethyl ether

Woods
see Section IV

– Acacia melanoxylon R.Br.

Australian blackwood
Sens: Sh

– Bowdichia nitida Bentham

sapupira, (black) sucupira
Sens: –

– Brya ebenus DC.

cocus wood
Sens: Sh

– Calocedrus decurrens (Torr.) Florin

incense cedar, pencil cedar
Sens: –

– Chlorophora excelsa (Welw.) Benth. & Hook

iroko, kambala
Sens: Sh

– Dalbergia latifolia Roxb.

East Indian rosewood, Bombay blackwood
Sens: Sh

– Dalbergia melanoxylon Guill. et Perr.

African blackwood
Sens: Sh

– Dalbergia nigra Allem.

Brazilian rosewood
Sens: Sh

– Dalbergia retusa Hemsl.

cocobolo, rosewood
Sens: Sh

– Dalbergia stevensonii Standley

Honduras rosewood
Sens: Sh

– Diospyros celebica Bakh.

Macassar ebony, coromandel
Sens: –

– Diospyros crassiflora Hiern.

African ebony
Sens: –

– Diospyros ebenum Koenig

Ceylon ebony, Indian ebony
Sens: –

– Diospyros melanoxylon Roxb.

ebony
Sens: –

– Distemonanthus benthamianus Baill.

ayan
Sens: Sh

– Entandrophragma angolense C.DC.

gedu nohor, edinam, tiama
Sens: –

– Entandrophragma candollei Harms

heavy sapele, omu
Sens: –

– Entandrophragma cylindricum Sprague

sapele
Sens: –

– Entandrophragma utile Sprague

utile
Sens: –

– Gonystylus bancanus (Miq.) Baill.

ramin
Sens: –

– Grevillea robusta A.Cunn.

Australian silky oak
Sens: Sh

– Khaya anthotheca C.DC.

African mahogany
Sens: Sh

– Khaya grandifoliola C.DC.

African mahogany, big leaf mahogany
Sens: –

– Khaya ivorensis A.Chev.

African mahogany, Grand Bassam mahogany
Sens: –

– Khaya senegalensis A.Juss.

African mahogany, Senegal mahogany
Sens: –

– Machaerium scleroxylon Tul.

pao ferro, Santos rosewood
Sens: Sh

– Mansonia altissima A.Chev.

mansonia, pruno, bété
Sens: Sh

– Paratecoma peroba (Record) Kuhlm.

ipe peroba
Sens: Sh

– Quercus petraea (Matuschka) Liebl.

durmast oak, sessile oak
Sens: –

– Quercus robur L.

European oak, common oak, pedunculate oak
Sens: –

– Quercus rubra L.

American red oak
Sens: –

– Swietenia macrophylla King

American mahogany, mahogany, broadleaf mahogany
Sens: –

– Swietenia mahagoni (L.) Jacq.

Caribbean mahogany, Cuban mahogany
Sens: –

– Tabebuia avellanedae (Griseb.) Lor.

lapacho, ipe
Sens: –

– Tabebuia serratifolia Nichols

bethabara, ipe
Sens: –

– Tectona grandis L.f.

teak
Sens: Sh

– Terminalia ivorensis A.Chev.

framiré, idigbo
Sens: –

– Terminalia superba Engl. u. Diels

fraké, limba, afara, white afara
Sens: Sa

– Thuja occidentalis L.

arborvitae, eastern white cedar, northern white cedar
Sens: –

– Thuja plicata (D.Don.) Donn.

western red cedar, giant arborvitae, shinglewood
Sens: Sah

– Tieghemella africana A.Chev.

douka
Sens: –

– Tieghemella heckelii Pierre

makoré, “cherry mahogany”, African “cherry”
Sens: –

– Triplochiton scleroxylon K.Schum.

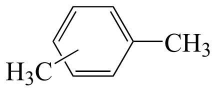
obeche, wawa, African whitewood
Sens: Sah

Xylanases

[37278-89-0]
see Section IV
Sens: Sa

Xylene (all isomers)

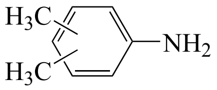
[1330-20-7]



At high levels of physical activity the observance of the BAT value should be checked regularly by biological monitoring.
VP[hPa]: 8
see Section XII

MAK[ml/m^3]: 50
MAK[mg/m^3]: 220
Peak lim: II(2)
Preg gr: D
Perc abs: H

Xylidine (isomers)



The substance can occur simultaneously as vapour and aerosol.

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 3
Muta cat: 3B

– 2,3-Xylidine

[87-59-2]
VP[hPa]: 0.1 at 25℃

– 2,5-Xylidine

[95-78-3]
VP[hPa]: 0.2

– 3,4-Xylidine

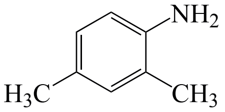
[95-64-7]
VP[hPa]: 0.04 at 25℃

– 3,5-Xylidine

[108-69-0]
VP[hPa]: 0.2 at 25℃

2,4-Xylidine

[95-68-1]

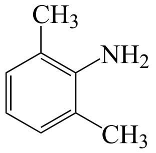


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.016

MAK[ml/m^3]: –
MAK[mg/m^3]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

2,6-Xylidine

[87-62-7]

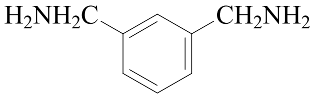


The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.13

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –
Perc abs: H
Carc cat: 2

m-Xylylenediamine

[1477-55-0]



The substance can occur simultaneously as vapour and aerosol.
VP[hPa]: 0.04
see Section IV
Sens: Sh

Yttrium

[7440-65-5]
and its compounds

Y

see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Zeolites (fibrous dust) ⟶ Erionite

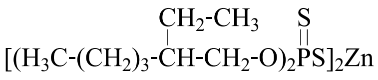
Zeolites, synthetic (non-fibrous)

[1318-02-1]
see Section IIb

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Zinc, O,O′-di-2-ethylhexyl dithiophosphate

[4259-15-8]



$$[(H_3C\text{-}(CH_2)_3\text{-}\overset{CH_2\text{-}CH_3}{\overset{|}{C}}H\text{-}CH_2\text{-}O)_2\overset{S}{\overset{||}{P}}S]_2Zn$$

see Section IIb and Xc

MAK[ml/m³]: –
MAK[mg/m³]: –
Peak lim: –
Preg gr: –

Zinc

[7440-66-6]
and its inorganic compounds (inhalable fraction)

Zn

MAK[mg/m³]: 2 I
Peak lim: I(2)
Zinc chloride: Peak limitation category I(1)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

Zinc

[7440-66-6]
and its inorganic compounds (respirable fraction)

Zn

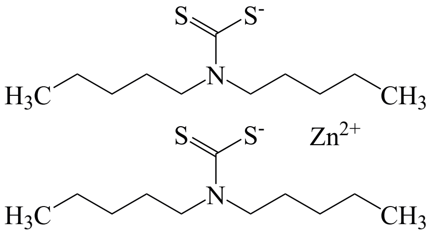
MAK[mg/m³]: 0.1 R
Peak lim: I(4)
Preg gr: C
Classification in Pregnancy Risk Group C was re-evaluated in 2011 and confirmed.

Zinc bis(dipentyldithiocarbamate) ⟶ Zinc diamyldithiocarbamate

Zinc chromate ⟶ Chromium(VI) compounds

Zinc diamyldithiocarbamate

[15337-18-5]
(inhalable fraction)

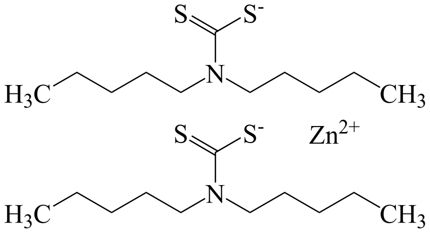


VP[hPa]: 6.3×10^{-13} at 25℃
see Section Xc

MAK[mg/m³]: 10 I
Peak lim: II(8)
Preg gr: D

Zinc diamyldithiocarbamate

[15337-18-5]
(respirable fraction)



VP[hPa]: 6.3×10^{-13} at 25°C
see Section Xc

MAK[mg/m³]:	5 R
Peak lim:	II(4)
Preg gr:	D

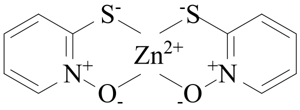
Zinc dimethyldithiocarbamate ⟶ Ziram

Zinc N,N-dipentylcarbamodithioate ⟶ Zinc diamyldithiocarbamate

Zinc molybdate ⟶ Molybdenum

Zinc pyrithione

[13463-41-7]

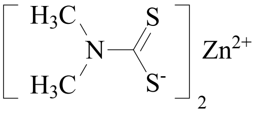


see Section IIb

MAK[ml/m³]:	–
MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–
Perc abs:	H

Ziram

[137-30-4]



MAK[mg/m³]:	0.01 I
Peak lim:	I(2)
Preg gr:	C
Sens:	Sh

Zirconium

[7440-67-7]
and its compounds (except zirconium dioxide)

$$Zr$$

see Section IIb

MAK[mg/m³]:	–
Peak lim:	–
Preg gr:	–

Zirconium dioxide

[1314-23-4; 12036-23-6]
(respirable fraction)

$$ZrO_2$$

except for ultrafine particles; see Section Vh
see Section Vf

MAK[mg/m³]:	0.3 R
multiplied with the material density	
Peak lim:	II(8)
Preg gr:	C
Carc cat:	4

b) Substances for which no MAK value can be established at present

For a number of the substances examined by the Commission, studies of the effects in man or in experimental animals have yielded insufficient information for the establishment of MAK values. These substances are listed below. The toxicological documentation has been published by the Commission in “The MAK Collection for Occupational Health and Safety”. Some of these reviews are available in English (available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)).

Acetoacetic acid ethyl ester [141-97-9]
Acrylic acid hydroxypropyl ester (all isomers) [25584-83-2]
★ Allyl propyl disulfide [2179-59-1]
3-Aminomethyl-3,5,5-trimethyl-cyclohexylamine (Isophorone diamine) [2855-13-2]
2-Aminopyridine [504-29-0]
Ammonium sulfamate [7773-06-0]
Arsine [7784-42-1]
Benzaldehyde [100-52-7]
Benzalkonium chloride [8001-54-5]
Bisphenol A diglycidyl ether [1675-54-3]
Boron oxide [1303-86-2]
Boron trifluoride [7637-07-2]
Bromine [7726-95-6]
2-Butanol [78-92-2]
sec-Butyl acetate [105-46-4]
2-tert-Butyl-p-cresol [2409-55-4]
p-tert-Butyl toluene [98-51-1]
γ-Butyrolactone [96-48-0]
Calcium sulfate (respirable fraction)
Anhydrite [7778-18-9]
Hemihydrate [10034-76-1]
Dihydrate [10101-41-4]
Gypsum [13397-24-5]
Camphor [76-22-2]
Chlorinated biphenyl oxides several CAS Nos, e.g. [55720-99-5]
Chlorinated biphenyl oxides form a group of compounds with different degrees and positions of chlorine substitution. Chlorinated biphenyl oxides with low chlorine content can occur as a particle-vapour mixture, whereas chlorinated biphenyl oxides with a large quantity of chlorine occur only as particles.

Chlorinated naphthalenes
Chlorinated naphthalenes form a group of compounds with different degrees and positions of chlorine substitution. Chlorinated naphthalenes with low chlorine content can occur as a particle-vapour mixture, whereas chlorinated naphthalenes with a large quantity of chlorine occur only as particles.

Chlorine trifluoride [7790-91-2]
Chloroacetyl chloride [79-04-9]
o-Chloroaniline [95-51-2]
m-Chloroaniline [108-42-9]
Chlorobenzoic acid (all isomers)
4-Chloromethyl-biphenyl [1667-11-4]
m-Chloronitrobenzene [121-73-3]
1-Chloro-1-nitropropane [600-25-9]
Chromium carbonyl [13007-92-6]
Chromium(III) compounds
Cyanogen chloride [506-77-4]
Cyclohexanol [108-93-0]
Cyclohexene [110-83-8]
Cyclopentadiene [542-92-7]
Demeton [8065-48-3]
see Section XII, Acetylcholinesterase inhibitors

Desflurane [57041-67-5]
Diallyl phthalate [131-17-9]
Diborane [19287-45-7]
Dibromodifluoromethane [75-61-6]
3,4-Dichloroaniline [95-76-1]
1,1-Dichloro-1-nitroethane [594-72-9]
2,2-Dichloropropionic acid [75-99-0]

2,2-Dichloropropionic acid, sodium salt [127-20-8]
Dicyanodiamide [461-58-5]
Dicyclohexylamine [101-83-7]
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodicyclohexylamine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".

Dicyclohexylamine nitrite [3129-91-7]
Diethylene glycol dinitrate [693-21-0]
Diisobutyl ketone [108-83-8]
Diketene [674-82-8]
see documentation "Ketene"

Dimethyl adipate [627-93-0] see also Dicarboxylic acid (C4–C6) dimethylester
Dimethylaminopropionitrile [1738-25-6]
Dimethyl glutarate [1119-40-0] see also Dicarboxylic acid (C4–C6) dimethylester
Dimethyl succinate [106-65-0] see also Dicarboxylic acid (C4–C6) dimethylester
Dimethyl sulfide [75-18-3]
4,6-Dinitro-o-cresol [534-52-1]
Dipentamethylenethiuram disulfide [94-37-1]
Diphenyl cresyl phosphate [26444-49-5]
Divinylbenzene (all isomers) [1321-74-0]
Ethyl 2-cyanoacrylate [7085-85-0]
Ethylenediamine [107-15-3]
Ethylenediaminetetraacetic acid (EDTA) [60-00-4]
Avoid exposure to mixtures with iron compounds (formation of FeEDTA).

2-Ethylhexanoic acid [149-57-5]
N-Ethylmorpholine [100-74-3]
Ethyltin compounds
Ethyl vinyl ether [109-92-2]
Ferbam [14484-64-1]
Ferrovanadium [12604-58-9]
Fluorine [7782-41-4]
Formamide [75-12-7]
Germanium tetrahydride [7782-65-2]
Gold [7440-57-5] and its inorganic compounds
Hafnium [7440-58-6] and its compounds
Hexachlorocyclopentadiene [77-47-4]
sec-Hexyl acetate [108-84-9]
Hydroxyacetic acid butyl ester [7397-62-8]
2-Hydroxyethyl methacrylate [868-77-9]
3-Hydroxy-2-naphthalenecarboxylic acid [92-70-6]
Imidazole [288-32-4]
Iodine [7553-56-2] and inorganic iodides
4-Isopropylphenyl isocyanate [31027-31-3]
Ketene [463-51-4]
D,L-Limonene [138-86-3] and similar mixtures
L-Limonene [5989-54-8]
Lithium [7439-93-2] and highly irritating lithium compounds (as lithium amide, hydride, hydroxide, nitride, oxide, tetrahydroaluminate, tetrahydroborate)
Magnesium oxide fume [1309-48-4]
3-Methoxy-n-butyl acetate [4435-53-4]
Methyl acetylene [74-99-7]
Methylcyclohexanol (all isomers) [25639-42-3]
1-Methylcyclohexan-2-one [583-60-8]
Methyl vinyl ketone [78-94-4]
Molybdenum [7439-98-7] and its compounds apart from molybdenum trioxide
Montmorillonite [1318-93-0] and Bentonite [1302-78-9]
quartz content must be considered separately

2-(4-Morpholinylmercapto)benzothiazole [102-77-2]
Nickel titanic yellow pigment [8007-18-9]
Nicotine [54-11-5]
Nitric acid [7697-37-2]
Osmium tetroxide [20816-12-0]
Palladium [7440-05-3] and palladium compounds

Pentaborane [19624-22-7]
2-Pentanone [107-87-9]
Perchloromethyl mercaptan [594-42-3]
1H,1H,2H-Perfluorohexene [19430-93-4]
Phosphorus, red [7723-14-0]
Phosphorus pentasulfide [1314-80-3]
o-Phthalic acid [88-99-3]
Phthalic anhydride [85-44-9]
Platinum compounds (Chloroplatinates)
A peak concentration of 2 μg/m³ should not be exceeded.

n-Propyl nitrate [627-13-4]
Pyrethrum [8003-34-7]
Resorcinol [108-46-3]
Rotenone [83-79-4]
Sevoflurane [28523-86-6]
Silicon carbide [409-21-2] (without fibres)
Sodium hydroxide [1310-73-2]
Stibine [7803-52-3]
Strontium [7440-24-6] and its inorganic compounds
Strychnine [57-24-9]
Sulfur monochloride [10025-67-9]
Sulfur pentafluoride [5714-22-7]
Tellurium [13494-80-9] and its inorganic compounds
1,1,2,2-Tetrabromoethane [79-27-6]
Tetramethyl succinonitrile [3333-52-6]
Tetramethyl urea (TMU) [632-22-4]
Thallium, soluble compounds
Thioglycolic acid [68-11-1]
Tin [7440-31-5] and its inorganic compounds
2,4,6-Tribromophenol [118-79-6]
Tri-n-butylamine [102-82-9]
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodi-n-butylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

2,4,5-Trichlorophenol [95-95-4]
Triisobutyl phosphate [126-71-6]
Trimethylphosphite [121-45-9]
Tungsten [7440-33-7] and its compounds (as W)
Wollastonite [13983-17-0] (fibrous dust)
Yttrium [7440-65-5] and its compounds
Zeolites, synthetic (non-fibrous) [1318-02-1]
Zinc pyrithione [13463-41-7]
Zirconium [7440-67-7] and its compounds (except zirconium dioxide)

Metal-working fluids, hydraulic fluids and other lubricants

(see Section Xc)

Abietic acid [514-10-3]
also includes disproportionation and transposition products

Alkyl amines, C11–14-branched, monohexyl and dihexyl phosphates [80939-62-4]
Alkyl benzenesulfonates C10–C14, linear [69669-44-9; 85117-50-6]
Alkyl ether carboxylic acids
2-Amino-2-ethyl-1,3-propanediol [115-70-8]
1-Amino-2-propanol [78-96-6]
Aminotris(methylenephosphonic acid) [6419-19-8] and its sodium salts
Azelaic acid [123-99-9]
Behenic acid [112-85-6]
1,2-Benzisothiazol-3(2H)-one [2634-33-5]
Benzyl alcohol mono(poly)hemiformal [14548-60-8]
releases formaldehyde

Bis[O,O-bis(2-ethylhexyl) dithiophosphorato-S,S′]dioxodi-μ-thioxodimolybdenum [68958-92-9; 72030-25-2]

N,N-Bis(2-ethylhexyl)-(1,2,4-triazole-1-yl)methanamine [91273-04-0]
releases formaldehyde

Bithionol [97-18-7]
2-Bromo-2-nitro-1,3-propanediol [52-51-7]
releases formaldehydeuse forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4"

2-Butyl-1,2-benzisothiazolin-3-one [4299-07-4]
Calcium bis(dinonylnaphthalenesulphonate) [57855-77-3]
5(or 6)-Carboxy-4-hexylcyclohex-2-ene-1-octanoic acid [53980-88-4]
2-Chloroacetamide [79-07-2]
p-Chloro-m-cresol [59-50-7]
Chlorothalonil [1897-45-6]
Citric acid alkali metal salts
The MAK value for citric acid (2 mg/m^3) protects from irritation, a higher value for alkali metal salts is not justifiable.

Dibenzyl disulfide [150-60-7]
2,2-Dibromo-2-cyanacetamide [10222-01-2]
1,2-Dibromo-2,4-dicyanobutane [35691-65-7]
3-(3,5-Di-tert-butyl-4-hydroxyphenyl)-N′-[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propanoyl]propanehydrazide [32687-78-8]
2,6-Di-tert-butylphenol [128-39-2]
Di-n-butyl phosphonate [1809-19-4] see also Di-n-octyl phosphonate
Diethylenetriaminepenta(methylenephosphonic acid) [15827-60-8] and its sodium salts [22042-96-2]
1,2-Dihydro-2,2,4-trimethyl-quinoline polymer [26780-96-1]
4-(Diiodomethylsulfonyl)-toluene [20018-09-1]
1,3-Dimethylol-5,5-dimethyl hydantoin [6440-58-0]
releases formaldehyde

4,4′-Dioctyldiphenylamine [101-67-7]
Di-n-octyl phosphonate [1809-14-9] see also Di-n-butyl phosphonate
Diphenylamine, octylated (Benzenamine, N-phenyl-, reaction products with 2,4,4-trimethylpentene) [68411-46-1]
Diphenylamine, reaction products with styrene and 2,4,4-trimethylpentene [68921-45-9]
2,2′-Dithiobis(N-methylbenzamide) [2527-58-4]
Dodecanedioic acid [693-23-2]
1-Dodecanol [112-53-8]
2-Ethyl-1,3-hexanediol [94-96-2]
Fatty acids, C14–18 saturated and C16–18-unsaturated [67701-06-8]
Fatty alcohol ethoxylates, C16–18 and C18-unsaturated [68920-66-1]
Fatty alcohols, C12–18 [67762-25-8]
1-Hexadecanol [36653-82-4]
Hexamethylenetetramine [100-97-0]
releases formaldehyde

1-Hexanol [111-27-3]
2-Hexyl-1-decanol [2425-77-6]
1-Hydroxyethyl-2-heptadecenyl-imidazoline [21652-27-7]
1-Hydroxyethylidene-1,1-diphosphonic acid [2809-21-4] and its sodium and potassium salts
2-Hydroxymethyl-2-nitro-1,3-propanediol [126-11-4]
use forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4"

12-Hydroxystearic acid [106-14-9]
Isononanoic acid [3302-10-1; 26896-18-4]
Isooctadecanol [27458-93-1]
Isotridecanol [27458-92-0]
Lithium-12-hydroxystearate [7620-77-1]
Lithium stearate [4485-12-5]
Methyl-1H-benzotriazole [29385-43-1]
4,4′-Methylenebis(2,6-di-tert-butylphenol) [118-82-1]
N,N′-Methylenebis(5-methyloxazolidine) [66204-44-2]
2-Methyl-4-isothiazolin-3-one [2682-20-4]
6-[(4-Methylphenyl)sulfonylamino]hexanoic acid [78521-39-8]
Myristic acid [544-63-8]
3-Nitrobenzoic acid [121-92-6]
(4-Nonylphenoxy)acetic acid [3115-49-9]
1-Octadecanol [112-92-5]
2-Octyl-1-dodecanol [5333-42-6]

Oleic acid [112-80-1]
Oleyl alcohol [143-28-2]
Palmitic acid [57-10-3]
Petroleum sulfonates, sodium salts [68608-26-4]
Phenothiazine [92-84-2]
phototoxic effect

1-Phenoxy-2-propanol [770-35-4]
2-Phenyl-1-ethanol [60-12-8]
Piperazine [110-85-0]
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N,N′-dinitrosopiperazine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".

Polybutenes and Polyisobutenes
Polydimethyl siloxanes, linear [63148-62-9; 9006-65-9; 9016-00-6]
Polyethylene glycol (average molecular weight > 600) [25322-68-3]
Polyethylenepolypropylene glycol [9003-11-6]
Polyoxyethylene oleyl ether [9004-98-2]
Polypropylene glycol (PPG) [25322-69-4]
Poly(propylene glycol) n-butyl ether [9003-13-8]
Propylene glycol [57-55-6]
Pyrrolidine [123-75-1]
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosopyrrolidine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".

Sebacic acid [111-20-6]
Stearic acid [57-11-4]
Tall oil, distilled [8002-26-4]
1-Tetradecanol [112-72-1]
Tetrahydrobenzotriazole [6789-99-7]
Triazinetriyltriiminotrishexanoic acid [80584-91-4]
Triethylene glycol n-butyl ether [143-22-6]
Tris(2,4-ditert-butylphenyl) phosphite [31570-04-4]
Tris[(2- or 4-)C9–C10-isoalkylphenyl]phosphorothioate [126019-82-7]
Tris(nonylphenyl) phosphite [26523-78-4]
Zinc, O,O′-di-2-ethylhexyl dithiophosphate [4259-15-8]

c) Substances for which the MAK value and classifications have been withdrawn

For the following substances the Commission has decided to withdraw the previous MAK values, designations and classifications because the earlier evaluation does not reflect the current data. A new evaluation has not yet been carried out and is not a priority.

Aldrin [309-00-2]
Carbaryl (1-Naphthyl methylcarbamate) [63-25-2]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Chlordane [57-74-9]
DDT (Dichlorodiphenyltrichloroethane) [50-29-3]
Demeton-methyl [8022-00-2]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Dichlorofluoromethane [75-43-4]
1,2-Dichloro-1,1,2,2-tetrafluoroethane [76-14-2]
Dieldrin [60-57-1]
EPN (O-Ethyl O-(4-nitrophenyl)phenylthiophosphonate) [2104-64-5]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Fenthion [55-38-9]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Malathion [121-75-5]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Mevinphos [7786-34-7]
see documentation "Phosdrin"BLW for acetylcholinesterase inhibitors still valid; see section XII.

Paraquat dichloride [1910-42-5]
Parathion [56-38-2]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Propoxur [114-26-1]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

TEPP [107-49-3]
BLW for acetylcholinesterase inhibitors still valid; see section XII.

Trichloronitromethane [76-06-2]

III. Carcinogenic Substances

Advances in our understanding of the modes of action and potency of carcinogens have made possible the improved differentiation of carcinogenic substances. Therefore, in 1998 an extended classification scheme was introduced[24]). The sections of the List of MAK and BAT Values previously called IIIA1, IIIA2 and III B were renamed as Categories 1, 2 and 3 of Section III and two new categories, 4 and 5, were added.

Substances which have been shown to be carcinogenic in man or in experimental animals are classified in the Categories 1 or 2 and are not assigned MAK or BAT values. Suspected carcinogens are classified in Category 3 and are assigned a MAK or BAT value only if neither the substance nor any of its metabolites is genotoxic or the genotoxic effect is not the main effect.

In the Categories 4 and 5 are classified substances with carcinogenic properties for which the available data are sufficient for assessment of the carcinogenic potency. For these substances an occupational exposure level (MAK or BAT value) is defined at which no or at most a very slight contribution to the cancer risk of the exposed persons is to be expected. The substances classified in Category 4 are known to act typically by non-genotoxic mechanisms. Category 5 contains genotoxic carcinogens of weak potency. For the monitoring of exposure to these substances, the establishment of BAT values is of particular importance.

Category 1

Substances that cause cancer in man and can be assumed to contribute to cancer risk. Epidemiological studies provide adequate evidence of a positive correlation between the exposure of humans and the occurrence of cancer. Limited epidemiological data can be substantiated by evidence that the substance causes cancer by a mode of action that is relevant to man.

Aflatoxins [1402-68-2]
4-Aminobiphenyl [92-67-1]
Arsenic [7440-38-2] and inorganic arsenic compounds (except for arsine)
Asbestos [1332-21-4] (fibrous dust)
Actinolite, Amosite, Anthophyllite, Chrysotile, Crocidolite and Tremolite
Cigarette smokers bear an increased risk of bronchial cancer.

Beech wood dust
Dusts have been shown epidemiologically to be unequivocally carcinogenic. The active carcinogenic principle has not been identified to date.

Benzene [71-43-2]
Benzidine [92-87-5] and its salts
Beryllium [7440-41-7] and its inorganic compounds
Bis(β-chloroethyl)sulfide (mustard gas) [505-60-2]
Bischloromethyl ether (Dichlorodimethylether) [542-88-1]
not to be confused with the asymmetric (Dichloromethyl)methyl ether

Brown coal tars (soft coal tars)
1,3-Butadiene [106-99-0]
Cadmium [7440-43-9] and its inorganic compounds (inhalable fraction)
α-Chlorinated toluenes:
    mixture of Benzoyl chloride [98-88-4],
    Benzyl chloride [100-44-7],
    Benzyl dichloride [98-87-3],
    Benzyl trichloride [98-07-7]
4-Chloro-o-toluidine [95-69-2]
Chromium(VI) compounds (inhalable fraction)

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[24]) For detailed documentation see “Changes in the classification of carcinogenic chemicals in the work area” (Greim H, editor (1999) Changes in the classification of carcinogenic chemicals in the work area. MAK Value Documentation, 1998. In: Occupational Toxicants. Volume 12. Weinheim: Wiley-VCH. p. 3–12. Also available from https://doi.org/10.1002/3527600418.mb0ckate0012
Greim H, editor (2000) Änderung der Einstufung krebserzeugender Arbeitsstoffe. In: Gesundheitsschädliche Arbeitsstoffe, Toxikologisch-arbeitsmedizinische Begründungen von MAK-Werten. 30. Lieferung. Weinheim: Wiley-VCH. Also available from https://doi.org/10.1002/3527600418.mb0ckatd0030
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Hartwig A, MAK Commission (2022) Changes in the Classification of Carcinogenic Chemicals in the Work Area. MAK Value Documentation, supplement – Translation of the German version from 2021. MAK Collect Occup Health Saf 7(1): Doc012. https://doi.org/10.34865/mb0ckat3egt7_1ad)

Coal tars, coal tar pitches, coal tar oils
Coke oven emissions
1,2-Dichloropropane [78-87-5]
Erionite [12510-42-8] (fibrous dust)
Hard metal containing tungsten carbide and cobalt (inhalable fraction)
Methylarsenic compounds
N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard) [51-75-2]
Monochlorodimethyl ether [107-30-2]
The classification in Category 1 applies to technical monochlorodimethyl ether which can be contaminated with up to 7% bischloromethyl ether.

2-Naphthylamine [91-59-8]
Nickel and nickel compounds (inhalable fraction)
Regarding compounds which have been found to be unequivocally carcinogenic in man, see documentation.

Oak wood dust
Dusts have been shown epidemiologically to be unequivocally carcinogenic. The active carcinogenic principle has not been identified to date.

N-Phenyl-2-naphthylamine [135-88-6]
1,3-Propane sultone [1120-71-4]
Sidestream smoke (passive smoking at the workplace)
Silica, crystalline (respirable fraction)
o-Toluidine [95-53-4]
Trichloroethene [79-01-6]
Vinyl chloride [75-01-4]

Category 2

Substances that are considered to be carcinogenic for man because sufficient data from long-term animal studies or evidence from animal studies substantiated by evidence from epidemiological studies indicate that they can contribute to cancer risk. Limited data from animal studies can be supported by evidence that the substance causes cancer by a mode of action that is relevant to man and by results of in vitro tests and short-term animal studies.

Acrylamide [79-06-1]
Acrylonitrile [107-13-1]
Allyl glycidyl ether [106-92-3]
Aluminium oxide [1344-28-1] (fibrous dust)
Aluminium silicate fibres (RCF)
Cristobalite can develop from aluminium silicate fibres used in building materials under thermal load, see documentation.

o-Aminoazotoluene [97-56-3]
6-Amino-2-ethoxynaphthalene [293733-21-8]
o-Anisidine [90-04-0]
Anthanthrene [191-26-4]
Antimony [7440-36-0] and its inorganic compounds (except for stibine)
Attapulgite [12174-11-7] (fibrous dust)
Auramine [492-80-8]
Auramine hydrochloride [2465-27-2]
Benzo[a]anthracene [56-55-3]
Benzo[b]fluoranthene [205-99-2]
Benzo[j]fluoranthene [205-82-3]
Benzo[k]fluoranthene [207-08-9]
Benzo[b]naphtho[2,1-d]thiophene [239-35-0]
Benzo[a]pyrene [50-32-8]
Benzyl chloride [100-44-7] see also α-Chlorinated toluenes
Benzyl dichloride [98-87-3] see also α-Chlorinated toluenes
Benzyl trichloride [98-07-7] see also α-Chlorinated toluenes
★ 1,3-Bis(hydroxymethyl)urea [140-95-4]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

★ Bismorpholino methane [5625-90-1]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

Bitumen (high-temperature processing, vapours and aerosols) [64742-93-4] (bitumen, oxidized)

Bromodichloromethane [75-27-4]
Bromoethane [74-96-4]
1-Bromopropane [106-94-5]
2,4-Butane sultone [1121-03-5]
Butanone oxime [96-29-7]
1,2-Butylene oxide [106-88-7]
Carbamic acid ethyl ester [51-79-6]
Chlordecone [143-50-0]
Chlorinated camphene [8001-35-2]
p-Chloroaniline [106-47-8]
p-Chlorobenzotrichloride [5216-25-1]
1-Chloro-2,3-epoxypropane (Epichlorohydrin) [106-89-8]
Chlorofluoromethane (FC-31) [593-70-4]
N-Chloroformylmorpholine [15159-40-7]
Chloroprene [126-99-8]
Chrysene [218-01-9]
Cobalt [7440-48-4] and cobalt compounds (inhalable fraction)
Cyclopenta[cd]pyrene [27208-37-3]
Dawsonite [12011-76-6] (fibrous dust)
2,4-Diaminoanisole [615-05-4]
4,4′-Diaminodiphenylmethane [101-77-9]
1,5-Diaminonaphthalene [2243-62-1]
Diazomethane [334-88-3]
Dibenzo[a,h]anthracene [53-70-3]
Dibenzo[a,e]pyrene [192-65-4]
Dibenzo[a,h]pyrene [189-64-0]
Dibenzo[a,i]pyrene [189-55-9]
Dibenzo[a,l]pyrene [191-30-0]
1,2-Dibromo-3-chloropropane [96-12-8]
1,2-Dibromoethane [106-93-4]
Dichloroacetylene [7572-29-4]
3,3′-Dichlorobenzidine [91-94-1]
1,4-Dichloro-2-butene [764-41-0]
1,2-Dichloroethane [107-06-2]
★ 1,1-Dichloroethene [75-35-4]
1,3-Dichloro-2-propanol [96-23-1]
1,3-Dichloropropene (cis and trans) [542-75-6]
Diesel engine emissions

Because of the new diesel engine technology the emissions have changed significantly in quality and quantity. Since it must be assumed that these new diesel engines were introduced at the end of the 1990s, all the available epidemiological studies which were evaluated in 2007 are based on exposures to emissions from older diesel engines. The emissions from the new diesel engines can not be evaluated until appropriate studies become available.

Diethyl sulfate [64-67-5]
Diglycidyl resorcinol ether [101-90-6]
3,3′-Dimethoxybenzidine [119-90-4]
3,3′-Dimethylbenzidine [119-93-7]
Dimethylcarbamoyl chloride [79-44-7]
1,1-Dimethylhydrazine [57-14-7]
1,2-Dimethylhydrazine [540-73-8]
N,N-Dimethyl-p-toluidine [99-97-8]
Dimethylsulfamoyl chloride [13360-57-1]
Dimethyl sulfate [77-78-1]
Dinitrotoluene (mixtures of isomers) [25321-14-6]
Ethylene oxide [75-21-8]
Ethylenimine [151-56-4]
Glass fibres, biopersistent (fibrous dust)
Glycidol [556-52-5]
Glycidyl trimethylammonium chloride [3033-77-0]
Hexamethylphosphoric acid triamide [680-31-9]
Hydrazine [302-01-2]
Hydrazobenzene [122-66-7]
Hydroquinone [123-31-9]
Indeno[1,2,3-cd]pyrene [193-39-5]

Indium [7440-74-6] and its inorganic compounds
Iodomethane [74-88-4]
★ Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

5-Methyl-o-anisidine [120-71-8]
4,4′-Methylenebis(2-chloroaniline) (MOCA) [101-14-4]
4,4′-Methylenebis(N,N-dimethylaniline) [101-61-1]
4,4′-Methylenebis(2-methylaniline) [838-88-0]
★ N-Methylolchloroacetamide [2832-19-1]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

1-Methylpyrene [2381-21-7]
Michler's ketone [90-94-8]
Monomethylhydrazine [60-34-4]
Naphthalene [91-20-3]
5-Nitroacenaphthene [602-87-9]
2-Nitroanisole [91-23-6]
4-Nitrobiphenyl [92-93-3]
★ 4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture)
In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

2-Nitronaphthalene [581-89-5]
2-Nitropropane [79-46-9]
N-Nitrosodi-n-butylamine [924-16-3]
N-Nitrosodiethanolamine [1116-54-7]
N-Nitrosodiethylamine [55-18-5]
N-Nitrosodiisopropylamine [601-77-4]
N-Nitrosodimethylamine [62-75-9]
N-Nitrosodi-n-propylamine [621-64-7]
N-Nitrosoethylphenylamine [612-64-6]
N-Nitrosomethylethylamine [10595-95-6]
N-Nitrosomethylphenylamine [614-00-6]
N-Nitrosomorpholine [59-89-2]
N-Nitrosopiperidine [100-75-4]
N-Nitrosopyrrolidine [930-55-2]
2-Nitrotoluene [88-72-2]
5-Nitro-o-toluidine [99-55-8]
Ochratoxin A [303-47-9]
4,4′-Oxydianiline [101-80-4]
Pentachlorophenol [87-86-5]
Phenyl glycidyl ether (PGE) [122-60-1]
Potassium titanates (fibrous dust) several CAS Nos and formulas
β-Propiolactone [57-57-8]
Propylene imine [75-55-8]
Rock wool (fibrous dust)
Silicon carbide [409-21-2] (fibrous dust)
Tetrabromobisphenol A [79-94-7]
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

Tetrafluoroethene [116-14-3]
Tetranitromethane [509-14-8]
4,4′-Thiodianiline [139-65-1]
2,4-Toluenediamine [95-80-7]
2,3,4-Trichloro-1-butene [2431-50-7]
1,2,3-Trichloropropane [96-18-4]
★ 1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

2,4,5-Trimethylaniline [137-17-7]
2,4,6-Trinitrotoluene [118-96-7]

N,N′,N′′-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine [4719-04-4]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

N,N′,N′′-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine [25254-50-6]
releases formaldehyde
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

Uranium [7440-61-1] and its hardly soluble inorganic compounds
4-Vinylcyclohexene [100-40-3]
4-Vinyl-1-cyclohexene dioxide [106-87-6]
2,4-Xylidine [95-68-1]
2,6-Xylidine [87-62-7]

For substances in Categories 1 and 2, exposure to which is considered to involve a distinct cancer risk for man, no MAK value is listed in Section IIa since a safe concentration range cannot be given. For some of these substances, even uptake through the intact skin is very dangerous. Substances in Categories 1 or 2, for which, as a result of the mechanism of action, a dose or concentration without carcinogenic effects, a “No Adverse Effect Level” (NAEL), can be expected, but the database is not sufficient to be able to derive a MAK value and reclassify them in Categories 4 or 5, are designated in Sections II and III of the List of MAK and BAT Values with the footnote *“Prerequisite for Category 4 (or 5) in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value”.*

Where it is necessary to employ such substances for industrial purposes, special measures are required for protection and monitoring. These include: 1. routine analysis of the workplace air with analytical methods which are appropriate and sufficiently sensitive for the purpose; 2. special medical supervision of exposed individuals whereby, e. g., regular tests must be performed to determine whether the substance or its metabolites are detectable in the human body or whether appropriate effect parameters have been altered.

Continual technical improvements should make it possible to prevent these substances from occurring in the workplace air or from directly affecting the individual at work. Where this goal cannot presently be attained, additional protective measures are required (e. g., individual respirators and protective clothing, shorter periods in the area of danger, etc.) so that exposure is minimal. The kind of protective measures which are necessary also depends on the particular physical characteristics of the substance and on the nature and intensity of its carcinogenic effect.

Category 3

Substances that cause concern that they could be carcinogenic for man but cannot be assessed conclusively because of lack of data. The classification in Category 3 is provisional. Substances for which the available studies have yielded evidence of carcinogenic effects that is not sufficient for classification of the substance in one of the other categories. Further studies are required before a final decision can be made. A MAK or BAT value can be established, provided no genotoxic effects have been detected for the substance or its metabolites or the genotoxic effect is not the main effect.

Acetamide [60-35-5]
Acrolein [107-02-8]
Allyl alcohol [107-18-6]
Allyl chloride [107-05-1]
4-Aminodiphenylamine [101-54-2]
3-Amino-9-ethylcarbazole [132-32-1]
p-Anisidine [104-94-9]
p-Aramid [26125-61-1] (fibrous dust)
Benzotriazole [95-14-7]
Benzoyl chloride [98-88-4] see also α-Chlorinated toluenes
Biphenyl [92-52-4]
Bitumen (high-temperature processing, vapours and aerosols) [8052-42-4; 64741-56-6/64742-93-4] (straight-run bitumen, air-rectified bitumen)
Bromochloromethane [74-97-5]
Bromomethane (Methyl bromide) [74-83-9]
1,4-Butane sultone [1633-83-6]
n-Butyl glycidyl ether (BGE) [2426-08-6]
tert-Butyl glycidyl ether [7665-72-7]
tert-Butyl-4-hydroxyanisole (BHA) [25013-16-5]
Calcium sodium metaphosphate [23209-59-8] (fibrous dust)
Carbon black (inhalable fraction)

Chlorinated paraffins unbranched chains, several CAS Nos, e.g. [63449-39-8]
Chlorinated paraffins form a group of compounds with different degrees and positions of chlorine substitution. Chlorinated paraffins with low chlorine content and short chain length can occur as a particle-vapour mixture, whereas chlorinated paraffins with a large quantity of chlorine or with long alkyl chains occur only as particles.

Chloroacetaldehyde [107-20-0]
2-Chloroacrylonitrile [920-37-6]
Chloroethane [75-00-3]
Chloroformic acid ethyl ester [541-41-3]
3-Chloro-2-methylpropene [563-47-3]
o-Chloronitrobenzene [88-73-3]
p-Chloronitrobenzene [100-00-5]
4-Chlorophenyl isocyanate [104-12-1]
3-Chloro-1,2-propanediol (α-Chlorohydrin) [96-24-2]
5-Chloro-o-toluidine [95-79-4]
Coal mine dust (respirable fraction)
Cresyl glycidyl ethers mixture of isomers [26447-14-3], o-isomer [2210-79-9]
Crotonaldehyde [123-73-9; 4170-30-3]
Cyclohexanone [108-94-1]
Diacetyl [431-03-8]
3,3′-Diaminobenzidine and its tetrahydrochloride [91-95-2; 7411-49-6]
Di-n-butyl phosphate [107-66-4] and its technical mixtures
Di-n-butyl phthalate [84-74-2]
1,1-Dichloroethane [75-34-3]
1,2-Dichloromethoxyethane [41683-62-9]
3,4-Dichloronitrobenzene [99-54-7]
4-(2,4-Dichlorophenoxy)benzenamine [14861-17-7]
2,2-Dichloro-1,1,1-trifluoroethane [306-83-2]
Diethanolamine [111-42-2]
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethanolamine, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".

Diethylcarbamoyl chloride [88-10-8]
1,1-Difluoroethylene [75-38-7]
Diglycidyl ether (DGE) [2238-07-5]
Diisodecyl phthalate [26761-40-0]
Diisotridecyl phthalate [27253-26-5]
2,5-Dimethoxy-4-chloroaniline [6358-64-1]
N,N-Dimethylaniline [121-69-7]
Dimethyl hydrogen phosphite [868-85-9]
Dinitrobenzene (all isomers) [25154-54-5]
Dinitronaphthalene (all isomers) [27478-34-8]
Diphenylamine [122-39-4]
Di(2-propylheptyl) phthalate (DPHP) [53306-54-0]
Distillates (petroleum) [64742-47-8] hydrotreated light (aerosol)
Distillates (petroleum) [64742-47-8] hydrotreated light (vapour)
Ditridecyl phthalate [119-06-2]
3,4-Epoxycyclohexane carboxylic acid (3,4-epoxycyclohexylmethyl) ester [2386-87-0]
Ethidium bromide [1239-45-8]
Ethylene [74-85-1]
Ethylene thiourea (Imidazoline-2-thione) [96-45-7]
Furfural [98-01-1]
Furfuryl alcohol [98-00-0]
Glyoxal [107-22-2]
Halloysite [12298-43-0] (fibrous dust)
Hexachloroethane [67-72-1]
Hexahydrophthalic acid diglycidylester [5493-45-8]
Hydrogen selenide [7783-07-5]
Iron oxides (inhalable fraction) [1345-25-1; 1309-37-1; 1309-38-2; 1317-61-9]
with the exception of iron oxides which are not biologically available

Isophorone [78-59-1]
Isopropylbenzene (cumene) [98-82-8]
Isopropyl glycidyl ether (IGE) [4016-14-2]
Isopropyl oil
residue of isopropyl alcohol production

Kaolinite [1332-58-7]
quartz content must be considered separately

Kerosine (petroleum) (aerosol) [8008-20-6]
applies to skin contact

Kerosine (petroleum) (vapour) [8008-20-6]
applies to skin contact

Magnesium oxide sulfate [12286-12-3] (fibrous dust)
2-Mercaptobenzothiazole [149-30-4]
Mercury [7439-97-6] and its inorganic compounds (as Hg)
Mercury, organic compounds
Metal-working fluids which contain nitrite or nitrite-forming compounds and substances which react with nitrite to yield nitrosamines
N-Methylaniline [100-61-8]
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosomethylaniline, see Section III "Amines which form carcinogenic nitrosamines on nitrosation".

Methyl tert-butyl ether [1634-04-4]
Methyldiethanolamine [105-59-9]
N-Methyl-N,2,4,6-tetranitroaniline [479-45-8]
Molybdenum trioxide [1313-27-5]
Naphthenic acids and sodium, calcium, potassium napthenates [1338-24-5; 61790-13-4; 61789-36-4; 66072-08-0] (technical mixtures)
1,5-Naphthylene diisocyanate [3173-72-6]
1-Naphthylthiourea [86-88-4]
Nemalite [1317-43-7] (fibrous dust)
2-Nitro-4-aminophenol [119-34-6]
4-Nitroaniline [100-01-6]
4-Nitrobenzoic acid [62-23-7]
Nitrogen dioxide [10102-44-0]
Nitroglycerin [55-63-0]
Nitromethane [75-52-5]
1-Nitronaphthalene [86-57-7]
2-Nitro-p-phenylenediamine [5307-14-2]
Nitropyrenes (Mono-, Di-, Tri-, Tetra-) (isomers)
N-Nitrosodiphenylamine [86-30-6]
3-Nitrotoluene [99-08-1]
4-Nitrotoluene [99-99-0]
Olaquindox (N-(2-Hydroxyethyl)-3-methyl-2-quinoxalinecarboxamide 1,4-dioxide) [23696-28-8]
Ozone [10028-15-6]
Pentachloroethane [76-01-7]
Perfluorooctanesulfonic acid (PFOS) [1763-23-1] and its salts
Phenol [108-95-2]
Phenyl arsenic compounds [637-03-6]
o-Phenylenediamine [95-54-5]
m-Phenylenediamine [108-45-2]
p-Phenylenediamine [106-50-3]
Phenylhydrazine [100-63-0]
Picric acid [88-89-1]
Portland cement dust [65997-15-1]
Cr(VI) content and quartz level to be assessed separately

Pyridine [110-86-1]
Quinone [106-51-4]
Rhodium [7440-16-6] and its inorganic compounds
Selenium [7782-49-2] and its inorganic compounds (as Se)
Sepiolite (fibrous dust) several CAS Nos and formulas
Slag wool (fibrous dust)
Talc [14807-96-6] (without asbestos fibres) (respirable fraction)
Tetrachloroethene [127-18-4]
Thiourea [62-56-6]
p-Toluidine [106-49-0]
Tribromomethane [75-25-2]
1,1,2-Trichloroethane [79-00-5]
Tricresyl phosphate, sum of all o-isomers [78-30-8]

Trimethyl phosphate [512-56-1]
2,4,7-Trinitrofluorenone [129-79-3]
Uranium compounds, soluble inorganic
Wood dust (except beech and oak wood dust)
Xylidine (isomers)

The monitoring of the health of employees using substances classified in Category 3 must be intensified. In addition, the branches of industry which produce and process such substances are requested – as are all relevantly involved research laboratories – to participate in the effort to shed light on the cancer-correlation question and, where necessary, to search for harmless alternative substances.

Category 3 will be re-evaluated annually to determine whether substances must be reassigned to Categories 1 or 2, whether the database permits their transfer to one of the Categories 4 or 5 or whether they require no classification and can be dismissed completely from Section III of this list.

Category 4

Substances that cause cancer in humans or animals or that are considered to be carcinogenic for humans and for which a MAK value can be derived. A non-genotoxic mode of action is of prime importance and genotoxic effects play no or at most a minor part, provided the MAK and BAT values are observed. Under these conditions no contribution to human cancer risk is expected. The classification is supported especially by evidence that, for example, increases in cellular proliferation, inhibition of apoptosis or disturbances in cellular differentiation are important in the mode of action. The classification and the MAK and BAT values take into consideration the manifold mechanisms contributing to carcinogenesis and their characteristic dose-time-response relationships.

Acrylic acid polymer (neutralized, cross-linked)
★ Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)
Due to particle overload effect in the lungs

★ Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)
Due to particle overload effect in the lungs

α-Aluminium oxide [1302-74-5] (corundum)
except for aluminium oxide fibres and ultrafine particles; see Section Vh

Amitrole [61-82-5]
Aniline [62-53-3]
Barium sulfate [7727-43-7] (respirable fraction)
except for ultrafine particles; see Section Vh

Butylated hydroxytoluene (BHT) [128-37-0]
n-Butyltin compounds (as Sn [7440-31-5])
Chlorinated biphenyls [1336-36-3]
Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.

Chloroform (Trichloromethane) [67-66-3]
Dichloroacetic acid [79-43-6] and its salts
1,4-Dichlorobenzene [106-46-7]
Di(2-ethylhexyl)phthalate (DEHP) [117-81-7]
N,N-Dimethylformamide [68-12-2]
1,4-Dioxane [123-91-1]
Dust, general limit value (respirable fraction) (biopersistent granular dusts)
except for ultrafine particles; see Section Vh

1,2-Epoxypropane [75-56-9]
Ethylbenzene [100-41-4]
★ 5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5]
releases formaldehyde

(Ethylenedioxy)dimethanol [3586-55-8]
releases formaldehyde

Formaldehyde [50-00-0]
Furan [110-00-9]
★ Glass wool, half-life < 40 days (fibrous and granular components)
Glutaraldehyde [111-30-8]

Graphite [7782-42-5] (respirable fraction)
except for ultrafine particles; see Section Vh

Heptachlor [76-44-8]
Hexachlorobenzene [118-74-1]
Hexachloro-1,3-butadiene [87-68-3]
α-Hexachlorocyclohexane [319-84-6]
β-Hexachlorocyclohexane [319-85-7]
1,2,3,4,5,6-Hexachlorocyclohexane techn. mixture of α-HCH [319-84-6] and β-HCH [319-85-7]
Hydrogen peroxide [7722-84-1]
Lead [7439-92-1] and its inorganic compounds (inhalable fraction)
except lead arsenate and lead chromate

Lead compounds, organic
Lindane (γ-1,2,3,4,5,6-Hexachlorocyclohexane) [58-89-9]
Magnesium oxide [1309-48-4] (respirable fraction)
except for ultrafine particles; see Section Vh

4,4′-Methylene diphenyl diisocyanate (MDI) [101-68-8] (inhalable fraction) see also "polymeric MDI"
Nitrilotriacetic acid [139-13-9] and its sodium salts
Avoid simultaneous exposure to iron compounds (formation of FeNTA).

Nitrobenzene [98-95-3]
n-Octyltin compounds (as Sn [7440-31-5])
Peracetic acid [79-21-0]
Perfluorooctanoic acid (PFOA) [335-67-1] and its salts
o-Phenylphenol [90-43-7] see also Sodium o-phenylphenol
Phenyltin compounds (as Sn [7440-31-5])
Pigment Yellow 12, Pigment Yellow 13, Pigment Yellow 83 [6358-85-6; 5102-83-0; 5567-15-7] (respirable fraction)
"polymeric MDI" [9016-87-9] (inhalable fraction) see also 4,4′-Methylene diphenyl diisocyanate (MDI)
"polymeric MDI" (pMDI) is a technical grade MDI, containing 30–80% w/w 4,4′-methylene diphenyl isocyanate (MDI); the remainder consists of MDI oligomers and MDI homologues.

Polytetrafluoroethene [9002-84-0] (respirable fraction)
except for ultrafine particles; see Section Vh

Polyvinyl chloride [9002-86-2]
except for ultrafine particles; see Section Vh

Sodium o-phenylphenol [132-27-4]
Sulfuric acid [7664-93-9]
Tantalum [7440-25-7] (respirable fraction)
except for ultrafine particles; see Section Vh

2,3,7,8-Tetrachlorodibenzo-p-dioxin [1746-01-6]
1,1,2,2-Tetrachloroethane [79-34-5]
Tetrachloromethane [56-23-5]
Tetramethylol acetylenediurea [5395-50-6]
releases formaldehyde

Titanium dioxide [13463-67-7] (respirable fraction)
except for ultrafine particles; see Section Vh

Tributyl phosphate [126-73-8]
Vanadium [7440-62-2] and its inorganic compounds (inhalable fraction)
Vinyl acetate [108-05-4]
N-Vinyl-2-pyrrolidone [88-12-0]
Zirconium dioxide [1314-23-4; 12036-23-6] (respirable fraction)
except for ultrafine particles; see Section Vh

Category 5

Substances that cause cancer in humans or animals or that are considered to be carcinogenic for humans and for which a MAK value can be derived. A genotoxic mode of action is of prime importance but is considered to contribute only very slightly to human cancer risk, provided the MAK and BAT values are observed. The classification and the MAK and BAT values are supported by information on the mode of action, dose-dependence and toxicokinetic data.

Acetaldehyde [75-07-0]
Dichloromethane [75-09-2]
Ethanol [64-17-5]
Isoprene (2-Methyl-1,3-butadiene) [78-79-5]
Styrene [100-42-5]

For these substances, exposure at the level of the MAK value makes only a small contribution to the cancer risk. The derivation of the MAK value is described in more detail in the documentation for each substance.

The monitoring of the health of employees using substances classified in Categories 4 and 5 must be intensified since after exposures at levels exceeding the MAK or BAT value an increase in the cancer risk is conceivable.

Groups of substances requiring special consideration

★ Formaldehyde releasers

Formaldehyde releasers are substances that release the biocide formaldehyde following hydrolysis. They are or were once used in aqueous metal-working fluids, adhesives, paints, disinfectants, cosmetics and for other applications.

Inhalation of formaldehyde is known to cause carcinogenic effects in the upper respiratory tract. Mechanistic data show that tumours do not form at formaldehyde concentrations that are not cytotoxic or do not increase cell proliferation in the respiratory epithelium. This effect threshold has led to the classification of formaldehyde in Carcinogen Category 4 (for details see the documentation for formaldehyde[25]).

For evaluation, the formaldehyde releasers are assumed to have the same qualitative effect as that induced by formaldehyde. The decisive factor for the carcinogenicity of formaldehyde releasers is the rate at which formaldehyde is released in the respiratory tract. Therefore, the quantitative risk is assessed by evaluating not only data for the substance itself, but also data for the rate of hydrolysis, which is dependent on pH and concentration. If the substance undergoes hydrolysis or there are no data available for the release of formaldehyde, it is assumed that the formaldehyde is released completely in the tissues. If it is possible to rule out the induction of carcinogenic effects by the formaldehyde formed, as is the case when the formaldehyde is inactivated in the nose faster than it is released, the substance is not classified as a carcinogen.

If the data allow to derive a MAK value (inhalation study of the formaldehyde releaser or analogy to formaldehyde), the substance is classified in Carcinogen Category 4. It must be taken into consideration that formaldehyde occurs as a vapour. If the formaldehyde releaser occurs as an aerosol due to its low vapour pressure (see Section I: Substances that can occur simultaneously as vapour and aerosol), the effects are more severe because of impaction in the respiratory tract and a MAK value cannot be derived in analogy to the MAK value of formaldehyde. This was the case for the effects in the lungs induced by exposure to N,N',N''-tris(β-hydroxypropyl)hexahydro-1,3,5-triazine.

If a MAK value cannot be established, the formaldehyde releaser is classified in Carcinogen Category 2 with the footnote "Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value".

Carcinogenic medicines

Results from animal studies or experience of effects in man suggest that a number of medicines have carcinogenic effects[26]. Exposure of employees to such substances can occur during the manufacturing process, therapeutic use and in research laboratories.

Substances with a genotoxic therapeutic mechanism are assumed to be carcinogenic. This assumption is supported by the development of novel tumours in patients undergoing treatment with alkylating cytostatics such as

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[25] Hartwig A, editor (2010) Formaldehyde. In: The MAK-Collection for Occupational Health and Safety. Part I: MAK Value Documentations. Volume 26. Weinheim: Wiley-VCH. p. 1–16. Also available from https://doi.org/10.1002/3527600418.mb5000e4814

[26] see Henschler D, editor (1990) Carcinogenic Medicines (used for tumour therapy). MAK Value Documentation, 1986. In: Occupational Toxicants. Volume 1. Weinheim: VCH. p. 1–7. Also available from https://doi.org/10.1002/3527600418.mb0200e0001

cyclophosphamide, ethylenimine or chlornaphazine as well as with ointments containing arsenic or tar after use for long periods.

Consequently, it must be assumed that a hazard exists when these substances are handled occupationally. Suitable precautions must guarantee that exposure to such substances is prevented.

Amines which form carcinogenic nitrosamines on nitrosation

Nitrosatable amines require particular attention because in the presence of nitrosating agents they may be transformed into potentially strongly carcinogenic nitroso compounds. A detailed account of "Nitrosation of volatile amines at the workplace" may be found online27)).

The formation of nitrosamines from such amines has not only been observed in model experiments but – at least for some of the compounds – has also been demonstrated at the workplace. The amine-containing substances and end products handled at work can themselves be contaminated to a considerable extent with the corresponding nitrosamines. Under conditions encountered in practice nitrosation is to be expected particularly with secondary amines, although in principle, primary and tertiary amines may also undergo nitrosation reactions. Nitrogen oxides are the most probable nitrosating agents. In addition, nitrosation of amines may be brought about by nitrosyl chloride, nitrite esters, metal nitrites and nitroso compounds.

The potential danger associated with any particular amine arises on the one hand from the readiness with which it undergoes nitrosation reactions, and on the other from the degree of carcinogenicity of the corresponding nitrosamine. For both parameters considerable differences are to be found between the various amines. In model studies several factors such as pH, temperature, catalysts and inhibitors are known to determine the extent of nitrosation. Nitrosation of amines can take place not only in acid milieu but also in alkaline. Because nitrogen oxides are effective nitrosating agents also in alkaline milieu, when nitrosatable amines are present nitrogen oxides should be excluded. The reaction of nitrite with nitrosatable amines is accelerated by the presence of formaldehyde, which also causes extension towards the alkaline of the pH range in which significant levels of nitrosation are possible (see documentation of MAK values28)) "Kühlschmierstoffe" (Metal-working fluids)). At present, however, it is not possible to make quantitative predictions as to the formation of nitrosamines under the complex conditions found at the workplace and in mixtures of substances found there. Two precautionary measures are therefore necessary when handling amines at the workplace:

1. Simultaneous exposure to nitrosating agents should be reduced to a minimum. This can be put into practice by eliminating nitrosating agents, or – if they play a role in the actual process – by replacing them with substances which do not lead to the formation of carcinogenic nitrosamines. In particular, the level of nitrogen oxides at the workplace should be monitored and reduced when necessary.
2. The level of nitrosamines in the workplace air and in substances containing amines should be monitored. This applies particularly when amines are used from which highly carcinogenic nitroso compounds, e. g., nitrosodimethylamine or nitrosodiethylamine, can be formed.

Monocyclic aromatic amino and nitro compounds

The List of MAK and BAT Values includes more than 30 monocyclic aromatic amino and nitro compounds, most of which are classified in Categories 1 to 3 for carcinogenic substances, but there are also some with MAK values and others for which no MAK value could be established and which are therefore listed in Section IIb of the List of MAK and BAT Values. Comparison of these compounds (see documentation "Monocyclic aromatic amino and nitro compounds" 200529)) reveals that their acute and chronic toxic effects are very similar. When they are tested with appropriate methods, they may be shown to have carcinogenic potential (Categories 1 or 2) or at least to be suspected carcinogens (Category 3). And the substances all cause very similar kinds of tumours. The substances are generally only weakly genotoxic. Therefore, it is considered that the acute toxic effects play an important role, a role in tumour promotion. The creation of the Categories 4 and 5 for carcinogenic substances made it necessary to review the contribution of genotoxic and non-genotoxic properties to the carcinogenicity of (especially) suspected carcinogens (substances in Category 3) and to decide whether they could be reclassified in one of the new categories. In addition, inconsistencies in the classification of these substances had become apparent. Because there is frequently insufficient

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27) Henschler D, editor (1990) Nitrosation of volatile amines at the workplace. MAK Value Documentation, 1984. In: Occupational Toxicants. Volume 1. Weinheim: VCH. p. 23–37. Also available from https://doi.org/10.1002/3527600418.mb0b03e0001

28) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

29) Greim H, editor (2005) Monocyclic aromatic amino and nitro compounds. MAK Value Documentation, 2003. In: The MAK-Collection for Occupational Health and Safety. Part I: MAK Value Documentations. Volume 21. Weinheim: Wiley-VCH. p. 3–45. Also available from https://doi.org/10.1002/3527600418.mb0maryvere0021

information available for the classification of individual substances, it seems sensible to draw conclusions on the basis of analogy with structurally related compounds. The comparison reveals that this is possible within certain limits but that, in the absence of appropriate data, it is not possible to decide with any certainty where a substance belongs in the spectrum between weak and powerful carcinogens.

Practically all the monocyclic aromatic amino and nitro compounds reviewed here are methaemoglobin producers and most cause haemosiderosis. This suggests that the N-hydroxylamines formed from the compounds are responsible for the toxic effects in experimental animals and in man. It has, however, not yet been demonstrated whether the observed differences between sexes and species and in target organs may all be explained in terms of toxicokinetically induced differences in the bioavailability of the effective metabolites. It is also not clear whether the genotoxic or acute toxic effects are influenced by the release of iron during methaemoglobin formation or erythrocyte turnover and by the "oxidative stress" associated with these processes.

In any case, toxic tissue changes and fibrosis precede tumour development in the spleen, liver and kidneys.

Genotoxic effects have been demonstrated for many monocyclic aromatic amino and nitro compounds and are likely for others. Because of this (albeit weak) genotoxicity, a classification in Category 5 for carcinogenic substances could seem appropriate. However, there is considerable evidence that tissue damage is decisive for the tumour development and that the substances should be classified in Category 4. But such a classification requires that the causes and dose-dependence of the tissue damage are understood.

The comparison of these substances also indicates that the haematotoxic members of the group must generally be seen to be risk factors for cancer and should be re-examined to decide whether they should be classified in one of the categories for carcinogenic substances.

Azo colourants

Azo colourants are characterised by the azo group —N=N—. They are made by the coupling of singly and multiply diazotized aryl amines. Of particular toxicological importance are colourants from doubly diazotized benzidine and benzidine derivatives (3,3′-dimethylbenzidine, 3,3′-dimethoxybenzidine, 3,3′-dichlorobenzidine). In addition, aminoazobenzene, aminonaphthalene and monocyclic aromatic amines are encountered. Reductive fission of the azo group, either by intestinal bacteria or by azo reductases of the liver and of extrahepatic tissues, can cause these compounds to be released. Such breakdown products have been detected in animal experiments as well as in man (urine). Mutagenicity, which has been observed with numerous azo colourants in in vitro test systems, and the carcinogenicity in animal experiments are attributed to the release of amines and their subsequent metabolic activation. There are now epidemiological indications that occupational exposure to benzidine-based azo colourants can increase the incidence of bladder carcinoma.

Thus all azo colourants whose metabolism can liberate a carcinogenic aryl amine are suspected of having carcinogenic potential. Due to the large number of such dyes (several hundred) it seems neither possible nor justifiable to substantiate this suspicion in each individual case by means of animal experimentation according to customary classification criteria. Instead, scientific models have to be relied on. Therefore, as a preventive measure to avoid putting exposed persons at risk, it is recommended that the substances be dealt with as if they were classified in the same categories as the corresponding carcinogenic or suspected carcinogenic amines (Categories 1, 2, 3). If there are indications that the colourant itself (e. g. a pigment) or any carcinogenic breakdown product is not biologically available, the absence of risk should be proved experimentally or substantiated by biomonitoring. Suitable animal experiments can also rule out a suspected carcinogenic potential.

Pyrolysis products of organic materials

If organic material is heated or combusted with a limited supply of oxygen, mixtures are produced whose compositions are dependent on the starting material and the reaction conditions. These mixtures contain, among numerous other substances, polycyclic aromatic hydrocarbons (PAH).

The extremely complex mixtures which have been examined to date contain, simultaneously and in widely differing proportions, carcinogenic components and substances which promote cancer development, as well as fractions which inhibit the carcinogenic effects of concurrently present components.

Many of the PAH which occur regularly in pyrolysis products are carcinogenic in animal studies. They are present at particularly high levels in

brown coal tars (soft coal tars),
coal tars (black coal tars),
coal tar pitches,
coal tar oils,
coke oven emissions.

The carcinogenic effect after occupational exposures to these mixtures of aromatic compounds has been demonstrated in epidemiological studies. Therefore, they are classified in
Category 1.

Particularly the local carcinogenic effects of these mixtures are accounted for largely in terms of their content of PAH. Such effects are therefore also to be expected with other PAH-containing mixtures. The levels and significance of other carcinogenic components of these mixtures has not yet been studied in detail. Thus, although
diesel engine emissions30)

also contain PAH, in this case it is probably the soot particles which determine the carcinogenic effect. This has been demonstrated only in animal studies and therefore diesel engine emissions are classified in
Category 2.

The carcinogenic effects of other mixtures such as, e. g., petrol engine emissions, used motor oils, curing smoke, used cutting oils, have not yet been studied in as much detail. The composition of these mixtures also makes them difficult to define. If, however, exposure to PAH which have been shown in animal studies to be carcinogenic, e. g.,

anthanthrene,
benzo[a]anthracene,
benzo[b]fluoranthene,
benzo[j]fluoranthene,
benzo[k]fluoranthene,
benzo[b]naphtho[2,1-d]thiophene,
benzo[a]pyrene,
chrysene,
cyclopenta[cd]pyrene,
dibenzo[a,h]anthracene,
dibenzo[a,e]pyrene,
dibenzo[a,h]pyrene,
dibenzo[a,i]pyrene,
dibenzo[a,l]pyrene,
indeno[1,2,3-cd]pyrene,
1-methylpyrene,
naphthalene,

can be demonstrated during work with such pyrolysis products, the mixtures should be handled
like the substances in Category 2, except for phenanthrene and pyrene, which are not classified in a Carcinogen category on the basis of the data (see documentation "Polycyclic aromatic hydrocarbons (PAH)" 201231)).

It will be possible to establish a clearer, more quantitative relationship between exposure and an increase in cancer risk when more precise data for the compositions of specific mixtures and of their cancer-producing effects are available (see also documentation "Polycyclic aromatic hydrocarbons (PAH)" 201231)). The Commission emphasizes the urgency of such investigations.

Polycyclic aromatic hydrocarbons (PAH) may be readily absorbed through the skin. Therefore, pyrolysis products and other mixtures containing PAH should be handled like substances designated with an "H" (see Section VII "Percutaneous absorption"; see also documentation "Polycyclic aromatic hydrocarbons (PAH)" 201231)).

Fibrous dusts

Not only certain kinds of asbestos but also the fibrous zeolite, **erionite**, is considered to produce tumours in man. In addition, a number of fibrous dusts have been shown to produce tumours in experimental animals after inhalation or after intratracheal instillation or direct local administration into the chest (intrapleural) or abdominal (intraperitoneal) cavity.

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30) Because of the new diesel engine technology the emissions have changed significantly in quality and quantity. Since it must be assumed that these new diesel engines were introduced at the end of the 1990s, all the available epidemiological studies which were evaluated in 2007 are based on exposures to emissions from older diesel engines. The emissions from the new diesel engines can not be evaluated until appropriate studies become available.

31) Hartwig A, editor (2012) Polycyclic aromatic hydrocarbons (PAH). MAK Value Documentation, 2008. In: The MAK-Collection for Occupational Health and Safety. Part I: MAK Value Documentations. Volume 27. Weinheim: Wiley-VCH. p. 1–216. Also available from https://doi.org/10.1002/3527600418.mb0223orge0027a

When all the information as to the effects of dust on man and the effects seen in studies with animals and cultured cells is taken into account, it must be concluded that, unlike the non-fibrous insoluble dusts of corresponding composition,

- the fibrous asbestos dust particles which are durable in the organism must be seen as the cause of the tumorigenic effects of asbestos
- and that, in principle, all kinds of elongated dust particles have the potential, like asbestos fibres, to cause tumours if they are sufficiently long, thin and durable in vivo.

Factors also suggested to play a role include other properties of fibres such as their surface characteristics.

The animal studies have also demonstrated that longer or more durable fibres have higher carcinogenic potency than shorter or less durable fibres.

Classification criteria

a) Properties of carcinogenic fibres

According to the internationally accepted convention established in the 1960s for measuring levels of asbestos dust at workplaces by counting the fibres under the light microscope, only particles with a ratio of length to diameter greater than 3:1 and which are longer than 5 μm and have a diameter less than 3 μm are counted. The term fibrous dust is used here for fibres of these dimensions. With such fibrous dusts in animal studies, the number of fibres has been shown to correlate positively with the tumour incidence.

The above definition, however, does not distinguish clearly between carcinogenic and non-carcinogenic fibres. The presently available data do not make it possible to state precisely from which fibre length or diameter or from which length to diameter ratio and from which durability fibres possess the biological activity resulting in tumour induction. Nevertheless, at present there is no other definition which has a better scientific basis.

The situation is made more difficult by the fact that, with the exception of a few inorganic and organic textile fibres, fibrous materials produce dusts in which the fibre lengths and diameters are spread over a wide range.

In addition, the diameter of fibres, e. g., asbestos fibres, can be reduced after incorporation by longitudinal splitting. Then fibres with diameters less than 3 μm can be found in the lungs although, before splitting, the fibres in the inhaled air did not fit the definition of fibrous dust.

b) Effects in man

Epidemiological studies of the inhabitants of three villages in central Anatolia together with mineralogical studies and analyses of the fibres in lung dust produced convincing evidence that erionite fibres cause mesothelioma and lung cancer.

In epidemiological studies carried out in factories producing glass fibre and glass wool, no convincing evidence of an increased risk of developing mesothelioma or lung cancer was found. An increased risk of developing lung cancer was found for persons exposed to rock and slag wool but could not be associated unequivocally with the exposure to these fibrous dusts.

The studies available to date neither confirm nor refute the proposal that man-made mineral fibres have carcinogenic effects but this was not to be expected since, even if the individual fibres were as carcinogenic as asbestos fibres, the tumorigenicity would not be detectable at the low exposure concentrations measured in these studies. At present there are no appropriate studies of workplaces where persons processing or using fibres are exposed to the much higher fibre concentrations necessary to examine with sufficient sensitivity the question of the carcinogenic effects in man.

c) Animal inhalation studies

The results of inhalation studies with fibrous dusts are not always consistent so that positive results obtained in some studies could not be confirmed in others. The main reason for this inconsistency is that it is difficult to ensure that a sufficient dose of the carcinogenic fibre fraction reaches the target tissue. The fibres which are relevant for the effects in man, for example, penetrate the nasal filter of rodents either only poorly or not at all. For crocidolite, which has been shown to be carcinogenic in man, positive results have been obtained in only one adequately documented inhalation study with rats but negative results in several adequately documented studies.

Thus a negative result in an inhalation study does not exclude the possibility that the substance has carcinogenic effects. Positive results in the lung must be analysed to determine whether overloading has occurred.

d) Animal studies with intratracheal instillation, intrapleural or intraperitoneal injection

Many kinds of fibre have proved to be carcinogenic after administration by intratracheal instillation or by intrapleural or intraperitoneal injection. These administration routes are unphysiological but they guarantee a high dose of fibres immediately after application at the sites which are relevant for man (bronchial tract, pleura and peritoneum). Thus, in the studies with intratracheal, intraperitoneal or intrapleural administration, a longer time and higher dose is available for tumour production than in inhalation studies where the fibre concentration in the target organs builds up only slowly.

With these methods, dose-response relationships can be established; they have demonstrated that the carcinogenic effect is determined by the form of the fibre. Inhalation studies with selected ceramic fibres have confirmed positive results obtained in injection studies. Although the possibility of overloading the target tissue cannot be excluded with these administration routes, a positive result from such a study is considered to be good evidence that the fibre would be carcinogenic in man.

e) Genotoxicity and cell transformation studies

Genotoxicity and cell transformation studies with various fibres also demonstrate that fibre form largely determines the effects of fibres. Whereas numerical and structural chromosome changes were detected in a number of test systems, there was no conclusive evidence that fibres can induce point mutations.

f) Durability

From the results of animal studies with durable and non-durable fibres it is concluded that durability in the biological system has a considerable effect on the carcinogenicity of fibres. At present, however, it is not possible to define the degree of durability necessary for carcinogenic activity or to state to what extent the durability determines the carcinogenic potency of the fibres. Gypsum and wollastonite, e. g., dissolve in the organism within a period of some days to a few weeks and show no signs of carcinogenic effects even after intraperitoneal administration.

g) Mechanism

The mechanism of the toxicity and carcinogenicity of fibres is very complex and many aspects are unclear.

The formation of tumours in the lungs and on serous skin is mainly the result of inflammatory processes. Chronic inflammation and cell proliferation are caused by the impairment of fibre clearance; whereby inflammation-promoting cytokines, growth factors, reactive oxygen (ROS) and nitrogen species (RNS), and chlorine radicals are released from macrophages, alveolar cells and mesothelial cells. The generation of these radicals leads to indirect genotoxic effects.

Additional mechanistic aspects are:

- the formation of ROS and RNS caused by the fibres themselves,
- the absorption of the fibres into the target cells by means of endocytosis, whereby ROS and RNS are released intracellularly causing genetic and epigenetic changes, and
- the stimulation of cell receptors and inflammasomes, which in turn activate intracellular signal pathways and thus give the impulse for cell proliferation and the resistance to apoptosis.

Summary

The fibre dust groups will be evaluated individually, and depending on the data available and taking into consideration the mechanism of action will be classified in one of the categories for carcinogens.

The results of the evaluation of the individual fibre groups are given in List IIa “Substances with MAK values and substances listed in Sections IIb, IIc and III to XII” (see also MAK Collection “Fibrous Dusts”[32]).

Organic fibrous dusts
Evaluation of the carcinogenicity of organic fibres in the critical dimension range is not possible. Studies are necessary, for example of carcinogenicity, surface characteristics, bioavailability and durability, to enable assessment of the carcinogenic effects of organic fibres.

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[32] Hartwig A, MAK Commission (2019) Fibrous dusts, inorganic. MAK Value Documentation, 2018. MAK Collect Occup Health Saf 4(4): 2054–2107. https://doi.org/10.1002/3527600418.mb0243fase6519

IV. Sensitizing substances

The allergies caused by substances at the workplace affect mostly the skin (contact eczema, contact urticaria), the respiratory passages (rhinitis, asthma, alveolitis) and the conjunctiva (blepharoconjunctivitis). The kind of allergy is determined by the route of uptake, the chemical properties of the substance and its aggregation state.

Contact allergies are generally manifested as contact eczema, the pathogenesis of which involves a T lymphocyte-mediated immune reaction of delayed type. Contact eczema is almost always caused by reactive substances of low molecular weight. Immunologically, these low molecular weight substances must be seen as haptens, prehaptens or prohaptens. They become complete allergens in the organism either by binding to peptides or proteins as such (haptens), after activation ex vivo (prehaptens) or after metabolism (prohaptens).

The development of a contact allergy of delayed type is determined by several factors, by the sensitization potential resulting from the chemical properties of the substance or the metabolites produced from it in the organism, by the exposure concentration and the duration and manner of exposure, by the genetic disposition of the person and, not least, by the state of the tissue with which the substance makes contact. The release of (pro-) inflammatory cytokines (e. g. TNF-α or interleukin-1β), which is triggered by existing inflammation of the skin or by irritation from a foreign substance, is necessary for the induction of sensitization. Thus, the irritating properties of a substance can increase its sensitization potential. Cytokine induction, which stimulates the immune response, can also be triggered by the additional contact with other irritating substances, e. g. detergents such as sodium dodecyl sulfate, which then provide the necessary (pro-)inflammatory stimulus. Furthermore, the irritating effect of these kinds of substances leads to increased penetration of the sensitizing substance. An effect which enhances (or decreases) penetration is also possible from non-irritating substances with suitable/adequate polarity (such as dimethyl sulfoxide). These types of cofactors and combinatorial effects, as well as particular factors relevant under conditions at the workplace and expressly pointed out in the documentation, are taken into account in the evaluation, as described in Chapter IVc. The **sensitization potency** of a substance is not necessarily reflected in the **incidence of sensitizations** which it causes because the clinical significance of a contact allergen is not only determined by its sensitization potency but also by the distribution of the substance and the possibilities of exposure to it. Quantitatively, the sensitization potential of a substance can best be estimated in animal studies, in particular in the Local Lymph Node Assay (LLNA) in the mouse. At present, in vitro studies are not yet sufficiently validated for this purpose.

Other allergic skin reactions, e. g., urticaria, involve immune reactions mediated by specific antibodies. Similar symptoms can also be produced, however, by mechanisms not involving immune reactions (see below).

Most respiratory allergens are macromolecules, mainly peptides or proteins. But low molecular weight substances can also produce specific immunological reactions in the airways (see List of allergens). Some of the low molecular weight respiratory allergens are also contact allergens.

The allergic reactions of the airways and conjunctiva which take the form of bronchial asthma or rhinoconjunctivitis mostly involve reaction of the allergen with specific IgE antibodies and belong to the manifestations of immediate type. However, in the deeper airways they can also first appear after a delay of several hours. Exogenous allergic alveolitis is induced generally by allergen-specific immune complexes of IgG type and by cell-mediated reactions. Allergic reactions of immediate type can also cause systemic reactions and even anaphylactic shock.

The development of allergies of the respiratory passages, like that of contact allergies, is dependent on a number of factors. In addition to the substance-specific potential for causing sensitization, the amount of the allergen, the exposure period and the genetically determined disposition of the exposed person play a decisive role. Factors which increase the sensitivity of the mucosa may play a role in predisposing a person to allergy; they may be genetically determined or acquired, for example, during infections or exposure to irritant substances. Particular attention should be drawn to atopic diathesis which is characterized by an increased susceptibility to atopic eczema (neurodermatitis) or to allergic rhinitis and allergic bronchial asthma and is often associated with increased IgE synthesis.

In addition, there are also a number of relatively rare disorders of quite different kinds which are immunologically induced and so belong with the allergic phenomena such as, for example, manifestations involving granuloma formation (e. g. berylliosis) and certain exanthematous skin disorders.

A number of substances only induce the formation of antigens and then contact sensitization when they have previously been put into an energetically excited state by the absorption of light (photocontact sensitization, “photoallergization”). Likewise, many other substances can cause a skin reaction after exposure to light but without proof of an immunological mechanism (phototoxicity). Differentiation between phototoxicity and immunological photocontact sensitization can be difficult, as the classical factors that distinguish between (photo)allergic and (photo)toxic effects are not always found. In Anglo-American usage the expression “photosensitization” is used for both mechanisms. Although photocontact sensitization and phototoxicity involve primarily the physical activation (photosensitization) of a chromophore, both types of reactions are in principle clinically and diagnostically distinguishable.

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It is still not possible to determine (and document scientifically) generally applicable threshold concentrations either for the induction of an allergy (sensitization) or for triggering the allergic reaction in an already sensitized person. The likelihood of induction increases with the concentration of the allergen to which persons are exposed. The concentrations required for the triggering of acute symptoms are generally lower than those required for sensitization. Even when MAK values are observed, the induction or triggering of an allergic reaction cannot be excluded with any certainty.

Sensitizing substances are indicated in the List of MAK and BAT Values under the abbreviation "Sens" by "Sa" or "Sh". This designation refers only to the organ or organ system in which the allergic reaction is manifested. The pathological mechanism producing the symptoms is not taken into account. "Sh" designates substances which can cause allergic reactions of the skin and the mucosa close to the skin (skin-sensitizing substances). The designation "Sa" (substances causing airway sensitization) indicates that a sensitization can involve symptoms of the airways and also of the conjunctiva, and that other effects associated with reactions of immediate type are also possible. These include systemic effects (anaphylaxis) and local effects on the skin (urticaria). The latter reactions only result in the additional designation with "Sh" when the skin symptoms are relevant under workplace conditions. Substances which increase photosensitivity in exposed persons by mechanisms not involving immune reactions (e. g. furocoumarins) are not separately designated. On the other hand, substances which cause photocontact sensitization are designated with "SP" (e. g. bithionol). Separate criteria for their evaluation are not necessary because, in essence, the criteria for the evaluation of substances causing contact sensitization may be applied.

Some substances can cause local or systemic reactions the symptoms of which are entirely or largely identical to those of allergic reactions but which do not involve specific immunological mechanisms; they involve, e. g., the release of various mediators by mechanisms which are not immunological. These reactions are not a result of antigen-antibody interactions and can therefore also appear on the very first contact with the substance. Such reactions are induced, e. g., by sulfites, by benzoic acid and acetylsalicylic acid and their derivatives and by a variety of dyes such as tartrazine. Such substances are not designated with an "S". However, attention is drawn to their potential for producing such non-immunological reactions in the documentation and in some cases in the List of MAK and BAT Values as well.

The criteria which are used in the evaluation of substances causing contact and airway sensitization are described below.

a) Criteria for the assessment of contact allergens

The allergological evaluation is based on a variety of information which must be seen as providing different qualities of evidence.

1) **Sufficient evidence** of an allergenic effect is provided by valid results from **either** i) **or** ii):
   i) effects in man
      - studies in which numerous clinically relevant cases of sensitization (i. e. association of symptoms and exposure) were observed in tests with large collectives of patients in at least two independent centres, or
      - epidemiological studies which reveal a relationship between sensitization and exposure, or
      - case reports of clinically relevant sensitization (association of symptoms and exposure) for more than one patient from at least two independent centres

   or

   ii) results of experimental studies
      - at least one positive result in an animal study without adjuvant carried out according to accepted guidelines, or
      - positive results from at least two less well-documented animal studies carried out according to accepted guidelines, one of which did not use adjuvant.
      - at least two positive results from in vitro studies carried out according to test guidelines, in which different key events of contact sensitization were tested
2) An allergenic effect can be considered **probable** on the basis described in i) **and** ii) below:
   i) effects in man
      - studies in which numerous clinically relevant cases of sensitization (association of symptoms and exposure) were observed in tests in just one centre, or
      - studies in which numerous cases of sensitization without details of clinical relevance were observed in tests with large collectives of patients in at least two independent centres

   and

   ii) results of experimental studies
      - a positive result in an animal study with adjuvant carried out according to accepted guidelines or
      - positive results from an in vitro study carried out according to test guidelines, or
      - evidence from structural considerations based on sufficiently valid results for structurally closely related compounds.

3) An allergenic effect is **not sufficiently documented**, but also not excluded, when only the data listed below are available:

– insufficiently documented case reports, or
– only one positive result in an animal study with adjuvant carried out according to accepted guidelines, or
– positive results in animal studies which were not carried out according to accepted guidelines, or
– evidence from studies of structure-effect relationships or from in vitro studies not carried out according to test guidelines.

Commentary:
Effects in man
The data obtained in numerous clinics and allergy centres from serial patch tests give us a useful picture of the frequency of skin sensitization and of the practical importance of the individual contact allergens. In contrast, useful results of reliable epidemiological studies are available for only few allergens.

The allergens which are observed most frequently, e. g., nickel, are not always the most potent sensitizers. On the other hand, very strongly sensitizing substances such as 2,4- dinitrochlorobenzene play quantitatively only a small role because only a small number of persons have sufficiently intensive contact with them. A number of highly potent contact allergens have been identified from clinical observations obtained in only a few patients, often after the first and only exposure (sometimes even after the first patch test). Examples of such substances are chloromethylimidazoline, diphenylcyclopropenone, quadratic acid diethyl ester, p-nitrobenzoyl bromide. For such exceptional substances, given proper scientific data, the evidence could be considered as ‘probable’ (category a2) even when the data come from just one centre.

The results of use tests in man with substances found at the workplace – often internal studies of the producing company – are of considerable value when they are carried out properly. Nowadays, the use of experimental sensitization tests must be rejected for ethical reasons, but historical results can be of importance in the evaluation of a substance.

Results of experimental studies
Animal studies to determine the potential of a substance to cause allergic sensitization were carried out with guinea pigs with or without the use of Freund’s complete adjuvant (FCA) and in the mouse. The most frequently used methods were the maximization test of Magnusson and Kligman (with FCA), and the Buehler test and LLNA (without FCA). The methods with FCA are generally more sensitive and their use can therefore occasionally result in overrating of the potential of sensitization. For this reason, a positive result in a test without adjuvant is considered in the test criteria to be better evidence than a positive result in one with adjuvant.

The tests with experimental animals generally yield useful data; that is, for most substances they have yielded results in agreement with the data obtained in man. One advantage of the experimental animal methods is that dose-response relationships can be studied.

The test systems used for in vitro studies refer to individual key events of the sensitization phase, such as the binding of the test substance to proteins, the activation of keratinocytes, the maturation and migration of dendritic cells or the activation and proliferation of T lymphocytes. The plausibility of positive findings from in vitro studies is examined. For this purpose, for example, the physico-chemical properties of the substances, existing knowledge of their reactivity with proteins or structure–effect relationships can be taken into consideration. An evaluation scheme in which merely a minimum number of positive findings is required is considered by the Commission to be too rigid an instrument for scientific evaluations.

Substances to which people have not yet been exposed or known to be exposed (e. g. because they have been newly synthesized or are newly available products) and for which, therefore, clinical data cannot be available (neither negative nor positive results of clinical observations can be applied as a criterion) can also be classified as probably sensitizing (category a2) simply on the basis of positive results from animal studies with adjuvant carried out according to accepted guidelines. Even plausible positive results from experimental studies not carried out according to accepted guidelines can be accepted, provided theoretical chemical structural considerations or well-founded mechanistic aspects indicate that the substance is so closely related to known allergens that it may be expected to have analogous properties.

Theoretical considerations require practical confirmation; therefore, they are generally of less importance in the final evaluation and cannot be the only criterion for a potential sensitizing effect in the absence of other clinical or experimental data.

b) Criteria for the evaluation of respiratory allergens

The kinds of data which may be used in the evaluation of respiratory allergens are listed below; here too the different kinds of data provide different qualities of evidence.

1) **Sufficient evidence** of allergenic effects of a substance in the airways or the lungs is provided by valid data from:
   - studies or case reports of a specific hyperreactivity of the airways or the lungs which are indicative of an immunological mechanism from more than one patient and at least two independent testing centres. In addition, the (clinical) symptoms or adverse effects on the function of the upper or lower airways or the lungs must be shown to be associated with the exposure to the substance.
2) An allergenic effect can be considered **probable** on the basis of the results listed below:
   - one single case report of a specific hyperreactivity of the airways or the lungs

   and
   - other indications of sensitizing effects, e. g., a close structure-effect relationship with known airway allergens.
3) An allergenic effect is **not sufficiently documented**, but also not excluded, when only the data listed below are available:
   - epidemiological studies which demonstrate an increased incidence of symptoms or impaired function in exposed persons, or
   - studies or case reports of a specific hyperreactivity of the airways or the lungs in only one patient, or
   - studies or case reports of sensitization (e. g. detection of IgE) without accompanying symptoms or impairment of function causally associated with the exposure, or
   - positive results of animal studies, or
   - positive results of in vitro studies, or
   - structure-effect relationships with known respiratory allergens.

Commentary:
Generally, the classification is based on the results of epidemiological studies. Case reports do not always withstand critical examination, not least because of the difficulty or impossibility of carrying out adequate control studies. This is particularly true of inhalation-provocation tests. In addition, it is not always possible to produce adequate exposure data.

Symptoms are usually not a sufficient criterion for the designation of a substance as a respiratory allergen; generally, it is necessary to demonstrate sensitization and record objective changes such as exposure-related impairment of lung function or bronchial hyperreactivity to specific stimuli. An immunological mechanism can generally be recognized on the basis of in vivo (e. g. prick test) or in vitro test results, ideally by detection of a specific antibody after proved exposure.

For many substances, an immunological mechanism has not yet been demonstrated directly. Therefore, indirect evidence of immunological mechanisms can also be taken into account in classification. These include:

- the existence of a latency period between the start of the exposure and the appearance of the first symptoms (sensitization period),
- the triggering of symptoms with low concentrations of the substance which do not cause symptoms in appropriate controls,
- occasional delayed reactions or sequential immediate and delayed reactions (dual reactions) in the inhalation-provocation test,
- associated cutaneous symptoms such as urticaria or Quincke's oedema.

An allergenic effect is not sufficiently documented, but also not excluded, when evidence of airway sensitization is available but the conditions described in the criteria are not fulfilled. In particular, epidemiological studies which demonstrate an increased incidence of symptoms or of impaired function in exposed persons (even with demonstrated dose-response relationships) do not provide sufficient evidence of sensitizing properties if no indications of a specific immunological mechanism are available. Likewise, studies or case reports which merely document workplace-related variations in lung function or bronchial hyperreactivity are not sufficient.

To date there is no thoroughly validated method to induce and detect respiratory allergies in an animal model.

In guinea pig models, sensitizing substances cause reactions like those seen in man. Sensitization can be induced by inhalation or by intradermal, subcutaneous injection or topical epidermal application. In these tests the respiratory hyperreactivity (respiration rate, tidal volume, respiratory minute volume, inhalation and exhalation times, exhalation rate) is measured. In the mouse IgE test, the potential of a substance to cause sensitization in BALB/c mice is determined as a function of the increase in the level of total IgE but not, to date, as a function of substance-specific IgE. In studies in rats, effects are often investigated after topical induction and inhalation challenge treatment.

With these models no observed effect levels (NOEL) can be established but it is questionable whether they apply for man. Systematic comparative tests have not yet been carried out.

To date, sensitive and specific standardized in vitro methods for detecting low molecular weight respiratory allergens (and which can differentiate between respiratory and contact allergens) are not available. In addition, it is not possible to date to give a valid assessment of the sensitizing potential of the substance (with the exception of a few classes of substances such as e. g. the diisocyanates or the dicarboxylic acid anhydrides) on the airways on the basis of structural or mechanistic properties alone. These may, however, be useful when the data from experimental studies are ambiguous.

c) Designation of a substance as an allergen

Whether or not it is necessary to designate a substance as an allergen in the List of MAK and BAT Values is determined on the basis of the available evidence of allergenic effects and, when possible, also on the basis of the expected levels of exposure.

- The substances characterized according to the criteria in Section IVa) or IVb) as belonging in Categories 1) or 2) are generally designated as allergens with "Sa", "Sh", "Sah" or "SP".
  - Substances for which these criteria are fulfilled are also designated with an "S" when the observed sensitization is associated mainly with cofactors which are (only) relevant under workplace conditions (e. g. (previous) damage to the skin caused by chemical or physical agents).
- On the other hand, substances are not designated with an "S" when
  - in spite of extensive handling of the substance, very few (well-documented) cases of sensitization are observed, or
  - the observed cases of sensitization are mainly associated with cofactors which are not relevant under workplace conditions (e. g. the presence of eczema on the lower leg), or
  - the criteria of Section IVa) or IVb) resulted in classification of the substance in category 3). This also includes substances for which a positive result was obtained in a study with experimental animals using adjuvant (maximization test); at the same time, however, no case of contact sensitization in humans was observed despite relevant exposure. A substance is not designated with "Sa" if the reactions which occurred are caused by irritating or pharmacological effects, since these effects were taken into account in establishing a MAK value.
- Thus, in individual cases a designation which differs from the designation according to the EU regulations for hazardous substances is possible.

The criteria are to be seen as guidelines for an intelligible evaluation of the data but in certain special cases their strict application may not be obligatory.

d) List of allergens

The list below shows the substances in Section IIa which are designated with Sa, Sh, Sah or SP. It does not claim to be a complete list of sensitizing substances and is subject to continual revision and extension.

Abietic acid [514-10-3] (Sh)
also includes disproportionation and transposition products
An immunological genesis of the asthma often seen in persons working with materials containing abietic acid has not been proved.

Acrylamide [79-06-1] (Sh)
Acrylic acid 2-ethylhexyl ester [103-11-7] (Sh)
Acrylic acid 2-hydroxyethyl ester [818-61-1] (Sh)
Acrylic acid hydroxypropyl ester (all isomers) [25584-83-2] (Sh)
Acrylonitrile [107-13-1] (Sh)
Alkali persulfates (Sah)
Allyl glycidyl ether [106-92-3] (Sh)
p-Aminoazobenzene [60-09-3] (Sh)
o-Aminoazotoluene [97-56-3] (Sh)
4-Aminodiphenylamine [101-54-2] (Sh)
2-Aminoethanol [141-43-5] (Sh)
2-(2-Aminoethoxy)ethanol [929-06-6] (Sh)
3-Aminomethyl-3,5,5-trimethyl-cyclohexylamine (Isophorone diamine) [2855-13-2] (Sh)
3-Aminophenol [591-27-5] (Sh)
p-Aminophenol [123-30-8] (Sh)

Ammonium persulfate [7727-54-0] (Sah)
α-Amylase (Sa)
α-Amylcinnamaldehyde [122-40-7] (Sh)
★ Aniline [62-53-3] (Sh)
Animal hair, epithelia and other materials derived from animals (Sah)
Azinphos-methyl [86-50-0] (Sh)
Benomyl [17804-35-2] (Sh)
1,2-Benzisothiazol-3(2H)-one [2634-33-5] (Sh)
Benzyl alcohol mono(poly)hemiformal [14548-60-8] (Sh)
releases formaldehyde

Beryllium [7440-41-7] and its inorganic compounds (Sah)
N,N-Bis(2-ethylhexyl)-(1,2,4-triazole-1-yl)methanamine [91273-04-0] (Sh)
releases formaldehyde

★ Bismorpholino methane [5625-90-1] (Sh)
releases formaldehyde

Bisphenol A (4,4′-Isopropylidenediphenol) [80-05-7] (SP)
Bisphenol A diglycidyl ether [1675-54-3] (Sh)
Bisphenol A diglycidyl methacrylate [1565-94-2] (Sh)
Bisphenol A ethoxylate dimethacrylate [24448-20-2] (Sh)
Bisphenol A glycerolate [4687-94-9] (Sh)
Bisphenol F diglycidyl ether (Sh)
Bithionol [97-18-7] (SP)
Bromelain [9001-00-7] (Sa)
2-Bromo-2-nitro-1,3-propanediol [52-51-7] (Sh)
releases formaldehyde
use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”

1,4-Butanediol diacrylate [1070-70-8] (Sh)
1,4-Butanediol diglycidyl ether [2425-79-8] (Sh)
1,4-Butanediol dimethacrylate [2082-81-7] (Sh)
1-Butanethiol [109-79-5] (Sh)
Butanone oxime [96-29-7] (Sh)
n-Butyl acrylate [141-32-2] (Sh)
tert-Butyl acrylate [1663-39-4] (Sh)
2-Butyl-1,2-benzisothiazolin-3-one [4299-07-4] (Sh)
p-tert-Butylcatechol [98-29-3; 27213-78-1] (Sh)
n-Butyl glycidyl ether (BGE) [2426-08-6] (Sh)
tert-Butyl glycidyl ether [7665-72-7] (Sh)
n-Butyl methacrylate [97-88-1] (Sh)
p-tert-Butylphenol [98-54-4] (Sh)
p-tert-Butylphenyl glycidyl ether [3101-60-8] (Sh)
Butynediol [110-65-6] (Sh)
N-Carboxyanthranilic anhydride [118-48-9] (Sh)
Cellulases (Sa)
Cereal flour dusts Rye, Wheat (Sa)
2-Chloroacetamide [79-07-2] (Sh)
Chloroacetic acid methyl ester [96-34-4] (Sh)
m-Chloroaniline [108-42-9] (Sh)
p-Chloroaniline [106-47-8] (Sh)
p-Chloro-m-cresol [59-50-7] (Sh)
1-Chloro-2,4-dinitrobenzene [97-00-7] (Sh)
1-Chloro-2,3-epoxypropane (Epichlorohydrin) [106-89-8] (Sh)
5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-dihydroisothiazol-3-one [26172-55-4; 2682-20-4] mixture in ratio 3:1 (Sh)
Chlorothalonil [1897-45-6] (Sh)
Chlorpromazine (2-Chloro-10-(3-dimethylaminopropyl)phenothiazine) [50-53-3] (SP)
Chromium(III) compounds (Sh)
does not apply for chromium(III) oxide and similar poorly soluble chromium(III) compounds

Chromium(VI) compounds (inhalable fraction) (Sh)
barium chromate and lead chromate are not designated with “Sh”

Cinnamaldehyde [104-55-2] (Sh)
Cinnamyl alcohol [104-54-1] (Sh)
Cobalt [7440-48-4] and cobalt compounds (inhalable fraction) (Sah)

Cresyl glycidyl ethers mixture of isomers [26447-14-3], o-isomer [2210-79-9] (Sh)
Cyanamide [420-04-2] (Sh)
Cyanuric chloride [108-77-0] (Sh)
N-Cyclohexyl-2-benzothiazolesulfenamide [95-33-0] (Sh)
N-Cyclohexyl-N′-phenyl-p-phenylendiamine [101-87-1] (Sh)
Diacetyl [431-03-8] (Sh)
4,4′-Diaminodiphenylmethane [101-77-9] (Sh)
1,5-Diaminonaphthalene [2243-62-1] (Sh)
2,2′-Dibenzothiazyl disulfide [120-78-5] (Sh)
2,2-Dibromo-2-cyanacetamide [10222-01-2] (Sh)
1,2-Dibromo-2,4-dicyanobutane [35691-65-7] (Sh)
3,4-Dichloroaniline [95-76-1] (Sh)
1,3-Dichloropropene (cis and trans) [542-75-6] (Sh)
Dicyclohexylcarbodiimide [538-75-0] (Sh)
Dicyclohexyl methane 4,4′-diisocyanate [5124-30-1] (Sh)
Diethanolamine [111-42-2] (Sh)
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethanolamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

Diethylene glycol diacrylate [4074-88-8] (Sh)
Diethylene glycol dimethacrylate [2358-84-1] (Sh)
Diethylenetriamine [111-40-0] (Sh)
Diglycidyl hexanediol [16096-31-4] (Sh)
Diglycidyl resorcinol ether [101-90-6] (Sh)
N,N′-(Dimethylamino)ethyl methacrylate [2867-47-2] (Sh)
N-(1,3-Dimethylbutyl)-N′-phenyl-p-phenylenediamine [793-24-8] (Sh)
1,1-Dimethylhydrazine [57-14-7] (Sh)
1,2-Dimethylhydrazine [540-73-8] (Sh)
Dimethylol dihydroxyethyleneurea [1854-26-8] (Sh)
1,3-Dimethylol-5,5-dimethyl hydantoin [6440-58-0] (Sh)
releases formaldehyde

Dipentamethylenethiuram disulfide [94-37-1] (Sh)
N,N-Diphenyl-p-phenylenediamine [74-31-7] (Sh)
Disperse blue 106/124 [68516-81-4; 15141-18-1] (Sh)
Disperse Orange 3 [730-40-5] (Sh)
Disperse Red 1 [2872-52-8] (Sh)
Disperse Red 17 [3179-89-3] (Sh)
Disperse Yellow 3 [2832-40-8] (Sh)
Disulfiram [97-77-8] (Sh)
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

2,2′-Dithiobis(N-methylbenzamide) [2527-58-4] (Sh)
3,4-Epoxycyclohexane carboxylic acid (3,4-epoxycyclohexylmethyl) ester [2386-87-0] (Sh)
1,2-Epoxypropane [75-56-9] (Sh)
Ethyl acrylate [140-88-5] (Sh)
★ 5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] (Sh)
releases formaldehyde

Ethylenediamine [107-15-3] (Sah)
Ethylene glycol dimethacrylate [97-90-5] (Sh)
2-Ethylhexyl mercaptoacetate [7659-86-1] (Sh)
Eugenol [97-53-0] (Sh)
Farnesol [4602-84-0] (Sh)
Formaldehyde [50-00-0] (Sh)
Formaldehyde condensation products with p-tert-butylphenol (low molecular) (Sh)
Formaldehyde condensation products with phenol (low-molecular) (Sh)
Geraniol [106-24-1] (Sh)
Glutaraldehyde [111-30-8] (Sah)
Glyceryl monothioglycolate [30618-84-9] (Sh)
Glycidyl methacrylate [106-91-2] (Sh)
Glycidyl trimethylammonium chloride [3033-77-0] (Sh)
Glyoxal [107-22-2] (Sh)
Gold [7440-57-5] and its inorganic compounds (Sh)
only soluble gold compounds

Hard metal containing tungsten carbide and cobalt (inhalable fraction) (Sah)
Hexahydrophthalic acid diglycidylester [5493-45-8] (Sh)
Hexahydrophthalic anhydride [85-42-7] (Sa)
1,6-Hexamethylene diisocyanate [822-06-0] (Sah)
Hexamethylenetetramine [100-97-0] (Sh)
releases formaldehyde

1,6-Hexanediol diacrylate [13048-33-4] (Sh)
Hydrazine [302-01-2] (Sh)
Hydrazine hydrate [7803-57-8] and hydrazine salts (Sh)
Hydroquinone [123-31-9] (Sh)
7-Hydroxycitronellal [107-75-5] (Sh)
2-Hydroxyethyl methacrylate [868-77-9] (Sh)
N-(2-Hydroxyethyl)piperidine [3040-44-6] (Sh)
Hydroxylamine [7803-49-8] and its salts (Sh)
4-(4-Hydroxy-4-methyl pentyl)-3-cyclohexene-1-carboxaldehyde (Lyral) [31906-04-4] (Sh)
3-Iodo-2-propynyl butylcarbamate [55406-53-6] (Sh)
Isobornyl acrylate [5888-33-5] (Sh)
Isoeugenol [97-54-1] (Sh)
Isophorone diisocyanate [4098-71-9] (Sah)
4-Isopropylphenyl isocyanate [31027-31-3] (Sh)
N-Isopropyl-N′-phenyl-p-phenylenediamine [101-72-4] (Sh)
D-Limonene [5989-27-5] (Sh)
D,L-Limonene [138-86-3] and similar mixtures (Sh)
L-Limonene [5989-54-8] (Sh)
Maleic anhydride [108-31-6] (Sah)
Manganese ethylenebis(dithiocarbamate) (Maneb) [12427-38-2] (Sh)
Merbromin [129-16-8] (Sh)
2-Mercaptobenzothiazole [149-30-4] (Sh)
Mercury [7439-97-6] and its inorganic compounds (as Hg) (Sh)
Mercury, organic compounds (Sh)
Methacrylic acid ethyl ester [97-63-2] (Sh)
Methacrylic acid 2-hydroxypropyl ester [923-26-2] (Sh)
Methacrylic acid methyl ester [80-62-6] (Sh)
★ Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] (Sh)
releases formaldehyde

Methyl acrylate [96-33-3] (Sh)
N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard) [51-75-2] (Sh)
N,N′-Methylenebis(5-methyloxazolidine) [66204-44-2] (Sh)
4,4′-Methylene diphenyl diisocyanate (MDI) [101-68-8] (inhalable fraction) see also “polymeric MDI” (Sah)
2-Methyl-4-isothiazolin-3-one [2682-20-4] (Sh)
★ N-Methylolchloroacetamide [2832-19-1] (Sh)
releases formaldehyde

2-Methyl-2-propanethiol [75-66-1] (Sh)
Methyltetrahydrophthalic anhydride [11070-44-3] (Sa)
N-Methyl-N,2,4,6-tetranitroaniline [479-45-8] (Sh)
Methyl vinyl ketone [78-94-4] (Sh)
Microbial rennets: endothiapepsin and mucorpepsin (Sa)
Monomethylhydrazine [60-34-4] (Sh)
2-(4-Morpholinylmercapto)benzothiazole [102-77-2] (Sh)
Naled [300-76-5] (Sh)
1,8-Naphthalic anhydride [81-84-5] (Sh)
1,5-Naphthylene diisocyanate [3173-72-6] (Sa)
Natural rubber latex [9006-04-6] (Sah)
Nickel and nickel compounds (inhalable fraction) (Sah)
Regarding compounds which have been found to be unequivocally carcinogenic in man, see documentation. There is sufficient evidence of sensitizing effects on the respiratory tract only for water-soluble nickel compounds.

4-Nitro-4′-aminodiphenylamine-2-sulfonic acid [91-29-2] (Sh)
★ 4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) (Sh)
In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.

p-Nitrocumene [1817-47-6] (Sh)

2-Nitro-p-phenylenediamine [5307-14-2] (Sh)
Oakmoss extracts (Sh)
2-Octyl-4-isothiazolin-3-one [26530-20-1] (Sh)
Olaquindox (N-(2-Hydroxyethyl)-3-methyl-2-quinoxalinecarboxamide 1,4-dioxide) [23696-28-8] (SP)
Palladium [7440-05-3] and palladium compounds
  Palladium chloride [7647-10-1] (Sh)
  bioavailable palladium(II) compounds (Sh)
Papain [9001-73-4] (Sa)
Pentaerythritol triacrylate [3524-68-3] (Sh)
2,3-Pentanedione [600-14-6] (Sh)
Pepsin [9001-75-6] (Sa)
o-Phenylenediamine [95-54-5] (Sh)
m-Phenylenediamine [108-45-2] (Sh)
p-Phenylenediamine [106-50-3] (Sh)
The “Ursol-Asthma” which used to be observed frequently, especially in persons dyeing furs with p-phenylenediamine, has not been demonstrated unequivocally to involve respiratory allergy to p-phenylenediamine; see documentation.

Phenyl glycidyl ether (PGE) [122-60-1] (Sh)
Phenylhydrazine [100-63-0] (Sh)
Phenyl isocyanate [103-71-9] (Sah)
N-Phenyl-1-naphthylamine [90-30-2] (Sh)
N-Phenyl-2-naphthylamine [135-88-6] (Sh)
Phthalic anhydride [85-44-9] (Sa)
Phytases (Sa)
Picric acid [88-89-1] (Sh)
Picryl chloride [88-88-0] (Sh)
Piperazine [110-85-0] (Sah)
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N,N′-dinitrosopiperazine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

Platinum compounds (Chloroplatinates) (Sah)
A peak concentration of 2 µg/m^3 should not be exceeded.

“polymeric MDI” [9016-87-9] (inhalable fraction) see also 4,4′-Methylene diphenyl diisocyanate (MDI) (Sah)
“polymeric MDI” (pMDI) is a technical grade MDI, containing 30–80% w/w 4,4′-methylene diphenyl isocyanate (MDI); the remainder consists of MDI oligomers and MDI homologues.

Pyrethrum [8003-34-7] (Sh)
does not apply for the constituents of insecticides (pyrethrins and cinerins) or for synthetic derivatives (pyrethroids) but only for the constituents of the plant drug and its crude extracts, including α-methylene sesquiterpene lactones (e.g. pyrethrosin)

Quinone [106-51-4] (Sh)
Resorcinol [108-46-3] (Sh)
Ricinus protein (Sa)
Rosin (colophony) [8050-09-7] (Sh)
An immunological genesis of the asthma often seen in persons working with materials containing rosin has not been proved.

Rubber components
  Dithiocarbamates (Sh)
  Thiazoles (Sh)
  p-Phenylenediamine compounds (Sh)
  Thiurams (Sh)
Sesquiterpene lactones (Sh)
Sodium diethyldithiocarbamate [148-18-5] (Sh)
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

Soya bean constituents (Sa)
Subtilisins (Sa)
Tall oil, distilled [8002-26-4] (Sh)
only applies to tall oil distillates containing abietic acid, see also documentation

Tetraethylene glycol diacrylate [17831-71-9] (Sh)
Tetraethylene glycol dimethacrylate [109-17-1] (Sh)
Tetraglycidyl-4,4′-methylenedianiline [28768-32-3] (Sh)
Tetrahydrofurfuryl methacrylate [2455-24-5] (Sh)
Tetramethylol acetylenediurea [5395-50-6] (Sh)
releases formaldehyde

Thimerosal [54-64-8] (Sh)
Thioglycolates (Sh)

Thioglycolic acid [68-11-1] (Sh)
Thiram [137-26-8] (Sh)
Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodimethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

2,4-Toluenediamine [95-80-7] (Sh)
2,5-Toluenediamine [95-70-5] (Sh)
Toluene diisocyanates (Sah)
p-Toluidine [106-49-0] (Sh)
1,2,3-Trichlorobenzene [87-61-6] (Sh)
Triethylene glycol diacrylate [1680-21-3] (Sh)
Triethylene glycol dimethacrylate [109-16-0] (Sh)
Triethylenetetramine [112-24-3] (Sh)
Triglycidyl-p-aminophenol [5026-74-4] (Sh)
1,3,5-Triglycidyl isocyanurate (mixture of isomers) [2451-62-9]
  α-isomer [59653-73-5]
  β-isomer [59653-74-6] (Sah)
Triisobutyl phosphate [126-71-6] (Sh)
★ Trimellitic anhydride [552-30-7] (Sa)
Trimethylhydroquinone [700-13-0] (Sh)
Trimethylolpropane triacrylate [15625-89-5] (Sh)
Trimethylquinone [935-92-2] (Sh)
2,4,6-Trinitrotoluene [118-96-7] (Sh)
Triphenylphosphine [603-35-0] (Sh)
Tripropylene glycol diacrylate [42978-66-5] (Sh)
N,N′,N′′-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine [4719-04-4] (Sh)
releases formaldehyde

N,N′,N′′-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine [25254-50-6] (Sh)
releases formaldehyde

Trypsin and Chymotrypsin [9002-07-7; 9004-07-3] (Sa)
Turpentine [8006-64-2] (Sh)
Vinylcarbazole [1484-13-5] (Sh)
Woods
  Acacia melanoxylon R.Br., Australian blackwood (Sh)
  Brya ebenus DC., cocus wood (Sh)
  Chlorophora excelsa (Welw.) Benth. & Hook, iroko, kambala (Sh)
  Dalbergia latifolia Roxb., East Indian rosewood, Bombay blackwood (Sh)
  Dalbergia melanoxylon Guill. et Perr., African blackwood (Sh)
  Dalbergia nigra Allem., Brazilian rosewood (Sh)
  Dalbergia retusa Hemsl., cocobolo, rosewood (Sh)
  Dalbergia stevensonii Standley, Honduras rosewood (Sh)
  Distemonanthus benthamianus Baill., ayan (Sh)
  Grevillea robusta A.Cunn., Australian silky oak (Sh)
  Khaya anthotheca C.DC., African mahogany (Sh)
  Machaerium scleroxylon Tul., pao ferro, Santos rosewood (Sh)
  Mansonia altissima A.Chev., mansonia, pruno, bété (Sh)
  Paratecoma peroba (Record) Kuhlm., ipe peroba (Sh)
  Tectona grandis L.f., teak (Sh)
  Terminalia superba Engl. u. Diels, fraké, limba, afara, white afara (Sa)
  Thuja plicata (D.Don.) Donn., western red cedar, giant arborvitae, shinglewood (Sah)
  Triplochiton scleroxylon K.Schum., obeche, wawa, African whitewood (Sah)
Xylanases [37278-89-0] (Sa)
m-Xylylenediamine [1477-55-0] (Sh)
Ziram [137-30-4] (Sh)

e) Evaluation of members of specific groups of substances

For numerous substances, a reliable evaluation of the sensitizing effects according to the criteria described above is not possible. Often the substance of interest is one of the many members of a specific group of substances. Valid data for man are generally available only for individual members of such groups of substances, those considered to be typical of the group and commercially available as test substances because they are used for this purpose. With other less frequently used substances or substances for which no reliable data as to the extent of their use is available, patch tests are carried out relatively rarely, with some substances – because of the danger of sensitization – only in special cases. The effects in man are made even more difficult to assess because these substances are often used in mixtures with other members of the same group of substances and so can be involved in concomitant sensitizations and in cross-reactions. Mixtures containing members of other groups of allergenic substances are also often used and then too it is not readily possible to determine the causality of the observed disorder. In addition, it is not always possible to establish all the components of the mixture involved and so an allergologically relevant component can be missed. Therefore, substances which are not listed in the List of MAK and BAT Values and which belong to groups of substances known to be able to cause sensitization should be handled with appropriate care.

It is emphasized that in general there is no danger of sensitization from fully polymerized plastics. A danger of sensitization, but only little, can result from release of residual monomer, e. g. during mechanical processing.

The groups of substances of which numerous members have sensitizing effects on the skin or airways include:

- acrylates and methacrylates
- dicarboxylic acid anhydrides
- diisocyanates
- glycidyl compounds (epoxides)
- dusts containing enzymes
- certain plant or animal proteins

In current usage, the general expression **“isocyanate”** is used for both **monoisocyanates** and **di- or polyisocyanates**. These classes of compounds must be strictly differentiated with regard to the areas of use as well as the toxicological and allergological properties: monoisocyanates such as methyl isocyanate or phenyl isocyanate are used practically almost exclusively during syntheses as precursors or intermediate products, for example in the production of insecticides or pesticides. On the other hand, diisocyanates in particular are used in the production of polyurethanes, which are processed to adhesives, insulating foams, lacquers, and foams. Findings of a sensitizing effect on the respiratory tract in humans are available almost only for diisocyanates because of the widespread use. Also monoisocyanates can have a marked irritating effect on the airways and a sensitizing effect on the respiratory tract cannot be excluded. However, data for the diisocyanates, which are assessed as potent respiratory allergens, does not justify classifying monoisocyanates as substances causing airway sensitization solely in analogy; an evaluation of the individual case is necessary.

The **antibiotics** are a group of substances which are very heterogeneous in chemical structure and in sensitizing effects. Persons may be exposed to these substances at work during isolation or production of the active principles, during preparation and packing of the medicines, and during their medical use in man and animals. Sensitization of the skin can result in the development of a systemic allergic reaction – including anaphylaxis – or haematogenic contact dermatitis after later parenteral use. Sensitization of the airways and allergic contact dermatitis have often been reported in persons exposed occupationally to β-lactam antibiotics (especially penicillins and cephalosporins). Allergic reactions after medicinal use of these antibiotics (enteral or parenteral), on the other hand, generally take the form of IgE-mediated reactions of immediate type. However, other immunological reactions such as medicinal skin eruptions and, in serious cases, also erythema exsudativum multiforme, Stevens-Johnson syndrome or Lyell’s syndrome can also develop. Some of the aminoglycoside antibiotics are also conspicuous for the relatively high rates of sensitization which they produce, especially as a result of application of medicaments to (chronically) eroded skin. Sensitization of the skin resulting from occupational contact with aminoglycosides has been reported more rarely. Individual macrolide antibiotics, especially those used in veterinary medicine, can cause immunological reactions in the airways and also (inhalation-mediated) contact dermatitis. Only rare individual cases of contact allergy or allergic airway reactions to most other macrolide antibiotics and to polyene or peptide antibiotics and tetracyclines have been reported.

Components of fragrance mixtures, another group of substances which differ widely in their structures, allergenic potencies and clinical significance, must also be evaluated individually. This becomes clear even on consideration of the components of the standard fragrance test mixtures. For many other fragrance components the clinical findings are inadequate because the substances are never or only very rarely used in patch tests. Non-occupational exposure to these practically ubiquitous fragrance mixtures can rarely be excluded and this makes the demonstration that sensitization was occupational more difficult.

V. Aerosols

a) General definitions

Aerosols are multiphase systems of particulate solids or liquids dispersed in gases, in particular in air. Aerosols which occur at the workplace include dusts, fumes and mists.

Dusts consist of particles of solid matter which have been produced mostly in mechanical processes or have been stirred up and dispersed in gases, in particular in air.

Airborne particles can be composed of compact fine particles and free ultrafine primary particles but can also consist of their aggregates or agglomerates. The following nomenclature will be used:

- **Primary particles** are compact single particles which are recognizable as such under the electron microscope, even when they are associated with other aggregates or agglomerates.
- **Aggregates**[33)][34)] are groups of primary particles which are firmly bound with each other.
- **Agglomerates**[33)][34)] are groups of particles (primary particles or aggregates), which are held together by weak forces (in particular van der Waals forces). They can be broken apart again into smaller units by input of a low level of energy (e. g. by treatment of an aqueous suspension with ultrasound).

Fibrous dusts consist of inorganic or organic fibres of certain dimensions dispersed in gases, in particular in air (see Section III “Carcinogenic substances, Fibrous dust”). Inorganic fibrous dusts arise during mechanical processing especially of fibrous minerals and of products made from or containing natural or man-made fibres. Fibre-shaped fragments of non-fibrous minerals and of non-fibrous products also count as fibrous dust. Fibres can also be released by erosion processes.

Fumes are dispersions of very finely divided solid matter in gases, in particular in air. They arise in thermal processes (e. g., welding fumes, metal oxide fumes, soot and flue ash) or chemical processes (e. g., the reaction of ammonia with hydrogen chloride).

Mists are dispersions of particulate liquids (droplets) in gases, in particular in air. They arise during nebulization of liquids, during condensation from the vapour phase and during chemical processes (e. g., oil mist, hydrogen chloride in damp air).

Ultrafine particles and their aggregates and agglomerates see Section Vh.

Ultrafine particles as components of dusts and fumes are identified by a mobility-equivalent diameter (D_M) < 100 nm (corresponds to a diffusion-equivalent diameter (D_{ae}) < 100 nm) (see Section Vh and documentation “Aerosols – Dusts, Fumes and Mists” 1999[35)]).

The **respirable dust fraction (R)** and the **inhalable fraction (I)** of the dust are the aerosol fractions relevant for health (according to DIN/EN 481) for which limit values apply (see Section Vd).

b) Properties of aerosols which determine their effects

Particulate substances encountered at the workplace can cause various disorders of the respiratory organs. These are mostly a result of overloading of the lung, or of carcinogenic, fibrotic (fibrogenic) or allergenic effects, or of chemical irritation or toxicity. The effects are determined in part by the site of deposition of inhaled particles or droplets in the respiratory tract. The deposition pattern of the particles or droplets and the intensity and rapidity of appearance of the effects are determined essentially by the size, mass, specific density, shape, surface area, chemical composition, biopersistence, solubility, and hygroscopic properties of the particles.

These parameters can act independently of one another as well as in combination. The effects of coarser particles are largely proportional to the mass or the volume.

[33)] The terms “aggregates” and “agglomerates” are not used uniformly on the international level. See, for example, the definitions of ISO 14887, NIST, BSI, IUPAC, etc.

[34)] When measuring the shape and size of airborne particles in aerosols, it is not possible to differentiate between compact particles and aggregates and agglomerates of the same size. It is also not possible to differentiate between liquid droplets and solid particles. As it is not possible to differentiate between aggregates and agglomerates in air measurements, even with an electron microscope, the groups of ultrafine primary particles observed are often summarised in practice as “aggregates and agglomerates (A+A)”.

[35)] Greim H, editor (1999) Aerosols – Dusts, Fumes and Mists. MAK Value Documentation, 1997. In: Occupational Toxicants. Volume 12. Weinheim: Wiley-VCH. p. 271–292. Also available from https://doi.org/10.1002/3527600418.mb0aeroaere0012

With all **aerosols of ultrafine particles** as compared with coarser particles, an important role is played by the large specific surface area, the low density of the agglomerate compared with the material density of ultrafine particles, the slight solubility and the uptake into the cells. These properties of ultrafine particles can result in other toxicologically relevant effects. When aggregates or agglomerates of ultrafine particles are deposited, their effects also depend on whether they disaggregate or not in the fluid environment of the lung.

In the milieu of the lung fluids, particulate substances have as a rule a bioavailability other than indicated by the physicochemical solubilities reported in the literature, which are mostly determined in water, or where appropriate also in other solvents. Thus, the poor solubility suggested by the reported data for a substance is not directly applicable to the lung tissue. With the diversity of particles deposited in the lung fluids, also changes in toxicity can occur in individual cases through masking and demasking, e. g., in the presence of particles with adsorbing surfaces.

In lung fluids, not only the dissolution of particles (such as metal particles) and the absorption of dissolved substances are observed, but also changes in the crystalline structure. For example, certain glass fibres become jelly-like (that is, they lose their rigidity and become rubberlike), or chrysotile fibres are split into their individual fibrils, which in this case causes an increase in the number of particularly fine fibres. Such processes of splitting have now been identified for other fibrous substances. The properties of ultrafine fibres (such as nanotubes) have not yet been adequately investigated.

c) Inhalation, deposition and clearance of aerosols in the respiratory tract

Uptake

The uptake of dusts and fumes into the body takes place mostly via the airways. Mists can also be taken up in relevant amounts through the skin.

Transport and deposition of particulate solids and droplets in the airways are determined by the size, shape and specific density of the particles or droplets.

The distribution of the inhaled aerosol within the various parts of the airways is affected not only by the properties of the particles but also markedly by:

1. individual differences in the anatomy of the airways,
2. individual breathing habits, especially the different transition from nasal to oral breathing during physical activity and differences in respiration rate, respiratory flow and thus respiratory volumes,
3. pathophysiological changes in the respiratory organs (e. g. obstructive airway disease).

The critical dimension for aerosol particles with a diameter > 0.5 µm is the **aerodynamic diameter** (D_{ae}). The aerodynamic diameter of a particle whatever its shape and density is defined as the geometric diameter of a sphere with the density 1 g/cm^3 which sediments at the same rate as the particle in still or laminarly flowing air. This definition also applies for fibrous particles. The aerodynamic diameter of a fibre is determined essentially by the diameter of the fibre and less by its length. For long fibres (l >> d) the aerodynamic diameter is about three times the fibre diameter.

For isometric particles with diameters less than 0.5 µm, the **diffusion-equivalent diameter** (D_d) determines the site of deposition in the airways. The diffusion-equivalent diameter of a particle is defined as the geometric diameter of a sphere which diffuses at the same rate as the particle in the same dispersion medium (at the workplace, in air).

On principle, it is necessary to distinguish between the aerosol fractions which enter the various regions of the airways during inhalation and exhalation and the parts of these fractions which are deposited in these airway regions.

Deposition can take place during inhalation or during exhalation. Some of the inhaled particles are not deposited in the airways but are exhaled.

Of particular importance for occupational health are the aerosol fractions which penetrate into the respirator organs and are deposited there; they are described below (Figure 1).

Only a fraction of the total particles present in the breathing zone (the part designated as the **inhaled fraction**) is inhaled. It is determined by the flow rates into the mouth and nose as well as the conditions of air flow around the head. Whereas almost all the smaller particles (D_{ae} < 5 µm) are inhaled, the fraction of particles which can be inhaled decreases with increasing particle size.

Of the particles in the inhaled fraction, larger solid particles and droplets (D_{ae} > 15 µm) are deposited almost exclusively in the extrathoracic region, i. e., in the region of the nose, pharynx and larynx.

Of the **fraction which enters the thorax (thoracic fraction)** some of the smaller solid particles and droplets are deposited in the tracheobronchial region or in the alveolar region.

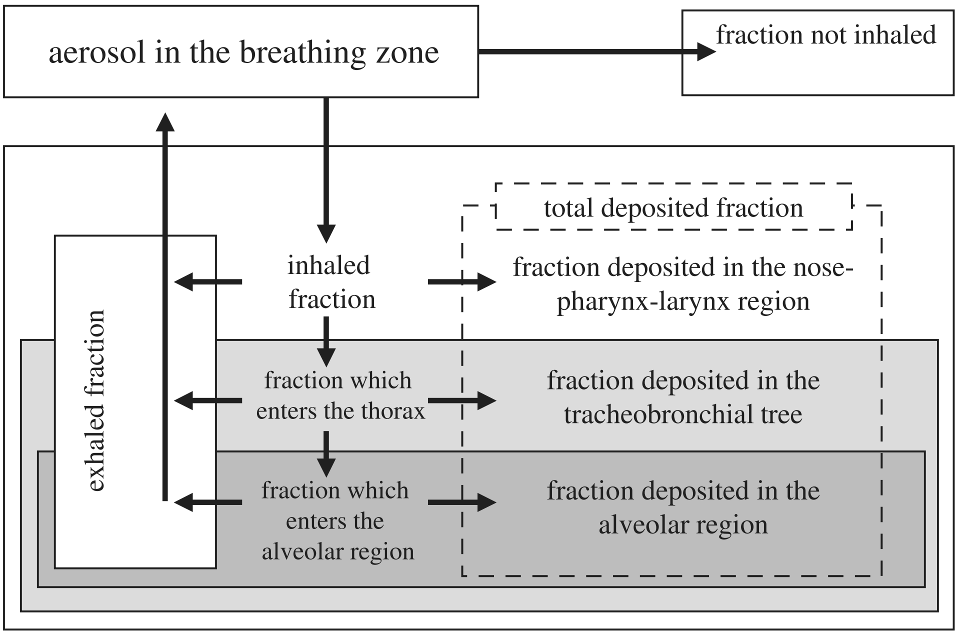

Figure 1. Subdivision of the aerosol in the breathing zone according to occupational medical criteria and deposition behaviour of the fractions.
The transfer of the inhaled fraction of the aerosol in the breathing zone into the thorax and the alveolar region, i. e., the alveoli, the non-ciliated bronchioles and the alveolar ducts, is represented by arrows. The arrows pointing to the right show the fractions deposited in the three regions of the respiratory tract, those pointing to the left show the contribution from these regions to the exhaled fraction.

The **fraction which enters the alveolar region (respirable fraction)** contains those particles which can penetrate into the airway regions which are not ciliated, i. e., the alveoli, the terminal non-ciliated bronchioles and the alveolar ducts; some of this fraction is deposited there.

Deposition and Clearance

Fraction deposited in the nose-pharynx-larynx region (extrathoracic fraction)

This is the aerosol fraction which is deposited after inhalation in the region of the nose, the mouth, the throat and the larynx; part of this fraction can be swallowed and so enter the digestive tract. The clearance from this region of the respiratory tract is complete within a few hours at most (Figure 2).

Fraction deposited in the tracheobronchial region

This is that part of the fraction which enters the thorax which is deposited in the region of the tracheobronchial tree in which the mucociliary clearance mechanism operates.

Isometric particles with diameters > 7 µm are completely eliminated from the tracheobronchial region of a healthy person within one day. There is evidence that some of the smaller particles and especially ultrafine particles may persist for several weeks in the tracheobronchial region. The rate of transport out of this region decreases with decreasing particle size.

Fraction deposited in the alveolar region

This is the fraction of the aerosol which is deposited in the alveolar region including the non-ciliated bronchioles (bronchioli respiratorii) and the alveolar ducts (ductuli alveolares). In this region there is no mucociliary clearance. This aerosol fraction can be transferred via the pulmonary interstitial tissue (interstitium) into the lymphatic system and especially ultrafine particles can also enter the blood capillaries. Alveolar macrophages can take in particles by phagocytosis and transport these through the tracheobronchial tree; swallowing then transfers them into the

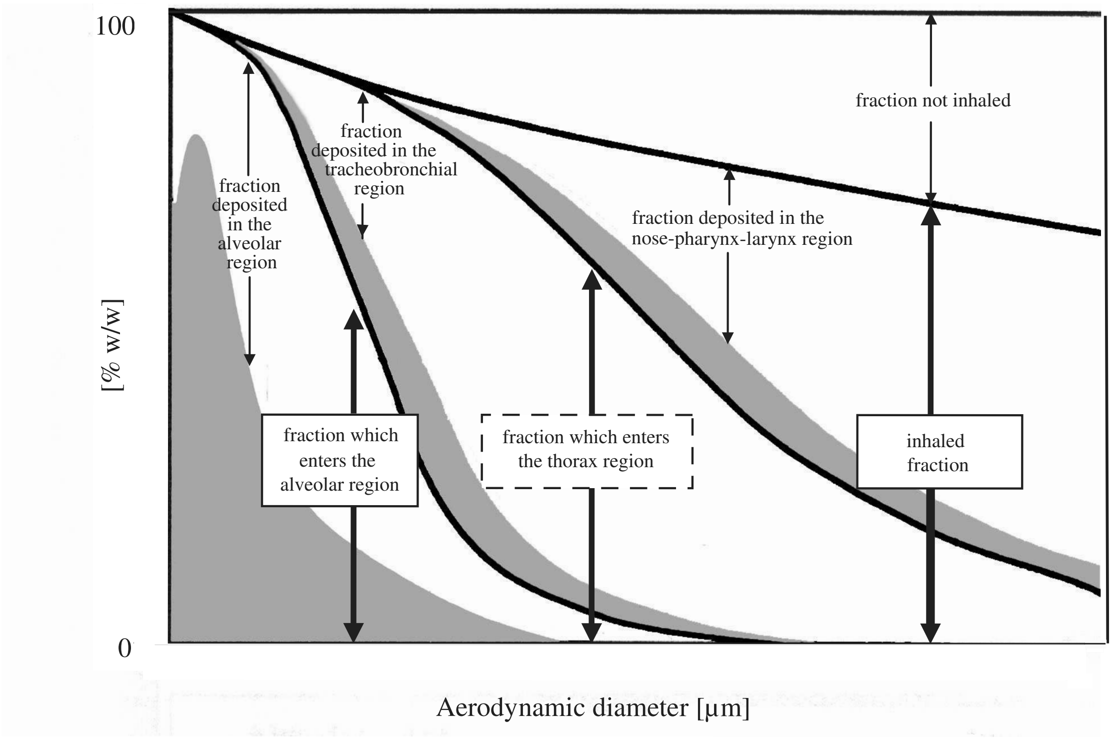

Figure 2. Diagram showing the fractions of the aerosol in the respiratory organs which are relevant for occupational health. Alongside the curves for the fractions deposited in the various regions, the fractions exhaled from those regions are shown as shaded areas. The two fractions in solid boxes are those corresponding to the conventions for measuring particle concentrations for checking the observance of MAK values.

digestive tract. The half-times for the elimination from the lung of insoluble particles deposited in the alveolar region are of the order of months or years.

Total deposited fraction

The total deposited fraction is that aerosol fraction which is inhaled but then not exhaled. This fraction includes the particles and droplets deposited in the nose, pharynx and larynx, the tracheobronchial tree and the non-ciliated deeper airways, and thus the entire range of the inhalable dust fraction.

It should be remembered that deposited droplets and soluble particles spread on the surfaces of the respiratory organs and lose their droplet or particulate form. Soluble components can be absorbed, which means that the constituents of the dissolved particles may be distributed and their cellular effects may no longer be only localized. They can enter the circulation and the lymphatic system and have systemic effects.

The insoluble fraction can be phagocytised by macrophages or, with certain limitations, be taken in by lung epithelial cells and transported from the alveolar region into the interstitial tissue. Especially ultrafine particles can enter the bloodstream by this route. Components which are neither dissolved nor absorbed can be transported from the tracheobronchial tree towards the larynx by mucociliary clearance, as can particles deposited in the nose-pharynx-larynx region. From there, they are swallowed, enter the digestive system and perhaps have effects there, or they are removed from the breathing zone or the body by coughing up and spitting out or by blowing of the nose.

d) Conventions for measuring concentrations of particles: definition of fractions

Measured particle concentrations should reflect the concentrations of those particles responsible for the pathogenic effects in the respiratory organs, as described in Section c. This requires that in sampling and assay devices the particles from the air are fractionated according to their aerodynamic diameters in a way which reflects the deposition pattern of the particles in the airways during breathing.

However, for measuring and sampling devices for the determination of various particle fractions in the workplace air, international conventions have been established for only three deposition curves (see DIN/EN 481, 1993)[36]). They are based on average analytical values obtained under defined experimental conditions for the aerosol fractions which enter the various regions of the respiratory organs.

Thus the analytical methods yield data for the three fractions which may be deposited, in each case including the fraction which is exhaled. That means that the aerosol fractions determined are those which enter the regions of the lung which are relevant for occupational health (see Figures 1 and 2).

1. **Inhalable fraction (I):** the deposition curve expresses, as a function of aerodynamic diameter, the mean probability that particles and droplets will be inhaled (inhaled fraction).
2. **Thoracic fraction:** the curve for this part of the inhalable fraction expresses, as a function of aerodynamic diameter, the mean probability that particles and droplets will enter the tracheobronchial tree and the alveolar region (fraction which enters the thorax).
3. **Respirable fraction (R):** the curve for this part of the thoracic fraction expresses, as a function of aerodynamic diameter, the mean probability that particles and droplets will enter the alveolar region (fraction which enters the alveolar region).
4. **Extrathoracic fraction:** this fraction is obtained by subtracting the thoracic fraction from the inhalable fraction.
5. **Tracheobronchial fraction:** this fraction is obtained by subtracting the alveolar fraction from the thoracic fraction.

The use of this analytical procedure for hygroscopic particles is justified by the fact that their aerodynamic diameters increase during transport into the respiratory organs as a result of uptake of water and that therefore the sites of deposition and proportion of particles deposited cannot be predicted.

The definitions of the "inhalable fraction" (I)[37]) and "respirable fraction" (R)[38]) correspond to the definitions of **"total dust"** (G) and **"fine dust"** (F) used until 1996 in the establishment of MAK values[39]). Since 1996 the internationally accepted definitions have been used.

e) Fibrogenic aerosols

As fibrogenic dusts are designated aerosols, including droplet aerosols, which contain insoluble particles which can cause dust lung diseases (e. g. silicosis) involving formation of connective tissue. Prerequisite for the development of such disorders is the deposition of the aerosol in the alveolar region. Therefore, the effective levels of fibrogenic aerosols are determined after sampling the respirable fraction (R) (previously "fine dust", (F)).

f) General limit value for dust

The "general limit value for dust" is established as a concentration of the respirable fraction (R) of biopersistent granular dusts[40]) of 0.3 mg/m^3 [41]) for dusts with a density of 1 g/cm^3 and a concentration of the inhalable fraction (I) of 4 mg/m^3.

Excursions above the limit value as described in Section Vg are permitted for the inhalable fraction. The permitted excursions may not exceed the "general limit value for dust" by a factor of more than two (see documentation "Aerosols – Dusts, Fumes and Mists" 1999[42])).

Observance of the general limit value for dust should prevent unspecific effects of dust (e. g. overloading effects) on the respiratory organs. The general limit value applies for poorly soluble and insoluble dusts which are not subject to other regulations and for mixtures of dusts even when for individual components of a dust specific MAK

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[36]) DIN (Deutsches Institut für Normung), editor (1993) DIN EN 481:1993-09 Workplaces atmospheres; size fraction definitions for measurement of airborne particles; German version EN 481:1993. Berlin: DIN Media. https://doi.org/10.31030/2582934

[37]) German: "E" for "Einatembare Fraktion"

[38]) German: "A" for "Alveolengängige Fraktion"

[39]) DFG (Deutsche Forschungsgemeinschaft), editor (1995) List of MAK and BAT Values. Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area, Report No. 31, p. 132. Weinheim: VCH
Kenny LC (1995) Pilot study of CEN protocols for the performance testing of workplace aerosol sampling instruments. Final report of the European contract MATI-CT92-0047. Sheffield: Health and Safety Executive
DGUV (Deutsche Gesetzliche Unfallversicherung e.V.), editor (2023) Messung von Gefahrstoffen – IFA-Arbeitsmappe. Berlin: Erich Schmidt Verlag

[40]) with the exception of ultrafine particles; see Section Vh

[41]) for dusts with a density of 1 g/cm^3

[42]) Greim H, editor (1999) Aerosols – Dusts, Fumes and Mists. MAK Value Documentation, 1997. In: Occupational Toxicants. Volume 12. Weinheim: Wiley-VCH. p. 271–292. Also available from https://doi.org/10.1002/3527600418.mb0aeroaere0012

values exist and are observed. The general limit value does not apply for soluble particles, especially not for salts from rock salt and potash deposits, or for ultrafine (see Section Vh) or dispersed coarse particle fractions.

Even when the general limit value for dust is observed, a health hazard may be ruled out only if it has been demonstrated that other substance-specific effects of the dust are not to be expected.

g) Exposures exceeding the MAK value

MAK values for aerosols which are designated with a reference to Section Vg have been derived from average long-term exposure levels without detectable effects (no observed adverse effect levels, NOAEL).

Impairment of respiratory organ function by these dusts is a result of long-term effects which are determined largely by the aerosol concentration to which the person is exposed over long periods of time. The MAK values correspond to the average long-term exposure levels without detectable effects (NOAEL) but apply to the concentration values averaged over a single shift. As the long-term exposure level is an average of variously high shift average levels, the occasional exceeding of the MAK value by single shift average levels can be tolerated. The permitted frequency and extent of the excursions above the MAK value are established on the basis of occupational medical and toxicological findings (see documentation "Derivation of MAK values for dusts from long-term threshold values" 1998[43]). In these cases the peak limitation categories do not apply.

For all other aerosols the peak limitation categories must be observed (see Section VI "Limitation of exposure peaks").

h) Ultrafine particles, their aggregates and agglomerates

Ultrafine primary particles are measured according to their mobility-equivalent diameter (D_M) < 100 nm (corresponds to a diffusion-equivalent diameter (D_{ae}) < 100 nm). They can occur as single particles in the workplace air or more often as basic units of aggregates and agglomerates. In these forms they can be seen under an electron microscope.

For the characterization of the potential danger associated with **ultrafine primary particles** and their aggregates and agglomerates, the following aspects are of significance.

- The particles are formed mostly in combustion processes and gas phase reactions.
- The mechanisms of deposition in the respiratory tract involve the Brownian motion of the particles.
- The effects of the particles in the respiratory tract increase not so much in proportion to the weight as in proportion to the surface area or number of particles per air volume.
- The probability of aggregate or agglomerate formation depends also on the concentration of primary particles in the workplace air.

Notes:

Depending on the definition of the limit value, for **dusts** and **fumes** either the inhalable fraction "I" or the respirable fraction "R" is determined. For **mists**, the inhalable fraction "I" is determined.

Sampling devices which sample fine dust according to the Johannesburg convention, which used to be used in Germany, fulfil the requirements of DIN/EN 481 for the sampling of respirable dust.

When sampling devices are used which collect fractions for assay according to deposition functions which differ from those described above, the results must be corrected using a correction factor which is dependent on the particle size distribution. The validity of the procedure must be documented.

It must be emphasized that the total dust fraction (G) which used to be determined in Germany and also the inhalable dust fraction (I) used today may not be automatically assumed to be equivalent to **"total dust"**, a term which is still widely found in the international literature. The term "total dust" does not describe a standardized dimension. Sampling devices which collect "total dust" must be validated.

The fractions PM_{10} and $PM_{2.5}$ collected during sampling of environmental air outdoors are defined by ISO 7708. PM_{10} corresponds to the thoracic fraction (function with 50 % deposition at 10 µm) whereas $PM_{2.5}$ is described by a curve with 50 % deposition at 2.5 µm. The respirable dust fraction (R) would therefore correspond to PM_4.

For the determination of **fibrous dusts**, fractions are not defined according to aerodynamic criteria. Instead the fibre lengths and diameters must be determined microscopically (see Section III "Carcinogenic substances, Fibrous dusts").

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[43]) Greim H, editor (1998) Derivation of MAK values for dusts from long-term threshold values. MAK Value Documentation, 1996. In: Occupational Toxicants. Volume 11. Weinheim: Wiley-VCH. p. 281–301. Also available from https://doi.org/10.1002/3527600418.mb0lsppere0011

VI. Limitation of exposure peaks

MAK values are conceived and applied as 8-hour time-weighted average values. The actual concentrations of substances in the workplace air are, however, frequently subject to considerable variation. Excursions above the average value must be limited in order to prevent local irritation, unreasonable annoyance and adverse systemic effects. For reasons of analytical practicability, peak values for the substances have been established for a 15-minute average. For a discussion of the use of longer sampling periods see documentation “Peak limitation” 2017[44]).

The effects on health of exceeding the MAK value for brief periods depend decisively on the mode of action of the substance in question. Since the year 2000, substances have been assessed individually and substance-specific excursion factors (ratio of permitted short-term peak value to the MAK value) have been established. For substances in Category I, the MAK value in the 15-minute average may generally not be exceeded (excursion factor = 1 is the default value) unless the available data permit the establishment of a different excursion factor. For some substances excursion factors > 1 have been derived. For substances in Category II, the default value is 2. For this group of substances, in appropriate cases, excursion factors deviating from the base value have been established. The permitted frequency per shift of excursions above the MAK value, the minimum period between individual exposure peaks, and the total permitted duration of excursions above the MAK value are to be seen as a convention. For all substances, however, the 8-hour time-weighted average value must be observed[45]).

This concept takes into account both the toxicological situation and the analytical practicability.

Thus, the two categories shown in the table below have been established for the limitation of peak concentrations at the workplace; see also documentation “Peak limitation” 2017, 2024[44]).

★ Excursion factors, duration, number per shift and interval between the peaks

	Category	Excursion factor	Duration	Number per shift	Minimum interval[c)]
I	Substances with immediate effects (irritants) or which cause sensitization of the airways	1[a)]	15 min, average value[b)]	4	1 h
II	Substances with delayed effects (systemic effects or effects in the lungs after repeated exposure)	2[a)]	15 min, average value	4	1 h

a) default value, or a substance-specific value (maximum 8)
b) In certain cases, a momentary value (concentration which should not be exceeded at any time) can also be established.
c) only for excursion factors > 1

In Section IIa of the List of MAK and BAT Values, the Peak limitation category for each substance is listed and in brackets also the appropriate excursion factor. Carcinogenic substances without a MAK value have no entry (–).

A description of analytical methods for monitoring workplaces and documentations for the individual substances has been published in “The MAK Collection for Occupational Health and Safety”[46]).

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[44]) Hartwig A, MAK Commission (2017) Peak limitation: Limitation of exposure peaks and short-term exposures. MAK Value Documentation, 2011. MAK Collect Occup Health Saf 2(1): 1–6. https://doi.org/10.1002/3527600418.mbpeakexpe5117
Hartwig A, MAK Commission (2024) Peak limitation: redefinition of the short-term exposure categories. MAK Value Documentation, addendum – Translation of the German version from 2024. MAK Collect Occup Health Saf 9: in preparation

[45]) but see Section Vg

[46]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

VII. Percutaneous absorption

At the workplace the absorption of substances through the skin can make a significant contribution to the systemic exposure of the employee or can even be the main exposure route.

The only relevant barrier to absorption of substances at work is the horny layer (stratum corneum) of the skin. The ability of a substance to penetrate this barrier is determined by its physicochemical properties. The rate of dermal penetration is also affected by workplace conditions and by individual factors. Solid, liquid and gaseous substances can be taken up percutaneously. For many substances the skin acts as a depot from which absorption continues even after the end of exposure. Normal working clothes do not generally provide any protection against percutaneous absorption. Quantification of the amount of a substance absorbed through the skin can only be realized by biological monitoring (see Section XI).

Substances are designated with an “H” if through dermal exposure the observance of the MAK value on its own no longer guarantees the prevention of important adverse effects on health which were considered for establishment of the limit value. In addition to systemic effects these can also include the sensitization of the respiratory tract if it has been demonstrated to be induced by skin contact. Substances are not designated with an “H” if toxic effects are not to be expected under workplace conditions, independent of the ability of the substance to penetrate the skin. It may not be assumed that the absence of a designation with “H” means that wearing inhalation protection is sufficient to adequately protect an employee from the substance if the MAK value can not be observed. Under these conditions, considerable absorption from the gas phase was detected, especially for amphiphilic substances. Substances in section IIb are dealt with in analogy to substances with MAK values and designated with “H” when a toxicologically relevant uptake can be assumed and one of the criteria for designation is fulfilled. Carcinogenic substances in Categories 1 and 2 and suspected carcinogens without a MAK value in Category 3 are designated with an “H” whenever it appears that dermal absorption can make a significant contribution to a person’s body burden. For an assessment of the measures necessary for adequate occupational hygiene, the reader is referred to the documentation for the substance in question.

A substance is designated with an “H” when one of the criteria listed below is fulfilled:

1. Designation with “H” on the basis of workplace studies

Field studies or scientifically documented casuistics demonstrate that percutaneous absorption is significant in practice in persons handling the substance:

The percutaneous absorption is certainly responsible for part of the systemic dose and can contribute to toxic effects.

2. Designation with “H” on the basis of animal studies

Percutaneous absorption can be demonstrated in animal studies and the exposure can contribute to toxic effects.

3. Designation with “H” on the basis of in vitro studies

A relevant level of percutaneous absorption which can contribute to toxic effects has been quantified with recognized methods. The flux through the skin has been determined and the permeability constant has been or may be calculated, or details of percentage absorption of the applied dose (percentage absorbed per unit of time and skin surface area) are available.

4. Designation with “H” on the basis of theoretical models

On the basis of data for analogous substances or calculations with mathematical models, a relevant level of percutaneous absorption may be expected.

The criteria 1 to 4 are arranged in order of decreasing significance; data obtained with exposed persons are most important. The quantitative criteria are described in detail in “Criteria for designation with an H”[47]).

The designation “H” is shown in the List of MAK and BAT Values and does not indicate that the substance can cause skin irritation.

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[47]) Hartwig A, MAK Commission (2017) Criteria for designation with an “H”. MAK Value Documentation, 2014. MAK Collect Occup Health Saf 2(3): 1112–1118. https://doi.org/10.1002/3527600418.mb0hmrkkrie5617

VIII. MAK values and pregnancy

Observance of the MAK values and BAT values does not guarantee, in every case, that the unborn child is reliably protected because numerous substances have not yet been investigated or have been only partially tested for prenatal toxicity.

Definition

The expression “prenatal toxicity” or developmental toxicity is taken in its broadest sense by the Commission; it includes any effect of the substance which elicits an alteration from the physiological norm in the development of the organism and leads to prenatal or postnatal death of the offspring or to permanent morphological or functional damage.

Effects in humans

Epidemiological studies that yield evidence of toxic effects of substances on the human embryo or foetus are of particular importance for the assessment. Limitations of such studies such as methodological weaknesses, low statistical power, mixed exposure, personal influencing factors and lifestyle make it difficult to draw clear conclusions about substance-specific effects and effect thresholds.

Animal Studies

The evaluation of the developmental toxicity of substances is based mainly on animal studies. Studies which have been carried out according to internationally recognized testing guidelines such as OECD or similar test guidelines (e. g. EU, Japan) play a decisive role. The OECD Test Guideline 414 in particular is appropriate for the determination of prenatal toxicity. Testing for perinatal and postnatal toxicity, to a limited extent also for prenatal toxicity, is carried out in one-generation studies according to OECD Test Guideline 415 (valid until 27 December 2019), in extended one-generation studies according to OECD Test Guideline 443, in two-generation studies according to OECD Test Guideline 416 or in screening tests according to OECD Test Guidelines 421 and 422. If studies are available that were not conducted according to these guidelines, their validity is to be determined individually. The most important criteria are a sufficiently large number of animals, the use of different dose groups with derivation of a NOAEL (no observed adverse effect level), in-depth studies (external, skeletal and visceral examinations of the foetuses in the developmental toxicity studies) and adequate documentation of the results.

Inhalation studies are of particular importance in assessment of the prenatal toxicity of substances present at the workplace. Also studies with oral administration or dermal application can be taken into consideration if the available data do not present evidence against extrapolation to inhalative administration (e. g. by a pronounced “first pass” effect). Studies carried out with routes of administration which are not relevant in humans (e. g. intraperitoneal) are not included in the evaluation as a rule.

In studies with an oral route of administration, higher doses than those with inhalative or dermal application are usually possible. For this reason, effects are also reported which occur only in the high dose range. Therefore, the test guidelines mentioned consider 1000 mg/kg body weight to be the maximum dose to be tested (limit dose). Such high dose effects are mostly irrelevant for assessing prenatal toxicity at concentrations near the MAK value. Prenatal toxic effects which are observed in the presence of marked maternal toxicity are of low relevance for the situation at the workplace as they are prevented by observance of the MAK value. Findings at doses or concentrations at which no or only slight maternal toxicity is observed are of particular relevance.

The preferred animal species usually recommended in the test guidelines for prenatal developmental toxicity (OECD 414) are female rats and rabbits. The generation studies (e. g. OECD 415, 416 and 443) including the screening tests (e. g. OECD 421 and 422) are usually carried out only with rats of both sexes.

In order to take into consideration the different stage of maturity of organs at birth in rodents compared with in humans (e. g. brain and kidneys), in studies with rodents the evaluation of developmental toxicity may include exposure extending into the postnatal period.

To consider the factor of uncertainty in assessing animal studies, the margin between the NOAEL for developmental toxicity in animal studies and the resulting exposure level or body burden if the MAK or BAT value is observed must be adequate. The necessary margin depends on a number of very different factors:

- comparative toxicokinetic data for humans and animals
- toxicokinetic data for a substance in the dams and embryos or foetuses to evaluate differences in level of exposure between maternal and foetal organs/tissues

- If such data are not available, the evaluation of specific substance properties such as molecular size, lipid solubility and protein binding plays an important role; such data determine the transplacental transfer of the substance from the mother animal and the internal exposure of the embryos or foetuses.
- The kind and severity of the results observed are important factors. Serious effects such as the increased occurrence of specific malformations at doses not causing simultaneous maternal toxicity should receive more emphasis than rather transient unspecific or less severe foetotoxic effects such as slightly decreased foetal body weight or delayed skeletal maturation. Thus, determination of an adequate margin is a substance-specific process which will result in documentations based on different justifications.

Taking into consideration developmental neurotoxicity

For substances whose MAK or BAT value is derived from a neurotoxic effect, information on developmental neurotoxicity has been included since 2016. Developmental neurotoxicity is taken into consideration also in the following cases: if the critical effect for the derivation of the MAK or BAT value is not neurotoxicity, but a substance has neurotoxic effects and neonatal or juvenile animals have been found to be more sensitive than adult animals for the substance-induced neurotoxic effects. The most suitable means of evaluating developmental neurotoxicity are studies with prenatal exposure and investigations of neurotoxic end points in developing or adult offspring which take into consideration the effects observed in adult animals, such as studies carried out according to test guidelines for developmental neurotoxicity (OECD Test Guideline 426) or extended one-generation studies (OECD Test Guideline 443) and other suitable studies of developmental neurotoxicity. In addition, relevant information on the toxicokinetics and mechanism of action are included. Possible developmental neurotoxicity is taken into consideration in the classification of the substance in a pregnancy risk group.

⋆ Substances designated as suspected of causing prenatal toxicity (Group B (suspected prenatal toxicity))

Substances which could not be clearly assigned to Pregnancy Risk Group A, B or C due to a lack of data or the incomplete investigation of developmental (neuro)toxicity were previously classified in Pregnancy Risk Group D. Substances for which a MAK or BAT value could not be established (listed in Section IIb) or which were classified in Carcinogen Category 1, 2 or 3 (without a MAK value) were previously not evaluated for prenatal toxicity. In 2024, a new group (Group B (suspected prenatal toxicity)[48]) was introduced to distinguish these substances based on their potential for causing prenatal toxicity. A substance is classified in this group if there are reasons to suspect a hazard potential, but no or insufficient data are available to carry out a risk assessment and establish a MAK or BAT value.

Mechanistic data from in vivo studies, primarily those carried out according to OECD Test Guidelines 421, 422, 426 or 443, and in some cases from in vitro studies can be used as evidence of a hazard potential. The evaluation must determine whether it is sufficiently plausible to assume a realistic risk for humans.

⋆ Pregnancy risk groups

Based on the criteria mentioned, the Commission is evaluating substances with MAK or BAT values as to whether prenatal toxic effects are unlikely when the MAK value or the BAT value is observed (Group C), whether, according to the currently available information, such effects cannot be excluded (Group B) or whether they have been unequivocally demonstrated (Group A). Since 2024, every substance is investigated for its potential for causing prenatal toxicity (Group B (suspected prenatal toxicity)) if not enough data are available to make a reliable assessment of the risks in relation to the MAK or BAT value. For a number of substances, however, it is not yet possible to make a statement as to prenatal toxicity (Group D). This is described in detail in the respective documentation.

The following pregnancy risk groups are defined:

Group A: Damage to the embryo or foetus in humans has been unequivocally demonstrated and is to be expected even when MAK and BAT values are observed.

Group B: According to currently available information damage to the embryo or foetus cannot be excluded after exposure to concentrations at the level of the MAK and BAT values. The documentation indicates, when the Commission’s assessment of the data makes it possible, which concentration would correspond to the classification in Pregnancy Risk Group C. Substances with this indication have the footnote *“Note regarding prerequisite for Group C, see documentation”*.

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[48] Hartwig A, MAK Commission (2024) Pregnancy groups: new group B (suspected prenatal toxicity). MAK Value Documentation, addendum – Translation of the German version from 2024. MAK Collect Occup Health Saf 9: in preparation

Group B (suspected prenatal toxicity): The available data give reason to suspect prenatal toxicity, but are insufficient to make a reliable assessment of the risks in relation to the MAK or BAT value.

Group C: Damage to the embryo or foetus is unlikely when the MAK value or the BAT value is observed.

Group D: Either there are no data for an assessment of damage to the embryo or foetus, including developmental neurotoxicity, or the currently available data are not sufficient for classification in one of the groups A, B or C or Group B (suspected prenatal toxicity).

Substances without a MAK or BAT value (carcinogenic substances or substances included in Section IIb) have no entry (–) or, if applicable, are assigned to Group B (suspected prenatal toxicity).

IX. Germ cell mutagens

Germ cell mutagens produce heritable gene mutations and heritable structural and numerical chromosome aberrations in germ cells. The consequences of germ cell mutations in subsequent generations include genetically determined phenotypic alterations without signs of illness, reduction in fertility, embryonic or perinatal death, more or less severe congenital malformations, and genetic diseases with various degrees of health impairment. The term “germ cell mutagenicity” refers specifically to mutagenicity in male and female germ cells and is distinguished from mutagenicity in somatic cells which can initiate cancer.

Epidemiological studies, however, have been unable to provide any evidence as yet that exposure to chemicals or to radiation results in hereditary diseases in man. Although structural changes have been demonstrated in the chromosomes of the germ cells of men exposed to radiation, even this finding can only provide indirect evidence that such exposures could lead to hereditary disorders in the offspring. The proof that an increased frequency of hereditary diseases is related to a particular exposure would be associated with great methodological difficulties. In the human population there are a large number of hereditary diseases of unknown origin with frequencies which differ widely in different subpopulations. Since mutational events occur largely randomly in the genome, it is not to be expected that one particular substance would induce one characteristic genetic disease. Therefore, it is most unlikely that proof of a causal relationship between exposure to a chemical and occurrence of heritable diseases will become available in the foreseeable future.

In this situation, for the identification of germ cell mutagens the results of animal experiments must be given particular attention. The mutagenic effect of chemicals on the germ cells of exposed parent animals can be demonstrated by observing an increased mutant frequency among the progeny. In addition, the demonstration of genotoxic effects of a substance in germ cells or somatic cells provides evidence of a potential hazard for subsequent generations.

The categories for classification of germ cell mutagens have been established in analogy to the categories for carcinogenic chemicals at the workplace.

1. Germ cell mutagens which have been shown to increase the mutant frequency in the progeny of exposed humans
2. Germ cell mutagens which have been shown to increase the mutant frequency in the progeny of exposed mammals

3A. Substances which have been shown to induce genetic damage in germ cells of humans or animals, or which produce mutagenic effects in somatic cells of mammals in vivo and have been shown to reach the germ cells in an active form
3B. Substances which are suspected of being germ cell mutagens because of their genotoxic effects in mammalian somatic cells in vivo; in exceptional cases, substances for which there are no in vivo data but which are clearly mutagenic in vitro and structurally related to known in vivo mutagens

4. not applicable (‡)
5. Germ cell mutagens or suspected substances (according to the definition of Category 3A and 3B), the potency of which is considered to be so low that, provided the MAK and BAT values are observed, their contribution to genetic risk for man is considered to be very slight

(‡) Category 4 carcinogenic substances are those with non-genotoxic mechanisms of action. By definition, germ cell mutagens are genotoxic. Therefore, a Category 4 for germ cell mutagens cannot apply. At some time in the future it is conceivable that a Category 4 could be established for genotoxic substances with primary targets other than the DNA (e. g. purely aneugenic substances) if research results make this seem sensible.

X. Substances requiring special consideration

a) Organic peroxides

The inflammatory and caustic effects of organic peroxides on the skin and mucous membranes vary considerably. For some of these compounds, even very small amounts of very dilute solutions produce severe necrosis of the skin or the cornea, resulting in loss of eyesight. Inhalation of the vapours causes various degrees of irritation in the respiratory passages. In practice, the danger of systemic effects is low. Sensitizations of the immediate type have been observed after inhalation of these substances. With hydroperoxides and with certain peroxides contact sensitization may be expected as well.

A number of organic peroxides have produced mutagenic effects in in vitro tests. In addition, tumours have been produced in animal experiments with, e. g., diacetyl peroxide, tert-butyl peroxide, dilauroyl peroxide and α,α-dimethylbenzyl hydroperoxide.

Effects on the skin in order of severity

Negligible or very weak effects on skin:	Di-tert-butyl peroxide	
	Dibenzoyl peroxide	(50 %)
	Dilauroyl peroxide	(50 %)
Moderate effects on skin:	tert-Butylhydroperoxide	
	tert-Butyl peracetate	(50 %)
Very severe effects on skin:	α,α-Dimethylbenzyl hydroperoxide (Cumene hydroperoxide)	
	Methyl ethyl ketone peroxide (2-Butanone peroxide)	(40 %)
	Cyclohexanone peroxide mixtures	(50 %)
	Dicyclohexyl peroxide	(50 %)
	Diacetyl peroxide	(30 %)
	Peroxyacetic acid	(40 %)

b) Gasolines

The Commission could not agree to assign a MAK value to “gasolines” because this term describes a number of very different mixtures such as motor gasolines (petrol), special boiling point gasolines, white spirits and pyrolysis gasolines. The toxicity of gasolines depends primarily on their content of aromatic compounds (benzene, toluene, xylenes, ethyl benzene, cumene), which varies markedly with the production method.

Procedures suggested for establishing MAK values by the mathematical evaluation of the composition of such mixtures of liquid solvents must be rejected on principle because such calculations cannot provide information as to the actual concentrations in the workplace air. Only when results are available from studies with defined gasoline-vapour mixtures (see Section I) can the Commission make any concrete statements.

Levels of additives such as 1,2-dibromoethane and 1,2-dichloroethane must be evaluated independently.

c) Metal-working fluids, hydraulic fluids and other lubricants

Definition

Lubricants are lubricating media based on mineral oils, natural oils or synthetic liquids. Lubricants in liquid form are to be viewed like metal-working fluids (DIN 51385) and lubricating greases of varying consistencies (DIN 51825). Hydraulic fluids are also included (DIN 51524), which are used for power transmission in hydrostatic/hydrodynamic systems and at the same time may enter the metal-working process, for example due to contamination.

When lubricants are defined according to type or field of application, automotive lubricants (motor oils, transmission oils) are differentiated from industrial lubricants, such as metal-working fluids and hydraulic fluids.

Chemically, lubricants are a heterogeneous group and have a complex composition. Metal-working fluids contain various substances which are also found in other lubricants. Therefore the substances which before 2013 had been listed separately in the List of MAK and BAT Values and in the documentations are now combined[49]). Hydraulic fluids have numerous components in common with both groups and are therefore also discussed here.

Metal-working fluids

Metal-working fluids are used to cool metallic workpieces and to increase the quality and speed of the cutting process (for example, turning, drilling, milling and cutting) and the service life of the tools.

During the shaping treatment and processing of workpieces (includes rolling and forming, for example), the fluids decrease friction and protect surfaces. They are subdivided into non-water miscible (earlier synonyms: honing oils, cutting oils, grinding oils and rolling oils) and water-miscible metal-working fluids. When used diluted with water, they are called water-mixed metal-working fluids, in practice also drilling fluid or emulsion and grinding water.

The modern non-water miscible metal-working fluids are generally multicomponent mixtures whose composition may vary considerably according to the intended use. They consist predominantly of base oils. These are either mineral oils (natural hydrocarbons, paraffinic or naphthenic), natural oils (such as rapeseed oils) or chemically synthesized oils such as synthetic ester oils (e. g. trimethyl propane esters and polyglycol ethers). Important technically desirable properties, such as load-carrying capacity, adjustment of the viscosity index and pour point are only achieved by including additives.

Essential additives are used for protection against wear, corrosion and ageing, as defoamers and as antimist additives and may also be surface-active substances (surfactants). Antioxidants prevent the degradation of lubricants, for example, while metal deactivators inhibit the catalytic activity and corrosion of non-ferrous metals.

Water-miscible metal-working fluids, which are typically used as water-mixed metalworking fluids at concentrations of 1 – 20 %, also contain additives such as emulsifiers, solubilisers, odour maskers and dyes. Biocides are used for the control of bacteria (preservation) in aqueous systems. As part of inspection/maintenance/care of water-mixed metal-working fluids, individual components may be added which do not always correspond to the original formulation of the manufacturer. For example, if there is increased bacterial growth, biocides might be added. Therefore, the composition may constantly vary in the course of time or during prolonged service lives.

The toxicological assessment of metal-working fluids is dependent on their composition and properties of their components, which differ greatly in number and proportion according to the intended use. The mineral oil component alone is therefore not representative of the potential effect. As a result, the MAK value of 5 mg/m^3 previously established for pure mineral oil is not applicable to present-day metal-working fluids since these are generally mixtures whose composition may vary considerably according to the intended use. For this reason, it is not possible to establish a single MAK value for all types of metal-working fluids. It is a substantial disadvantage that there is no regulation requiring declaration of components of metal-working fluids. Therefore, it is virtually impossible to make a systematic evaluation. New components and compositions are to be expected with advancing technology. Disclosure of the composition is an absolute requirement for an adequate assessment by the Commission.

Hydraulic fluids and other lubricants such as greases

Hydraulic fluids are operating liquids for hydrostatic/hydrodynamic power transmissions. They consist mainly of oils such as mineral oils, natural oils or synthetic fluids of varying structure and viscosity with additives (DIN 51524). The use of hydraulic fluids and other lubricants such as greases may involve intensive skin contact. Skin contact with components of hydraulic fluids results mainly when they are added to water-mixed metal-working fluids during metal working.

There are numerous applications for which liquid lubricants are not suitable (for example, plain and rolling bearings in machine tools). In these cases, greases covering a wide range of viscosity are used. From a physical point of view, greases are colloidal suspensions of thickeners in oils. Mainly metal soaps are used as thickeners, but also mineral substances and polymers.

Hazards

Following skin contact, the effects on health expected most frequently are sensitizing and irritant effects on the skin in the sense of toxic irritant reactions or type IV sensitization (see Section IV “Sensitizing substances” and TRGS 401[50])). Systemic toxicity as a result of skin absorption is, however, of minor importance.

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[49]) Hartwig A, MAK Commission (2023) Komponenten von Kühlschmierstoffen, Hydraulikflüssigkeiten und anderen Schmierstoffen. MAK-Begründung, Nachtrag. MAK Collect Occup Health Saf 8(2): Doc034. https://doi.org/10.34865/mb0215khsdgt8_2ad

[50]) Ausschuss für Gefahrstoffe (2011) Gefährdung durch Hautkontakt – Ermittlungen, Beurteilung, Maßnahmen (TRGS 401). https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/TRGS-401.html

When metal-working fluids are in use, it is possible for vapours resulting from high temperatures at the cutting edge and aerosols due to high rotation speeds to pass into the workplace atmosphere. To date, hardly any animal studies or epidemiological data are available for long-term effects following uptake in the lungs under working conditions. However, the toxic profiles of individual components which are absorbed in the lungs or dermally suggest evidence of a systemic toxic reaction. There may be irritant or toxic reactions in the respiratory tract and lungs following inhalation. It can be assumed that systemic toxicity and local effects on the skin and respiratory tract are mainly due to the additives.

Carcinogenic nitrosamines resulting from nitrosatable secondary amines such as diethanolamine and morpholine (see Section III "Amines which form carcinogenic nitrosamines on nitrosation"; see TRGS 552[51]) and 611[52])), may be of potential toxicological relevance in water-mixed metal-working fluids, particularly if the fluids contain no inhibitors against their formation.

Both the nitrite concentration and the pH of the water-mixed metal-working fluid have substantial influence on formation of nitrosamines and the rate of their formation. Bacterial nitrite formation can be avoided by the addition of biocides.

Since the nitrosamine concentration does not always correlate with the nitrite concentration, it is more reliable to determine nitrosamine rather than nitrite levels in metal-working fluids containing secondary amines (these do not comply with TRGS 611, unless the provision in Paragraph 2.4 applies). In particular, the absence of nitrite at a particular sampling time does not rule out the possibility that nitrosamines are present. The use of non-water miscible metal-working fluids leads to the formation of polycyclic aromatic hydrocarbons (PAH; reference substance: benzo[a]pyrene). They form at non-critical concentrations if their mineral base oils are sufficiently refined or hydrogenated. According to TRGS 905[53]), the mass content of benzo[a]pyrene in the base oils of non-water miscible metal-working fluids should be lower than 0.005 % (50 ppm).

For systemically hardly toxic components of metal-working fluids which were assessed as non-irritating to mucous membranes and for which no MAK value can be established, it is pointed out that no adverse effects on health are expected at a concentration of up to 10 mg metal-working fluid/m^3, which corresponds to the technical exposure limit of the German BGR/GUV-R 143, 2011[54]).

The Commission prepares toxicological/occupational-medical reviews of individual components with the aim of publishing practicable assessments in the form of MAK values, if possible. The list, which is subject to constant revision, should assist in the assessment of the effects of metal-working fluids, hydraulic fluids and other lubricants on a case by case basis and in taking any necessary action for health protection.

Documentation has been published for the following substances:

Abietic acid [514-10-3]
also includes disproportionation and transposition products

Adipic acid [124-04-9]
Alkyl amines, C11–14-branched, monohexyl and dihexyl phosphates [80939-62-4]
Alkyl benzenesulfonates C10–C14, linear [69669-44-9; 85117-50-6]
Alkyl ether carboxylic acids
1-(2-Allyloxy)-2-(2,4-dichlorophenyl)ethyl)-1H-imidazole [35554-44-0]
2-Aminobutanol [96-20-8]
2-(2-Aminoethoxy)ethanol [929-06-6]
2-Amino-2-ethyl-1,3-propanediol [115-70-8]
2-Amino-2-methyl-1-propanol [124-68-5]
1-Amino-2-propanol [78-96-6]
N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine [2372-82-9]
Aminotris(methylenephosphonic acid) [6419-19-8] and its sodium salts
Azelaic acid [123-99-9]
Behenic acid [112-85-6]
1,2-Benzisothiazol-3(2H)-one [2634-33-5]

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[51]) Ausschuss für Gefahrstoffe (2018) Krebserzeugende N-Nitrosamine der Kat 1A und 1B (TRGS 552). https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/TRGS-552.html

[52]) Ausschuss für Gefahrstoffe (2007) Verwendungsbeschränkungen für wassermischbare bzw. wassergemischte Kühlschmierstoffe, bei deren Einsatz N-Nitrosamine auftreten können (TRGS 611). https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/TRGS-611.html

[53]) Ausschuss für Gefahrstoffe (2020) Verzeichnis krebserzeugender, keimzellmutagener oder reproduktionstoxischer Stoffe (TRGS 905). https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/TRGS-905.html

[54]) DGUV (Deutsche Gesetzliche Unfallversicherung e. V.), editor (2011) Regel 109-003 „Tätigkeiten mit Kühlschmierstoffen". https://publikationen.dguv.de/regelwerk/regeln/1006/taetigkeiten-mit-kuehlschmierstoffen

Benzoic acid [65-85-0] (inhalable fraction)
see also Benzoic acid alkali salts
Causes pseudoallergic reactions, see documentation.

Benzoic acid [65-85-0] (respirable fraction)
see also Benzoic acid alkali salts
Causes pseudoallergic reactions, see documentation.

Benzotriazole [95-14-7]
Benzyl alcohol [100-51-6]
Benzyl alcohol mono(poly)hemiformal [14548-60-8]
releases formaldehyde

Bis[O,O-bis(2-ethylhexyl) dithiophosphorato-S,S′]dioxodi-μ-thioxodimolybdenum [68958-92-9; 72030-25-2]
N,N-Bis(2-ethylhexyl)-(1,2,4-triazole-1-yl)methanamine [91273-04-0]
releases formaldehyde

★ 1,3-Bis(hydroxymethyl)urea [140-95-4]
releases formaldehyde

★ Bismorpholino methane [5625-90-1]
releases formaldehyde

Bithionol [97-18-7]
Boric acid [10043-35-3] and tetraborates
Boric acid [10043-35-3]
2-Bromo-2-nitro-1,3-propanediol [52-51-7]
releases formaldehydeuse forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”

Butylated hydroxytoluene (BHT) [128-37-0]
2-Butyl-1,2-benzisothiazolin-3-one [4299-07-4]
p-tert-Butylbenzoic acid [98-73-7]
tert-Butyl-4-hydroxyanisole (BHA) [25013-16-5]
Calcium bis(dinonylnaphthalenesulphonate) [57855-77-3]
Calcium hydroxide [1305-62-0]
5(or 6)-Carboxy-4-hexylcyclohex-2-ene-1-octanoic acid [53980-88-4]
2-Chloroacetamide [79-07-2]
p-Chloro-m-cresol [59-50-7]
5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-dihydroisothiazol-3-one [26172-55-4; 2682-20-4] mixture in ratio 3:1
Chlorothalonil [1897-45-6]
Citric acid [77-92-9]
Citric acid alkali metal salts
Coconut oil [8001-31-8]
Cyclohexylhydroxydiazene-1-oxide, potassium salt [66603-10-9]
N-Cyclohexylhydroxy-diazen-1-oxide, copper salt [15627-09-5]
1-Decanol [112-30-1]
n-Decyl oleate [3687-46-5]
Dibenzyl disulfide [150-60-7]
2,2-Dibromo-2-cyanacetamide [10222-01-2]
1,2-Dibromo-2,4-dicyanobutane [35691-65-7]
3-(3,5-Di-tert-butyl-4-hydroxyphenyl)-N′-[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propanoyl]propanehydrazide [32687-78-8]
3,5-Di-tert-butyl-4-hydroxyphenylpropionic acid octadecyl ester [2082-79-3]
2,6-Di-tert-butylphenol [128-39-2]
Di-n-butyl phosphate [107-66-4] and its technical mixtures
Di-n-butyl phosphonate [1809-19-4] see also Di-n-octyl phosphonate
Di-n-butyl phthalate [84-74-2]
Di-tert-dodecyl pentasulfide and Di-tert-dodecyl polysulfide [31565-23-8; 68583-56-2; 68425-15-0]
Diethylenetriaminepenta(methylenephosphonic acid) [15827-60-8] and its sodium salts [22042-96-2]
1,2-Dihydro-2,2,4-trimethyl-quinoline polymer [26780-96-1]
4-(Diiodomethylsulfonyl)-toluene [20018-09-1]
Diisodecyl phthalate [26761-40-0]
Diisotridecyl phthalate [27253-26-5]
1,3-Dimethylol-5,5-dimethyl hydantoin [6440-58-0]
releases formaldehyde

4,4′-Dioctyldiphenylamine [101-67-7]
Di-n-octyl phosphonate [1809-14-9] see also Di-n-butyl phosphonate

Diphenylamine [122-39-4]
Diphenylamine, octylated (Benzenamine, N-phenyl-, reaction products with 2,4,4-trimethylpentene) [68411-46-1]
Diphenylamine, reaction products with styrene and 2,4,4-trimethylpentene [68921-45-9]
Dipropylene glycol [25265-71-8]
Distillates (petroleum) [64742-47-8] hydrotreated light (aerosol)
Distillates (petroleum) [64742-47-8] hydrotreated light (vapour)
2,2′-Dithiobis(N-methylbenzamide) [2527-58-4]
Ditridecyl phthalate [119-06-2]
Dodecanedioic acid [693-23-2]
1-Dodecanol [112-53-8]
★ 5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5]
releases formaldehyde

(Ethylenedioxy)dimethanol [3586-55-8]
releases formaldehyde

2-Ethyl-1,3-hexanediol [94-96-2]
2-Ethylhexyl oleate [26399-02-0]
Fatty acids, C14–18 saturated and C16–18-unsaturated [67701-06-8]
Fatty alcohol ethoxylates, C16–18 and C18-unsaturated [68920-66-1]
Fatty alcohols, C12–18 [67762-25-8]
Glycerol [56-81-5]
1-Hexadecanol [36653-82-4]
Hexamethylene bis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate) [35074-77-2]
Hexamethylenetetramine [100-97-0]
releases formaldehyde

1-Hexanol [111-27-3]
2-Hexyl-1-decanol [2425-77-6]
Hexylene glycol [107-41-5]
1-Hydroxyethyl-2-heptadecenyl-imidazoline [21652-27-7]
1-Hydroxyethylidene-1,1-diphosphonic acid [2809-21-4] and its sodium and potassium salts
N-(2-Hydroxyethyl)piperidine [3040-44-6]
2-Hydroxymethyl-2-nitro-1,3-propanediol [126-11-4]
use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”

12-Hydroxystearic acid [106-14-9]
3-Iodo-2-propynyl butylcarbamate [55406-53-6]
Isodecyl oleate [59231-34-4]
Isononanoic acid [3302-10-1; 26896-18-4]
Isooctadecanol [27458-93-1]
Isotridecanol [27458-92-0]
Kerosine (petroleum) (aerosol) [8008-20-6]
Kerosine (petroleum) (vapour) [8008-20-6]
Lauric acid [143-07-7]
Lithium-12-hydroxystearate [7620-77-1]
Lithium stearate [4485-12-5]
2-Mercaptobenzothiazole [149-30-4]
★ Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8]
releases formaldehyde

Methyl-1H-benzotriazole [29385-43-1]
Methyldiethanolamine [105-59-9]
4-Methyl-1,3-dioxolan-2-one [108-32-7]
Methylene bis(dibutyldithiocarbamate) [10254-57-6] (inhalable fraction)
Methylene bis(dibutyldithiocarbamate) [10254-57-6] (respirable fraction)
4,4′-Methylenebis(2,6-di-tert-butylphenol) [118-82-1]
N,N′-Methylenebis(5-methyloxazolidine) [66204-44-2]
2-Methyl-4-isothiazolin-3-one [2682-20-4]
★ N-Methylolchloroacetamide [2832-19-1]
releases formaldehyde

6-[(4-Methylphenyl)sulfonylamino]hexanoic acid [78521-39-8]
Myristic acid [544-63-8]
Naphtha (petroleum) hydrotreated, heavy [64742-48-9]
Naphthenic acids and sodium, calcium, potassium napthenates [1338-24-5; 61790-13-4; 61789-36-4; 66072-08-0] (technical mixtures)
3-Nitrobenzoic acid [121-92-6]

★ 4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture)
(4-Nonylphenoxy)acetic acid [3115-49-9]
1-Octadecanol [112-92-5]
1-Octanol [111-87-5]
2-Octyl-1-dodecanol [5333-42-6]
2-Octyl-4-isothiazolin-3-one [26530-20-1]
4-tert-Octylphenol [140-66-9]
Oleic acid [112-80-1]
Oleyl alcohol [143-28-2]
Oleyl sarcosine [110-25-8]
Palmitic acid [57-10-3]
★ Palm kernel oil [8023-79-8]
Petroleum sulfonates, calcium salts (technical mixture in mineral oil) [61789-86-4]
Petroleum sulfonates, sodium salts [68608-26-4]
Phenothiazine [92-84-2]
phototoxic effect

2-Phenoxyethanol [122-99-6]
1-Phenoxy-2-propanol [770-35-4]
2-Phenyl-1-ethanol [60-12-8]
N-Phenyl-1-naphthylamine [90-30-2]
o-Phenylphenol [90-43-7] see also Sodium o-phenylphenol
Piperazine [110-85-0]
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N,N′-dinitrosopiperazine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

Polyalphaolefins several CAS Nos, e. g. [68649-11-6]
Polybutenes and Polyisobutenes
Polybutenes [9003-29-6]
Polyisobutenes [9003-27-4]
Polydimethyl siloxanes, linear [63148-62-9; 9006-65-9; 9016-00-6]
Polyethylene glycol (average molecular weight 200–600) [25322-68-3]
Because formation of a mist is possible, exposure should be minimized for reasons of occupational safety and hygiene.

Polyethylene glycol (average molecular weight > 600) [25322-68-3]
Polyethylenepolypropylene glycol [9003-11-6]
Polyoxyethylene oleyl ether [9004-98-2]
Polypropylene glycol (PPG) [25322-69-4]
Poly(propylene glycol) n-butyl ether [9003-13-8]
Polytetrafluoroethene [9002-84-0] (inhalable fraction)
Polytetrafluoroethene [9002-84-0] (respirable fraction)
except for ultrafine particles; see Section Vh

Propylene glycol [57-55-6]
Pyrrolidine [123-75-1]
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosopyrrolidine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

Sebacic acid [111-20-6]
Sodium diethyldithiocarbamate [148-18-5]
Use in metal-working fluids is not permitted: see TRGS 611. Reaction with nitrosating agents can result in the formation of carcinogenic N-nitrosodiethylamine, see Section III “Amines which form carcinogenic nitrosamines on nitrosation”.

Sodium o-phenylphenol [132-27-4]
Sodium pyrithione [3811-73-2; 15922-78-8]
Stearic acid [57-11-4]
Succinic acid [110-15-6]
Tall oil, distilled [8002-26-4]
Tartaric acid [87-69-4]
1-Tetradecanol [112-72-1]
Tetrahydrobenzotriazole [6789-99-7]
Tetramethylol acetylenediurea [5395-50-6]
releases formaldehyde

Thiabendazole [148-79-8]
2,2′-Thiobis(4-methyl-6-tert-butylphenol) [90-66-4]
2,2′-Thiodiethylene Bis[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate] [41484-35-9]
Triazinetriyltriiminotrishexanoic acid [80584-91-4]

Tricresyl phosphate, isomers, „free of o-isomers" [1330-78-5; 563-04-2; 78-32-0]
Triethanolamine [102-71-6]
Triethylene glycol n-butyl ether [143-22-6]
Triethylene glycol monomethyl ether [112-35-6]
★ 1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3]
releases formaldehyde

Triglycerides (lard oil, palm oil, rapeseed oil, soybean oil) see also coconut oil
O,O,O-Triphenyl monothiophosphate [597-82-0]
Triphenyl phosphate [115-86-6]
Triphenyl phosphate, isopropylated [68937-41-7]
Tris(2,4-ditert-butylphenyl) phosphite [31570-04-4]
N,N′,N′′-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine [4719-04-4]
releases formaldehyde

N,N′,N′′-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine [25254-50-6]
releases formaldehyde

Tris[(2- or 4-)C9–C10-isoalkylphenyl]phosphorothioate [126019-82-7]
Tris(nonylphenyl) phosphite [26523-78-4]
White mineral oil (pharmaceutical) [8042-47-5]
Zinc, O,O′-di-2-ethylhexyl dithiophosphate [4259-15-8]
Zinc diamyldithiocarbamate [15337-18-5] (inhalable fraction)
Zinc diamyldithiocarbamate [15337-18-5] (respirable fraction)

d) Metals and metal compounds

In the List of MAK and BAT Values, metals are listed as the element "and its inorganic compounds"; the limit value is then expressed consistently in terms of the metal content. For the individual compounds of most metals, the data available from animal studies or from known effects on man are insufficient for evaluation. Whenever analogy of various compounds of a metal and the element itself seems plausible, these substances should be put in a single category. Therefore, it is necessary that the individual metal compounds be specified as exactly as possible. Generally organic metal compounds should be evaluated separately from the inorganic compounds with respect to the establishment of a MAK value and of carcinogenic potential.

And since the type and extent of metal-related damage depends markedly on the nature of the chemical bond, differences in water solubility of metal compounds can influence their acute and chronic toxicity. On principle, therefore, every metal compound should be tested individually and then categorized according to its toxicity and any carcinogenic potential. At present, sufficient data for such a classification is available for only a few metal compounds.

e) Radioactive materials

For procedures in handling radionuclides, reference is made to the special regulations of the "Strahlenschutzverordnung" (radiation protection guidelines). The current version of the guideline may be found in the relevant issue of the "Bundesgesetzblatt".

Assessment Values in Biological Material

XI. Significance and use of assessment values in biological material

Definition

The Commission derives **assessment values in biological material** to enable the occupational-medical and toxicological evaluation of the individual body burden which results from exposure to a substance at the workplace.

The **BAT value** (**B**iologischer **A**rbeitsstoff-**T**oleranzwert, "biological tolerance value") describes the occupational-medical and toxicological derived concentration for a substance, or one or more of its metabolites or a reaction product of the agent with endogenous macromolecules (adducts) or a deviation of a biological indicator from its norm caused by the agent or its metabolites at which the health of an employee generally is not adversely affected even when the person is repeatedly exposed during long periods (see Section XIII).

In addition, the Commission examines all hazardous substances at the workplace with a BAT value with respect to whether prenatal toxicity occurs when the BAT value is observed and classifies them in the appropriate pregnancy risk groups (see Section XIII).

The **BLW** (**B**iologischer **L**eit**w**ert, "biological guidance value") is the concentration of a chemical substance or its metabolites or the deviation from the norm of biological parameters induced by the substance in exposed humans which serves as an indicator for necessary protective measures (see Section XIV).

The **BAR** (**B**iologischer **A**rbeitsstoff-**R**eferenzwert, "biological reference value") describes the background level of a substance which is present concurrently at a particular time in a reference population of persons of working age who are not occupationally exposed to this substance (see Section XV).

EKA (**E**xpositionsäquivalente für **k**rebserzeugende **A**rbeitsstoffe, "exposure equivalents for carcinogenic substances") are established by the Commission for carcinogenic substances in the form of relationships between the concentration of the carcinogen in the workplace air and that of the substance or its metabolites in biological material (see Section XVI).

Prerequisites

Assessment values in biological material can be established only for such substances which can be taken up via the respiratory tract, skin and gastrointestinal tract during occupational exposure. Another prerequisite for the establishment of assessment values is that sufficient occupational-medical and toxicological data are available for the substance and that these data are supported primarily by observations in man. The data must have been obtained with scientific methods. For the establishment of new assessment values and the annual review of the list, the submission of suggestions and reports of experience with such substances in man is requested.

Documentation of the scientific evaluations

The reasons why assessment values in biological material were established at a particular level are documented by the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area in scientific evaluations which are published online in "The MAK Collection for Occupational Health and Safety"[55]).

As a rule, the Commission makes its decisions regarding the establishment of assessment values on the basis of scientific texts which have undergone a peer review procedure. When necessary, after detailed discussion, other sources such as unpublished internal company reports are cited and are then identified as such in the reference list at the end of the documentation. The unabridged reports are made available to the Commission and are filed at the Commission's scientific central office. Information required by a third party about the company reports cited in the Commission's documentation is supplied in writing by the chair of the Commission at own discretion. Access to company reports is not made available to third parties.

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[55]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

Purpose

In the context of specific occupational-medical check-ups, BAT values are intended to protect employees from impairment of health at work. They enable an occupational medical toxicological assessment of occupational exposure. For substances that can be absorbed through the skin, individual exposures can be determined only by biological monitoring.

Evaluation of the health risk

The protection of the health of the individual, which is the reason for establishing assessment values in biological material, can be monitored by periodic quantitative determination of the chemical compounds or their metabolites in biological material or of biological parameters. The methods used must be diagnostically specific and sensitive enough for the purpose, acceptable to the employee and practicable for the physician. The assessment values in biological material are only valid, if the specified sampling time and other requirements named in the evaluation texts are adhered to during sampling.

Ideally, samples should be taken when the parameter has reached a steady state after undergoing absorption and distribution processes, and sometimes also metabolic processes. On the one hand, the steady state may be reached in as little as a few minutes. This is the case for exposure markers that do not require extensive distribution processes and for which metabolism plays only a minor role, such as when concentrations of aromatic substances or halogenated hydrocarbons are determined in the blood. On the other hand, it often takes several hours for the concentrations of metabolites in the urine to reach the steady state. Alternatively, different sampling times may be chosen depending on the kinetics of the substance (for example, before the next shift).

For parameters underlying extremely rapid elimination kinetics (elimination half-lives of < 1 hour), the samples must be taken immediately after the end of exposure (for example, when determining the concentrations of most of the highly volatile hazardous substances in blood. These have short half-lives and are exhaled via the respiratory passages). Exposure situations at the workplace sometimes vary considerably. As a result, the (short-term) exposure levels determined immediately before sampling do not reliably represent the level of exposure over the whole working day.

Persistent chemical agents and accumulating substances, however, are successively stored in the body during long-term exposure and it may take a long time (weeks, months or years) to reach a steady state. It is important, therefore, to consider the half-life of the parameter, particularly at the beginning of occupational exposure to a new substance and after work breaks without exposure such as holidays[56]). If a marked increase in a specific parameter is found in consecutive samples, particularly at the beginning of occupational exposure to a new substance, exposure may already have reached a level that is hazardous to the health, even if the values are (still) below the assessment value. Therefore, it may be necessary to carry out a number of determinations in order to demonstrate early on that there is a risk of exceeding the assessment value.

Whole blood, serum and urine samples are used as assay materials, occasionally and under certain conditions, also samples of alveolar air. The analyses should be carried out under the conditions of statistical quality control according to the requirements of the guidelines of the German Medical Association for quality assurance of medical laboratory analyses (Richtlinien der Bundesärztekammer zur Qualitätssicherung laboratoriumsmedizinischer Untersuchungen (RiLiBÄK)) and the occupational medical rule (Arbeitsmedizinische Regel, AMR) 6.2 Biomonitoring. The Commission's working group "Analyses in Biological Materials" has compiled a series of valid and recognised methods[57]).

For workers who come into direct skin contact with substances which are designated with an "H", it is particularly necessary to check that the assessment values have not been exceeded or, in the case of carcinogenic substances, to assess the systemic dose in terms of the EKA.

Evaluation of analytical data

Results from analyses of substances in biological material can only be interpreted with occupational-medical and toxicological knowledge and in Germany are subject to medical discretion.

In occupational-medical health practice analyses of urine specimens for the purpose of biological monitoring are carried out using spontaneously voided urine samples (spot urine samples). These are not suitable for an

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[56]) Weistenhöfer W, Göen T, Drexler H, Hartwig A, MAK Commission (2023) Requirements for a suitable human biomonitoring parameter. Assessment values in biological material - Translation of the German version from 2023. MAK Collect Occup Health Saf 8(4):Doc085. https://doi.org/10.34865/bbgeneralegt8_4ad

[57]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

analysis if they have been highly concentrated or highly diluted through diuresis. In occupational-medical practice the creatinine content of the urine specimen is used as a criterion for the specimen's acceptance while the specific weight or the osmolality is of little importance as a basis for evaluation. Creatinine concentrations < 0.3 g/l or > 3.0 g/l are criteria which would exclude the usability of the spot urine sample58).

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58) Weihrauch M, Schulze B, Schaller KH (1999) Creatinine as a Reference Parameter for the Concentration of Substances in Urine. BAT Value Documentation, 2000. In: Lehnert G, Greim H, editors. Biological Exposure Values for Occupational Toxicants and Carcinogens. Volume 3. Weinheim: Wiley-VCH. p. 35–44. Also available from https://doi.org/10.1002/3527600418.bb6027urie0003
Bader M, Ochsmann E (2016) Addendum to Creatinine as Reference Parameter for the Concentration of Substances in Urine. BAT Value Documentation, 2010. MAK Collect Occup Health Saf 1(1): 266–268. https://doi.org/10.1002/3527600418.bbgeneral05e1715

XII. List of substances

For interpretation of the occupational-medical and experimental toxicological data, reference should also be made to “The MAK Collection for Occupational Health and Safety”[59]).

Abbreviations

BV = assessment values in biological material (BAT/EKA/BLW/BAR)
BAT = biological tolerance value (“Biologischer Arbeitsstoff-Toleranzwert”, see Section XIII)
BLW = biological guidance value (“Biologischer Leitwert”, see Section XIV)
BAR = biological reference value (“Biologischer Arbeitsstoff-Referenzwert”, see Section XV)
EKA = exposure equivalents for carcinogenic substances (“Expositionsäquivalente für krebserzeugende Arbeitsstoffe”, see Section XVI)

In the table under Substance

Perc abs: H = danger from percutaneous absorption (see Sections VII and XI)
Carc cat = Carcinogen category (see Section III)
Preg(BAT): = Pregnancy Risk Group for BAT value (see Section XIII)

Assay material:

B = whole blood
B_E = erythrocyte fraction of whole blood
U = urine
P/S = plasma/serum

Sampling time:

a = not fixed in the steady state
These substances have long half-lives. As a result, it may take a long time (weeks, months or years) to reach a steady state after taking up or resuming an activity at the workplace. More information can be found in the substance documentation.
b = end of exposure or end of shift
c = at the end of the shift, for long-term exposures after several previous shifts
d = at the beginning of the next shift
e = time after end of exposure: … hours
f = after exposure for at least 3 months
g = immediately after exposure
h = at the end of the shift, for long-term exposure after several previous shifts; determination of individual pre-exposure values for use as reference values (see documentation)
i = at the end of the shift on the last day of the working week after at least 2 weeks of exposure

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[59]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

1 Substances which have been examined for possible biological monitoring and for which there is documentation in "The MAK Collection for Occupational Health and Safety"[60]).

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Acetone [67-64-1]				
		Preg(BAT): B Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Acetone	BAT	50 mg/l see Section XIII.1	U	b
	BAR	2.5 mg/l see Section XV.1	U	b
Acetylcholinesterase inhibitors				
Acetylcholinesterase	BAT	not established see Section XIII.2	B_E	h
	BLW	Reduction of activity to 70% of reference value see Section XIV.1 BLW derived as ceiling value because of acute toxic effects	B_E	h
Acrolein (2-Propenal) [107-02-8]				
	Carc cat: 3			
S-(3-Hydroxypropyl)mercapturic acid N-Acetyl-S-(3-hydroxypropyl)cysteine	BAR	600 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
Acrylamide [79-06-1]				
Perc abs: H	**Carc cat: 2**			
N-(2-Carbonamideethyl)valine	EKA	see Section XVI.1	B_E	f
	BLW	550 pmol/g globin see Section XIV.1	B_E	f
	BAR	50 pmol/g globin see Section XV.1 evaluated for non-smokers	B_E	f
S-(2-Carbamoylethyl)mercapturic acid N-Acetyl-S-(2-carbamoylethyl)cysteine	BAR	100 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	b
Acrylonitrile [107-13-1]				
Perc abs: H	**Carc cat: 2**			
S-(2-Cyanoethyl)mercapturic acid N-Acetyl-S-(2-cyanoethyl)cysteine	BAR	15 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
N-(2-Cyanoethyl)valine	EKA	see Section XVI.1	B_E	f
	BAR	12 pmol/g globin see Section XV.1 evaluated for non-smokers	B_E	f

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[60]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Alkali chromates (Cr(VI) compounds)				
Perc abs: H the chromates of barium, lead, strontium and zinc are not designated with "H"	**Carc cat: 1**			
Chromium	EKA	see Section XVI.1	B_E	f
	EKA	see Section XVI.1	U	b
★ **Aluminium [7429-90-5]**				
		Preg(BAT): D		
Aluminium	BAT	50 µg/g creatinine see Section XIII.1	U	c
	BAR	15 µg/g creatinine see Section XV.1	U	c
4-Aminobiphenyl [92-67-1]				
Perc abs: H	**Carc cat: 1**			
4-Aminobiphenyl (released from haemoglobin conjugate)	EKA	not established see Section XVI.2	B	b
	BLW	not established see Section XIV.2	B_E	f
	BAR	15 ng/l see Section XV.1 evaluated for non-smokers	B_E	f
★ **Aniline [62-53-3]**				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Aniline (after hydrolysis)	BAT	500 µg/l see Section XIII.1 BAT value derived as ceiling value because of acute toxic effects	U	b
Aniline (released from haemoglobin conjugate)	BLW	100 µg/l see Section XIV.1	B_E	f
Antimony [7440-36-0] and its inorganic compounds (except for stibine)				
	Carc cat: 2			
Antimony	EKA	not established see Section XVI.2	U	c
	BAR	0.2 µg/l see Section XV.1	U	c

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Arsenic [7440-38-2] and inorganic arsenic compounds (except for arsine)				
Perc abs: H arsenic and gallium arsenide are not designated with "H"	**Carc cat: 1**			
Σ Arsenic(III), arsenic(V) and monomethylarsonic acid	BLW	10 µg/l see Section XIV.1	U	b
	EKA	see Section XVI.1	U	b
Arsenic(III)	BAR	0.5 µg/l see Section XV.1	U	b
Arsenic(V)	BAR	0.5 µg/l see Section XV.1	U	b
Monomethylarsonic acid	BAR	2 µg/l see Section XV.1	U	b
Dimethylarsinic acid	BAR	10 µg/l see Section XV.1	U	b
Barium compounds, soluble (as Ba [7440-39-3])				
Barium	BAR	10 µg/l see Section XV.1	U	c
Benzene [71-43-2]				
Perc abs: H	**Carc cat: 1**			
Benzene	EKA	see Section XVI.1	U	b
	BAR	0.3 µg/l see Section XV.1 evaluated for non-smokers	U	b
S-Phenylmercapturic acid N-Acetyl-S-phenylcysteine	EKA	see Section XVI.1	U	c
	BAR	0.3 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
trans, trans-Muconic acid	EKA	see Section XVI.1	U	b
	BAR	150 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	b
Benzidine [92-87-5]				
Perc abs: H	**Carc cat: 1**			
Benzidine	EKA	not established see Section XVI.2	U	c
	BAR	not established see Section XV.2	U	c
Benzidine adducts	EKA	not established see Section XVI.2	P/S, B_E	f
	BAR	not established see Section XV.2	P/S, B_E	f

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Beryllium [7440-41-7] and its inorganic compounds	**Carc cat: 1**			
Beryllium	EKA	not established see Section XVI.2	U	a
	BAR	0.02 µg/l see Section XV.1	U	a
Bisphenol A (4,4′-Isopropylidenediphenol) [80-05-7]				
Bisphenol A (after hydrolysis)	BLW	80 mg/l see Section XIV.1	U	b
Bisphenol S [80-09-1]				
Bisphenol S (after hydrolysis)	BAR	1 µg/l see Section XV.1	U	b
Boric acid [10043-35-3] and tetraborates				
Boron	BAT	not established see Section XIII.2	U	difference between pre-shift and post-shift urine
Bromomethane (Methyl bromide) [74-83-9]	**Carc cat: 3**			
Bromide	BLW	12 mg/l see Section XIV.1	P/S	c
S-Methylcysteine-albumin	EKA	not established see Section XVI.2	S	a
1-Bromopropane [106-94-5] **Perc abs: H**	**Carc cat: 2**			
S-(n-Propyl)mercapturic acid N-Acetyl-S-n-propylcysteine	EKA	see Section XVI.1	U	c
1,3-Butadiene [106-99-0]	**Carc cat: 1**			
S-(3,4-Dihydroxybutyl)mercapturic acid N-Acetyl-S-(3,4-dihydroxybutyl)cysteine	EKA	see Section XVI.1	U	c
	BAR	400 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
S-(2-Hydroxy-3-butenyl)mercapturic acid N-Acetyl-S-(2-hydroxy-3-butenyl)cysteine	EKA	see Section XVI.1	U	c
	BAR	< 2 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
1-Butanol [71-36-3]				
1-Butanol	BAT	2 mg/g creatinine see Section XIII.1	U	d
	BAT	10 mg/g creatinine see Section XIII.1	U	b

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
2-Butanone (Methyl ethyl ketone) [78-93-3]				
Perc abs: H				
2-Butanone	BAT	2 mg/l see Section XIII.1	U	b
2-Butoxyethanol [111-76-2]				
Perc abs: H				
Butoxyacetic acid (after hydrolysis)	BAT	150 mg/g creatinine see Section XIII.1	U	c
2-Butoxyethyl acetate [112-07-2]				
Perc abs: H				
Butoxyacetic acid (after hydrolysis)	BAT	150 mg/g creatinine see Section XIII.1	U	c
Butylated hydroxytoluene (BHT) [128-37-0]				
	Carc cat: 4			
Butylhydroxytoluene acid (after hydrolysis)	BAR	7 µg/l see Section XV.1	U	b
p-tert-Butylphenol (ptBP) [98-54-4]				
Perc abs: H				
p-tert-Butylphenol (after hydrolysis)	BAT	2 mg/l see Section XIII.1	U	b
★ **Cadmium [7440-43-9] and its inorganic compounds**				
Perc abs: H	**Carc cat: 1**			
Cadmium	BLW	2 µg/g creatinine see Section XIV.1	U	a
	BAR	1 µg/l see Section XV.1 evaluated for non-smokers	B	a
	BAR	0.8 µg/l see Section XV.1 evaluated for non-smokers	U	a
Carbon disulfide [75-15-0]				
Perc abs: H				
2-Thiothiazolidine-4-carboxylic acid (TTCA)	BAT	2 mg/g creatinine see Section XIII.1	U	b
Carbon monoxide [630-08-0]				
		Preg(BAT): B		
CO-Hb	BAT	5% see Section XIII.1 BAT value derived as ceiling value because of acute toxic effects. Evaluated for non-smokers.	B	b

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Chlorinated biphenyls [1336-36-3]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Σ PCB 28, PCB 52, PCB 101, PCB 138, PCB 153, PCB 180	BAT	15 µg/l see Section XIII.1	P	a
PCB 28	BAR	0.02 µg/l see Section XV.1	P	a
PCB 52	BAR	< 0.01 µg/l see Section XV.1	P	a
PCB 101	BAR	< 0.01 µg/l see Section XV.1	P	a
Chlorobenzene [108-90-7]				
		Preg(BAT): C		
4-Chlorocatechol (after hydrolysis)	BAT	80 mg/g creatinine see Section XIII.1	U	b
1-Chloro-2,3-epoxypropane (Epichlorohydrin) [106-89-8]				
Perc abs: H	**Carc cat: 2**			
S-(3-Chloro-2-hydroxypropyl)mercapturic acid N-Acetyl-S-(3-chloro-2-hydroxypropyl)cysteine	EKA	see Section XVI.1	U	c
Chloroprene (2-Chloro-1,3-butadiene) [126-99-8]				
Perc abs: H	**Carc cat: 2**			
S-(3,4-Dihydroxybutyl)mercapturic acid N-Acetyl-S-(3,4-dihydroxybutyl)cysteine	BAR	400 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
Chromium [7440-47-3] and its compounds				
Total chromium	BAR	0.6 µg/l see Section XV.1	U	b
Cobalt [7440-48-4] and cobalt compounds				
Perc abs: H	**Carc cat: 2**			
Cobalt	EKA	see Section XVI.1	U	c
	BLW	35 µg/l see Section XIV.1	U	c
	BAR	1.5 µg/l see Section XV.1	U	c
Copper [7440-50-8] and its inorganic compounds				
Copper	BAT	not established see Section XIII.2	U	–
	BAR	not established see Section XV.2	U	–

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Cresol (all isomers) [1319-77-3]: o-cresol [95-48-7], m-cresol [108-39-4], p-cresol [106-44-5]				
Perc abs: H				
Cresol (sum of all isomers after hydrolysis)	BAT	not established see Section XIII.2	U	b
	BLW	not established see Section XIV.2	U	b
Cyclohexane [110-82-7]				
1,2-Cyclohexanediol (after hydrolysis)	BAT	150 mg/g creatinine see Section XIII.1	U	c
Cyclohexanone [108-94-1]				
Perc abs: H	**Carc cat: 3**			
1,2-Cyclohexanediol (after hydrolysis)	EKA	see Section XVI.1	U	c
Cyclohexanol (after hydrolysis)	EKA	see Section XVI.1	U	b
4,4′-Diaminodiphenylmethane [101-77-9]				
Perc abs: H	**Carc cat: 2**			
4,4′-Diaminodiphenylmethane (after hydrolysis)	BLW	not established see Section XIV.2	U	b
	BAR	< 0.5 μg/l see Section XV.1	U	b
4,4′-Diaminodiphenylmethane (released from haemoglobin conjugate)	BAR	< 5 ng/l see Section XV.1	B_E	f
1,2-Dichlorobenzene [95-50-1]				
Perc abs: H				
1,2-Dichlorobenzene	BAT	140 μg/l see Section XIII.1	B	g
3,4- and 4,5-Dichlorocatechol (after hydrolysis)	BAT	150 mg/g creatinine see Section XIII.1	U	c
1,4-Dichlorobenzene [106-46-7]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): C**		
2,5-Dichlorophenol (after hydrolysis)	BAT	10 mg/l see Section XIII.1	U	c
	EKA	see Section XVI.1	U	c
	BAR	25 μg/l see Section XV.1	U	c
Dichloromethane [75-09-2]				
Perc abs: H	**Carc cat: 5**	**Preg(BAT): B**		
Dichloromethane	BAT	500 μg/l see Section XIII.1	B	g
	EKA	see Section XVI.1	B	g
1,2-Dichloropropane [78-87-5]				
Perc abs: H	**Carc cat: 1**			
S-(2-Hydroxypropyl)mercapturic acid N-Acetyl-S-(2-hydroxypropyl)cysteine	BAR	not established see Section XV.2	U	c

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Diethylene glycol dimethyl ether [111-96-6]				
Perc abs: H		**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Methoxyacetic acid	BAT	15 mg/g creatinine see Section XIII.1	U	i
Diethylene glycol monomethyl ether [111-77-3]				
Perc abs: H		**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Methoxyacetic acid	BAT	15 mg/g creatinine see Section XIII.1	U	i
Di(2-ethylhexyl)phthalate (DEHP) [117-81-7]				
Perc abs: H	**Carc cat: 4**			
Σ (MEHP + 5-OH-MEHP + 5-oxo-MEHP + 5-cx-MEPP) (after hydrolysis)	BLW	4 mg/g creatinine see Section XIV.1	U	c
N,N-Dimethylacetamide [127-19-5]				
Perc abs: H		**Preg(BAT): C**		
N-Methylacetamide plus N-hydroxymethyl-N-methylacetamide	BAT	25 mg/l see Section XIII.1	U	c
N,N-Dimethylformamide [68-12-2]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
N-Methylformamide plus N-hydroxymethyl-N-methylformamide	BAT	20 mg/l see Section XIII.1	U	b
S-(Methylcarbamoyl)mercapturic acid N-Acetyl-S-(N-methylcarbamoyl)cysteine	BAT	25 mg/g creatinine see Section XIII.1	U	c
Dimethyl sulfate [77-78-1]				
Perc abs: H	**Carc cat: 2**			
N-Methylvaline	EKA	see Section XVI.1	B_E	f
1,4-Dioxane [123-91-1]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): C**		
2-Hydroxyethoxy acetic acid	BAT	200 mg/g creatinine see Section XIII.1	U	b
1,2-Epoxypropane (1,2-Propylene oxide) [75-56-9]				
	Carc cat: 4	**Preg(BAT): C**		
N-(2-Hydroxypropyl)valine	BAT	2500 pmol/g globin see Section XIII.1	B_E	f
	EKA	see Section XVI.1	B_E	f
	BAR	10 pmol/g globin see Section XV.1 evaluated for non-smokers	B_E	f
S-(2-Hydroxypropyl)mercapturic acid N-Acetyl-S-(2-hydroxypropyl)cysteine	BAR	25 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
2-Ethoxyethanol [110-80-5]				
Perc abs: H				
Ethoxyacetic acid	BAT	50 mg/l see Section XIII.1	U	c
2-Ethoxyethyl acetate [111-15-9]				
Perc abs: H				
Ethoxyacetic acid	BAT	50 mg/l see Section XIII.1	U	c
1-Ethoxy-2-propanol [1569-02-4]				
Perc abs: H				
1-Ethoxy-2-propanol	BAT	not established see Section XIII.2	U	b
1-Ethoxy-2-propyl acetate [54839-24-6]				
Perc abs: H				
1-Ethoxy-2-propanol	BAT	not established see Section XIII.2	U	b
Ethylbenzene [100-41-4]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): C**		
Mandelic acid plus phenyl glyoxylic acid	BAT	250 mg/g creatinine see Section XIII.1	U	b
	EKA	see Section XVI.1	U	b
Ethylene [74-85-1]				
	Carc cat: 3			
N-(2-Hydroxyethyl)valine	EKA	not established see Section XVI.2	B_E	f
Ethylene glycol dinitrate [628-96-6]				
Perc abs: H				
Ethylene glycol dinitrate	BAT	not established see Section XIII.2	B	–
Ethylene oxide [75-21-8]				
Perc abs: H	**Carc cat: 2**			
N-(2-Hydroxyethyl)valine	EKA	see Section XVI.1	B_E	f
	BAR	60 pmol/g globin see Section XV.1 evaluated for non-smokers	B_E	f
S-(2-Hydroxyethyl)mercapturic acid N-Acetyl-S-(2-hydroxyethyl)cysteine	BAR	5 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	b
Gadolinium [7440-54-2]				
Gadolinium	BAR	not established see Section XV.2	U	–

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Glycidol [556-52-5]				
Perc abs: H	**Carc cat: 2**			
N-(2,3-Dihydroxypropyl)valine	BAR	15 pmol/g globin see Section XV.1 evaluated for non-smokers	B_E	f
Halothane (2-Bromo-2-chloro-1,1,1-trifluoroethane) [151-67-7]				
Trifluoroacetic acid	BAT	2.5 mg/l see Section XIII.1	B	c
n-Heptane [142-82-5]				
Heptane-2,5-dione	BAT	250 µg/l see Section XIII.1	U	b
Hexachlorobenzene [118-74-1]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): D**		
Hexachlorobenzene	BAT	150 µg/l see Section XIII.1	P/S	a
1,6-Hexamethylene diisocyanate [822-06-0]				
Hexamethylenediamine (after hydrolysis)	BAT	15 µg/g creatinine see Section XIII.1	U	b
n-Hexane [110-54-3]				
2,5-Hexanedione plus 4,5-dihydroxy-2-hexanone (after hydrolysis)	BAT	5 mg/l see Section XIII.1	U	b, c
2-Hexanone [591-78-6]				
Perc abs: H				
2,5-Hexanedione plus 4,5-dihydroxy-2-hexanone (after hydrolysis)	BAT	5 mg/l see Section XIII.1	U	b, c
Hydrazine [302-01-2]				
Perc abs: H	**Carc cat: 2**			
Hydrazine	EKA	not established see Section XVI.2	U, P	b
Hydrogen fluoride [7664-39-3] and inorganic fluorine compounds (fluorides)				
Perc abs: H Hydrogen fluoride is not designated with “H”		**Preg(BAT): C**		
Fluoride	BAT	4 mg/l see Section XIII.1	U	b
Indium [7440-74-6] and its inorganic compounds				
Perc abs: H	**Carc cat: 2**			
Indium	BLW	not established see Section XIV.2	P/S	a
	BAR	not established see Section XV.2	P/S	a

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Iodine [7553-56-2] and inorganic iodides				
Perc abs: H				
Iodine	BAR	not established see Section XV.2	U	–
Isoflurane [26675-46-7]				
		Preg(BAT): D		
Isoflurane	BAT	4 µg/l see Section XIII.1	U	b
Isopropylbenzene (cumene) [98-82-8]				
Perc abs: H	**Carc cat: 3**	**Preg(BAT): C**		
2-Phenyl-2-propanol (after hydrolysis)	BAT	10 mg/g creatinine see Section XIII.1	U	b
Lead [7439-92-1] and its inorganic compounds (except lead arsenate and lead chromate)				
	Carc cat: 4	**Preg(BAT): A**		
Lead	BAT	150 µg/l see Section XIII.1	B	a
	BAR	30 µg/l see Section XV.1 for women	B	a
	BAR	40 µg/l see Section XV.1 for men	B	a
★ **Lead tetraethyl [78-00-2]**				
Perc abs: H	**Carc cat: 4**			
Lead	BAT	not established see Section XIII.2	U	b
	BLW	150 µg/l see section XIV.1	B	a
Diethyllead	BAT	not established see Section XIII.2	U	b
★ **Lead tetramethyl [75-74-1]**				
Perc abs: H	**Carc cat: 4**			
Lead	BAT	not established see Section XIII.2	U	b
	BLW	150 µg/l see section XIV.1	B	b
Lindane (γ-1,2,3,4,5,6-Hexachlorocyclohexane) [58-89-9]				
Perc abs: H	**Carc cat: 4**	**Preg(BAT): C**		
Lindane	BAT	25 µg/l see Section XIII.1	P/S	b
Lithium compounds, inorganic (as Li [7439-93-2])				
Lithium	BAR	50 µg/l see Section XV.1	U	a

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Manganese [7439-96-5] and its inorganic compounds				
Manganese	BAT	not established see Section XIII.2	B	a
	BAR	15 µg/l see Section XV.1	B	a
Mercury [7439-97-6] and its inorganic compounds				
Perc abs: H	**Carc cat: 3**			
Mercury	BAT	25 µg/g creatinine see Section XIII.1 30 µg/l urine	U	a
Mercury, organic compounds				
Perc abs: H	**Carc cat: 3**			
Mercury	BAT	not established see Section XIII.2	B	a
	EKA	not established see Section XVI.2	B	a
Methanol [67-56-1]				
Perc abs: H		**Preg(BAT): C**		
Methanol	BAT	15 mg/l see Section XIII.1	U	b
Methaemoglobin-forming substances				
Methaemoglobin-forming substances	BAT	not established see Section XIII.2 Values of 1.5% methaemoglobin or more indicate exposure to methaemoglobin inducers. The causative substance should be used to evaluate the toxicity.	B	b
Methoxyacetic acid [625-45-6]				
Perc abs: H		**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Methoxyacetic acid	BAT	15 mg/g creatinine see Section XIII.1	U	i
2-Methoxyethanol [109-86-4]				
Perc abs: H		**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Methoxyacetic acid	BAT	15 mg/g creatinine see Section XIII.1	U	i
2-Methoxyethyl acetate [110-49-6]				
Perc abs: H		**Preg(BAT): B** Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum		
Methoxyacetic acid	BAT	15 mg/g creatinine see Section XIII.1	U	i

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
1-Methoxy-2-propanol [107-98-2]				
1-Methoxy-2-propanol	BAT	15 mg/l see Section XIII.1	U	b
Methyl tert-butyl ether [1634-04-4]				
	Carc cat: 3			
Methyl tert-butyl ether	BAT	not established see Section XIII.2	B, U	b
tert-Butanol	BAT	not established see Section XIII.2	B, U	–
4,4′-Methylenebis(2-chloroaniline) (MOCA) [101-14-4]				
Perc abs: H	**Carc cat: 2**			
4,4′-Methylenebis(2-chloroaniline) (MOCA) (after hydrolysis)	BAR	< 1 µg/l see Section XV.1	U	b
4,4′-Methylene diphenyl diisocyanate (MDI) [101-68-8] (inhalable fraction)				
Perc abs: H	**Carc cat: 4**			
4,4′-Diaminodiphenylmethane (after hydrolysis)	BLW	10 µg/l see Section XIV.1	U	b
Methyl formate [107-31-3]				
Perc abs: H				
Methanol	BAT	not established see Section XIII.2	U	b
4-Methyl-2-pentanone (Methyl isobutyl ketone) [108-10-1]				
Perc abs: H				
4-Methyl-2-pentanone	BAT	0.7 mg/l see Section XIII.1	U	b
N-Methyl-2-pyrrolidone [872-50-4]				
Perc abs: H				
5-Hydroxy-N-methyl-2-pyrrolidone	BAT	150 mg/l see Section XIII.1	U	b
Molybdenum [7439-98-7] and its compounds				
Molybdenum	BAT	not established see Section XIII.2	U, P	b
	BAR	150 µg/l see Section XV.1	U	b
Naphthalene [91-20-3]				
Perc abs: H	**Carc cat: 2**			
1-Naphthol plus 2-naphthol (after hydrolysis)	EKA	see Section XVI.1	U	c
	BAR	35 µg/l see Section XV.1	U	c
1,2-Dihydroxynaphthalene (after hydrolysis)	EKA	see Section XVI.1	U	c
S-(1-Naphthyl)mercapturic acid N-Acetyl-S-(1-naphthyl)cysteine	EKA	see Section XVI.1	U	c

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
2-Naphthylamine [91-59-8]				
Perc abs: H	**Carc cat: 1**			
2-Naphthylamine	EKA	not established see Section XVI.2	U	b
	BAR	not established see Section XV.2	U	b
2-Naphthylamine adducts	EKA	not established see Section XVI.2	B_E	f
	BAR	not established see Section XV.2	B_E	f
1,5-Naphthylene diisocyanate [3173-72-6]				
	Carc cat: 3			
1,5-Diaminonaphthalene	BLW	not established see Section XIV.2	U	b
Neuropathy target esterase inhibitors				
Reduction of activity of neuropathy target esterase in lymphocytes	BAT	not established see Section XIII.2	B	h
Nickel [7440-02-0] and its compounds				
	Carc cat: 1			
Nickel	BAR	3 µg/l see Section XV.1	U	c
Nickel [7440-02-0] (nickel metal, nickel oxide, nickel carbonate, nickel sulfide, sulfidic ores)				
	Carc cat: 1			
Nickel	EKA	see Section XVI.1	U	c
Nickel (easily soluble nickel compounds, e. g. nickel acetate and similar soluble salts, nickel chloride, nickel sulfate)				
	Carc cat: 1			
Nickel	EKA	not established see Section XVI.2	U	c
Nitrobenzene [98-95-3]				
Perc abs: H	**Carc cat: 4**			
Aniline (released from haemoglobin conjugate)	BLW	100 µg/l see Section XIV.1	B_E	f
Nitroglycerin [55-63-0]				
Perc abs: H	**Carc cat: 3**			
1,2-Glyceryl dinitrate	BLW	not established see Section XIV.2	P/S	b
1,3-Glyceryl dinitrate	BLW	not established see Section XIV.2	P/S	b

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Parathion [56-38-2]				
p-Nitrophenol (after hydrolysis)	BAT	not established see Section XIII.2	U	c
Acetylcholinesterase	BAT	not established see Section XIII.2	B_E	h
	BLW	Reduction of activity to 70% of reference value see Section XIV.1 BLW derived as ceiling value because of acute toxic effects	B_E	h
Pentachlorophenol [87-86-5]				
Perc abs: H	**Carc cat: 2**			
Pentachlorophenol	EKA	not established see Section XVI.2	P/S	a
Pentachlorophenol (after hydrolysis)	EKA	not established see Section XVI.2	U	a
Perfluorooctanesulfonic acid (PFOS) [1763-23-1] and its salts				
Perc abs: H	**Carc cat: 3**			
Perfluorooctanesulfonic acid	BAT	15 mg/l see Section XIII.1	S	a
Perfluorooctanoic acid (PFOA) [335-67-1] and its salts				
Perc abs: H	**Carc cat: 4**			
Perfluorooctanoic acid	BAT	5 mg/l see Section XIII.1	S	a
Phenol [108-95-2]				
Perc abs: H	**Carc cat: 3**			
Phenol (after hydrolysis)	BLW	200 mg/l see Section XIV.1	U	b
Polychlorinated biphenyls (PCB)				
see Chlorinated biphenyls				
Polycyclic aromatic hydrocarbons (PAH)				
Perc abs: H	**see Section III “pyrolysis products of organic materials”**			
3-Hydroxybenzo[a]pyrene (after hydrolysis)	EKA	see Section XVI.1	U	d
1-Hydroxypyrene (after hydrolysis)	BAR	0.3 µg/g creatinine see Section XV.1 evaluated for non-smokers	U	c
2-Propanol [67-63-0]				
		Preg(BAT): C		
Acetone	BAT	25 mg/l see Section XIII.1	B	b
	BAT	25 mg/l see Section XIII.1	U	b

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Pyrethrum [8003-34-7] and Pyrethroids (e. g. allethrin, cyfluthrin, cypermethrin, deltamethrin, permethrin, phenothrin, resmethrin, tetramethrin)				
trans-Chrysanthemumdicarboxylic acid, 4-fluoro-3-phenoxybenzoic acid, cis- and trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid or cis-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylic acid (all parameters after hydrolysis)	BAT	not established see Section XIII.2	U	b
Selenium [7782-49-2] and its inorganic compounds				
Perc abs: H	**Carc cat: 3**			
Selenium	BAT	150 µg/l see Section XIII.1	S	a
	BAR	100 µg/l see Section XV.1	P/S	a
	BAR	30 µg/g creatinine see Section XV.1	U	c
Styrene [100-42-5]				
	Carc cat: 5			
Mandelic acid plus phenyl glyoxylic acid	BAT	600 mg/g creatinine see Section XIII.1	U	b
Tetrachloroethene [127-18-4]				
Perc abs: H	**Carc cat: 3**			
Tetrachloroethene	BAT	200 µg/l see Section XIII.1	B	e 16 hours after end of exposure
	EKA	see Section XVI.1	B	e 16 hours after end of exposure
Tetrachloromethane (Carbon tetrachloride) [56-23-5]				
Perc abs: H	**Carc cat: 4**			
Tetrachloromethane	BAT	3.5 µg/l see Section XIII.1	B	c
Tetrahydrofuran [109-99-9]				
Perc abs: H				
Tetrahydrofuran	BAT	2 mg/l see Section XIII.1	U	b
Toluene [108-88-3]				
Perc abs: H		**Preg(BAT): C**		
Toluene	BAT	600 µg/l see Section XIII.1	B	g
	BAT	75 µg/l see Section XIII.1	U	b
o-Cresol (after hydrolysis)	BAT	1.5 mg/l see Section XIII.1	U	b

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
2,4-Toluenediamine [95-80-7]				
Perc abs: H	**Carc cat: 2**			
2,4-TDA (after hydrolysis)	EKA	see Section XVI.1	U	b
	BAR	not established see Section XV.2	U	b
2,4-Toluene diisocyanate [584-84-9]				
		Preg(BAT): C		
Sum of 2,4- and 2,6-TDA (after hydrolysis)	BAT	5 µg/g creatinine see Section XIII.1	U	b
2,4-TDA (after hydrolysis)	BAR	not established see Section XV.2	U	b
2,6-Toluene diisocyanate [91-08-7]				
		Preg(BAT): C		
Sum of 2,4- and 2,6-TDA (after hydrolysis)	BAT	5 µg/g creatinine see Section XIII.1	U	b
Toluene diisocyanates, mixture [26471-62-5]				
		Preg(BAT): C		
Sum of 2,4- and 2,6-TDA (after hydrolysis)	BAT	5 µg/g creatinine see Section XIII.1	U	b
o-Toluidine [95-53-4]				
Perc abs: H	**Carc cat: 1**			
o-Toluidine (after hydrolysis)	BAR	0.2 µg/l see Section XV.1 evaluated for non-smokers	U	b
Tributyl phosphate [126-73-8]				
Perc abs: H	**Carc cat: 4**			
Di-n-butyl phosphate	BAR	0.5 µg/l see Section XV.1	U	b
1,1,1-Trichloroethane (Methyl chloroform) [71-55-6]				
Perc abs: H		**Preg(BAT): C**		
1,1,1-Trichloroethane	BAT	275 µg/l see Section XIII.1	B	at the beginning of the next shift, after several previous shifts
Trichloroethene [79-01-6]				
Perc abs: H	**Carc cat: 1**			
Trichloroacetic acid	EKA	see Section XVI.1	U	c
	BAR	0.07 mg/l see Section XV.1	U	c
Tricresyl phosphate, sum of all o-isomers [78-30-8]				
Perc abs: H	**Carc cat: 3**			
Di-o-cresylphosphate	BAT	not established see Section XIII.2	U	b
	BAR	not established see Section XV.2	U	b

Substance Parameter	**BV**	**Value or correlation**	**Assay material**	**Sampling time**
Trimethylbenzene (all isomers) [25551-13-7]: 1,2,3-Trimethylbenzene [526-73-8], 1,2,4-Trimethylbenzene [95-63-6], 1,3,5-Trimethylbenzene [108-67-8]				
Dimethyl benzoic acids (sum of all isomers after hydrolysis)	BAT	400 mg/g creatinine see Section XIII.1	U	c
2,4,6-Trinitrotoluene [118-96-7] (and isomers in technical mixtures)				
Perc abs: H	**Carc cat: 2**			
4-Amino-2,6-dinitrotoluene (after hydrolysis)	BAR	< 1 µg/l see Section XV.1	U	b
2-Amino-4,6-dinitrotoluene (after hydrolysis)	BAR	< 4 µg/l see Section XV.1	U	b
Uranium [7440-61-1] and its hardly soluble inorganic compounds				
Perc abs: H	**Carc cat: 2**			
Uranium	BAR	not established see Section XV.2	U	a
Uranium compounds, soluble inorganic				
Perc abs: H	**Carc cat: 3**			
Uranium	BAR	not established see Section XV.2	U	a
Vanadium [7440-62-2] and its inorganic compounds				
	Carc cat: 4			
Vanadium	BAT	not established see Section XIII.2	U	c
	EKA	not established see Section XVI.2	U	c
	BAR	0.15 µg/l see Section XV.1	U	c
Vinyl chloride [75-01-4]				
	Carc cat: 1			
Thiodiglycolic acid	EKA	not established see Section XVI.2	U	c
	BAR	1.5 mg/l see Section XV.1 This BAR is not suitable for the assessment of vinyl chloride monomer exposures < 5 ml/m^3.	U	d
Vitamin K antagonists				
Quick value	BAT	Reduction to no less than 70% see Section XIII.1 BAT value derived as ceiling value because of acute toxic effects	B	a
★ **Xylene (all isomers) [1330-20-7]**				
Perc abs: H		**Preg(BAT): D**		
Methylhippuric acids (=toluric acids) (all isomers)	BAT	1800 mg/g creatinine see Section XIII.1	U	b

XIII. Biological Tolerance Values (BAT values)

The Commission establishes BAT values ("Biologische Arbeitsstoff-Toleranzwerte": biological tolerance values) to enable the occupational-medical and toxicological evaluation of the risk to an individual's health which results from exposure to a substance at the workplace. The BAT value describes the average occupational-medical and toxicological derived concentration for a substance, or one or more of its metabolites or a reaction product of the agent with endogenous macromolecules (adducts) or a deviation of a biological indicator from its norm caused by the agent or its metabolites at which the health of an employee generally is not adversely affected even when the person is repeatedly exposed during long periods. As a rule, exposure to the substance is assumed for the whole of working life. BAT values are based on a relationship between external and systemic exposure or between the systemic exposure and the resulting effect of the substance.

The BAT value is exceeded when, following several individual examinations, the average concentration of the parameter is greater than the BAT value; individual measured values greater than the BAT value must be evaluated in relation to occupational-medical and toxicological data. Adverse effects on health can not necessarily be deduced from one single excursion above the BAT value. This is not valid for acute toxicity, which must not be permitted at any time. The individual evaluations of substances include evidence of acute toxic effects. Substances with a BAT value which targets an acute toxic effect are marked accordingly in the List of MAK and BAT Values ("derivation of the BAT value as ceiling value because of acute toxic effects").

Derivation of BAT values

The derivation of a BAT value can be based on various constellations of scientific data.

- Studies in humans which reveal a direct relationship between concentrations of a substance or metabolites in biological material (internal exposure) and adverse effects on health are preferred, or
- studies in humans which reveal a relationship between a biological indicator (effect parameter) and adverse effects on health.
- If such information is not available, studies are preferred which reveal a quantitative relationship between exposure concentration and internal exposure and therefore permit the linking of MAK and BAT values.
- In individual cases, the assessment value is derived from a NOAEL from experiments with animals by means of a human toxicokinetic model.

The following considerations of sex-specific factors apply for the establishment of BAT-values:

1. The range of the variation in toxicokinetics and the anatomical and physiological characteristics in humans is very wide even for a single sex; the ranges for the two sexes overlap.
2. The resulting sex-specific differences in toxicokinetics generally vary in a range which is insignificant compared with the uncertainty involved in establishing limit values.
3. During pregnancy and breast-feeding, certain changes in the toxicokinetics of xenobiotics can occur. In practice, however, the effects of these changes are limited so that for health protection at the workplace the effects on the unborn child and the breast-fed baby are of particular importance (see Section VIII "MAK values and pregnancy").

BAT values are not suitable for the derivation of biological assessment values for exposures from the general environment by means of fixed conversion factors.

Correlations between BAT and MAK values

When a substance is inhaled under steady state conditions in controlled laboratory experiments, the relationship between the external exposure and the internal exposure can be expressed in terms of toxicokinetics. As a result of the conditions at the workplace, it is not necessarily possible to deduce the internal exposure from the concentration of certain substances in the air, and vice versa. In addition to inhalation of the substance, a series of other factors can determine the extent of exposure of the organism. These factors include for example the level of physical activity (respiratory minute volume), absorption through the skin and individual variations in metabolic or excretory patterns.

In general, for substances with low vapour pressure which are readily absorbed through the skin, there is no correlation between the external and internal exposure. For these substances a BAT value can therefore be established only on the basis of a relationship between the internal exposure and effect.

The concentrations of substances in the workplace air may vary with time and the biological parameters may not vary to the same extent. Therefore, the levels in the air cannot always be deduced from the results of investigations in biological material.

In spite of all these influencing factors and the consequent differences in the definitions of MAK and BAT values, the two limit values are based on equivalent effects of substances on the organism. Exceptions are substances for which the MAK value was not established on the basis of systemic effects but because of local irritation of skin and mucous membranes. In these cases the BAT value can still be based on "critical toxicity" resulting from systemic exposure, so that the MAK and BAT values may then be based on different end points.

BAT values and pregnancy

Observance of the BAT values does not guarantee the protection of the unborn child in every case, as for numerous hazardous substances at the workplace there are no or no adequate studies of their prenatal toxicity. On the basis of the prerequisites named in Section VIII "MAK values and pregnancy", the Commission examines all hazardous substances at the workplace with MAK or BAT values with respect to whether prenatal toxicity occurs when the MAK or BAT value is observed.

If there is a correlation between the MAK and BAT values, the pregnancy risk group for the MAK value usually applies also for the correlating BAT value.

If the BAT value was not derived in correlation with the MAK value, a procedure like that described in Section VIII "MAK values and pregnancy" is followed for the pregnancy risk group for the BAT value.

Allergenic substances

Depending on individual disposition, allergic reactions can be induced by various kinds of substances, more or less rapidly and in differing degrees of severity after sensitization of, for example, the skin or respiratory passages. The observance of BAT values cannot provide a guarantee that such reactions will not occur.

Mixtures of substances

BAT values apply as a rule for exposure to pure substances. They are not necessarily applicable for persons exposed to preparations containing more than one toxic substance (blends, mixtures, solutions). For mixtures of components with similar effects, a BAT value based on a biological parameter can be helpful in the assessment of health risks, as long as it provides a measure of critical clinical-functional effects of the components. The Commission makes every effort to define and publish such criteria for the biological effects of interfering components of mixtures.

1 Substances for which BAT values can be derived:

Acetone [67-64-1]
Aluminium [7429-90-5]
Aniline [62-53-3]
1-Butanol [71-36-3]
2-Butanone (Methyl ethyl ketone) [78-93-3]
2-Butoxyethanol [111-76-2]
2-Butoxyethyl acetate [112-07-2]
p-tert-Butylphenol (ptBP) [98-54-4]
Carbon disulfide [75-15-0]
Carbon monoxide [630-08-0]
Chlorinated biphenyls [1336-36-3]
Chlorobenzene [108-90-7]
Cyclohexane [110-82-7]
1,2-Dichlorobenzene [95-50-1]
1,4-Dichlorobenzene [106-46-7]
Dichloromethane [75-09-2]
Diethylene glycol dimethyl ether [111-96-6]
Diethylene glycol monomethyl ether [111-77-3]
N,N-Dimethylacetamide [127-19-5]
N,N-Dimethylformamide [68-12-2]
1,4-Dioxane [123-91-1]
1,2-Epoxypropane (1,2-Propylene oxide) [75-56-9]
2-Ethoxyethanol [110-80-5]
2-Ethoxyethyl acetate [111-15-9]

Ethylbenzene [100-41-4]
Halothane (2-Bromo-2-chloro-1,1,1-trifluoroethane) [151-67-7]
n-Heptane [142-82-5]
Hexachlorobenzene [118-74-1]
1,6-Hexamethylene diisocyanate [822-06-0]
n-Hexane [110-54-3]
2-Hexanone [591-78-6]
Hydrogen fluoride [7664-39-3] and inorganic fluorine compounds (fluorides)
Isoflurane [26675-46-7]
Isopropylbenzene (cumene) [98-82-8]
Lead [7439-92-1] and its inorganic compounds (except lead arsenate and lead chromate)
Lindane (γ-1,2,3,4,5,6-Hexachlorocyclohexane) [58-89-9]
Mercury [7439-97-6] and its inorganic compounds
Methanol [67-56-1]
Methoxyacetic acid [625-45-6]
2-Methoxyethanol [109-86-4]
2-Methoxyethyl acetate [110-49-6]
1-Methoxy-2-propanol [107-98-2]
4-Methyl-2-pentanone (Methyl isobutyl ketone) [108-10-1]
N-Methyl-2-pyrrolidone [872-50-4]
Perfluorooctanesulfonic acid (PFOS) [1763-23-1] and its salts
Perfluorooctanoic acid (PFOA) [335-67-1] and its salts
2-Propanol [67-63-0]
Selenium [7782-49-2] and its inorganic compounds
Styrene [100-42-5]
Tetrachloroethene [127-18-4]
Tetrachloromethane (Carbon tetrachloride) [56-23-5]
Tetrahydrofuran [109-99-9]
Toluene [108-88-3]
2,4-Toluene diisocyanate [584-84-9]
2,6-Toluene diisocyanate [91-08-7]
Toluene diisocyanates, mixture [26471-62-5]
1,1,1-Trichloroethane (Methyl chloroform) [71-55-6]
Trimethylbenzene (all isomers) [25551-13-7]: 1,2,3-Trimethylbenzene [526-73-8], 1,2,4-Trimethylbenzene [95-63-6], 1,3,5-Trimethylbenzene [108-67-8]
Vitamin K antagonists
★ Xylene (all isomers) [1330-20-7]

2 For the substances listed below, there is at present insufficient data for the derivation of a BAT value; however, documentation for these substances has been published in “The MAK Collection for Occupational Health and Safety”[61]):

Acetylcholinesterase inhibitors
Boric acid [10043-35-3] and tetraborates
Copper [7440-50-8] and its inorganic compounds
Cresol (all isomers) [1319-77-3]: o-cresol [95-48-7], m-cresol [108-39-4], p-cresol [106-44-5]
1-Ethoxy-2-propanol [1569-02-4]
1-Ethoxy-2-propyl acetate [54839-24-6]
Ethylene glycol dinitrate [628-96-6]
★ Lead tetraethyl [78-00-2]
★ Lead tetramethyl [75-74-1]
Manganese [7439-96-5] and its inorganic compounds
Mercury, organic compounds
Methaemoglobin-forming substances
Methyl tert-butyl ether [1634-04-4]
Methyl formate [107-31-3]
Molybdenum [7439-98-7] and its compounds
Neuropathy target esterase inhibitors
Parathion [56-38-2]

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[61]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

Pyrethrum [8003-34-7] and Pyrethroids (e. g. allethrin, cyfluthrin, cypermethrin, deltamethrin, permethrin, phenothrin, resmethrin, tetramethrin)
Tricresyl phosphate, sum of all o-isomers [78-30-8]
Vanadium [7440-62-2] and its inorganic compounds

3 BAT values examined with regard to their pregnancy risk group:

3.1 Substances at the workplace **with** a correlation between MAK and BAT value

Acetone [67-64-1]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
Carbon monoxide [630-08-0]	Group B
Chlorobenzene [108-90-7]	Group C
1,4-Dichlorobenzene [106-46-7]	Group C
Dichloromethane [75-09-2]	Group B
Diethylene glycol dimethyl ether [111-96-6]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
Diethylene glycol monomethyl ether [111-77-3]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
N,N-Dimethylacetamide [127-19-5]	Group C
N,N-Dimethylformamide [68-12-2]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
1,4-Dioxane [123-91-1]	Group C
1,2-Epoxypropane (1,2-Propylene oxide) [75-56-9]	Group C
Ethylbenzene [100-41-4]	Group C
Isoflurane [26675-46-7]	Group D
Isopropylbenzene (cumene) [98-82-8]	Group C
Lead [7439-92-1] and its inorganic compounds (except lead arsenate and lead chromate)	Group A
Methanol [67-56-1]	Group C
Methoxyacetic acid [625-45-6]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
2-Methoxyethanol [109-86-4]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
2-Methoxyethyl acetate [110-49-6]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
2-Propanol [67-63-0]	Group C
Toluene [108-88-3]	Group C
2,4-Toluene diisocyanate [584-84-9]	Group C
2,6-Toluene diisocyanate [91-08-7]	Group C
Toluene diisocyanates, mixture [26471-62-5]	Group C
1,1,1-Trichloroethane (Methyl chloroform) [71-55-6]	Group C
Xylene (all isomers) [1330-20-7]	Group D

3.2 Substances at the workplace **with no** correlation between MAK and BAT value

★ Aluminium [7429-90-5]	Group D
★ Aniline [62-53-3]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
Chlorinated biphenyls [1336-36-3]	Group B
	Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum
Hexachlorobenzene [118-74-1]	Group D
Hydrogen fluoride [7664-39-3] and inorganic fluorine compounds (fluorides)	Group C
Lindane (γ-1,2,3,4,5,6-Hexachlorocyclohexane) [58-89-9]	Group C

XIV. Biological Guidance Values (BLW)

The BLW (“biological guidance value”) is the average concentration of a chemical substance or its metabolites or the deviation from the norm of biological parameters induced by the substance in exposed humans which serves as an indicator for necessary protective measures. BLWs are assigned only for hazardous substances for which the available toxicological or occupational-medical data are insufficient for the establishment of BAT values (i. e. for carcinogenic substances and suspected carcinogens). BLW values are established on the assumption that persons are exposed for their entire working lives.

The BLW is based on occupational-medical information as to the effects of handling the hazardous material together with toxicological data. Since observance of the BLW does not exclude a risk of adverse effects on health, it is necessary to extend our knowledge of the relationships between exposure to the substance, the systemic dose and the resulting risks for health, so that BAT values may be derived.

The BLW is exceeded if, in several examinations of one person, the mean concentration of the parameter is above the BLW. Individual measured values above the BLW must be assessed from the point of view of occupational medicine and toxicology.

1 Substances for which BLW can be derived:

Acetylcholinesterase inhibitors
Acrylamide [79-06-1]
Aniline [62-53-3]
Arsenic [7440-38-2] and inorganic arsenic compounds (except for arsine)
Bisphenol A (4,4′-Isopropylidenediphenol) [80-05-7]
Bromomethane (Methyl bromide) [74-83-9]
★ Cadmium [7440-43-9] and its inorganic compounds
Cobalt [7440-48-4] and cobalt compounds
Di(2-ethylhexyl)phthalate (DEHP) [117-81-7]
★ Lead tetraethyl [78-00-2]
★ Lead tetramethyl [75-74-1]
4,4′-Methylene diphenyl diisocyanate (MDI) [101-68-8] (inhalable fraction)
Nitrobenzene [98-95-3]
Parathion [56-38-2]
Phenol [108-95-2]

2 For the substances listed below, there is at present insufficient data for the derivation of a BLW; however, documentation for these substances has been published in “The MAK Collection for Occupational Health and Safety”[62]):

4-Aminobiphenyl [92-67-1]
Cresol (all isomers) [1319-77-3]: o-cresol [95-48-7], m-cresol [108-39-4], p-cresol [106-44-5]
4,4′-Diaminodiphenylmethane [101-77-9]
Indium [7440-74-6] and its inorganic compounds
1,5-Naphthylene diisocyanate [3173-72-6]
Nitroglycerin [55-63-0]

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[62]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

XV. Biological Reference Values (BAR)

The BAR (“biological reference value”) represents the internal exposure to a substance at a particular time of a reference population of persons of working age who are not occupationally exposed to this substance (background exposure). This background exposure may (also) have an endogenous cause.

The reference level for a substance or its metabolite in biological material is derived with the help of the measured level in a random sample from a defined population group. The BAR is based on the 95th percentile without regarding effects on health. It must be taken into account that the background exposure and thus also the reference level can be influenced by such factors as age, sex, social status, residential environment, life style and geographical region. For substances which occur also in tobacco smoke, the BAR is generally derived only for non-smokers.

Occupational exposure can be assessed by comparing biomonitoring values in occupationally exposed persons with the BAR, provided the sampling time is observed.

1 Substances for which a BAR can be derived:

Acetone [67-64-1]
Acrolein (2-Propenal) [107-02-8]
Acrylamide [79-06-1]
Acrylonitrile [107-13-1]
Aluminium [7429-90-5]
4-Aminobiphenyl [92-67-1]
Antimony [7440-36-0] and its inorganic compounds (except for stibine)
Arsenic [7440-38-2] and inorganic arsenic compounds (except for arsine)
Barium compounds, soluble (as Ba [7440-39-3])
Benzene [71-43-2]
Beryllium [7440-41-7] and its inorganic compounds
Bisphenol S [80-09-1]
1,3-Butadiene [106-99-0]
Butylated hydroxytoluene (BHT) [128-37-0]
Cadmium [7440-43-9] and its inorganic compounds
Chlorinated biphenyls [53469-21-9]
Chloroprene (2-Chloro-1,3-butadiene) [126-99-8]
Chromium [7440-47-3] and its compounds
Cobalt [7440-48-4] and cobalt compounds
4,4′-Diaminodiphenylmethane [101-77-9]
1,4-Dichlorobenzene [106-46-7]
1,2-Epoxypropane (1,2-Propylene oxide) [75-56-9]
Ethylene oxide [75-21-8]
Glycidol [556-52-5]
Lead [7439-92-1] and its inorganic compounds (except lead arsenate and lead chromate)
Lithium compounds, inorganic (as Li [7439-93-2])
Manganese [7439-96-5] and its inorganic compounds
4,4′-Methylenebis(2-chloroaniline) (MOCA) [101-14-4]
Molybdenum [7439-98-7] and its compounds
Naphthalene [91-20-3]
Nickel [7440-02-0] and its compounds
Polycyclic aromatic hydrocarbons (PAH)
Selenium [7782-49-2] and its inorganic compounds
o-Toluidine [95-53-4]
Tributyl phosphate [126-73-8]
Trichloroethene [79-01-6]
2,4,6-Trinitrotoluene [118-96-7] (and isomers in technical mixtures)
Vanadium [7440-62-2] and its inorganic compounds
Vinyl chloride [75-01-4]

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2 For the substances listed below, there is at present insufficient data for the derivation of a BAR; however, documentation for these substances has been published in “The MAK Collection for Occupational Health and Safety”[63]):

Benzidine [92-87-5]
Copper [7440-50-8] and its inorganic compounds
1,2-Dichloropropane [78-87-5]
Gadolinium [7440-54-2]
Indium [7440-74-6] and its inorganic compounds
Iodine [7553-56-2] and inorganic iodides
2-Naphthylamine [91-59-8]
2,4-Toluenediamine [95-80-7]
2,4-Toluene diisocyanate [584-84-9]
Tricresyl phosphate, sum of all o-isomers [78-30-8]
Uranium [7440-61-1] and its hardly soluble inorganic compounds
Uranium compounds, soluble inorganic

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[63]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

XVI. Exposure equivalents for carcinogenic substances (EKA)

For chemical substances which, by their own action or by that of their reactive intermediates or metabolites, are known to cause cancer in man or for which there is good evidence of a human cancer risk (Carcinogen categories 1 and 2) or which cause concern because they are or could be carcinogenic (Carcinogen category 3) and for which no MAK value can be derived, also no BAT values are derived. Therefore, the handling of such substances must take place under the conditions described in Section III of the List of MAK and BAT Values. For substances in Carcinogen categories 3, 4 and 5, BAT values are derived, if there are sufficient data. For carcinogenic substances and suspected carcinogens for which there are insufficient data for the derivation of a BAT value or the conditions for deriving a BAT value are not fulfilled, a BLW can be established.

In order to be able to evaluate internal exposure in the case of carcinogenic substances, the Commission investigates the relationships between the concentration of the carcinogen in the workplace air and that of the substance or its metabolites in biological material (“Expositionsäquivalente für krebserzeugende Arbeitsstoffe”, EKA: exposure equivalents for carcinogenic substances). From these relationships, the expected internal exposure which results from uptake of the substance exclusively by inhalation may be determined.

1 Carcinogenic substances and suspected carcinogens for which correlations (“exposure equivalents for carcinogenic substances”, EKA) can be evaluated:

(printed in italics: Equivalent Values according to ERB (=exposure-risk relationships as defined in “Risk-related concept of measures for activities involving carcinogenic hazardous substances (TRGS 910)”[64]))

Acrylamide [79-06-1] H

Air Acrylamide [mg/m^3]	Sampling time: after exposure for at least 3 months Erythrocyte fraction of whole blood N-(2-Carbonamideethyl)valine [pmol/g globin]
0.035	200
0.07	*400*
0.10	550
0.15	*800*
0.30	1600

Acrylonitrile [107-13-1] H

Air Acrylonitrile [ml/m^3]	 [mg/m^3]	Sampling time: after exposure for at least 3 months Erythrocyte fraction of whole blood N-(2-Cyanoethyl)valine [pmol/g globin]
0.12	*0.26*	*650*
0.23	0.5	1400
0.45	1	2450
1.2	*2.6*	*6500*
3	7	17 000

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[64] Ausschuss für Gefahrstoffe (2014) Risikobezogenes Maßnahmenkonzept für Tätigkeiten mit krebserzeugenden Gefahrstoffen (TRGS 910). https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/TRGS-910.html

Alkali chromates (Cr(VI) compounds)

H (the chromates of barium, lead, strontium and zinc are not designated with "H")

Air CrO_3 [mg/m³]	Sampling time: after exposure for at least 3 months Erythrocyte fraction of whole blood[a] Chromium [µg/l whole blood]	Sampling time: end of exposure or end of shift Urine[b] Chromium [µg/l]
0.03	9	12
0.05	17	20
0.08	25	30
0.10	35	40

[a] **not** applicable for exposure to welding fumes

[b] **also** applicable for exposure to welding fumes

Arsenic [7440-38-2] and inorganic arsenic compounds (apart from arsine)

H (metallic arsenic and gallium arsenide are not designated with "H")

Air Arsenic and inorganic arsenic compounds (apart from arsine) [µg/m³][a]	Sampling time: end of exposure or end of shift Urine Σ Arsenic(III), arsenic(V), monomethylarsonic acid [µg/l]
0.5	2.0
0.8	2.5
1	3.0
5	8.0
8.3	11.0
10	13.0
50	36.0
100	57.0

[a] determined in the inhalable fraction

Benzene [71-43-2] H

		Sampling time: at the end of the shift, for long-term exposures after several previous shifts	Sampling time: end of exposure or end of shift	
Air		Urine	Urine	
Benzene		S-Phenyl-mercapturic acid[a]	trans, trans-Muconic acid	Benzene
[ml/m^3]	[mg/m^3]	[µg/g creatinine]	[µg/g creatinine]	[µg/l]
0.03	0.1	1.5[b]	–	0.5[b]
0.06	*0.2*	*3* [b]	–	*0.8*[b]
0.15	0.5	5	–	1.5
0.3	1.0	12	300	2.75
0.6	*2.0*	*25*	*500*	*5.0*
1.0	3.3	45	750	7.5
2.0	6.5	90	1200	12.5

[a] N-Acetyl-S-phenylcysteine

[b] non-smokers only

1-Bromopropane [106-94-5] H

		Sampling time: at the end of the shift, for long-term exposures after several previous shifts
Air		Urine
1-Brompropane		S-(n-Propyl)mercapturic acid[a]
[ml/m^3]	[mg/m^3]	[mg/g creatinine]
1	5	2.0
2	10	3.4
5	25	7.0
10	50	12.0
20	101	20.0

[a] N-Acetyl-S-n-propylcysteine

1,3-Butadiene [106-99-0]

		Sampling time: at the end of the shift, for long-term exposures after several previous shifts	
Air		Urine	
1,3-Butadiene		S-(3,4-Dihydroxybutyl)-mercapturic acid a)	S-(2-Hydroxy-3-butenyl)-mercapturic acid b)
[ml/m^3]	[mg/m^3]	[µg/g creatinine]	[µg/g creatinine]
0.2	*0.45*	*600*	*10*
0.5	1.1	1000	20
1	2.3	1600	40
2	*4.5*	*2900*	*80*
3	6.8	4200	120

a) N-Acetyl-S-(3,4-dihydroxybutyl)-cysteine
b) N-Acetyl-S-(2-hydroxy-3-butenyl)-cysteine

1-Chloro-2,3-epoxypropane (Epichlorohydrin) [106-89-8] H

		Sampling time: at the end of the shift, for long-term exposures after several previous shifts
Air		Urine
1-Chloro-2,3-epoxypropane		S-(3-Chloro-2-hydroxypropyl)mercapturic acid a)
[ml/m^3]	[mg/m^3]	[mg/g creatinine]
0.06	0.23	0.80
0.13	0.5	1.75
0.26	1	3.5
0.6	*2.3*	*8*
2	*8*	*28*

a) N-Acetyl-S-(3-chloro-2-hydroxypropyl)cysteine

Cobalt [7440-48-4] and cobalt compounds H

	Sampling time: at the end of the shift, for long-term exposures after several previous shifts
Air	Urine
Cobalt	Cobalt
[mg/m^3]	[µg/l]
0.005	3
0.010	6
0.025	15
0.050	30
0.100	60
0.500	300

Cyclohexanone [108-94-1] H

Air		Sampling time: at the end of the shift, for long-term exposures after several previous shifts	Sampling time: end of exposure or end of shift
		Urine	Urine
Cyclohexanone		1,2-Cyclohexanediol (after hydrolysis)	Cyclohexanol (after hydrolysis)
[ml/m³]	[mg/m³]	[mg/l]	[mg/l]
10	40	50	6
20	80	100	12
50	200	250	30

1,4-Dichlorobenzene [106-46-7] H

Air		Sampling time: at the end of the shift, for long-term exposures after several previous shifts
		Urine
1,4-Dichlorobenzene		2,5-Dichlorophenol (after hydrolysis)
[ml/m³]	[mg/m³]	[mg/l]
2	12	10
5	30.5	20
10	61	30
20	122	60
30	183	90

Dichloromethane [75-09-2] H

Air		Sampling time: during exposure, at least 2 hours after beginning of exposure
		Whole blood
Dichloromethane		Dichloromethane
[ml/m³]	[mg/m³]	[mg/l]
10	35	0.1
20	70	0.2
50	175	0.5
100	350	1

Dimethyl sulfate [77-78-1] H

Air Dimethyl sulfate [ml/m³]	 [mg/m³]	Sampling time: after exposure for at least 3 months Erythrocyte fraction of whole blood N-Methylvaline [µg/l whole blood]
0.002	0.01	10
0.006	0.03	13
0.01	0.05	17
0.04	0.20	40

1,2-Epoxypropane [75-56-9]

Air 1,2-Epoxypropane [ml/m³]	 [mg/m³]	Sampling time: after exposure for at least 3 months Erythrocyte fraction of whole blood N-(2-Hydroxypropyl)valine [pmol/g globin]
0.5	1.2	600
1.0	2.4	1300
2.0	4.8	2600
2.5	6.0	3200

Ethylbenzene [100-41-4] H

Air Ethylbenzene [ml/m³]	 [mg/m³]	Sampling time: end of exposure or end of shift Urine Mandelic acid plus phenyl glyoxylic acid [mg/g creatinine]
10	44	130
20	88	250
25	110	330
50	220	670
100	440	1300

Ethylene oxide [75-21-8] H

Air Ethylene oxide		Sampling time: after exposure for at least 3 months Erythrocyte fraction of whole blood N-(2-Hydroxyethyl)valine
[ml/m^3]	[mg/m^3]	[pmol/g globin]
0.1	*0.18*	*400*
0.5	0.92	2000
1	*1.83*	*4000*
2	3.66	8000

Naphthalene [91-20-3] H

Air Naphthalene		Sampling time: at the end of the shift, for long-term exposures after several previous shifts Urine		
		1,2-Dihydroxy-naphthalene (after hydrolysis)	S-(1-Naphthyl)-mercapturic acid[a]	(1+2)-Naphthol (after hydrolysis)
[ml/m^3]	[mg/m^3]	[µg/l]	[µg/l]	[µg/l]
0.2	1	–[b]	30	220
0.4	2	4000	60	500
0.9	5	13 500	175	1500
1.4	7.5	23 300	280	2300
1.9	10	34 200	390	3300

[a] N-Acetyl-S-(1-naphthyl)cysteine

[b] Extrapolation not possible due to high scattering of individual values in this concentration range

Nickel [7440-02-0] (nickel metal, nickel oxide, nickel carbonate, nickel sulfide, sulfidic ores)

Air Nickel	Sampling time: at the end of the shift, for long-term exposures after several previous shifts Urine Nickel
[mg/m^3]	[µg/l]
0.10	15
0.30	30
0.50	45

Polycyclic aromatic hydrocarbons (PAH) H

Air Benzo[a]pyrene [µg/m³]	Sampling time: at the beginning of the next shift Urine 3-Hydroxybenzo[a]pyrene (after hydrolysis) [ng/g creatinine]
0.07	0.7
0.35	2
0.7	3.5
1.0	5
1.5	7

Tetrachloroethylene [127-18-4] H

Air Tetrachloroethylene [ml/m³]	 [mg/m³]	Sampling time: 16 hours after end of exposure Whole blood Tetrachloroethylene [µg/l]
3	21	60
10	69	200
20	138	400
30	206	600
50	344	1000

2,4-Toluenediamine [95-80-7] H

Air 2,4-Toluenediamine [mg/m³]	Sampling time: end of exposure or end of shift Urine 2,4-Toluenediamine (after hydrolysis) [µg/g creatinine]
0.0025	6
0.01	13
0.017	20
0.035	37
0.100 [a)]	100 [a)]

[a)] values obtained by extrapolation

Trichloroethylene [79-01-6] H

Air		Sampling time: at the end of the shift, for long-term exposures after several previous shifts Urine
Trichloroethylene		Trichloroacetic acid
[ml/m³]	[mg/m³]	[mg/l]
0.6	3.3	1.2
6	*33*	*12*
10	55	20
11	60	22
15	82	30
20	109	40
25	137	50

2 Carcinogenic substances and suspected carcinogens for which correlations ("exposure equivalents for carcinogenic materials", EKA) cannot be evaluated, or only evaluated incompletely, but which are documented in "The MAK Collection for Occupational Health and Safety"[65]):

4-Aminobiphenyl [92-67-1]
Antimony [7440-36-0] and its inorganic compounds (except for stibine)
Benzidine [92-87-5]
Beryllium [7440-41-7] and its inorganic compounds
Bromomethane (Methyl bromide) [74-83-9]
Ethylene [74-85-1]
Hydrazine [302-01-2]
Mercury, organic compounds
2-Naphthylamine [91-59-8]
Nickel (easily soluble nickel compounds, e. g. nickel acetate and similar soluble salts, nickel chloride, nickel sulfate)
Pentachlorophenol [87-86-5]
Vanadium [7440-62-2] and its inorganic compounds
Vinyl chloride [75-01-4]

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[65]) available online under https://mak-dfg.publisso.de or https://onlinelibrary.wiley.com/doi/book/10.1002/3527600418 (up to 2019)

CAS Number Index

CAS numbers of the substances listed in Sections II to XVI and on the announcement list

CAS number	Substance
50-00-0	Formaldehyde
50-29-3	DDT (Dichlorodiphenyltrichloroethane)
50-32-8	Benzo[a]pyrene
50-53-3	Chlorpromazine (2-Chloro-10-(3-dimethylaminopropyl)phenothiazine)
51-75-2	N-Methyl-bis(2-chloroethyl)amine (nitrogen mustard)
51-79-6	Carbamic acid ethyl ester
52-51-7	2-Bromo-2-nitro-1,3-propanediol
53-70-3	Dibenzo[a,h]anthracene
54-11-5	Nicotine
54-64-8	Thimerosal
55-18-5	N-Nitrosodiethylamine
55-38-9	Fenthion
55-63-0	Nitroglycerin
56-23-5	Tetrachloromethane
56-38-2	Parathion
56-55-3	Benzo[a]anthracene
56-81-5	Glycerol
57-10-3	Palmitic acid
57-11-4	Stearic acid
57-12-5	Cyanides
57-14-7	1,1-Dimethylhydrazine
57-24-9	Strychnine
57-55-6	Propylene glycol
57-57-8	β-Propiolactone
57-74-9	Chlordane
58-89-9	Lindane
59-50-7	p-Chloro-m-cresol
59-89-2	N-Nitrosomorpholine
60-00-4	Ethylenediaminetetraacetic acid (EDTA)
60-09-3	p-Aminoazobenzene
60-12-8	2-Phenyl-1-ethanol
60-29-7	Ethyl ether
60-34-4	Monomethylhydrazine
60-35-5	Acetamide
60-57-1	Dieldrin
61-82-5	Amitrole
62-23-7	4-Nitrobenzoic acid
62-53-3	Aniline
62-56-6	Thiourea
62-73-7	Dichlorvos
62-74-8	Sodium fluoroacetate
62-75-9	N-Nitrosodimethylamine
63-25-2	Carbaryl (1-Naphthyl methylcarbamate)
64-17-5	Ethanol
64-18-6	Formic acid
64-19-7	Acetic acid
64-67-5	Diethyl sulfate
65-85-0	Benzoic acid
67-56-1	Methanol
67-63-0	2-Propanol
67-64-1	Acetone

CAS number	Substance
67-66-3	Chloroform (Trichloromethane)
67-68-5	Dimethyl sulfoxide
67-72-1	Hexachloroethane
68-11-1	Thioglycolic acid
68-12-2	N,N-Dimethylformamide
71-36-3	1-Butanol
71-41-0	Pentanol (isomers): 1-Pentanol
71-43-2	Benzene
71-55-6	1,1,1-Trichloroethane
72-20-8	Endrin
72-43-5	Methoxychlor (DMDT)
74-11-3	Chlorobenzoic acid (all isomers): p-Chlorobenzoic acid
74-31-7	N,N-Diphenyl-p-phenylenediamine
74-83-9	Bromomethane
74-85-1	Ethylene
74-87-3	Chloromethane
74-88-4	Iodomethane
74-89-5	Methylamine
74-90-8	Hydrogen cyanide
74-93-1	Methanethiol
74-96-4	Bromoethane
74-97-5	Bromochloromethane
74-98-6	Propane
74-99-7	Methyl acetylene
75-00-3	Chloroethane
75-01-4	Vinyl chloride
75-04-7	Ethylamine
75-05-8	Acetonitrile
75-07-0	Acetaldehyde
75-08-1	Ethanethiol
75-09-2	Dichloromethane
75-12-7	Formamide
75-15-0	Carbon disulfide
75-18-3	Dimethyl sulfide
75-21-8	Ethylene oxide
75-25-2	Tribromomethane
75-27-4	Bromodichloromethane
75-28-5	Butane (both isomers): Isobutane
75-31-0	2-Aminopropane
75-34-3	1,1-Dichloroethane
75-35-4	1,1-Dichloroethene
75-38-7	1,1-Difluoroethylene
75-43-4	Dichlorofluoromethane
75-44-5	Phosgene
75-45-6	Chlorodifluoromethane
75-50-3	Trimethylamine
75-52-5	Nitromethane
75-55-8	Propylene imine
75-56-9	1,2-Epoxypropane
75-61-6	Dibromodifluoromethane
75-63-8	Bromotrifluoromethane
75-64-9	tert-Butylamine
75-65-0	tert-Butanol
75-66-1	2-Methyl-2-propanethiol
75-68-3	1-Chloro-1,1-difluoroethane
75-69-4	Trichlorofluoromethane

CAS number	Substance
75-71-8	Dichlorodifluoromethane
75-72-9	Chlorotrifluoromethane (FC-13)
75-74-1	Lead tetramethyl
75-83-2	Hexane (all isomers except n-Hexane) and Methylcyclopentane: 2,2-Dimethylbutane
75-84-3	Pentanol (isomers): 2,2-Dimethyl-1-propanol
75-85-4	Pentanol (isomers): 2-Methyl-2-butanol
75-91-2	tert-Butyl hydroperoxide
75-99-0	2,2-Dichloropropionic acid
76-01-7	Pentachloroethane
76-03-9	Trichloroacetic acid
76-06-2	Trichloronitromethane
76-11-9	1,1,1,2-Tetrachloro-2,2-difluoroethane
76-12-0	1,1,2,2-Tetrachloro-1,2-difluoroethane
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane
76-14-2	1,2-Dichloro-1,1,2,2-tetrafluoroethane
76-22-2	Camphor
76-44-8	Heptachlor
77-47-4	Hexachlorocyclopentadiene
77-73-6	Dicyclopentadiene
77-78-1	Dimethyl sulfate
77-92-9	Citric acid
78-00-2	Lead tetraethyl
78-10-4	Silicic acid tetraethyl ester
78-18-2	1-Hydroxy-1′-hydroperoxydicyclohexyl peroxide
78-30-8	Tricresyl phosphate, sum of all o-isomers
78-32-0	Tricresyl phosphate, isomers, „free of o-isomers”
78-59-1	Isophorone
78-78-4	Pentane (all isomers): Isopentane
78-79-5	Isoprene (2-Methyl-1,3-butadiene)
78-81-9	Isobutylamine
78-83-1	Isobutanol
78-87-5	1,2-Dichloropropane
78-92-2	2-Butanol
78-93-3	2-Butanone
78-94-4	Methyl vinyl ketone
78-96-6	1-Amino-2-propanol
79-00-5	1,1,2-Trichloroethane
79-01-6	Trichloroethene
79-04-9	Chloroacetyl chloride
79-06-1	Acrylamide
79-07-2	2-Chloroacetamide
79-09-4	Propionic acid
79-10-7	Acrylic acid
79-11-8	Monochloroacetic acid
79-20-9	Methyl acetate
79-21-0	Peracetic acid
79-22-1	Chloroformic acid methyl ester
79-24-3	Nitroethane
79-27-6	1,1,2,2-Tetrabromoethane
79-29-8	Hexane (all isomers except n-Hexane) and Methylcyclopentane: 2,3-Dimethylbutane
79-34-5	1,1,2,2-Tetrachloroethane
79-41-4	Methacrylic acid
79-43-6	Dichloroacetic acid
79-44-7	Dimethylcarbamoyl chloride
79-46-9	2-Nitropropane
79-94-7	Tetrabromobisphenol A

CAS number	Substance
80-05-7	Bisphenol A
80-09-1	Bisphenol S
80-15-9	α,α-Dimethylbenzyl hydroperoxide
80-62-6	Methacrylic acid methyl ester
81-81-2	Warfarin
81-84-5	1,8-Naphthalic anhydride
83-79-4	Rotenone
84-74-2	Di-n-butyl phthalate
85-01-8	Phenanthrene
85-42-7	Hexahydrophthalic anhydride
85-44-9	Phthalic anhydride
85-68-7	Benzylbutyl phthalate
86-30-6	N-Nitrosodiphenylamine
86-50-0	Azinphos-methyl
86-57-7	1-Nitronaphthalene
86-88-4	1-Naphthylthiourea
87-59-2	Xylidine (isomers): 2,3-Xylidine
87-61-6	1,2,3-Trichlorobenzene
87-62-7	2,6-Xylidine
87-68-3	Hexachloro-1,3-butadiene
87-69-4	Tartaric acid
87-86-5	Pentachlorophenol
88-10-8	Diethylcarbamoyl chloride
88-12-0	N-Vinyl-2-pyrrolidone
88-72-2	2-Nitrotoluene
88-73-3	o-Chloronitrobenzene
88-88-0	Picryl chloride
88-89-1	Picric acid
88-99-3	o-Phthalic acid
90-04-0	o-Anisidine
90-30-2	N-Phenyl-1-naphthylamine
90-43-7	o-Phenylphenol
90-66-4	2,2′-Thiobis(4-methyl-6-tert-butylphenol)
90-94-8	Michler's ketone
91-08-7	Toluene diisocyanates: 2,6-Toluene diisocyanate
91-17-8	Decahydronaphthalene
91-20-3	Naphthalene
91-23-6	2-Nitroanisole
91-29-2	4-Nitro-4′-aminodiphenylamine-2-sulfonic acid
91-59-8	2-Naphthylamine
91-94-1	3,3′-Dichlorobenzidine
91-95-2	3,3′-Diaminobenzidine and its tetrahydrochloride
92-52-4	Biphenyl
92-67-1	4-Aminobiphenyl
92-70-6	3-Hydroxy-2-naphthalenecarboxylic acid
92-84-2	Phenothiazine
92-87-5	Benzidine
92-93-3	4-Nitrobiphenyl
93-76-5	2,4,5-Trichlorophenoxyacetic acid
94-36-0	Dibenzoyl peroxide
94-37-1	Dipentamethylenethiuram disulfide
94-75-7	2,4-Dichlorophenoxyacetic acid
94-96-2	2-Ethyl-1,3-hexanediol
95-14-7	Benzotriazole
95-33-0	N-Cyclohexyl-2-benzothiazolesulfenamide
95-48-7	Cresol (all isomers): o-Cresol

CAS number	Substance
95-50-1	1,2-Dichlorobenzene
95-51-2	o-Chloroaniline
95-53-4	o-Toluidine
95-54-5	o-Phenylenediamine
95-63-6	Trimethylbenzene (all isomers): 1,2,4-Trimethylbenzene
95-64-7	Xylidine (isomers): 3,4-Xylidine
95-68-1	2,4-Xylidine
95-69-2	4-Chloro-o-toluidine
95-70-5	2,5-Toluenediamine
95-76-1	3,4-Dichloroaniline
95-78-3	Xylidine (isomers): 2,5-Xylidine
95-79-4	5-Chloro-o-toluidine
95-80-7	2,4-Toluenediamine
95-95-4	2,4,5-Trichlorophenol
96-12-8	1,2-Dibromo-3-chloropropane
96-14-0	Hexane (all isomers except n-Hexane) and Methylcyclopentane: 3-Methylpentane
96-18-4	1,2,3-Trichloropropane
96-20-8	2-Aminobutanol
96-23-1	1,3-Dichloro-2-propanol
96-24-2	3-Chloro-1,2-propanediol (α-Chlorohydrin)
96-29-7	Butanone oxime
96-33-3	Methyl acrylate
96-34-4	Chloroacetic acid methyl ester
96-37-7	Hexane (all isomers except n-Hexane) and Methylcyclopentane: Methylcyclopentane
96-45-7	Ethylene thiourea (Imidazoline-2-thione)
96-48-0	γ-Butyrolactone
97-00-7	1-Chloro-2,4-dinitrobenzene
97-18-7	Bithionol
97-53-0	Eugenol
97-54-1	Isoeugenol
97-56-3	o-Aminoazotoluene
97-63-2	Methacrylic acid ethyl ester
97-77-8	Disulfiram
97-88-1	n-Butyl methacrylate
97-90-5	Ethylene glycol dimethacrylate
98-00-0	Furfuryl alcohol
98-01-1	Furfural
98-07-7	Benzyl trichloride
98-29-3	p-tert-Butylcatechol
98-51-1	p-tert-Butyl toluene
98-54-4	p-tert-Butylphenol
98-73-7	p-tert-Butylbenzoic acid
98-82-8	Isopropylbenzene (cumene)
98-83-9	α-Methyl styrene
98-87-3	Benzyl dichloride
98-88-4	Benzoyl chloride
98-95-3	Nitrobenzene
99-08-1	3-Nitrotoluene
99-54-7	3,4-Dichloronitrobenzene
99-55-8	5-Nitro-o-toluidine
99-65-0	Dinitrobenzene (all isomers): 1,3-Dinitrobenzene
99-97-8	N,N-Dimethyl-p-toluidine
99-99-0	4-Nitrotoluene
100-00-5	p-Chloronitrobenzene
100-01-6	4-Nitroaniline
100-21-0	p-Phthalic acid

CAS number	**Substance**
100-25-4	Dinitrobenzene (all isomers): 1,4-Dinitrobenzene
100-37-8	2-Diethylaminoethanol
100-40-3	4-Vinylcyclohexene
100-41-4	Ethylbenzene
100-42-5	Styrene
100-44-7	Benzyl chloride
100-51-6	Benzyl alcohol
100-52-7	Benzaldehyde
100-61-8	N-Methylaniline
100-63-0	Phenylhydrazine
100-74-3	N-Ethylmorpholine
100-75-4	N-Nitrosopiperidine
100-97-0	Hexamethylenetetramine
101-14-4	4,4′-Methylenebis(2-chloroaniline)
101-54-2	4-Aminodiphenylamine
101-61-1	4,4′-Methylenebis(N,N-dimethylaniline)
101-67-7	4,4′-Dioctyldiphenylamine
101-68-8	4,4′-Methylene diphenyl diisocyanate (MDI)
101-72-4	N-Isopropyl-N′-phenyl-p-phenylenediamine
101-77-9	4,4′-Diaminodiphenylmethane
101-80-4	4,4′-Oxydianiline
101-83-7	Dicyclohexylamine
101-84-8	Diphenyl ether
101-87-1	N-Cyclohexyl-N′-phenyl-p-phenylendiamine
101-90-6	Diglycidyl resorcinol ether
102-71-6	Triethanolamine
102-77-2	2-(4-Morpholinylmercapto)benzothiazole
102-82-9	Tri-n-butylamine
103-09-3	2-Ethylhexyl acetate
103-11-7	Acrylic acid 2-ethylhexyl ester
103-71-9	Phenyl isocyanate
104-12-1	4-Chlorophenyl isocyanate
104-51-8	n-Butylbenzene
104-54-1	Cinnamyl alcohol
104-55-2	Cinnamaldehyde
104-76-7	2-Ethylhexanol
104-91-6	4-Nitrosophenol
104-94-9	p-Anisidine
105-46-4	sec-Butyl acetate
105-59-9	Methyldiethanolamine
105-60-2	ε-Caprolactam
105-74-8	Dilauroyl peroxide
106-14-9	12-Hydroxystearic acid
106-24-1	Geraniol
106-35-4	3-Heptanone
106-44-5	Cresol (all isomers): p-Cresol
106-46-7	1,4-Dichlorobenzene
106-47-8	p-Chloroaniline
106-49-0	p-Toluidine
106-50-3	p-Phenylenediamine
106-51-4	Quinone
106-65-0	Dimethyl succinate
106-87-6	4-Vinyl-1-cyclohexene dioxide
106-88-7	1,2-Butylene oxide
106-89-8	1-Chloro-2,3-epoxypropane
106-91-2	Glycidyl methacrylate

CAS number	Substance
106-92-3	Allyl glycidyl ether
106-93-4	1,2-Dibromoethane
106-94-5	1-Bromopropane
106-97-8	Butane (both isomers): n-Butane
106-99-0	1,3-Butadiene
107-02-8	Acrolein
107-05-1	Allyl chloride
107-06-2	1,2-Dichloroethane
107-07-3	2-Chloroethanol
107-13-1	Acrylonitrile
107-15-3	Ethylenediamine
107-18-6	Allyl alcohol
107-19-7	Propargyl alcohol
107-20-0	Chloroacetaldehyde
107-21-1	Ethylene glycol
107-22-2	Glyoxal
107-25-5	Methyl vinyl ether
107-30-2	Monochlorodimethyl ether
107-31-3	Methyl formate
107-41-5	Hexylene glycol
107-49-3	TEPP
107-66-4	Di-n-butyl phosphate
107-71-1	tert-Butyl peracetate
107-75-5	7-Hydroxycitronellal
107-83-5	Hexane (all isomers except n-Hexane) and Methylcyclopentane: 2-Methylpentane
107-87-9	2-Pentanone
107-98-2	1-Methoxy-2-propanol
108-03-2	1-Nitropropane
108-05-4	Vinyl acetate
108-10-1	4-Methyl-2-pentanone
108-11-2	4-Methyl-2-pentanol
108-20-3	Isopropyl ether
108-21-4	Propylacetate: Isopropyl acetate
108-22-5	Isopropenyl acetate
108-24-7	Acetic anhydride
108-31-6	Maleic anhydride
108-32-7	4-Methyl-1,3-dioxolan-2-one
108-39-4	Cresol (all isomers): m-Cresol
108-42-9	m-Chloroaniline
108-45-2	m-Phenylenediamine
108-46-3	Resorcinol
108-65-6	1-Methoxypropyl-2-acetate
108-67-8	Trimethylbenzene (all isomers): 1,3,5-Trimethylbenzene
108-69-0	Xylidine (isomers): 3,5-Xylidine
108-70-3	1,3,5-Trichlorobenzene
108-77-0	Cyanuric chloride
108-83-8	Diisobutyl ketone
108-84-9	sec-Hexyl acetate
108-87-2	Methylcyclohexane
108-88-3	Toluene
108-90-7	Chlorobenzene
108-91-8	Cyclohexylamine
108-93-0	Cyclohexanol
108-94-1	Cyclohexanone
108-95-2	Phenol
109-16-0	Triethylene glycol dimethacrylate

CAS number	**Substance**
109-17-1	Tetraethylene glycol dimethacrylate
109-53-5	Isobutyl vinyl ether
109-59-1	2-Isopropoxyethanol
109-60-4	Propylacetate: n-Propyl acetate
109-66-0	Pentane (all isomers): n-Pentane
109-73-9	n-Butylamine
109-79-5	1-Butanethiol
109-86-4	2-Methoxyethanol
109-87-5	Dimethoxymethane
109-89-7	Diethylamine
109-92-2	Ethyl vinyl ether
109-94-4	Ethyl formate
109-99-9	Tetrahydrofuran
110-00-9	Furan
110-01-0	Tetrahydrothiophene (THT)
110-05-4	Di-tert-butyl peroxide
110-12-3	Methyl-2-hexanone
110-15-6	Succinic acid
110-19-0	Isobutyl acetate
110-22-5	Diacetyl peroxide
110-25-8	Oleyl sarcosine
110-49-6	2-Methoxyethyl acetate
110-54-3	n-Hexane
110-65-6	Butynediol
110-80-5	2-Ethoxyethanol
110-82-7	Cyclohexane
110-83-8	Cyclohexene
110-85-0	Piperazine
110-86-1	Pyridine
110-91-8	Morpholine
110-94-1	Glutaric acid
111-15-9	2-Ethoxyethyl acetate
111-20-6	Sebacic acid
111-27-3	1-Hexanol
111-30-8	Glutaraldehyde
111-40-0	Diethylenetriamine
111-42-2	Diethanolamine
111-44-4	2,2′-Dichlorodiethyl ether
111-46-6	Diethylene glycol
111-76-2	2-Butoxyethanol
111-77-3	Diethylene glycol monomethyl ether
111-87-5	1-Octanol
111-90-0	Diethylene glycol monoethyl ether
111-96-6	Diethylene glycol dimethyl ether
112-07-2	2-Butoxyethyl acetate
112-24-3	Triethylenetetramine
112-27-6	Triethylene glycol
112-30-1	1-Decanol
112-34-5	Diethylene glycol monobutyl ether
112-35-6	Triethylene glycol monomethyl ether
112-53-8	1-Dodecanol
112-72-1	1-Tetradecanol
112-80-1	Oleic acid
112-85-6	Behenic acid
112-92-5	1-Octadecanol
114-26-1	Propoxur

CAS number	Substance
115-10-6	Dimethyl ether
115-70-8	2-Amino-2-ethyl-1,3-propanediol
115-86-6	Triphenyl phosphate
116-14-3	Tetrafluoroethene
117-81-7	Di(2-ethylhexyl)phthalate (DEHP)
118-48-9	N-Carboxyanthranilic anhydride
118-74-1	Hexachlorobenzene
118-79-6	2,4,6-Tribromophenol
118-82-1	4,4′-Methylenebis(2,6-di-tert-butylphenol)
118-91-2	Chlorobenzoic acid (all isomers): o-Chlorobenzoic acid
118-96-7	2,4,6-Trinitrotoluene
119-06-2	Ditridecyl phthalate
119-34-6	2-Nitro-4-aminophenol
119-61-9	Benzophenone (Announcement list)
119-64-2	Tetrahydronaphthalene
119-90-4	3,3′-Dimethoxybenzidine
119-93-7	3,3′-Dimethylbenzidine
120-71-8	5-Methyl-o-anisidine
120-78-5	2,2′-Dibenzothiazyl disulfide
120-82-1	1,2,4-Trichlorobenzene
121-44-8	Triethylamine
121-45-9	Trimethylphosphite
121-69-7	N,N-Dimethylaniline
121-73-3	m-Chloronitrobenzene
121-75-5	Malathion
121-91-5	m-Phthalic acid
121-92-6	3-Nitrobenzoic acid
122-39-4	Diphenylamine
122-40-7	α-Amylcinnamaldehyde
122-60-1	Phenyl glycidyl ether (PGE)
122-66-7	Hydrazobenzene
122-99-6	2-Phenoxyethanol
123-30-8	p-Aminophenol
123-31-9	Hydroquinone
123-42-2	Diacetone alcohol
123-51-3	Pentanol (isomers): 3-Methyl-1-butanol
123-54-6	2,4-Pentanedione
123-73-9	Crotonaldehyde
123-75-1	Pyrrolidine
123-77-3	Azodicarbonamide
123-86-4	n-Butyl acetate
123-91-1	1,4-Dioxane
123-92-2	Amyl acetate (all isomers): 3-Methylbutyl acetate
123-99-9	Azelaic acid
124-04-9	Adipic acid
124-17-4	Diethylene glycol monobutyl ether acetate
124-38-9	Carbon dioxide
124-40-3	Dimethylamine
124-68-5	2-Amino-2-methyl-1-propanol
126-11-4	2-Hydroxymethyl-2-nitro-1,3-propanediol
126-71-6	Triisobutyl phosphate
126-73-8	Tributyl phosphate
126-99-8	Chloroprene
127-18-4	Tetrachloroethene
127-19-5	N,N-Dimethylacetamide
127-20-8	2,2-Dichloropropionic acid, sodium salt

CAS number	Substance
128-37-0	Butylated hydroxytoluene
128-39-2	2,6-Di-tert-butylphenol
129-00-0	Pyrene
129-16-8	Merbromin
129-79-3	2,4,7-Trinitrofluorenone
131-17-9	Diallyl phthalate
132-27-4	Sodium o-phenylphenol
132-32-1	3-Amino-9-ethylcarbazole
135-01-3	Diethylbenzene: 1,2-Diethylbenzene
135-88-6	N-Phenyl-2-naphthylamine
137-05-3	Methyl 2-cyanoacrylate
137-17-7	2,4,5-Trimethylaniline
137-26-8	Thiram
137-30-4	Ziram
137-32-6	Pentanol (isomers): 2-Methyl-1-butanol
138-86-3	D,L-Limonene
139-13-9	Nitrilotriacetic acid
139-65-1	4,4′-Thiodianiline
140-66-9	4-tert-Octylphenol
140-88-5	Ethyl acrylate
140-95-4	1,3-Bis(hydroxymethyl)urea
141-32-2	n-Butyl acrylate
141-43-5	2-Aminoethanol
141-78-6	Ethyl acetate
141-79-7	4-Methyl-3-penten-2-one
141-97-9	Acetoacetic acid ethyl ester
142-03-0	Aluminium compounds, soluble (irritating): Aluminium diacetate
142-82-5	n-Heptane
143-07-7	Lauric acid
143-22-6	Triethylene glycol n-butyl ether
143-28-2	Oleyl alcohol
143-33-9	Sodium cyanide
143-50-0	Chlordecone
148-18-5	Sodium diethyldithiocarbamate
148-79-8	Thiabendazole
149-30-4	2-Mercaptobenzothiazole
149-57-5	2-Ethylhexanoic acid
150-60-7	Dibenzyl disulfide
151-50-8	Potassium cyanide
151-56-4	Ethylenimine
151-67-7	Halothane
156-62-7	Calcium cyanamide
189-55-9	Dibenzo[a,i]pyrene
189-64-0	Dibenzo[a,h]pyrene
191-26-4	Anthanthrene
191-30-0	Dibenzo[a,l]pyrene
192-65-4	Dibenzo[a,e]pyrene
193-39-5	Indeno[1,2,3-cd]pyrene
205-82-3	Benzo[j]fluoranthene
205-99-2	Benzo[b]fluoranthene
207-08-9	Benzo[k]fluoranthene
218-01-9	Chrysene
239-35-0	Benzo[b]naphtho[2,1-d]thiophene
288-32-4	Imidazole
300-76-5	Naled
301-04-2	Lead acetate

CAS number	Substance
302-01-2	Hydrazine
303-47-9	Ochratoxin A
306-83-2	2,2-Dichloro-1,1,1-trifluoroethane
309-00-2	Aldrin
319-84-6	α-Hexachlorocyclohexane
319-85-7	β-Hexachlorocyclohexane
333-41-5	Diazinon
334-88-3	Diazomethane
335-67-1	Perfluorooctanoic acid (PFOA)
373-02-4	Nickel and nickel compounds: Nickel acetate
382-21-8	Perfluoroisobutene (Announcement list)
409-21-2	Silicon carbide
420-04-2	Cyanamide
431-03-8	Diacetyl
460-19-5	Oxalonitrile
461-58-5	Dicyanodiamide
463-51-4	Ketene
463-82-1	Pentane (all isomers): tert-Pentane
470-17-7	Sesquiterpene lactones: Isoalantolactone
477-43-0	Sesquiterpene lactones: Dehydrocostus lactone
479-45-8	N-Methyl-N,2,4,6-tetranitroaniline
492-80-8	Auramine
504-29-0	2-Aminopyridine
505-60-2	Bis(β-chloroethyl)sulfide (mustard gas)
506-77-4	Cyanogen chloride
508-59-8	Sesquiterpene lactones: Parthenin
509-14-8	Tetranitromethane
512-56-1	Trimethyl phosphate
513-53-1	2-Butanethiol
513-79-1	Cobalt: Cobalt(II) carbonate
513-86-0	Acetoin (Announcement list)
514-10-3	Abietic acid
526-73-8	Trimethylbenzene (all isomers): 1,2,3-Trimethylbenzene
528-29-0	Dinitrobenzene (all isomers): 1,2-Dinitrobenzene
534-52-1	4,6-Dinitro-o-cresol
535-80-8	Chlorobenzoic acid (all isomers): m-Chlorobenzoic acid
538-75-0	Dicyclohexylcarbodiimide
540-59-0	1,2-Dichloroethylene sym
540-73-8	1,2-Dimethylhydrazine
540-88-5	tert-Butyl acetate
541-41-3	Chloroformic acid ethyl ester
541-73-1	1,3-Dichlorobenzene
541-85-5	5-Methyl-3-heptanone
542-75-6	1,3-Dichloropropene
542-88-1	Bischloromethyl ether
542-92-7	Cyclopentadiene
543-27-1	Chloroformic acid butyl ester
544-63-8	Myristic acid
546-43-0	Sesquiterpene lactones: Alantolactone
552-30-7	Trimellitic anhydride
553-21-9	Sesquiterpene lactones: Costunolide
556-52-5	Glycidol
563-04-2	Tricresyl phosphate, isomers, „free of o-isomers”
563-47-3	3-Chloro-2-methylpropene
581-89-5	2-Nitronaphthalene
583-60-8	1-Methylcyclohexan-2-one

CAS number	Substance
584-02-1	Pentanol (isomers): 3-Pentanol
584-84-9	Toluene diisocyanates: 2,4-Toluene diisocyanate
591-27-5	3-Aminophenol
591-78-6	2-Hexanone
592-34-7	Chloroformic acid butyl ester
593-70-4	Chlorofluoromethane (FC-31)
594-27-4	Methyltin compounds: Tetramethyltin
594-42-3	Perchloromethyl mercaptan
594-72-9	1,1-Dichloro-1-nitroethane
597-82-0	O,O,O-Triphenyl monothiophosphate
598-56-1	N,N-Dimethylethylamine
598-75-4	Pentanol (isomers): 3-Methyl-2-butanol
600-14-6	2,3-Pentanedione
600-25-9	1-Chloro-1-nitropropane
601-77-4	N-Nitrosodiisopropylamine
602-87-9	5-Nitroacenaphthene
603-35-0	Triphenylphosphine
612-64-6	N-Nitrosoethylphenylamine
614-00-6	N-Nitrosomethylphenylamine
615-05-4	2,4-Diaminoanisole
620-11-1	Amyl acetate (all isomers): 3-Pentyl acetate
621-64-7	N-Nitrosodi-n-propylamine
624-41-9	Amyl acetate (all isomers): 2-Methylbutyl acetate
624-83-9	Methyl isocyanate
625-16-1	Amyl acetate (all isomers): 1,1-Dimethylpropyl acetate
625-45-6	Methoxyacetic acid
626-38-0	Amyl acetate (all isomers): 1-Methylbutyl acetate
627-13-4	n-Propyl nitrate
627-93-0	Dimethyl adipate
628-63-7	Amyl acetate (all isomers): 1-Pentyl acetate
628-96-6	Ethylene glycol dinitrate
630-08-0	Carbon monoxide
632-22-4	Tetramethyl urea (TMU)
637-03-6	Phenyl arsenic compounds
646-06-0	1,3-Dioxolane
650-51-1	Sodium trichloroacetate
674-82-8	Diketene
680-31-9	Hexamethylphosphoric acid triamide
693-21-0	Diethylene glycol dinitrate
693-23-2	Dodecanedioic acid
700-13-0	Trimethylhydroquinone
730-40-5	Disperse Orange 3
754-12-1	2,3,3,3-Tetrafluoropropene
763-69-9	Ethyl-3-ethoxypropionate
764-41-0	1,4-Dichloro-2-butene
770-35-4	1-Phenoxy-2-propanol
793-24-8	N-(1,3-Dimethylbutyl)-N′-phenyl-p-phenylenediamine
811-97-2	1,1,1,2-Tetrafluoroethane
818-61-1	Acrylic acid 2-hydroxyethyl ester
822-06-0	1,6-Hexamethylene diisocyanate
838-88-0	4,4′-Methylenebis(2-methylaniline)
868-77-9	2-Hydroxyethyl methacrylate
868-85-9	Dimethyl hydrogen phosphite
872-50-4	N-Methyl-2-pyrrolidone
877-44-1	1,2,4-Triethylbenzene
920-37-6	2-Chloroacrylonitrile

CAS number	Substance
923-26-2	Methacrylic acid 2-hydroxypropyl ester
924-16-3	N-Nitrosodi-n-butylamine
929-06-6	2-(2-Aminoethoxy)ethanol
930-55-2	N-Nitrosopyrrolidine
935-92-2	Trimethylquinone
996-35-0	N,N-Dimethylisopropylamine
1070-70-8	1,4-Butanediol diacrylate
1116-54-7	N-Nitrosodiethanolamine
1119-40-0	Dimethyl glutarate
1120-71-4	1,3-Propane sultone
1121-03-5	2,4-Butane sultone
1239-45-8	Ethidium bromide
1302-74-5	α-Aluminium oxide
1302-78-9	Bentonite
1303-00-0	Arsenic: Gallium arsenide
1303-28-2	Arsenic: Arsenic pentoxide
1303-86-2	Boron oxide
1305-62-0	Calcium hydroxide
1305-78-8	Calcium oxide
1306-38-3	Cerium dioxide
1307-96-6	Cobalt: Cobalt(II) oxide
1308-06-1	Cobalt: Cobalt(II,III) oxide
1309-37-1	Iron oxides
1309-38-2	Iron oxides
1309-48-4	Magnesium oxide
1309-48-4	Magnesium oxide fume
1310-73-2	Sodium hydroxide
1313-27-5	Molybdenum trioxide
1313-99-1	Nickel and nickel compounds: Nickel monoxide
1314-06-3	Nickel and nickel compounds: Nickel sesquioxide
1314-23-4	Zirconium dioxide
1314-56-3	Phosphorus pentoxide
1314-80-3	Phosphorus pentasulfide
1317-33-5	Molybdenum disulfide (Announcement list)
1317-42-6	Cobalt: Cobalt(II) sulfide
1317-43-7	Nemalite
1317-61-9	Iron oxides
1318-02-1	Zeolites, synthetic (non-fibrous)
1318-93-0	Montmorillonite
1319-77-3	Cresol (all isomers)
1321-74-0	Divinylbenzene (all isomers)
1327-41-9	Aluminium compounds, soluble (irritating): Aluminium chloride, basic
1327-53-3	Arsenic: Arsenic trioxide
1330-20-7	Xylene (all isomers)
1330-78-5	Tricresyl phosphate, isomers, „free of o-isomers”
1332-21-4	Asbestos
1332-58-7	Kaolinite
1333-86-4	Carbon black
1336-36-3	Chlorinated biphenyls
1338-23-4	Methyl ethyl ketone peroxide
1338-24-5	Naphthenic acids and sodium, calcium, potassium napthenates
1344-28-1	Aluminium oxide
1344-28-1	γ-Aluminium oxide
1344-28-1	δ-Aluminium oxide
1345-25-1	Iron oxides
1402-68-2	Aflatoxins

CAS number	Substance
1461-25-2	n-Butyltin compounds: Tetra-n-butyltin
1464-53-5	Diepoxybutane
1477-55-0	m-Xylylenediamine
1484-13-5	Vinylcarbazole
1565-94-2	Bisphenol A diglycidyl methacrylate
1569-02-4	1-Ethoxy-2-propanol
1589-47-5	2-Methoxypropanol-1
1633-83-6	1,4-Butane sultone
1634-04-4	Methyl tert-butyl ether
1663-39-4	tert-Butyl acrylate
1667-11-4	4-Chloromethyl-biphenyl
1675-54-3	Bisphenol A diglycidyl ether
1680-21-3	Triethylene glycol diacrylate
1738-25-6	Dimethylaminopropionitrile
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin
1748-81-8	Sesquiterpene lactones: Carabrone
1758-61-8	Dicyclohexyl peroxide
1763-23-1	Perfluorooctanesulfonic acid (PFOS)
1809-14-9	Di-n-octyl phosphonate
1809-19-4	Di-n-butyl phosphonate
1817-47-6	p-Nitrocumene
1854-23-5	4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w)
1854-26-8	Dimethylol dihydroxyethyleneurea
1891-29-8	Sesquiterpene lactones: Lactucin
1897-45-6	Chlorothalonil
1910-42-5	Paraquat dichloride
1912-24-9	Atrazine
2082-79-3	3,5-Di-tert-butyl-4-hydroxyphenylpropionic acid octadecyl ester
2082-81-7	1,4-Butanediol dimethacrylate
2095-03-6	Bisphenol F diglycidyl ether: p,p′-Bisphenol F diglycidyl ether
2104-64-5	EPN (O-Ethyl O-(4-nitrophenyl)phenylthiophosphonate)
2179-59-1	Allyl propyl disulfide
2224-44-4	4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w)
2238-07-5	Diglycidyl ether (DGE)
2243-62-1	1,5-Diaminonaphthalene
2358-84-1	Diethylene glycol dimethacrylate
2372-82-9	N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine
2381-21-7	1-Methylpyrene
2386-87-0	3,4-Epoxycyclohexane carboxylic acid (3,4-epoxycyclohexylmethyl) ester
2406-68-0	Phenyltin compounds
2409-55-4	2-tert-Butyl-p-cresol
2425-77-6	2-Hexyl-1-decanol
2425-79-8	1,4-Butanediol diglycidyl ether
2426-08-6	n-Butyl glycidyl ether (BGE)
2431-50-7	2,3,4-Trichloro-1-butene
2451-62-9	1,3,5-Triglycidyl isocyanurate (mixture of isomers)
2455-24-5	Tetrahydrofurfuryl methacrylate
2465-27-2	Auramine hydrochloride
2527-58-4	2,2′-Dithiobis(N-methylbenzamide)
2551-62-4	Sulfur hexafluoride
2634-33-5	1,2-Benzisothiazol-3(2H)-one
2682-20-4	2-Methyl-4-isothiazolin-3-one
2682-20-4	5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-dihydroisothiazol-3-one
2687-91-4	N-Ethyl-2-pyrrolidone

CAS number	Substance
2807-30-9	2-Propyloxyethanol
2809-21-4	1-Hydroxyethylidene-1,1-diphosphonic acid
2832-19-1	N-Methylolchloroacetamide
2832-40-8	Disperse Yellow 3
2855-13-2	3-Aminomethyl-3,5,5-trimethyl-cyclohexylamine (Isophorone diamine)
2867-47-2	N,N′-(Dimethylamino)ethyl methacrylate
2872-52-8	Disperse Red 1
3033-77-0	Glycidyl trimethylammonium chloride
3040-44-6	N-(2-Hydroxyethyl)piperidine
3101-60-8	p-tert-Butylphenyl glycidyl ether
3115-49-9	(4-Nonylphenoxy)acetic acid
3129-91-7	Dicyclohexylamine nitrite
3173-72-6	1,5-Naphthylene diisocyanate
3179-89-3	Disperse Red 17
3302-10-1	Isononanoic acid
3333-52-6	Tetramethyl succinonitrile
3333-67-3	Nickel and nickel compounds: Nickel carbonate
3524-68-3	Pentaerythritol triacrylate
3586-55-8	(Ethylenedioxy)dimethanol
3687-31-8	Arsenic: Lead arsenate
3687-46-5	n-Decyl oleate
3689-24-5	TEDP
3811-73-2	Sodium pyrithione
3926-62-3	Sodium monochloroacetate
4016-14-2	Isopropyl glycidyl ether (IGE)
4074-88-8	Diethylene glycol diacrylate
4080-31-3	Methenamine 3-chloroallylchloride
4098-71-9	Isophorone diisocyanate
4170-30-3	Crotonaldehyde
4259-15-8	Zinc, O,O′-di-2-ethylhexyl dithiophosphate
4299-07-4	2-Butyl-1,2-benzisothiazolin-3-one
4435-53-4	3-Methoxy-n-butyl acetate
4485-12-5	Lithium stearate
4602-84-0	Farnesol
4687-94-9	Bisphenol A glycerolate
4719-04-4	N,N′,N′′-Tris(β-hydroxyethyl)hexahydro-1,3,5-triazine
5026-74-4	Triglycidyl-p-aminophenol
5064-31-3	Nitrilotriacetic acid: Trisodium nitrilotriacetate
5102-83-0	Pigment Yellow 12, Pigment Yellow 13, Pigment Yellow 83
5124-30-1	Dicyclohexyl methane 4,4′-diisocyanate
5216-25-1	p-Chlorobenzotrichloride
5307-14-2	2-Nitro-p-phenylenediamine
5333-42-6	2-Octyl-1-dodecanol
5395-50-6	Tetramethylol acetylenediurea
5493-45-8	Hexahydrophthalic acid diglycidylester
5567-15-7	Pigment Yellow 12, Pigment Yellow 13, Pigment Yellow 83
5625-90-1	Bismorpholino methane
5714-22-7	Sulfur pentafluoride
5888-33-5	Isobornyl acrylate
5912-86-7	Isoeugenol: cis-Isoeugenol
5932-68-3	Isoeugenol: trans-Isoeugenol
5989-27-5	D-Limonene
5989-54-8	L-Limonene
6032-29-7	Pentanol (isomers): 2-Pentanol
6358-64-1	2,5-Dimethoxy-4-chloroaniline
6358-85-6	Pigment Yellow 12, Pigment Yellow 13, Pigment Yellow 83

CAS number	Substance
6419-19-8	Aminotris(methylenephosphonic acid)
6423-43-4	Propylene glycol dinitrate
6440-58-0	1,3-Dimethylol-5,5-dimethyl hydantoin
6754-13-8	Sesquiterpene lactones: Helenalin
6789-99-7	Tetrahydrobenzotriazole
7085-85-0	Ethyl 2-cyanoacrylate
7397-62-8	Hydroxyacetic acid butyl ester
7411-49-6	3,3′-Diaminobenzidine and its tetrahydrochloride
7429-90-5	Aluminium
7429-90-5	Aluminium and its poorly soluble compounds
7439-92-1	Lead
7439-93-2	Lithium
7439-96-5	Manganese
7439-97-6	Mercury
7439-98-7	Molybdenum
7440-02-0	Nickel
7440-02-0	Nickel and nickel compounds: Metallic nickel
7440-05-3	Palladium
7440-05-3	Palladium: Metallic palladium
7440-06-4	Platinum compounds (Chloroplatinates)
7440-16-6	Rhodium
7440-22-4	Silver
7440-24-6	Strontium
7440-25-7	Tantalum
7440-28-0	Thallium, soluble compounds
7440-31-5	Tin
7440-33-7	Tungsten
7440-36-0	Antimony
7440-38-2	Arsenic
7440-38-2	Arsenic: Metallic arsenic
7440-39-3	Barium compounds, soluble
7440-41-7	Beryllium
7440-43-9	Cadmium
7440-47-3	Chromium
7440-48-4	Cobalt
7440-48-4	Cobalt alloys
7440-48-4	Cobalt: Metallic cobalt
7440-50-8	Copper
7440-54-2	Gadolinium
7440-57-5	Gold
7440-58-6	Hafnium
7440-61-1	Uranium
7440-62-2	Vanadium
7440-65-5	Yttrium
7440-66-6	Zinc
7440-67-7	Zirconium
7440-74-6	Indium
7446-09-5	Sulfur dioxide
7446-70-0	Aluminium compounds, soluble (irritating): Aluminium chloride
7553-56-2	Iodine
7572-29-4	Dichloroacetylene
7620-77-1	Lithium-12-hydroxystearate
7631-86-9	Silica, amorphous: a) synthetic amorphous silica
7637-07-2	Boron trifluoride
7647-01-0	Hydrogen chloride
7647-10-1	Palladium: Palladium chloride

CAS number	Substance
7659-86-1	2-Ethylhexyl mercaptoacetate
7664-38-2	Phosphoric acid
7664-39-3	Hydrogen fluoride
7664-41-7	Ammonia
7664-93-9	Sulfuric acid
7665-72-7	tert-Butyl glycidyl ether
7697-37-2	Nitric acid
7704-34-9	Sulfur (Announcement list)
7718-54-9	Nickel and nickel compounds: Nickel chloride
7719-12-2	Phosphorus trichloride
7722-84-1	Hydrogen peroxide
7723-14-0	Phosphorus, red
7723-14-0	Phosphorus, white/yellow
7726-95-6	Bromine
7727-43-7	Barium sulfate
7727-54-0	Ammonium persulfate
7747-35-5	5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO)
7773-06-0	Ammonium sulfamate
7778-18-9	Calcium sulfate
7778-39-4	Arsenic: Arsenic acid
7778-44-1	Arsenic: Calcium arsenate
7779-27-3	1,3,5-Triethylhexahydro-1,3,5-triazine
7782-41-4	Fluorine
7782-42-5	Graphite
7782-49-2	Selenium
7782-50-5	Chlorine
7782-65-2	Germanium tetrahydride
7782-79-8	Hydrazoic acid
7783-06-4	Hydrogen sulfide
7783-07-5	Hydrogen selenide
7784-25-0	Aluminium compounds, soluble (non-irritating): Aluminium ammonium disulfate
7784-42-1	Arsine
7784-46-5	Arsenic: Sodium arsenite
7786-34-7	Mevinphos
7786-81-4	Nickel and nickel compounds: Nickel sulfate
7790-91-2	Chlorine trifluoride
7803-49-8	Hydroxylamine
7803-51-2	Phosphine
7803-52-3	Stibine
7803-57-8	Hydrazine hydrate
8001-31-8	Coconut oil
8001-35-2	Chlorinated camphene
8001-54-5	Benzalkonium chloride
8002-26-4	Tall oil, distilled
8003-34-7	Pyrethrum
8006-64-2	Turpentine
8007-18-9	Nickel titanic yellow pigment
8008-20-6	Kerosine (petroleum)
8022-00-2	Demeton-methyl
8023-79-8	Palm kernel oil
8042-47-5	White mineral oil (pharmaceutical)
8050-09-7	Rosin (colophony)
8052-42-4	Bitumen (high-temperature processing, vapours and aerosols)
8065-48-3	Demeton
9000-50-4	Oakmoss extracts
9001-00-7	Bromelain

CAS number	Substance
9001-73-4	Papain
9001-75-6	Pepsin
9002-07-7	Trypsin and Chymotrypsin
9002-84-0	Polytetrafluoroethene
9002-86-2	Polyvinyl chloride
9003-01-4	Acrylic acid polymer (neutralized, cross-linked): Sodium polyacrylate
9003-11-6	Polyethylenepolypropylene glycol
9003-13-8	Poly(propylene glycol) n-butyl ether
9003-27-4	Polybutenes and Polyisobutenes: Polyisobutenes
9003-29-6	Polybutenes and Polyisobutenes: Polybutenes
9004-07-3	Trypsin and Chymotrypsin
9004-98-2	Polyoxyethylene oleyl ether
9006-04-6	Natural rubber latex
9006-65-9	Polydimethyl siloxanes, linear
9014-01-1	Subtilisins
9016-00-6	Polydimethyl siloxanes, linear
9016-87-9	“polymeric MDI”
10024-97-2	Nitrous oxide
10025-67-9	Sulfur monochloride
10025-87-3	Phosphorus oxychloride
10026-13-8	Phosphorus pentachloride
10026-24-1	Cobalt: Cobalt(II) sulfate·7 H_2O
10028-15-6	Ozone
10035-10-6	Hydrogen bromide
10043-01-3	Aluminium compounds, soluble (irritating): Aluminium sulfate
10043-35-3	Boric acid
10043-67-1	Aluminium compounds, soluble (non-irritating): Aluminum potassium sulfate
10049-04-4	Chlorine dioxide
10102-43-9	Nitrogen monoxide
10102-44-0	Nitrogen dioxide
10222-01-2	2,2-Dibromo-2-cyanacetamide
10254-57-6	Methylene bis(dibutyldithiocarbamate)
10595-95-6	N-Nitrosomethylethylamine
10605-21-7	Carbendazim
11070-44-3	Methyltetrahydrophthalic anhydride
12011-76-6	Dawsonite
12030-97-6	Potassium titanates (fibrous dust): Potassium titanate
12035-36-8	Nickel and nickel compounds: Nickel dioxide
12035-72-2	Nickel and nickel compounds: Nickel sulbsulfide
12036-23-6	Zirconium dioxide
12042-91-0	Aluminium compounds, soluble (non-irritating): Aluminium chlorohydrate
12054-48-7	Nickel and nickel compounds: Nickel hydroxide
12056-46-1	Potassium titanates (fibrous dust): Potassium titanate
12056-49-4	Potassium titanates (fibrous dust): Potassium titanate
12056-51-8	Potassium titanates (fibrous dust): Potassium titanate
12174-11-7	Attapulgite
12179-04-3	Boric acid: Sodium tetraborate pentahydrate
12185-10-3	Phosphorus, white/yellow
12286-12-3	Magnesium oxide sulfate
12298-43-0	Halloysite
12427-38-2	Manganese ethylenebis(dithiocarbamate) (Maneb)
12510-42-8	Erionite
12604-58-9	Ferrovanadium
13007-92-6	Chromium carbonyl
13048-33-4	1,6-Hexanediol diacrylate
13360-57-1	Dimethylsulfamoyl chloride

CAS number	Substance
13463-39-3	Nickel carbonyl (Announcement list)
13463-40-6	Iron pentacarbonyl
13463-41-7	Zinc pyrithione
13463-67-7	Titanium dioxide
13464-58-9	Arsenic: Arsenous acid
13473-90-0	Aluminium compounds, soluble (irritating): Aluminium nitrate
13494-80-9	Tellurium
13838-16-9	Enflurane
13952-84-6	sec-Butylamine
13983-17-0	Wollastonite
14265-45-3	Sulfites
14464-46-1	Silica, crystalline: Cristobalite
14484-64-1	Ferbam
14548-60-8	Benzyl alcohol mono(poly)hemiformal
14807-96-6	Talc
14808-60-7	Silica, crystalline: Quartz
14861-17-7	4-(2,4-Dichlorophenoxy)benzenamine
15141-18-1	Disperse blue 106/124
15159-40-7	N-Chloroformylmorpholine
15337-18-5	Zinc diamyldithiocarbamate
15467-20-6	Nitrilotriacetic acid: Disodium nitrilotriacetate
15468-32-3	Silica, crystalline: Tridymite
15501-74-3	Sepiolite (fibrous dust): Sepiolite
15625-89-5	Trimethylolpropane triacrylate
15627-09-5	N-Cyclohexylhydroxy-diazen-1-oxide, copper salt
15827-60-8	Diethylenetriaminepenta(methylenephosphonic acid)
15922-78-8	Sodium pyrithione
16065-83-1	Chromium(III) compounds
16096-31-4	Diglycidyl hexanediol
16812-54-7	Nickel and nickel compounds: Nickel sulfide
16984-48-8	Fluorides
17702-41-9	Decaborane
17804-35-2	Benomyl
17831-71-9	Tetraethylene glycol diacrylate
18307-23-8	Sepiolite (fibrous dust): Sepiolite
18540-29-9	Chromium(VI) compounds
18662-53-8	Nitrilotriacetic acid: Trisodium nitrilotriacetate monohydrate
18917-91-4	Aluminium compounds, soluble (irritating): Aluminium lactate
18994-66-6	Nitrilotriacetic acid: Monosodium nitrilotriacetate
19287-45-7	Diborane
19430-93-4	1H,1H,2H-Perfluorohexene
19624-22-7	Pentaborane
20018-09-1	4-(Diiodomethylsulfonyl)-toluene
20554-84-1	Sesquiterpene lactones: Parthenolide
20706-25-6	2-(Propyloxy)ethyl acetate
20816-12-0	Osmium tetroxide
21652-27-7	1-Hydroxyethyl-2-heptadecenyl-imidazoline
22398-80-7	Indium phosphide
23209-59-8	Calcium sodium metaphosphate
23255-03-0	Nitrilotriacetic acid: Disodium nitrilotriacetate monohydrate
23696-28-8	Olaquindox (N-(2-Hydroxyethyl)-3-methyl-2-quinoxalinecarboxamide 1,4-dioxide)
23971-84-8	Sesquiterpene lactones: Anthecotulide
24448-20-2	Bisphenol A ethoxylate dimethacrylate
25013-15-4	Methyl styrene (all isomers)
25013-16-5	tert-Butyl-4-hydroxyanisole (BHA)
25154-54-5	Dinitrobenzene (all isomers)

CAS number	Substance
25254-50-6	N,N′,N′′-Tris(β-hydroxypropyl)hexahydro-1,3,5-triazine
25265-71-8	Dipropylene glycol
25321-14-6	Dinitrotoluene (mixtures of isomers)
25322-68-3	Polyethylene glycol (average molecular weight > 600)
25322-68-3	Polyethylene glycol (average molecular weight 200–600)
25322-69-4	Polypropylene glycol (PPG)
25340-17-4	Diethylbenzene: Diethylbenzene, Mixture [25340-17-4] 1,3-Diethylbenzene [141-93-5] 1,4-Diethylbenzene [105-05-5]
25551-13-7	Trimethylbenzene (all isomers)
25584-83-2	Acrylic acid hydroxypropyl ester (all isomers)
25639-42-3	Methylcyclohexanol (all isomers)
26125-61-1	p-Aramid
26172-55-4	5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-dihydroisothiazol-3-one
26399-02-0	2-Ethylhexyl oleate
26444-49-5	Diphenyl cresyl phosphate
26447-14-3	Cresyl glycidyl ethers
26471-62-5	Toluene diisocyanates: Toluene diisocyanates, mixture
26523-78-4	Tris(nonylphenyl) phosphite
26530-20-1	2-Octyl-4-isothiazolin-3-one
26628-22-8	Sodium azide
26636-01-1	Methyltin compounds: Dimethyltin bis(isooctylmercaptoacetate) (DMT(IOMA)$_2$)
26675-46-7	Isoflurane
26761-40-0	Diisodecyl phthalate
26780-96-1	1,2-Dihydro-2,2,4-trimethyl-quinoline polymer
26896-18-4	Isononanoic acid
26898-17-9	Dibenzyltoluene (Announcement list)
27208-37-3	Cyclopenta[cd]pyrene
27213-78-1	p-tert-Butylcatechol
27253-26-5	Diisotridecyl phthalate
27458-92-0	Isotridecanol
27458-93-1	Isooctadecanol
27478-34-8	Dinitronaphthalene (all isomers)
27579-97-1	Sesquiterpene lactones: (+)-Frullanolide and (-)-Frullanolide
27776-01-8	Benzyltoluene (Announcement list)
28272-18-6	Sesquiterpene lactones: Pyrethrosin
28523-86-6	Sevoflurane
28553-12-0	Diisononyl phthalate (Announcement list)
28768-32-3	Tetraglycidyl-4,4′-methylenedianiline
29118-24-9	trans-1,3,3,3-Tetrafluoropropene
29222-48-8	Trimethylpentane (all isomers)
29385-43-1	Methyl-1H-benzotriazole
30618-84-9	Glyceryl monothioglycolate
30899-19-5	Pentanol (isomers): Mixture of isomers, Pentanol
31027-31-3	4-Isopropylphenyl isocyanate
31142-56-0	Aluminium compounds, soluble (irritating): Aluminium citrate
31565-23-8	Di-tert-dodecyl pentasulfide and Di-tert-dodecyl polysulfide
31570-04-4	Tris(2,4-ditert-butylphenyl) phosphite
31906-04-4	4-(4-Hydroxy-4-methyl pentyl)-3-cyclohexene-1-carboxaldehyde (Lyral)
32687-78-8	3-(3,5-Di-tert-butyl-4-hydroxyphenyl)-N′-[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propanoyl] propanehydrazide
33204-39-6	Sesquiterpene lactones: Arteglasin A
34590-94-8	Dipropylene glycol monomethyl ether
35001-25-3	Sesquiterpene lactones: Laurenobiolide
35074-77-2	Hexamethylene bis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate)
35554-44-0	1-(2-Allyloxy)-2-(2,4-dichlorophenyl)ethyl)-1H-imidazole

CAS number	Substance
35691-65-7	1,2-Dibromo-2,4-dicyanobutane
36653-82-4	1-Hexadecanol
37278-89-0	Xylanases
39290-78-3	Aluminium compounds, soluble (irritating): Aluminum chloride hydroxide sulfate
40776-40-7	Sesquiterpene lactones: (+)-Frullanolide and (-)-Frullanolide
41484-35-9	2,2′-Thiodiethylene Bis[3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate]
41683-62-9	1,2-Dichloromethoxyethane
42978-66-5	Tripropylene glycol diacrylate
51229-78-8	Methenamine 3-chloroallylchloride
53306-54-0	Di(2-propylheptyl) phthalate (DPHP)
53980-88-4	5(or 6)-Carboxy-4-hexylcyclohex-2-ene-1-octanoic acid
54208-63-8	Bisphenol F diglycidyl ether: o,o′-Bisphenol F diglycidylether
54839-24-6	1-Ethoxy-2-propyl acetate
54849-38-6	Methyltin compounds: Methyltin tris(isooctylmercatoacetate) (MMT(IOMA)$_3$)
55406-53-6	3-Iodo-2-propynyl butylcarbamate
55720-99-5	Chlorinated biphenyl oxides
57041-67-5	Desflurane
57469-07-5	Bisphenol F diglycidyl ether: o,p′-Bisphenol F diglycidylether
57583-35-4	Methyltin compounds: Dimethyltin bis(2-ethylhexylmercaptoacetate) (DMT(2-EHMA)$_2$)
57855-77-3	Calcium bis(dinonylnaphthalenesulphonate)
59118-99-9	Methyltin compounds: Bis[methyltin di(2-mercaptoethyloleate)]sulfide
59231-34-4	Isodecyl oleate
59766-31-3	Potassium titanates (fibrous dust): Potassium titanate
60007-93-4	Aluminium compounds, soluble (irritating): Aluminium gluconate
61789-36-4	Naphthenic acids and sodium, calcium, potassium napthenates
61789-86-4	Petroleum sulfonates, calcium salts (technical mixture in mineral oil)
61790-13-4	Naphthenic acids and sodium, calcium, potassium napthenates
63148-62-9	Polydimethyl siloxanes, linear
63449-39-8	Chlorinated paraffins
64741-56-6	Bitumen (high-temperature processing, vapours and aerosols)
64742-47-8	Distillates (petroleum)
64742-48-9	Naphtha (petroleum)
64742-93-4	Bitumen (high-temperature processing, vapours and aerosols)
65997-15-1	Portland cement dust
66072-08-0	Naphthenic acids and sodium, calcium, potassium napthenates
66204-44-2	N,N′-Methylenebis(5-methyloxazolidine)
66603-10-9	Cyclohexylhydroxydiazene-1-oxide, potassium salt
67701-06-8	Fatty acids, C14–18 saturated and C16–18-unsaturated
67762-25-8	Fatty alcohols, C12–18
68359-37-5	Cyfluthrin
68411-46-1	Diphenylamine, octylated (Benzenamine, N-phenyl-, reaction products with 2,4,4-trimethylpentene)
68425-15-0	Di-tert-dodecyl pentasulfide and Di-tert-dodecyl polysulfide
68516-81-4	Disperse blue 106/124
68583-56-2	Di-tert-dodecyl pentasulfide and Di-tert-dodecyl polysulfide
68608-26-4	Petroleum sulfonates, sodium salts
68649-11-6	Polyalphaolefins
68920-66-1	Fatty alcohol ethoxylates, C16–18 and C18-unsaturated
68921-45-9	Diphenylamine, reaction products with styrene and 2,4,4-trimethylpentene
68937-41-7	Triphenyl phosphate, isopropylated
68958-92-9	Bis[O,O-bis(2-ethylhexyl) dithiophosphorato-S,S′]dioxodi-μ-thioxodimolybdenum
69669-44-9	Alkyl benzenesulfonates C10–C14, linear
70657-70-4	2-Methoxypropylacetate-1
72030-25-2	Bis[O,O-bis(2-ethylhexyl) dithiophosphorato-S,S′]dioxodi-μ-thioxodimolybdenum
72623-83-7	Mineral oils (petroleum), severely refined
78521-39-8	6-[(4-Methylphenyl)sulfonylamino]hexanoic acid

CAS number	Substance
80584-91-4	Triazinetriyltriiminotrishexanoic acid
80939-62-4	Alkyl amines, C11–14-branched, monohexyl and dihexyl phosphates
85117-50-6	Alkyl benzenesulfonates C10–C14, linear
91273-04-0	N,N-Bis(2-ethylhexyl)-(1,2,4-triazole-1-yl)methanamine
92045-44-8	Mineral oils (petroleum), severely refined
92045-45-9	Mineral oils (petroleum), severely refined
92062-35-6	Mineral oils (petroleum), severely refined
94624-12-1	Pentanol (isomers): Mixture of isomers, Pentanol
95481-62-2	Dicarboxylic acid (C4–C6) dimethylester, mixture
103616-17-7	Aluminium compounds, soluble (irritating): Aluminium maltolate
126019-82-7	Tris[(2- or 4-)C9–C10-isoalkylphenyl]phosphorothioate
134954-21-5	Sesquiterpene lactones: α-Peroxyachifolide
293733-21-8	6-Amino-2-ethoxynaphthalene

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A current list of members, permanent guests and other guests is available at: https://www.dfg.de/en/about-us/statutory-bodies/senate/health-hazards/members-guests

Constitution and Procedures of the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area

I.

The activity of the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area is based on the following regulations of the statutes of the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG).

§ 1
Purpose of the Association

(1) The DFG promotes research of the highest quality. The focus is on funding projects developed by the academic community itself in the area of knowledge-driven research. It funds research projects, creates competitive opportunities and conducts procedures for the review, evaluation, selection and decision of research proposals. The DFG helps shape the overall conditions and standards of academic research. It maintains dialogue with society, politics and business and supports the transfer of knowledge. It advises state institutions and institutions working in the public interest on issues relating to academic research and research policy.

(2) The DFG acts in a research-driven manner in all its procedures. Excellent research requires a broad spectrum of ideas and pluralistic debate; for this reason, the DFG takes particular care to promote international cooperation, early career researchers, gender equality and diversity in science and the humanities.

§ 11
Senate

(1) The Senate is the central scientific body of the DFG. It deliberates and resolves, within the principles adopted by the General Assembly, on all major matters of the DFG, unless they are reserved for the Joint Committee.

(2) The Senate determines which review boards are to be formed and how they are to be structured. In doing so it ensures that the review boards in all their forms and disciplines cover the full range of fields in science and the humanities and take due account of their disciplinary research interests and interdisciplinary relationships.

(3) The Senate consists of 39 members.

(4) 36 members are elected by the General Assembly based on a rolling system. Researchers who work at institutions of higher education or other research institutions are eligible for election. The General Assembly may also elect other persons, in consideration of certain expertise relevant to the DFG. Voting is based on the person; elected members of the Senate do not act as representatives of institutions. Adequate representation of the entire spectrum of research disciplines must be sought in the composition of the elected members. The Senate may invite guests to its meetings on a permanent or occasional basis.

(5) The ex officio members of the Senate are the respective President of the German Rectors' Conference, the Union of the German Academies of Sciences and Humanities and the Max Planck Society. Members of the Senate by virtue of their office may be represented at meetings by other authorised representatives of their respective institutions to be appointed in advance.

(6) The term of office of the elected members of the Senate is three years. It begins on the first day of the calendar year following the election. Re-election for a second term is possible. If an elected member of the Senate retires during their term of office, the Senate may co-opt a substitute member from previous lists of nominees for the remainder of the term of office of the retiring member. For the elections, the Executive Committee, acting on proposals received from the members of the DFG and with the involvement of the Senate, prepares slates of nominations, which as a rule comprise three names for each vacant seat. Details are governed by rules of procedure to be determined by the General Assembly.

(7) Meetings of the Senate are convened by the President. He or she must convene the Senate at the request of at least one-third of its members.

(8) Within its mandate, the Senate may establish committees and commissions whose members need not be members of the Senate.

II.

The following principles apply for the Constitution and Procedure of the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area:

(1) The Senate has assigned to the Deutsche Forschungsgemeinschaft's Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area the responsibility of investigating the scientific foundations for the protection of workers' health from the effects of toxic chemicals at the workplace. The most important practical results

of the Commission's work are scientific recommendations for the establishment of MAK and BAT values, for the classification of carcinogenic substances and for the evaluation of embryotoxic and/or foetotoxic effects and of germ cell mutagens as well as the investigation and evaluation of analytical methods for controlling exposure and for examining observance of limit values for health protection at the workplace. In addition, the Commission investigates further current problems of hazards to health caused by occupational exposures and proposes possible appropriate solutions.

A two-step procedure appears to be the best solution for the realization of health protection measures at the workplace which are in line with the current state of the science: The results of the Commission's work already mentioned above are annually reviewed and published by the Deutsche Forschungsgemeinschaft. At the same time they are handed to the Bundesminister für Arbeit und Soziales who examines the recommendations, also taking nonscientific viewpoints into account, and who then makes them legally binding in an appropriate form – altered or unaltered – as a basis for health protection.

(2) The Commission works in scientific freedom and independence. It is not subject to instructions regarding selection or priority setting for the examination of substances and other matters to be investigated. It is the Commission's duty, however, to take up suggestions, in so far as they are of scientific significance, from industrial users and as far as possible to treat with precedence suggestions from the Bundesminister für Arbeit und Soziales who is responsible for health protection at the workplace.

(3) The complete transparency of the Commission's work programme is guaranteed by means of the advance announcement of planned changes and additions on the homepage of the Commission at the DFG. A most comprehensive information basis for the Commission's recommendations is ensured by the request to supply the Commission with information and commentaries and the associated possibility of involving appropriate scientific experts in the decision-making process.

The derivation of MAK and BAT values and the classification of carcinogenic substances or substances suspected of having carcinogenic potential and the evaluation of embryotoxic and/or foetotoxic effects and germ cell mutagens are published in the form of detailed scientific documentations ("Begründungen").

(4) The sole object of the Commission's work is to protect, as far as possible and necessary, and in line with the most up to date scientific information, the health of workers and of their offspring. The Commission regards health as the highest value which it does not weigh up against other factors. Therefore, only scientific arguments regarding health at the workplace are considered in discussions and decision-making. Other aspects such as sociopolitical, economic, technological and other non-substance-related considerations are excluded.

(5) For the reasons stated in 4., requests for participation of experts, other than those concerned with health aspects of protection at work, in the Commission's discussions cannot be complied with.

(6) At the same time the Commission does not undervalue the necessity for political decisions in the process of realizing protection at work. It does, however, reject mixing political with scientific judgements in its own work.

(7) By publishing its recommendations, the Commission contributes to fulfilling the constitutional obligation of the Deutsche Forschungsgemeinschaft to provide advice on scientific matters to parliaments and public authorities. Should the Bundesministerium für Arbeit und Soziales (see 1. above) deviate in any particular case from the recommendations, the Commission considers it essential that it makes the reasons known.

(8) The presidency and governing body of the Deutsche Forschungsgemeinschaft can check observance of the rules of procedure, but ensure unchanged and immediate publication of the Commission's results, in so far as there are no imperative opposing reasons.

III.

Newly appointed Members and Permanent Guest Contributors of the Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area receive written notice from the President of the Deutsche Forschungsgemeinschaft in which the following fundamentals of the Commission's work are laid down:

In order to fulfil the statutory functions of the Deutsche Forschungsgemeinschaft as advisers to the legislative and executive organs, the Senate has set up Commissions for various fields of knowledge, for example, for protection at work, protection of health and protection of the environment. The Commission in which you have been appointed is one of these.

The Commissions have the responsibility of ascertaining the current state of scientific data available in the respective field and of formulating it in such a way that the government authorities to be advised are in a position to reach competent decisions on their own responsibility. To this end it is desirable that in the individual Commissions the scientific position is elaborated so that it can be upheld by all members. Such a consensus is then represented in public as the standpoint of the Deutsche Forschungsgemeinschaft.

In view of this responsibility of the Commission, scientists are appointed members ad personam in their capacity as authoritative experts and not as representatives of the institutions or companies in which they work.

As well as these members there are also permanent guest contributors working in the Commissions. Scientists and other experts from public authorities are appointed permanent guest contributors with advisory function and may take on research assignments as well as official responsibilities. As they belong to institutes potentially affected by the Commission's advice they have no voting rights. In this way a possible conflict of interests should be avoided from the outset.

The Senate appoints the Commissions for periods of office lasting six years each. Members and permanent guest contributors are also appointed for six years and can be reappointed once. A further extension of a personal mandate is only possible in justified exceptional cases.

The strict division aimed at between recognition of a scientific standpoint and its "application" in the broadest sense, be it from the political, legal, economic or other social point of view, presupposes that extra-scientific problems of the government bodies the Commission is required to advise do not find admittance into the vote of the Commission. Political consequences of scientific facts, problems of realization, decisions about the reasonableness of particular risks, economic aspects, etc, do not belong within the responsibility of the Deutsche Forschungsgemeinschaft nor its Commissions.

For the procedure of the Commissions, discussions as well as data and facts referred to in the discussions are dealt with in strict confidentiality up until their publication by the Deutsche Forschungsgemeinschaft as a Report from the Commission concerned. Nobody, through appointment in a Commission, may gain a competitive advantage by exploiting advance information.

IV.

Procedure of the Commission for prospective new entries and changes to MAK values and Assessment Values in Biological Material

1. Prospective changes and new entries are announced one year in advance in the List of MAK and BAT Values, usually on 1st July. In addition, the new entries are published on the homepage of the Commission at the DFG (https://www.dfg.de/download/pdf/dfg_im_profil/gremien/senat/arbeitsstoffe/ankuendigungsliste.pdf). If necessary, in addition to the regular updates each year in July, further announcements of prospective changes and new entries can be made there at any time. In the case of changes, the type of prospective change is reported and the reason for it. On announcement of the changes the Commission requests that relevant information and comments be received.
2. Completed substance evaluations in the Sections MAK Values and Assessment Values in Biological Material are listed in detail in the "Changes and New entries" of the List of MAK and BAT Values (Appendix page I) and published on the homepage of the Commission at the DFG (List of changes and new entries in German; https://www.dfg.de/download/pdf/dfg_im_profil/gremien/senat/arbeitsstoffe/aenderungen_neuaufnahmen.pdf). The Commission has approved these suggestions, but presents them for discussion for the period of six months. Until this date new data or scientific comments can be sent to the secretarial office of the Commission; these will be examined by the Commission and as far as is necessary taken into account for the final ratification.

List of changes and new entries of substances in the parts MAK values and classifications and assessment values in biological material reviewed in 2023/2024

MAK values and classifications

a) alphabetical sorting:

Allyl propyl disulfide [2179-59-1] **change**
see Section IIb

MAK[ml/m^3]: – previous MAK[ml/m^3]: 2

MAK[mg/m^3]: – previous MAK[mg/m^3]: 12

Peak lim: – previous Peak lim: I(1)

Preg gr: –

Perc abs: –

Sens: –

Carc cat: –

Muta cat: –

Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction) **new entry**

MAK[mg/m^3]: 0.5 I

Peak lim: II(8)

Preg gr: D

Perc abs: –

Carc cat: 4
Due to particle overload effect in the lungs

Muta cat: –

Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction) **new entry**

MAK[mg/m^3]: 0.05 R

Peak lim: II(8)

Preg gr: D

Perc abs: –

Carc cat: 4
Due to particle overload effect in the lungs

Muta cat: –

Aluminium compounds, soluble (irritating) **new entry**

MAK[mg/m^3]: 0.0002 I

Peak lim: I(2)

Preg gr: C

Perc abs: –

Carc cat: –

Muta cat: –

Aluminium compounds, soluble (non-irritating)	**new entry**
MAK[mg/m^3]: 0.005 I	
Peak lim: II(2)	
Preg gr: C	
Perc abs: –	
Carc cat: –	
Muta cat: –	

Aniline [62-53-3] see Section XII	**change**
MAK[ml/m^3]: 2	
MAK[mg/m^3]: 7.7	
Peak lim: II(2)	
Preg gr: B	previous Preg gr: C
Perc abs: H	
Sens: Sh	
Carc cat: 4	
Muta cat: –	

1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	**change**
MAK[ml/m^3]: –	
MAK[mg/m^3]: –	
Peak lim: –	
Preg gr: –	
Perc abs: –	
Sens: –	
Carc cat: 2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.	previous Carc cat: –
Muta cat: 3B	previous Muta cat: –

Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	**change**
MAK[ml/m^3]: –	
MAK[mg/m^3]: –	
Peak lim: –	
Preg gr: –	
Perc abs: –	
Sens: Sh	
Carc cat: 2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.	previous Carc cat: –
Muta cat: 3B	previous Muta cat: –

Chlorinated biphenyls [1336-36-3]	**change**
Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles. see Section XII	
MAK[mg/m³]: 0.003 I (PCB 28 + PCB 52 + PCB 101 + PCB 138 + PCB 153 + PCB 180) × 5	
Peak lim: II(8)	
Preg gr: B Note regarding prerequisite for Group C see documentation	previous Preg gr: B Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum; see also Section XII
Perc abs: H	
Sens: –	
Carc cat: 4	
Muta cat: 5	

1,1-Dichloroethene [75-35-4]	**change**
MAK[ml/m³]: –	previous MAK[ml/m³]: 2
MAK[mg/m³]: –	previous MAK[mg/m³]: 8.0
Peak lim: –	previous Peak lim: II(2)
Preg gr: –	previous Preg gr: C
Perc abs: H	previous Perc abs: –
Sens: –	
Carc cat: 2	previous Carc cat: 3
Muta cat: –	

5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5]	**change**
releases formaldehyde see Section Xc	
MAK[ml/m³]: 0.15	previous MAK[ml/m³]: –
MAK[mg/m³]: 0.89	previous MAK[mg/m³]: –
Peak lim: I(2)	previous Peak lim: –
Preg gr: C	previous Preg gr: –
Perc abs: –	
Sens: Sh	
Carc cat: 4	previous Carc cat: –
Muta cat: 5	previous Muta cat: –

Ethyl formate [109-94-4]	**change**
MAK[ml/m^3]: 100	
MAK[mg/m^3]: 310	
Peak lim: I(1)	
Preg gr: C	
Perc abs: H	
Sens: –	
Carc cat: –	previously not evaluated
Muta cat: –	previously not evaluated

Glass wool, half-life < 40 days (fibrous and granular components)	**new entry**
MAK[mg/m^3]: 0.1 R	
Peak lim: II(8)	
Preg gr: D	
Perc abs: –	
Carc cat: 4	
Muta cat: –	

Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	**change**
MAK[ml/m^3]: –	previous
MAK[mg/m^3]: –	previous MAK[mg/m^3]: 2 I
Peak lim: –	previous Peak lim: II(2)
Preg gr: –	previous Preg gr: B
Perc abs: –	
Sens: Sh	
Carc cat: 2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.	previous Carc cat: –
Muta cat: 3B	previous Muta cat: –

2-Methoxyethanol [109-86-4] see Section XII	**change**
MAK[ml/m^3]: 1	
MAK[mg/m^3]: 3.2 MAK value applies for the sum of the concentrations of 2-methoxyethanol and 2-methoxyethyl acetate in the air.	
Peak lim: II(8)	
Preg gr: B Note regarding prerequisite for Group C see documentation	previous Preg gr: B
Perc abs: H	
Sens: –	
Carc cat: –	
Muta cat: –	

N-Methylolchloroacetamide [2832-19-1]
releases formaldehyde
see Section Xc

change

MAK[ml/m^3]: –

MAK[mg/m^3]: –

Peak lim: –

Preg gr: –

Perc abs: –

Sens: Sh

Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

previous Carc cat: 3

Muta cat: 3B

previous Muta cat: –

Naphtha (petroleum) hydrotreated, heavy [64742-48-9]
see Section Xc

Review of classification: no change

MAK[ml/m^3]: 50

MAK[mg/m^3]: 300

Peak lim: II(2)

Preg gr: D

Perc abs: –

Sens: –

Carc cat: –

Muta cat: –

4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture)
The substance can occur simultaneously as vapour and aerosol.In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.
see Section Xc

change

MAK[ml/m^3]: –

previous MAK[ml/m^3]: 0.5

MAK[mg/m^3]: –

previous MAK[mg/m^3]: 4.2

Peak lim: –

previous Peak lim: I(2)

Preg gr: –

previous Preg gr: D

Perc abs: –

Sens: Sh

Carc cat: 2
Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

previous Carc cat: –

Muta cat: 3B

previous Muta cat: –

Palm kernel oil [8023-79-8] see Section Xc	**new entry**
MAK[mg/m^3]: 5 R	
Peak lim: II(4)	
Preg gr: C	
Perc abs: –	
Sens: –	
Carc cat: –	
Muta cat: –	

1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	**change**
MAK[ml/m^3]: –	
MAK[mg/m^3]: –	
Peak lim: –	
Preg gr: –	
Perc abs: –	
Sens: –	
Carc cat: 2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.	previous Carc cat: 3
Muta cat: 3B	previous Muta cat: –

Trimellitic anhydride [552-30-7]	**change**
MAK[mg/m^3]: 0.0005 I	previous MAK[mg/m^3]: 0.04 R
Peak lim: I(1)	
Preg gr: D	previous Preg gr: –
Perc abs: –	
Sens: Sa	
Carc cat: –	
Muta cat: –	

b) sorting by MAK values and classifications:

A. MAK value [mg/m^3] **1. change**	**previous**	**new**
1,1-Dichloroethene [75-35-4]	8.0	–
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	–	0.89
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	2 I	–

4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4".	4.2	–
Trimellitic anhydride [552-30-7]	0.04 R	0.0005 I

A. MAK value [mg/m^3] **2. new entry**	**previous**	**new**
Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)		0.5 I
Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)		0.05 R
Aluminium compounds, soluble (irritating)		0.0002 I
Aluminium compounds, soluble (non-irritating)		0.005 I
Glass wool, half-life < 40 days (fibrous and granular components)		0.1 R
Palm kernel oil [8023-79-8] see Section Xc		5 R

A. MAK value [mg/m^3] **3. Review of classification: no change**	**previous**	**new**
Aniline [62-53-3] see Section XII	7.7	7.7
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	–
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–
Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	0.003 I (PCB 28 + PCB 52 + PCB 101 + PCB 138 + PCB 153 + PCB 180) × 5	0.003 I (PCB 28 + PCB 52 + PCB 101 + PCB 138 + PCB 153 + PCB 180) × 5
Ethyl formate [109-94-4]	310	310
2-Methoxyethanol [109-86-4] see Section XII	3.2 MAK value applies for the sum of the concentrations of 2-methoxyethanol and 2-methoxyethyl acetate in the air.	3.2 MAK value applies for the sum of the concentrations of 2-methoxyethanol and 2-methoxyethyl acetate in the air.
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	–	–

Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	300	300
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–

B. Peak limitation **1. change**	**previous**	**new**
Allyl propyl disulfide [2179-59-1] see Section IIb	I(1)	–
1,1-Dichloroethene [75-35-4]	II(2)	–
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	–	I(2)
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	II(2)	–
4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4´-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4".	I(2)	–

B. Peak limitation **2. new entry**	**previous**	**new**
Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)		II(8)
Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)		II(8)
Aluminium compounds, soluble (irritating)		I(2)
Aluminium compounds, soluble (non-irritating)		II(2)
Glass wool, half-life < 40 days (fibrous and granular components)		II(8)
Palm kernel oil [8023-79-8] see Section Xc		II(4)

B. Peak limitation **3. Review of classification: no change**	**previous**	**new**
Aniline [62-53-3] see Section XII	II(2)	II(2)
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	–
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–

Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	II(8)	II(8)
Ethyl formate [109-94-4]	I(1)	I(1)
2-Methoxyethanol [109-86-4] see Section XII	II(8)	II(8)
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	–	–
Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	II(2)	II(2)
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–
Trimellitic anhydride [552-30-7]	I(1)	I(1)

C. Pregnancy risk group **1. change**	**previous**	**new**
Aniline [62-53-3] see Section XII	C	B
Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	B Note regarding prerequisites for Pregnancy Risk Group C see BAT addendum; see also Section XII	B Note regarding prerequisite for Group C see documentation
1,1-Dichloroethene [75-35-4]	C	–
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	–	C
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	B	–
2-Methoxyethanol [109-86-4] see Section XII	B	B Note regarding prerequisite for Group C see documentation
4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4".	D	–
Trimellitic anhydride [552-30-7]	–	D

C. Pregnancy risk group **2. new entry**	**previous**	**new**
Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)		D
Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)		D
Aluminium compounds, soluble (irritating)		C
Aluminium compounds, soluble (non-irritating)		C
Glass wool, half-life < 40 days (fibrous and granular components)		D
Palm kernel oil [8023-79-8] see Section Xc		C

C. Pregnancy risk group **3. Review of classification: no change**	**previous**	**new**
Allyl propyl disulfide [2179-59-1] see Section IIb	–	–
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	–
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–
Ethyl formate [109-94-4]	C	C
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	–	–
Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	D	D
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–

D. Percutaneous absorption **1. change**	**previous**	**new**
1,1-Dichloroethene [75-35-4]	–	H

D. Percutaneous absorption **2. new entry**	**previous**	**new**
Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)		–
Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)		–
Aluminium compounds, soluble (irritating)		–
Aluminium compounds, soluble (non-irritating)		–
Glass wool, half-life < 40 days (fibrous and granular components)		–
Palm kernel oil [8023-79-8] see Section Xc		–

D. Percutaneous absorption **3. Review of classification: no change**	**previous**	**new**
Allyl propyl disulfide [2179-59-1] see Section IIb	–	–
Aniline [62-53-3] see Section XII	H	H
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	–
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–
Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	H	H
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	–	–
Ethyl formate [109-94-4]	H	H
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	–	–
2-Methoxyethanol [109-86-4] see Section XII	H	H
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	–	–
Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	–	–
4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see "GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4".	–	–
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–
Trimellitic anhydride [552-30-7]	–	–

E. Sensitization **2. new entry**	**previous**	**new**
Palm kernel oil [8023-79-8] see Section Xc		–

E. Sensitization

3. Review of classification: no change

	previous	new
Allyl propyl disulfide [2179-59-1] see Section IIb	–	–
Aniline [62-53-3] see Section XII	Sh	Sh
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	–
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	Sh	Sh
Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	–	–
1,1-Dichloroethene [75-35-4]	–	–
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	Sh	Sh
Ethyl formate [109-94-4]	–	–
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	Sh	Sh
2-Methoxyethanol [109-86-4] see Section XII	–	–
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	Sh	Sh
Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	–	–
4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.	Sh	Sh
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	–
Trimellitic anhydride [552-30-7]	Sa	Sa

F. Carcinogenicity **1. change**	**previous**	**new**
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
1,1-Dichloroethene [75-35-4]	3	2
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	–	4
Ethyl formate [109-94-4]	previously not evaluated	–
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	–	2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	3	2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.	–	2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	3	2 Prerequisite for Category 4 in principle fulfilled, but insufficient data available for the establishment of a MAK or BAT value.

F. Carcinogenicity **2. new entry**	**previous**	**new**
Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)		4 Due to particle overload effect in the lungs
Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)		4 Due to particle overload effect in the lungs
Aluminium compounds, soluble (irritating)		–

Aluminium compounds, soluble (non-irritating)	–
Glass wool, half-life < 40 days (fibrous and granular components)	4
Palm kernel oil [8023-79-8] see Section Xc	–

F. Carcinogenicity
3. Review of classification: no change

	previous	new
Allyl propyl disulfide [2179-59-1] see Section IIb	–	–
Aniline [62-53-3] see Section XII	4	4
Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	4	4
2-Methoxyethanol [109-86-4] see Section XII	–	–
Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	–	–
Trimellitic anhydride [552-30-7]	–	–

G. Germ cell mutagenicity
1. change

	previous	new
1,3-Bis(hydroxymethyl)urea [140-95-4] releases formaldehyde see Section Xc	–	3B
Bismorpholino methane [5625-90-1] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	3B
5-Ethyl-3,7-dioxa-1-azabicyclo[3.3.0]octane (EDAO) [7747-35-5] releases formaldehyde see Section Xc	–	5
Ethyl formate [109-94-4]	previously not evaluated	–
Methenamine 3-chloroallylchloride [4080-31-3; 51229-78-8] releases formaldehyde see Section Xc	–	3B
N-Methylolchloroacetamide [2832-19-1] releases formaldehyde see Section Xc	–	3B
4-(2-Nitrobutyl)morpholine (70% w/w) and 4,4′-(2-Ethyl-2-nitro-1,3-propanediyl)bismorpholine (20% w/w) [2224-44-4; 1854-23-5] (mixture) The substance can occur simultaneously as vapour and aerosol. In this mixture formaldehyde can be released and nitrosamines formed. Use forbidden as component of metal-working fluids and corrosion inhibitors: see “GefStoffV 2010, Anhang II (zu §16 Absatz 2), Nr. 4”.	–	3B
1,3,5-Triethylhexahydro-1,3,5-triazine [7779-27-3] releases formaldehyde The substance can occur simultaneously as vapour and aerosol. see Section Xc	–	3B

G. Germ cell mutagenicity **2. new entry**	**previous**	**new**
Aluminium and its poorly soluble compounds [7429-90-5] (inhalable fraction)		–
Aluminium and its poorly soluble compounds [7429-90-5] (respirable fraction)		–
Aluminium compounds, soluble (irritating)		–
Aluminium compounds, soluble (non-irritating)		–
Glass wool, half-life < 40 days (fibrous and granular components)		–
Palm kernel oil [8023-79-8] see Section Xc		–

G. Germ cell mutagenicity **3. Review of classification: no change**	**previous**	**new**
Allyl propyl disulfide [2179-59-1] see Section IIb	–	–
Aniline [62-53-3] see Section XII	–	–
Chlorinated biphenyls [1336-36-3] Chlorinated biphenyls form a group of compounds with different degrees and positions of chlorine substitution; often, more than one of these substances occur simultaneously at the workplace. Chlorinated biphenyls with low chlorine content (up to 5 chlorine atoms) can occur as a particle-vapour mixture, whereas chlorinated biphenyls with a large quantity of chlorine occur only as particles.	5	5
1,1-Dichloroethene [75-35-4]	–	–
2-Methoxyethanol [109-86-4] see Section XII	–	–
Naphtha (petroleum) hydrotreated, heavy [64742-48-9] see Section Xc	–	–
Trimellitic anhydride [552-30-7]	–	–

H. Substances in section IIb **1. change**	**previous**	**new**
Allyl propyl disulfide [2179-59-1] see Section IIb	12 mg/m^3	–

Part Assessment Values in Biological Material

Biological Tolerance Values (BAT values)

	Aluminium [7429-90-5]	
	50 µg aluminium/g creatinine	confirmation of BAT value
	Aniline [62-53-3]	
	500 µg aniline/l urine	confirmation of BAT value
⋆	**Lead tetraethyl [78-00-2]**	
	not established, parameter diethyllead in urine not established, parameter total lead in urine	previous BAT value
⋆	**Lead tetramethyl [75-74-1]**	
	not established, parameter total lead in urine	previous BAT value
⋆	**Xylene [1330-20-7]**	
	1800 mg methylhippuric acids (= toluric acids) (all isomers)/g creatinine	reevaluation of BAT value

Biological Guidance Values (BLW)

⋆	**Lead tetraethyl [78-00-2]**	
	150 µg lead/l blood	previous BAT value in urine
⋆	**Lead tetramethyl [75-74-1]**	
	150 µg lead/l blood	previous BAT value in urine
⋆	**Cadmium [7440-43-9]**	
	2 µg cadmium/g creatinine	no previous BLW

Pregnancy Risk Groups at BAT value

⋆	**Aluminium [7429-90-5]**	Group D
⋆	**Aniline [62-53-3]**	Group B with note regarding prerequisite for Group C
	Xylene [1330-20-7]	Group D

Announcement list of substances being examined for the establishment of MAK values and assessment values in biological material

The “Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area” of the Deutsche Forschungsgemeinschaft is discussing changes of, or additions to, the MAK values and classifications as well as assessment values in biological material of the following substances for the 2025 list (Report 61) and future subsequent lists:

Substance	Point of discussion	Reason
Acetoin [513-86-0]	MAK value, new entry	Suggestion from the Commission
Acrylamide [79-06-1]	Re-evaluation of EKA	Suggestion from the Commission
Acrylates (monomers and oligomers)	Sensitizing effect	Suggestion from the Commission
2-Amino-2-ethyl-1,3-propanediol [115-70-8]	MAK value	Suggestion from the Commission
Benzophenone [119-61-9]	MAK value, new entry	Suggestion from the Commission
Benzophenone-3 [131-57-7]	MAK value, new entry	Suggestion from the Commission
	Carcinogenic effect, new entry	Suggestion from the Commission
Benzyl formate [104-57-4]	MAK value, new entry	Suggestion from the Commission
Benzyl alcohol mono(poly)hemiformal [14548-60-8]	Carcinogenic effect	Suggestion from the Commission
Benzyltoluene [27776-01-8]	MAK value, new entry	Suggestion from the Commission
N,N-Bis(2-ethylhexyl)-(1,2,4-triazole-1-yl)methanamine [91273-04-0]	Carcinogenic effect	Suggestion from the Commission
Bisphenol A (4,4′-Isopropylidenediphenol) [80-05-7]	MAK value	Suggestion from the Commission
	Re-evaluation of BLW	Suggestion from the Commission
2-Bromo-2-nitro-1,3-propanediol [52-51-7]	Carcinogenic effect	Suggestion from the Commission
1-Butanol [71-36-3]	Re-evaluation of BAT value	Suggestion from the Commission
p-tert-Butylbenzoic acid [98-73-7]	MAK value	Suggestion from the Commission
tert-Butyl hydroperoxide [75-91-2]	MAK value	Suggestion from the Commission
p-tert-Butylphenol [98-54-4]	MAK value	Suggestion from the Commission
Calcium sulfate (inhalable fraction) Anhydrite [7778-18-9] Hemihydrate [10034-76-1] Dihydrate [10101-41-4] Gypsum [13397-24-5]	MAK value	Suggestion from the Commission
Carbon dioxide [124-38-9]	MAK value	Suggestion from the Commission
Carbon disulfide [75-15-0]	Re-evaluation of the Pregnancy Risk Group at BAT value	Suggestion from the Commission
Chlorpromazine (2-Chloro-10-(3-dimethylaminopropyl)phenothiazine) [50-53-3]	MAK value	Suggestion from the Commission
Chromium(III) compounds	MAK value	Suggestion from the Commission
Copper [7440-50-8] and its inorganic compounds	MAK value	Suggestion from the Commission
Decaborane [17702-41-9]	MAK value	Suggestion from the Commission
Dibenzyltoluene	MAK value, new entry	Suggestion from the Commission
1,3-Dichlorobenzene [541-73-1]	Evaluation of assessment values in biological material	Suggestion from the Commission
1,2-Dichloroethylene sym [540-59-0] (cis [156-59-2] and trans [156-60-5])	MAK value	Suggestion from the Commission
Dichloromethane [75-09-2]	Carcinogenic effect	Suggestion from the Commission
2,2-Dichloropropionic acid [75-99-0]	MAK value	Suggestion from the Commission

Substance	Point of discussion	Reason
Diethyl carbonate [105-58-8]	MAK value	Suggestion from the Commission
Diisononyl phthalate [28553-12-0]	MAK value, new entry	Suggestion from the Commission
Dimethyl carbonate [616-38-6]	MAK value	Suggestion from the Commission
1,3-Dimethylol-5,5-dimethyl hydantoin [6440-58-0]	Carcinogenic effect	Suggestion from the Commission
N,N-Dimethyl-n-propylamine [926-63-6]	MAK value, new entry	Suggestion from users
Dipropylene glycol monomethyl ether [34590-94-8] (mixture of isomers)	MAK value	Suggestion from the Commission
Dust, general limit value (inhalable fraction)	MAK value	Suggestion from the Commission
Ethylene carbonate [96-49-1]	MAK value	Suggestion from the Commission
Ethyl methyl carbonate [623-53-0]	MAK value	Suggestion from the Commission
N-Ethyl-2-pyrrolidone [2687-91-4]	Evaluation of BLW	Suggestion from the Commission
Fluranes (desflurane, enflurane, isoflurane, sevoflurane)	MAK value	Suggestion from the Commission
	Evaluation of assessment values in biological material	Suggestion from the Commission
Graphene [1034343-98-0]	MAK value, new entry	Suggestion from the Commission
	Carcinogenic effect, new entry	Suggestion from the Commission
Halothane [151-67-7]	MAK value	Suggestion from the Commission
Hexamethylenetetramine [100-97-0]	Carcinogenic effect	Suggestion from the Commission
n-Hexane [110-54-3]	Re-evaluation of BAT value	Suggestion from the Commission
	Evaluation of the Pregnancy Risk Group at BAT value	Suggestion from the Commission
2-Hexanone [591-78-6]	MAK value	Suggestion from the Commission
	Re-evaluation of BAT value	Suggestion from the Commission
	Evaluation of the Pregnancy Risk Group at BAT value	Suggestion from the Commission
Hydrazoic acid [7782-79-8]	MAK value	Suggestion from the Commission
Iodomethane [74-88-4]	Carcinogenic effect	Suggestion from the Commission
Isophorone diisocyanate [4098-71-9]	MAK value	Suggestion from the Commission
Lithium compounds, inorganic (as Li [7439-93-2])	Re-evaluation of assessment values in biological material	Suggestion from the Commission
Manganese [7439-96-5] and its inorganic compounds (inhalable fraction)	MAK value	Suggestion from AGS
	Re-evaluation of assessment values in biological material	Suggestion from the Commission
Manganese [7439-96-5] and its inorganic compounds (respirable fraction)	MAK value	Suggestion from AGS
Melamine [108-78-1]	MAK value, new entry	Suggestion from the Commission
	Carcinogenic effect, new entry	Suggestion from the Commission
	Evaluation of assessment values in biological material	Suggestion from the Commission
2-Mercaptobenzothiazole [149-30-4]	Evaluation of assessment values in biological material	Suggestion from the Commission
Mercury, organic compounds	Carcinogenic effect	Suggestion from the Commission
Metal-working fluids	Toxicity and carcinogenic effect	see Section Xc
5-Methyl-3-heptanone [541-85-5]	MAK value	Suggestion from the UAIII
Methyl isocyanate [624-83-9]	MAK value	Suggestion from the Commission

Substance	Point of discussion	Reason
4-Methyl-2-pentanone [108-10-1]	MAK value	Suggestion from the Commission
	Re-evaluation of assessment values in biological material	Suggestion from the Commission
N-Methyl-2-pyrrolidone [872-50-4]	Re-evaluation of BAT value	Suggestion from the Commission
Molybdenum [7439-98-7] and its compounds	Re-evaluation of BAR	Suggestion from the Commission
Molybdenum disulfide [1317-33-5]	MAK value, new entry	Suggestion from the Commission
1,5-Naphthylene diisocyanate [3173-72-6]	MAK value	Suggestion from the Commission
Nickel carbonyl [13463-39-3]	MAK value, new entry	Suggestion from the Commission
Pentachlorophenol [87-86-5]	Carcinogenic effect	Suggestion from the Commission
Perfluoroisobutene [382-21-8]	MAK value, new entry	Suggestion from the Commission
Perfluorooctanesulfonic acid (PFOS) [1763-23-1] and its salts	Re-evaluation of BAT value	Suggestion from the Commission
Perfluorooctanoic acid (PFOA) [335-67-1] and its salts	Re-evaluation of BAT value	Suggestion from the Commission
Phenol [108-95-2]	MAK value	Suggestion from the UAIII
	Re-evaluation of BLW	Suggestion from the Commission
2-Phenoxyethanol [122-99-6]	Evaluation of assessment values in biological material	Suggestion from the Commission
p-Phenylenediamine [106-50-3]	MAK value	Suggestion from the Commission
Quartz [14808-60-7]	MAK value	Suggestion from the Commission
Selenium [7782-49-2] and its inorganic compounds (as Se)	MAK value	Suggestion from the UAIII
	Re-evaluation of the Pregnancy Risk Group at BAT value	Suggestion from the Commission
Silica, amorphous: b) quartz glass [60676-86-0], fused silica [60676-86-0], silica fume (calcined) [69012-64-2], diatomaceous earth [68855-54-9]	MAK value	Suggestion from the Commission
	Carcinogenic effect	Suggestion from the Commission
Soya bean constituents	MAK value	Suggestion from the Commission
Styrene [100-42-5]	Re-evaluation of BAT value	Suggestion from the Commission
	Re-evaluation of the Pregnancy Risk Group at BAT value	Suggestion from the Commission
Sulfur [7704-34-9]	MAK value	Suggestion from the Commission
Tetrahydrofuran [109-99-9]	Re-evaluation of BAT value	Suggestion from the Commission
	Re-evaluation of the Pregnancy Risk Group at BAT value	Suggestion from the Commission
Tributyl phosphate [126-73-8]	Percutaneous absorption	Suggestion from the Commission
Trimethylbenzene (all isomers) [25551-13-7]	MAK value	Suggestion from the Commission
Zinc [7440-66-6] and its inorganic compounds (inhalable fraction)	MAK value	Suggestion from AGS

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The Commission requests that company physicians, the manufacturers and users of industrial chemicals, research institutes dealing with these compounds, as well as boards of control and other governmental institutions, submit the names of any additional substances which occur at the workplace and have not as yet been considered.

Scientific and technical data and information applying to the compounds listed above should be submitted by

1st February 2025

to the

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