

Warning**Danger**

The GESTIS Column Model 2025

An aid to substitute assessment

1 Risk	2a Acute health hazards (single exposure)	2b Chronic health hazards (repeated exposure)	3 Environmental hazards ¹	4 Physico-chemical effects (fire, explosion, corrosion et al.) ² , H-phrases marked in blue occur several times.	5 Hazards from release behaviour	6 Process-related hazards
very high	<ul style="list-style-type: none"> Acutely toxic substances/mixtures, Cat. 1 or 2 (H300, H310, H330) Substances/mixtures that in contact with acids liberate highly toxic gases (EUH032) 	<ul style="list-style-type: none"> Carcinogenic substances/mixtures, Cat. 1A or 1B (H350, H350i) Carcinogenic activities or processes according to TRGS 906 Substances/mixtures mutagenic to germ cells, Cat. 1A or 1B (H340) 	<ul style="list-style-type: none"> Substances/mixtures acutely hazardous to the aquatic environment, Cat. 1 (H400) Substances/mixtures chronically hazardous to the aquatic environment, Cat. 1 (H410) Substances/mixtures of German Water Hazard Class WGK 3 vPvB substances, very persistent and very bioaccumulative (EUH441) vPvM substances, very long-lasting contamination of water resources (EUH451) 	<ul style="list-style-type: none"> Unstable explosive substances/mixtures (H200) Explosive substances/mixtures/articles, divisions 1.1 (H201), 1.2 (H202), 1.3 (H203), 1.4 (H204), 1.5 (H205) and 1.6 (without H-phase) Flammable gases, Cat. 1A (H220, H230, H231, H232) and Cat. 1B and 2 (H221) Pyrophoric gases (H232) Flammable liquids, Cat. 1 (H224) Self-reactive substances/mixtures, Types A (H240) and B (H241) Organic peroxides, Types A (H240) and B (H241) Pyrophoric liquids or solids, Cat. 1 (H250) Substances/mixtures which in contact with water emit flammable gases, Cat. 1 (H260) Oxidising liquids or solids, Cat. 1 (H271) 	<ul style="list-style-type: none"> Gases Liquids with a vapour pressure > 250 hPa (mbar) (e.g. dichloromethane) Dust-generating solids Aerosols 	<ul style="list-style-type: none"> Open processing Possibility of direct skin contact Large-area application Process index 4 according to TRGS 500 (open design or partially open design, natural ventilation)
high	<ul style="list-style-type: none"> Acutely toxic substances/mixtures, Cat. 3 (H301, H311, H331) Substances/mixtures toxic in contact with eyes (EUH070) Substances/mixtures that in contact with water or acids liberate toxic gases (EUH029, EUH031) Substances/mixtures with specific target organ toxicity (single exposure), Cat. 1: Organ damage (H370) Skin sensitising substances/mixtures (H317, Sh) Substances/mixtures that sensitise the respiratory organs (H334, Sa) Substances/mixtures corrosive to the skin, Cat. 1, 1A (H314) 	<ul style="list-style-type: none"> Substances/mixtures toxic to reproduction, Cat. 1A or 1B (H360, H360F, H360D, H360FD, H360Fd, H360Df) Carcinogenic substances/mixtures, Cat. 2 (H351) Substances/mixtures mutagenic to germ cells, Cat. 2 (H341) Substances/mixtures with specific target organ toxicity (repeated exposure), Cat. 1: Organ damage (H372) Endocrine disruptors (EUH380) 	<ul style="list-style-type: none"> Substances/mixtures chronically hazardous to the aquatic environment, Cat. 2 (H411) Substances hazardous to the ozone layer (H420) Substances that may cause endocrine disruption in the environment (EUH430) PBT substances accumulating in the environment (EUH440) PMT substances, long-lasting contamination of water resources (EUH450) 	<ul style="list-style-type: none"> Aerosols, Cat. 1 (H222 and H229) Flammable liquids, Cat. 2 (H225) Flammable solids, Cat. 1 (H228) Self-reactive substances/mixtures, Types C and D (H242) Organic peroxides Types C and D (H242) Self-heating substances/mixtures Cat. 1 (H251) Substances/mixtures which in contact with water emit flammable gases, Cat. 2 (H261) Oxidising gases, Cat. 1 (H270) Oxidising liquids or solids, Cat. 2 (H272) Desensitised explosives, Cat. 1 (H206) and Cat. 2 (H207) Substances/mixtures with certain properties (EUH001, EUH014, EUH018, EUH019, EUH044) 	<ul style="list-style-type: none"> Liquids with a vapour pressure 50...250 hPa (mbar) (e.g. methanol) 	<ul style="list-style-type: none"> Process index 2 according to TRGS 500 (partially open design, process-related opening with simple extraction, open with simple extraction)
medium	<ul style="list-style-type: none"> Acutely toxic substances/mixtures, Cat. 4 (H302, H312, H332) Substances/mixtures with specific target organ toxicity (single exposure), Cat. 2: Possible organ damage (H371) Substances/mixtures corrosive to the skin, Cat. 1B, 1C (H314) Eye-damaging substances/mixtures (H318) Substances/mixtures with corrosive effect on respiratory organs (EUH071) Nontoxic gases that can cause suffocation by displacing air (e.g. nitrogen) 	<ul style="list-style-type: none"> Substances/mixtures toxic to reproduction, Cat. 2 (H361, H361f, H361d, H361fd) Substances/mixtures with specific target organ toxicity (repeated exposure), Cat. 2: Possible organ damage (H373) Substances/mixtures that can harm babies via their mothers' milk (H362) Substances suspected of endocrine disruption (EUH381) 	<ul style="list-style-type: none"> Substances/mixtures chronically hazardous to the aquatic environment, Cat. 3 (H412) Substances/mixtures of German Water Hazard Class WGK 2 Substances suspected of endocrine disruption in the environment (EUH431) 	<ul style="list-style-type: none"> Aerosols, Cat. 2 (H223 and H229) Flammable liquids, Cat. 3 (H226) Flammable solids, Cat. 2 (H228) Self-reactive substances/mixtures, Types E and F (H242) Organic peroxides, Types E and F (H242) Self-heating substances/mixtures, Cat. 2 (H252) Substances/mixtures which in contact with water emit flammable gases, Cat. 3 (H261) Oxidising liquids or solids, Cat. 3 (H272) Gases under pressure (H280, H281) Corrosive to metals (H290) Desensitised explosives, Cat. 3 (H207) and Cat. 4 (H208) 	<ul style="list-style-type: none"> Liquids with a vapour pressure 10...50 hPa (mbar), with the exception of water (e.g. toluene) 	<ul style="list-style-type: none"> Closed processing with possibilities of exposure, e.g. during filling, sampling or cleaning Process index 1 according to TRGS 500 (closed design, tightness not ensured, partially open design with effective extraction)
low	<ul style="list-style-type: none"> Skin-irritant substances/mixtures (H315) Eye-irritant substances/mixtures (H319) Skin damage when working in moisture Substances/mixtures with a risk of aspiration (H304) Skin-damaging substances/mixtures (EUH066) Substances/mixtures with specific target organ toxicity (single exposure), Cat. 3: irritation of the respiratory organs (H335) Substances/mixtures with specific target organ toxicity (single exposure), Cat. 3: drowsiness, dizziness (H336) 	<ul style="list-style-type: none"> Substances chronically harmful in other ways (no H-phase, but still a hazardous substance!) 	<ul style="list-style-type: none"> Substances/mixtures chronically hazardous to the aquatic environment, Cat. 4 (H413) Substances/mixtures of German Water Hazard Class WGK 1 Substances/ mixtures that are generally hazardous to the aquatic environment (agw) 	<ul style="list-style-type: none"> Aerosols, Cat. 3 (H229 without H222, H223) Not readily flammable substances/mixtures (flash point > 60...100 °C, no H-phase) Self-reactive substances/mixtures, Type G (no H-phase) Organic peroxides, Type G (no H-phase) 	<ul style="list-style-type: none"> Liquids with a vapour pressure 2...10 hPa (mbar) (e.g. xylene) 	<ul style="list-style-type: none"> Process index 0,5 according to TRGS 500 (closed design, tightness ensured, partially closed design with integrated extraction, partially open design with highly effective extraction)
negligible	<ul style="list-style-type: none"> Safe substances on the basis of experience (e.g. water, sugar, paraffin and the like) 		<ul style="list-style-type: none"> Substances/mixtures not hazardous to the aquatic environment (nwg) 	<ul style="list-style-type: none"> Non-combustible or only not at all readily flammable substances/mixtures (flash point of liquids > 100 °C, no H-phase) 	<ul style="list-style-type: none"> Liquids with a vapour pressure < 2 hPa (mbar) (e.g. ethylene glycol) Non-dust-generating solids 	<ul style="list-style-type: none"> Process index 0,25 according to TRGS 500

¹ The water hazard class is only referred to as an assessment criterion for substances/mixtures that have not (yet) been classified in terms of their environmental hazard properties.

² Due to their specific problems, substances with a dust explosion hazard must be tested in individual cases by experts and therefore are not assigned to any below-mentioned hazard class.

Notes on Evaluating Substitute Substances by the Column Model

Are recommendations already available on substitute substances?

Answering the question of which product has the lower health risk is difficult. Recommendations for a series of questions regarding substitute substances can be applied directly, such as:

- Technical Rules for Hazardous Substances in the 600 series, www.baua.de/EN/Service/Legislative-texts-and-technical-rules/Rules/TRGS/TRGS.html
- National governmental or accident insurance recommendations,
- Industry guidelines,
- SUBSPORTplus Information Portal of BAuA: <https://www.baua.de/EN/Topics/Chemicals-biological-agents/Hazardous-substances/Subsportplus>

Procedures

If there are no recommendations available to help you solve your substitute substance problem, the Column Model can help you make a quick comparison of substances and mixtures. To do so, you only need the brief information found in the Material Safety Data Sheet or on the package labelling.

Proceed as follows:

1. Copy the Column Model table once for each product and note each product's name on a different copy.
2. Refer to the Material Safety Data Sheet for the requisite information. There you will find the hazard classes, H-phrases in Chapter 2 and the German

Water Hazard Classes in Chapter 15 of the Material Safety Data Sheet and information on the exposure potential in Chapter 9. You can also find additional information in Chapters 3, 5, 11, and 12. Check the presence of supplemental information for classification as skin sensitizing, respiratory sensitizing, carcinogenic, germ cell mutagenic or toxic for reproduction substance by the German Committee on Hazardous Substances (AGS) in the TRGS 900, 905 or 907.

3. Note the information you find for the respective product on the copy of the Column Model table. Note the procedure used in the last column.
4. Now compare the columns below separately for each product to be evaluated:
 - acute and chronic health hazards,
 - environmental hazards,
 - physico-chemical effects,
 - hazards from release behaviour,
 - hazards caused by procedures.

Please bear in mind:

- Comparisons are only to be made within a column, and never within a line. The columns for "acute health hazards" and "chronic health hazards" count as one single column.
- Also mixtures are assessed only on the basis of their labelling with respect to their acute and chronic health hazards.

Interpretation of the results

On the basis of the outcome of the risk assessment, a product must be substituted if it reduces the risk to employees. A risk exists if employees are capable of spatially and temporally encountering a hazard source (hazardous substance). The hazards inherent in hazardous substances have to first become effective (e.g. through exposure, fire, explosion) in order to become relevant risks.

The columns 2, 3 and 4 constitute hazards. The columns 5 and 6 are to be interpreted as „hazards becoming effective”.

- If the potential substitute product rates better in all five columns than the product in use, the substitution problem is solved.
- It will mostly be the case that the potential substitute product rates better in some columns, but worse in one or two other columns. This obliges you to assess which potential hazards – in other words, which columns – play a larger role in your particular situation. If, for example, sources of combustion cannot be excluded in your production processes, then the fire and explosion characteristics together with the exposure potential will have the greater weight. If your production methods result in large quantities of waste by-products, then the environmental hazards will be emphasized.
- Minor differences in the hazard classification only justify the introduction of a substitute substance if the data available for the substitute substance is similar in quantity and quality to that of the substance being substituted.
- In the event of opposing reasons, the difference in a single hazard classification may not be sufficient for the introduction of a substitute substance.
- Columns 2 to 4 (hazards) and 5 and 6 (hazards becoming effective) must always be assessed

collectively. If, for instance, a potential substitute substance is only a minor hazard according to columns 2 to 4, but the probability of a hazard becoming effective according to columns 5 and 6 is considerably greater, this substance may not be suitable as a substitute substance.

- With the Column Model, mixtures are not assessed on the basis of their components. The practicality of this procedure is obtained at the expense of certain disadvantages resulting, for instance, from the existence of classification boundaries for mixtures.
- Document your decisions in an appropriate manner (e.g. by attaching the copies described above).

Technical remarks

- Substances, mixtures and articles of the hazard class “Explosives”, which are not classified as an unstable explosive: All divisions of this class are listed in the “Very high risk” line, as the divisions do not include any gradation of risk on the basis of their intrinsic properties, but subdivides substances, mixtures and articles in their packaged form. If explosives are unpackaged, the risk from the substances/mixtures/articles in division 1.5 is in principle the same as that in division 1.1. A generally applicable statement on recommended substitutes cannot therefore be made within this hazard class.
- Flammable gases: Categories 1A, 1B and 2 of the “Flammable gases” hazard category are listed together in the “Very high risk” line. Flammable gases of Categories 1A, 1B and 2 have an explosion range and the same safety measures have to be taken. Unlike flammable liquids, Category 2 flammable gases should not be considered less hazardous, and these substances/mixtures have been given the highest risk classification.

Conditions for Using the Column Model according to the German Hazardous Substances Ordinance

What is the problem?

A supposedly less dangerous product can be more dangerous in reality; yet the concrete hazardous characteristics may not have been tested. For the risk assessment, the Hazardous Substances Ordinance therefore states: "If no test data or suitable sound information is available on the acutely toxic, irritant, skin-sensitizing or germ cell mutagenic effects or on the specific target organ toxicity after repeated exposure, the substances or mixtures are to be treated in the risk assessment as substances with hazard class Acute Toxicity (oral, dermal and inhalative) Category 3, Skin Corrosion/Irritation Category 2, Skin Sensitisation Category 1, Germ Cell Mutagenicity Category 2 or Specific Target Organ Toxicity after repeated exposure (STOT RE) Category 2."

What effect does this have on the Column Model?

If the Material Safety Data Sheet gives details on none or only a few required tests and if an inquiry with the manufacturer has not yielded any information, then it must be assumed when using the Column Model that the respective characteristics are present.

What does this mean specifically?

- If no information is available on tests for acute toxicity, then the substance or mixture has to be categorized at least as a "high risk" in the column "acute health hazards" (in

terms of "acute toxic substances/mixtures, category 3", H301, H311, H331).

- If no information is available on tests of skin corrosion/irritation, then the substance or mixture has to be categorized at least as a "low risk" in the column "acute health hazards" (in terms of a "skin irritant", H315).
- If no information is available on tests for skin sensitisation, then the substance or mixture has to be categorized at least as a "high risk" in the column "acute health hazards" (in terms of a "skin sensitizer, category 1", H317).
- If no information is available on tests for germ cell mutagenicity, then the substance or mixture has to be categorized at least as a "high risk" in the column "chronic health hazards" (in terms of a "germ cell mutagenic substance, category 2", H341).
- If no information is available on tests for specific target organ toxicity after repeated exposure, then the substance or mixture has to be categorized at least as a "medium risk" in the column "chronic health hazards" (in terms of "possible organ damage" H373).

The most consistent procedure is the one in which those products lacking information with regard to the five basic tests described here are not even considered as potential substitutes, or in which products lacking such information are replaced by others that are backed by studies and tests.

The Legal Basis for Finding Substitutes

**The German Hazardous Substances
Ordinance demands, among other
things, the following from the
employer:**

**Article 6 (1) of the German Hazardous
Substances Ordinance:**

When conducting a risk assessment as part of the assessment of working conditions in accordance with Article 5 of the Occupational Safety & Health Act, the employer has to ascertain whether employees are engaged in activities with hazardous substances or whether hazardous substances may arise or be released during such activities. If this is the case, he must assess all the resultant risks to the health and safety of employees from the following points of view: ... 4. Scope for substitution ...

**Article 7 (3) of the German Hazardous
Substances Ordinance:**

On the basis of the outcome of the substitution test in accordance with Article 6, Section 1, Sentence 2, Number 4, the employer must give priority to substitution. He must replace hazardous substances or processes with substances, mixtures, products or processes that are not hazardous or are less hazardous to the health and safety of employees under the associated conditions of use.

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