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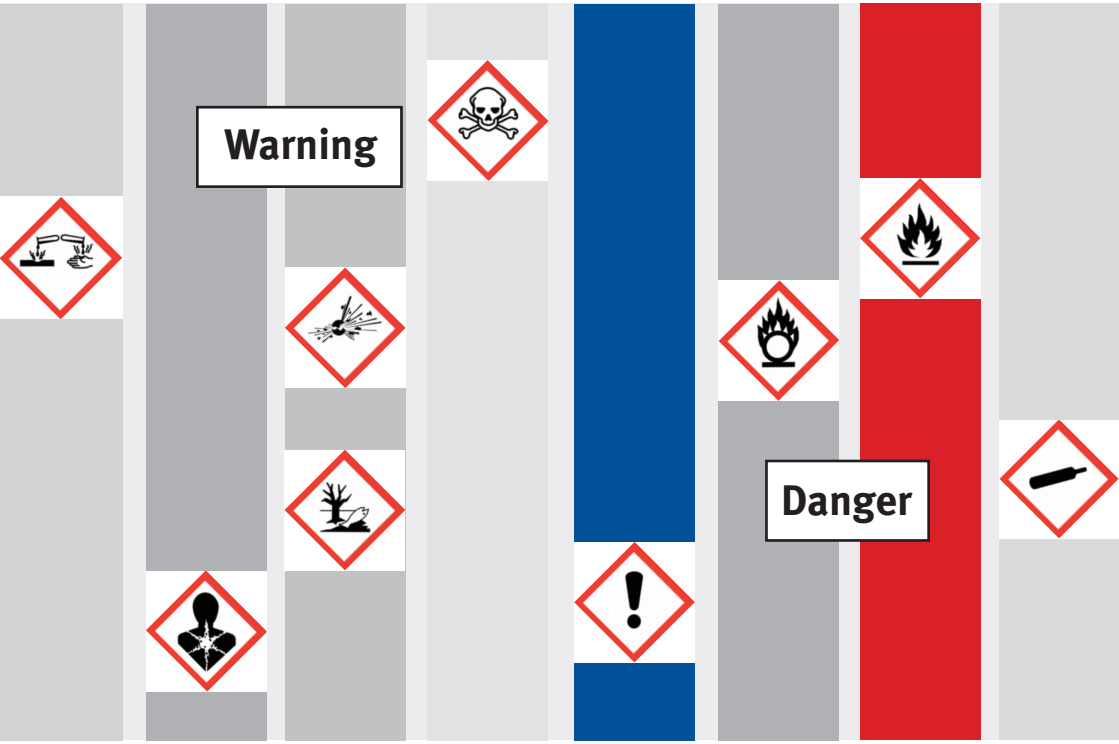

The GHS Column Model 2014

An aid to substitute assessment

1 Risk	2a Acute health hazards (single exposure)	2b Chronic health hazards (repeated exposure)	3 Environmental hazards [1]
very high	• Acutely toxic substances/mixtures, Cat. 1 and 2 (**H300, H310, H330**) • Substances/mixtures that in contact with acids liberate highly toxic gases (**EUH032**)	• Carcinogenic substances/ mixtures, Cat. 1A/1B (AGS: K1, K2, **H350, H350i**) • Carcinogenc activities or processes according to TRGS 906 • Substances/mixtures mutagenic to germ cells, Cat. 1A or 1B (AGS: M1, M2, **H340**)	• 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** • PBT substances • vPvB substances
high	• Acutely toxc 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**) • Eye-damaging substances/mixtures (**H318**)	• Substances/mixtures toxic to reproduction, Cat. 1A or 1B (AGS: R_E1, R_F1, R_E2, R_F2, **H360, H360F, H360D, H360FD, H360Fd, H360Df**) • Carcinogenic substances/ mixtures, Cat. 2 (AGS: K3, **H351**) • Substances/mixtures mutagenic to germ cells, Cat. 2 (AGS: M3, **H341**) • Substances/mixtures with specific target organ toxicity (repeated exposure), Cat. 1: Organ damage (**H372**)	• Substances/mixtures chronically hazardous to the aquatic environment, Cat. 2 (**H411**) • Substances hazardous to the ozone layer (**H420**)
medium	• 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 corrosive to the skin (**H314, pH ≥ 11,5, pH ≤ 2**) • Substances/mixtures with corrosive effect on respiratory organs (**EUH071**) • Nontoxic gases that can cause suffocation by displacing air (e.g. nitrogen)	• Substances/mixtures toxic to reproduction, Cat. 2 (AGS: R_E3, R_F3, **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/mixtures chronically hazardous to the aquatic environment, Cat. 3 (**H412**) • Substances/mixtures of German Water Hazard Class **WGK 2**
low	• 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**)	• Substances chronically harmful in other ways (no H-phrase, but still a hazardous substance!)	• Substances/mixtures chronically hazardous to the aquatic environment, Cat. 4 (**H413**) • Substances/mixtures of German Water Hazard Class **WGK 1**
negligible	• Safe substances on the basis of experience (e.g. water, paraffin and the like)		• Substances/mixtures not hazardous to the aquatic environment (**NWG**, former **WGK 0**)

[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.

4 Physico-chemical hazards (fire, explosion, corrosion et al.) [2] H-phrases marked in blue occur several times.	5 Hazards from release behaviour	6 Process-related hazards
• Unstable explosive substances/mixtures (**H200**) • Explosive substances/mixtures/products, divisions 1.1 (**H201**), 1.2 (**H202**), 1.3 (**H203**), 1.4 (**H204**), 1.5 (**H205**) and 1.6 (without H-phrase) • Flammable gases, Cat. 1 (**H220**) and Cat. 2 (**H221**) • 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**)	• Gases • Liquids with a vapour pressure › 250 hPa (mbar) (e.g. dichloromethane) • Dust-generating solids • Aerosols	• 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)
• Flammable aerosols, Cat. 1 (**H222**) • 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**) • Substances/mixtures with certain properties (**EUH001, EUH006, EUH014, EUH018, EUH019, EUH044**)	• Liquids with a vapour pressure 50 … 250 hPa (mbar) (e.g. methanol)	• Process index 2 according to TRGS 500 (partially open design, process-related opening with simple extraction, open with simple extraction)
• Flammable aerosols, Cat. 2 (**H223**) • 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**) • Substances/mixtures corrosive to metals (**H290**)	• Liquids with a vapour pressure 10 … 50 hPa (mbar), with the exception of water (e.g. toluene)	• 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)
• Not readily flammable substances/mixtures (flash point › 60 … 100 °C, no H-phrase) • Self-reactive substances/mixtures, Type G (no H-phrase) • Organic peroxides, Type G (no H-phrase)	• Liquids with a vapour pressure 2 … 10 hPa (mbar) (e.g. xylene)	• 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)
• Non-combustible or only not at all readily flammable substances/mixtures (flash point of liquids › 100 °C, no H-phrase)	• Liquids with a vapour pressure ‹ 2 hPa (mbar) (e.g. ethylene glycol) • Non-dust-generating solids	• Process index 0,25 according to TRGS 500

[2] In view of their specific problems, explosive dusts must be tested in individual cases by a skilled person and have not therefore been assigned to a 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 whole series of questions regarding substitute substances can be applied directly, such as:

- Technical rules for Hazardous substances in the 600 series,
- Recommendations "Exposure assessment of the German Social Accident Insurance Institutions",
- LASI-guidelines, series of BAuA
- Product codes, GISCODEs,
- Other industry guidelines.

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 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.
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 hazards
   - 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 to 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.
- For further interpretation of the results refer to TRGS 600 Annex 2.
- Document your decisions in an appropriate manner (e.g. by attaching the copies described above).

Technical remarks

- Explosive substances/mixtures and products with explosive substances: All subclasses of hazard category "Explosive substances/Mixtures/Products with explosive substances" are listed in the "Very high risk" line, as the subclass does not include any gradation of risk on the basis of their intrinsic properties, but subdivides substances, mixtures and products in their packaged form. In their unpackaged state, the risk from the substances/mixtures/products with explosives in subclass 1.5 is in principle the same as that in subclass 1.1. A generally applicable statement on recommended substitutes cannot therefore be made within this hazard class.
- Flammable gases: Categories 1 and 2 of the "Flammable gases" hazard category are listed together in the "Very high risk" line. Flammable gases of Categories 1 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 TRGS 600

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 are available on the acutely toxic, irritant, skin-sensitizing or mutagenic effect or on the effect due to repeated exposure, the substances or mixtures are to be treated in the risk assessment as hazardous substances with the associated effects." TRGS 600 therefore demands: "The Column Model must only be applied if the manufacturer has assessed the substances or mixtures (in terms of the health risk at least in terms of acute toxicity, skin irritation, irritation of the mucous membranes, mutagenic potential and skin sensitization) on the basis of the available data and experience with reference to any gaps in the data (see Safety Data Sheet, Chapters 9 and 11) and has declared that hazardous properties exceeding those of the classification (particularly in terms of toxicity in the event of repeated application) are not be expected on the basis of this assessment".

What effect does this have on the Column Model?

If the information on required tests is unavailable, whereas the instructions in the Material Safety Data Sheet are conform to the TRGS 600, "Yet, it is the experience of the manufacturer that no hazards are to be expected beyond those on the label", then the Column Model can be applied without exception.

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?

1. If no information is available on tests for acute toxicity, then the substance or mixture has to be categorized as a "medium risk" in the column "acute health hazards" (in terms of "acute toxic substances/mixtures, category 4", H302, H312, H332).[1)]

2. If no information is available on tests of irritant effects to the skin/mucous membrane, then the substance or mixture has to be categorized at least as a "low risk" in the column "acute health hazards" (in terms of an "skin irritant", H315).

3. If no information is available on tests for mutagenic properties, then the substance or mixture has to be categorized as a "high risk" in the column "chronic health hazards" (in terms of a germ cell mutagenic substance, category 2, H341).

4. If no information is available on tests for skin sensitisation, then the substance or mixture has to be categorized as a "high risk" in the column "acute health hazards" (in terms of a skin sensitizer, category 1, H317).

The most consistent procedure is the one in which those products lacking information with regard to the four 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.

[1)] If no information is available on the acute toxicity, in the risk assessment according to TRGS 400 protective measures must be laid down for these substances on the basis of the property Acute Tox.3 (H301, H311, H331).

The Legal Basis for Finding Substitutes

The Hazardous Substance Ordinance demands, among other things, the following from the employer:

Article 6 (1) of the 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 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, preparations, 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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