



The Column Model

An aid to substitute assessment

1 Risks	2a Acute health hazards (single affection, e.g. accident with chemicals)	2b Chronic health hazards (repeated affection)
Very high risk	<ul style="list-style-type: none"> ◆ Very toxic substances/preparations (R26, R27, R28) ◆ Substances/preparations which may liberate very toxic gases when in contact with acids (R32) 	<ul style="list-style-type: none"> ◆ Carcinogenic substances of categories 1 or 2 (Carc.Cat.1, K1, Carc.Cat.2, K2, R45, R49) ◆ Mutagenic substances of categories 1 or 2 (Mut.Cat.1, M1, Mut.Cat.2, M2, R46) ◆ Preparations containing carcinogenic or mutagenic substances of categories 1 or 2 in concentrations $\geq 0.1\%$
High risk	<ul style="list-style-type: none"> ◆ Toxic substances/preparations (R23, R24, R25) ◆ Substances/preparations causing severe burns (highly corrosive) (R35) ◆ Substances/preparations which may liberate toxic gases when in contact with water or acids (R29, R31) ◆ Skin sensitizing substances (R43, Sh) ◆ Substances sensitizing the respiratory tract (R42, Sa) ◆ Preparations containing skin or respiratory tract sensitizing substances in a concentration $\geq 1\%$ (in case of gases $\geq 0.2\%$) 	<ul style="list-style-type: none"> ◆ Substances toxic to reproduction of categories 1 or 2 (Repr.Cat.1, R_e1, R_f1, Repr.Cat.2, R_e2, R_f2, R60, R61) ◆ Preparations containing substances toxic to reproduction of categories 1 or 2 in concentrations $\geq 0.5\%$ (in case of gases $\geq 0.2\%$) ◆ Carcinogenic substances of category 3 (Carc.Cat.3, K3, R40) ◆ Mutagenic substances of category 3 (Mut.Cat.3, M3, R68) ◆ Preparations containing carcinogenic or mutagenic substances of category 3 in concentrations $\geq 1\%$ ◆ Substances which can accumulate in the human body (R33)
Medium risk	<ul style="list-style-type: none"> ◆ Substances/preparations harmful to health (R20, R21, R22) ◆ Substances, which may accumulate in breast milk (R64) ◆ Substances/preparations causing burns (corrosive) (R34, pH ≥ 11.5, resp. ≤ 2) ◆ Substances harmful to eyesight (R41) ◆ Non toxic gases; may cause suffocation by air displacement (e.g. nitrogen) 	<ul style="list-style-type: none"> ◆ Substances toxic to reproduction of category 3 (Repr.Cat.3, R_e3, R_f3, R62, R63) ◆ Preparations containing substances of category 3 toxic to reproduction in concentrations $\geq 5\%$ (in case of gases $\geq 1\%$)
Low risk	<ul style="list-style-type: none"> ◆ Irritant substances/preparations (R36, R37, R38) ◆ Skin affections when working in wet environment ◆ Substances/preparations which may cause lung damage if swallowed (R65) ◆ Skin affecting substances/preparations (R66) ◆ Vapours causing drowsiness and dizziness (R67) 	<ul style="list-style-type: none"> ◆ Otherwise chronically affecting substances (no R-phrase, but nonetheless a hazardous substance!)
Negligible risk	<ul style="list-style-type: none"> ◆ Harmless substances by experience (e.g. water, sugar, paraffin and similar) 	

1) German water pollution classes are only considered a ranking criteria with those substances/preparations, which have not been assessed for properties harmful to the environment.

3 Environmental hazards ¹⁾	4 Fire and explosion hazards ²⁾	5 Exposure potential	6 Hazards caused by procedures
<ul style="list-style-type: none"> ◆ Substances/preparations with the warning symbol N and hazards indications R50, R51, R53, R54, R55, R56, R57, R58, R59 ◆ Substances/preparations of the German water pollution class WGK 3 	<ul style="list-style-type: none"> ◆ Explosive substances/preparations (R2, R3) ◆ Extremely flammable gases and liquids (R12) ◆ Spontaneously flammable substances/preparations (R17) ◆ Highly flammable substances/preparations (R11) ◆ Substances/preparations, liberating extremely flammable gases when in contact with water (R15) ◆ Oxidizing substances/preparations (R7, R8, R9) ◆ Substances/preparations with specific properties (R1, R4, R5, R6, R7, R14, R16, R18, R19, R30, R44) 	<ul style="list-style-type: none"> ◆ Gases ◆ Liquids with a vapour pressure > 250 hPa (mbar) (e.g. dichloromethane) ◆ Dust producing solids ◆ Aerosols ◆ Liquids with a vapour pressure of 50 ... 250 hPa (mbar) (e.g. methanol) 	<ul style="list-style-type: none"> ◆ Open processing ◆ Possibility of direct skin contact ◆ Application on large area
<ul style="list-style-type: none"> ◆ Substances/preparations without warning symbol N, but with hazards indications R52, R53 ◆ Substances/preparations of the German water pollution class WGK 2 	<ul style="list-style-type: none"> ◆ Flammable substances/preparations (R10) 	<ul style="list-style-type: none"> ◆ Liquids with a vapour pressure of 10 ... 50 hPa (mbar), except water (e.g. toluene) 	<ul style="list-style-type: none"> ◆ Closed processing but exposure possibilities e.g. when filling, sampling or cleaning
<ul style="list-style-type: none"> ◆ Substances/preparations of the German water pollution class WGK 1 	<ul style="list-style-type: none"> ◆ Hardly flammable substances/preparations (flashpoint 55 ... 100 °C) 	<ul style="list-style-type: none"> ◆ Liquids with a vapour pressure of 2 ... 10 hPa (mbar) (e.g. xylene) 	
<ul style="list-style-type: none"> ◆ Not water polluting substances/preparations (NWG, formerly WGK 0) 	<ul style="list-style-type: none"> ◆ Inflammable or very hardly flammable substances/preparations (for liquids flashpoint > 100 °C) 	<ul style="list-style-type: none"> ◆ Liquids with a vapour pressure < 2 hPa (mbar) (e.g. glycol) ◆ Solids releasing no dusts 	<ul style="list-style-type: none"> ◆ Tightly closed equipment ◆ Closed equipment with exhaust facilities at points of emission

2) Explosive dusts have to be analysed carefully in each single case because of their specific problems, thus no risk level is attributed to them here.

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
- ◆ BG/BGIA-recommendations, LASI-guidelines
- ◆ 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 preparations. 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 levels, R-phrases and the German water pollution 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
 - > Fire and explosion hazards
 - > Exposure potential
 - > 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.
- ◆ The column "acute health hazards" has a peculiarity in the R-phrases 20, 21, 22, 23, 24, and 25: if these R-phrases occur in combination with R-phrase 48, then the substances or products in question are categorized in the next higher risk level. These are then chronic health hazards.
- ◆ Also products (preparations) are assessed only on the basis of their preparation labelling with respect to their acute and chronic health hazards.

Interpretation of the results

- ◆ 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.
- ◆ 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).

The Legal Basis for Determining Substance Hazards and Finding Substitutes

The Hazardous Substance Ordinance says that the employer do (among other things):

§ 9 (1) Gefahrstoffverordnung [Hazardous Substance Ordinance]:

The employer shall ensure that any worker health or safety risk arising from any work activity involving hazardous substances is eliminated or minimized through implementation of the measures specified in the risk assessment. In complying with this requirement, the employer shall prioritize use of a substitute substance or preparation. In particular, the employer shall avoid activities involving hazardous substances or shall replace hazardous substances with substances, preparations, products or processes that are not deleterious, or less deleterious, to worker health and safety under the relevant application conditions. The employer shall indicate in the risk assessment documentation his reasons for foregoing implementation of any available substitution.

Remark: This does not apply if the risk assessment shows that workers' risk is negligible.

§ 7 (9) Gefahrstoffverordnung [Hazardous Substance Ordinance]:

If the risk assessment shows that worker risk is negligible owing to (a) the nature of the company work environment (b) the use of only small amounts of hazardous substances and (c) the fact that the cumulative duration and amount of exposure to hazardous substances is relatively low, and (d) if the health and safety measures realized for workers pursuant to Article 8 (1) through 8 (8) are sufficient, no further safeguards pursuant to Articles 9 through 17 shall be required (protection class 1). The first sentence shall not apply to activities involving hazardous substances which

1. are classified or labeled as toxic, highly toxic, carcinogenic, mutagenic, or toxic to reproduction pursuant to EC category 1 or 2; or
2. have been classified by a Federal Ministry of Economics and Labor advisory as class 1 or 2 substances that are carcinogenic, mutagenic, or toxic to reproduction.

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. TRGS 600 thus demands: "In order to evaluate the substances used and released in processing, these ingredients/preparations should be assessed

and labelled on the basis of available data on toxicity, skin irritation, mucous irritation, skin sensitisation and potential to mutagenic characteristics.

The employer must determine whether such studies have already been conducted. Until this infor-

mation as to their characteristics are available, these characteristics are to be presumed present when deciding on substitutes and protective measures ..."

What effects 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 preparation has to be categorized as a "medium risk" in the column "acute health hazards" (in terms of a harmful substance/preparation, R20, 21 or 22).
2. If no information is available on tests of irritant effects to the skin/mucous membrane, then the substance or preparation has to be categorized at least as a "low risk" in the column "acute health hazards" (in terms of an "irritant", R38).
3. If no information is available on tests for mutagenic properties, then the substance or preparation has to be categorized as a "high risk" in the column "chronic health hazards" (in terms of a mutagenic substance of category 3, R68).
4. If no information is available on tests for skin sensitisation, then the substance or preparation has to be categorized as a "high risk" in the column "acute health hazards" (in terms of a skin sensitizing substance/preparation, R43).

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.

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