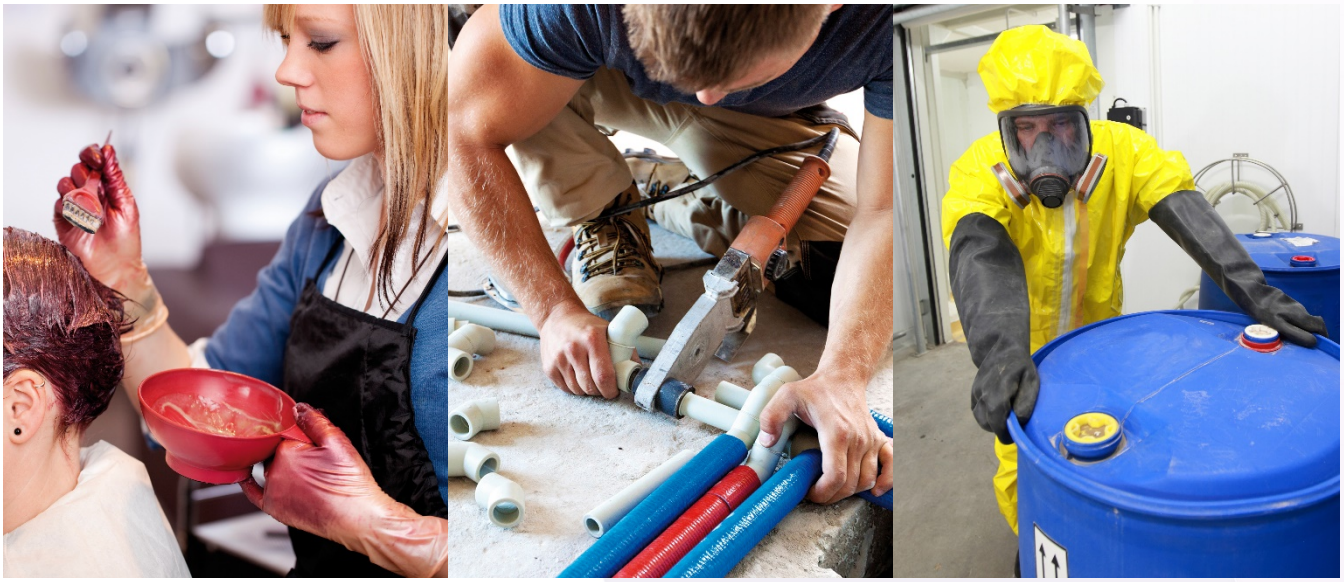
European Agency for Safety and Health at Work



Substitution of dangerous substances at workplaces

A training course for OSH practitioners

Trainers´ manual – 2021 update

European Agency for Safety and Health at Work

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This training is based on a concept developed by Dolores Romano (2011): Alternatives Assessment and Training Guidance. SUBSPORT Substitution Support Portal - Moving towards safer alternatives

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Table of Contents

1 Introduction

1.1 Goals

Trainers should introduce themselves (name and organization) and inform participants about:

- Goals of the training
- Programme of the training
- Methodology that will be followed

In this stage, participants should also introduce themselves to the group (name and organization) and share their expectations regarding the training.

1.2 Goals of the training

The overall goal of this training is to provide participants with basic concepts and tools to support the substitution of hazardous substances.

Substitution of many substances of concern can be initiated and supported by getting inspired by examples of others. There are many uses of hazardous chemicals that can be avoided by copying what others have already done. The trainer may underline the advantages of substitution: reduce costs and risks, possibility of know-how transfer or other help. Once started or when dealing with substitution that is more complex, a more systematic approach may be needed.

The training seeks to help participants get started in substitution processes, understand the different stakeholders involved and their interests, to understand which substances are of most concern, find how and where to look for new ideas and alternatives and get introduced to existing tools to assess alternatives.

1.3 Programme of the training

The training material consists of several modules prepared to arrange the different training time frames: half a day, one day, two days and three days. The trainer will decide which modules to cover considering the background and interests of the participants and/or the available time for developing the training.

Half a day training 

The following six modules are proposed for **the half-a-day training.** The following agenda and time schedule is recommended:

- Introduction to the session (20 min)
- Substitution in the regulation (30 min)
- The substitution process (30 min)
- Identification of chemicals of high concern (30 min)
- How and where to identify alternatives (60 min)
- Cost assessment (40 min)

At least 3.5 hours (without breaks) are needed to carry out all six activities.

Internet connections and a laptop should be available for the lecturer and for each group of participants (see chapter 1.4. Training method).

One-day training 

The following modules are proposed for **the one-day training.** The following agenda and time schedule is recommended:

- Introduction to the session (20 min)
- Substitution in regulations and directives (30 min)
- The substitution process (60 min)
- Identification of chemicals of high concern (30 min)
- How and where to identify alternatives (60 min)
- Alternatives assessment (110 min)
- Cost assessment (40 min)

To carry out all activities at least 6 hours – without breaks - are needed.

Internet connections and a laptop should be available for the lecturer and for each group of participants (see chapter 1.4. Training method).

Two-days training 

The following modules are proposed for **the two-days training.** The following agenda and time schedule is recommended:

- Introduction to the session (20 min)
- Substitution in the regulation (30 min)
- The substitution process (60 min)
- Identification of chemicals of high concern (30 min)
- How and where to identify alternatives (60 min)
- Alternatives assessment (470 min)
- Cost assessment (40 min)

At least 12 hours of full working time without breaks are needed to carry out all activities

Internet connections and a laptop should be available for the lecturer and for each participant.

Three-days training 

The following modules are proposed for **the three-days training.** The following agenda and time schedule is recommended:

- Introduction to the session (20 min)
- Substitution in regulations and directives (30 min)
- The substitution process (60 min)
- Identification of chemicals of high concern (30 min)
- How and where to identify alternatives (60 min)
- Alternatives assessment (830 min)
- Cost assessment (40 min)

To carry out all activities at least 18 hours of full working time without breaks are needed.

Internet connections and a laptop should be available for the lecturer and for each participant.

1.4 Notes on methodology

The trainer should explain the work method, so participants understand how they have to carry out the activities. The trainer shall divide the participants in small groups of 3 to 5 persons and remember them to nominate a scribe.

Text box 1. Small Group Activity Method

The Small Group Activity Method (SGAM) is based on the idea that every workshop is a place where learning is shared. With SGAM, learning is not a one-way street which runs from trainer to worker. Nor is SGAM simply a bull session where we all sit around and talk. Rather, SGAM is a structured procedure that allows us to share information. It is based on the three learning exchanges:

- Worker to worker
- Worker to Trainer
- Trainer to Worker

Worker to Worker: Most of us learn best from each other. We should never underestimate how much real education takes place worker to worker.

SGAM is set up in such a way as to make this worker-to-worker learning exchange a key element of all our workshops. We do this by first allowing people to learn from each other by solving problems in their small groups.

Worker to Trainer: Lecture-style training assumes that the trainer knows all the answers. SGAM believes that trainers also have a lot to learn. On many subjects, any group of workers will often have as much, or more, collective knowledge as any one expert or teacher. With SGAM the trick is to learn as much as possible from the workshop participants. This is done mainly during the report-backs. Because SGAM allows us to listen to those that we are training, we get to learn more and more about the realities people face. Also, because our training method shows genuine respect for workers' knowledge it helps build confidence among those we are training. Confidence is the key to adult learning.

Trainer to Worker: This is the traditional learning procedure of school. It also has its place in SGAM. It comes at the end. This is our chance to clear up confusion and make the points we think are key. By waiting until the summary section, we now know better what people need to know.

2 Substitution in legislation

The trainer shall introduce the issue following the introductory text and goals of the chapter. The trainer shall also explain how to carry out the activity: what the participants should read, topics to discuss, and the timing as explained in the specific chapter.

Depending on the available time, the trainer might choose to ask participants to read only the first two texts. Participants get into vivid discussions with the first text and may spend all the available time choosing or establishing their own definition. To save time the trainer should ask participants to first read through the whole texts and afterwards get into the discussions.

The following notes intend to help trainers during discussions in plenary sessions.

Task 1: Presentation the OSH legislation on dangerous substances

Text 1.1: OSH Framework Directive

Assessment on relevance for substitution

The Framework Directive defines the basic legal requirements for the organisation of safety and health in enterprises and the principles of prevention.

Text 1.2: Chemical Agents Directive

The CAD of EU recommends following a hierarchy or 'order of priority' of control measures to prevent or reduce the exposure of workers to dangerous substances (Article 6 of the CAD). This hierarchy is known as the STOP principle:

S = Substitution (also covering the complete elimination of a dangerous substance)

T = Technological measures

O = Organisational measures

P = Personal protective measures.

Substitution is defined as first priority; all Member States have to follow this principle in their national legislation. Substitution is stated as a general demand; in the text of this directive, there are no concrete measures laid down to prevent the application/use of less effective and less prioritized risk reduction measures.

Text 1.3: Carcinogens and Mutagens Directive

Assessment of relevance for substitution

Substitution is defined as first priority; all Member States have to follow this principle in their national legislation.

Strict obligations are put on enterprises, when using a carcinogenic or mutagenic substance. This also supports the idea of substitution.

Task 2: Presentation of regulations on the use of chemicals and their impact on substitution

Text 2.1: REACH Regulation

Assessment of relevance for substitution

An important objective of this regulation is to encourage and, when possible, to ensure that less dangerous substances or technologies eventually replace substances of very high concern, where suitable economically and technically viable alternatives are available.

All applicants for authorisation should provide an analysis of alternatives considering their risks and the technical and economic feasibility of substitution.

Substitution of a substance is required when manufacturing, use or placing on the market of that substance causes an unacceptable risk to human health or to the environment, considering the availability of suitable safer alternatives.

Text 2.2: CLP Regulation

Assessment of relevance for substitution

No paragraph in the CLP-Regulation refers directly to substitution but the classification is often used in risk assessments, and in prioritizing substances that may need to be substituted, or to identify problem substances using information communicated via the hazard pictograms and hazard statements. Also, the classification system is used as background for substitution paragraphs in other legislation, i.e. the Directive on protection of workers from the risk related to exposure to carcinogens or mutagens at work (Directive 2004/37/EC), and in most tools for the management of chemicals, risk assessment and substitution.

Text 2.3: Biocides Regulation

Assessment of relevance for substitution

The wording of the biocides regulation is close to a substitution obligation. The Commission can prohibit or restrict the market access or the use of a biocidal product if "*another authorized biocidal product or a non-chemical control or prevention method already exists which presents a significantly lower overall risk for human health…. "*

3 The Substitution Process

The trainer shall introduce this topic following the introductory text and goals of the chapter in the material for the participants. The trainer shall also explain how to carry out the activity: what exactly to read, what to discuss and the timing as explained in the chapter.

Depending on the available time, the trainer might choose to ask participants to read only the first two texts. Participants get into vivid discussions with the first text and may spend all the available time choosing or establishing their own definition. To save time the trainer should ask participants to first read through the whole texts and afterwards get into the discussion.

The following notes intend to help trainers during discussions in plenary sessions.

Text 3.1: Definitions

The perception of different stakeholders varies widely, especially regarding the issue of whether substitution should be a “fundamental principle”, a “duty to both manufacturers and users”, a “preferable risk reduction strategy” or “just another tool for managing the same level of risk”.

The focus of CEFIC is on risk and not on hazard. According to this notion, substitution is not a preferable risk reduction strategy but only one equivalent strategy among many others, such as technical and organizational solutions, including the personal protection of exposed individuals.

Greenpeace views on substitution are significantly different from those of the chemical industry; Greenpeace focuses much more on hazard and systematic replacement of all hazardous chemicals. This approach shows that the NGOs’ confidence in other risk reduction measures than replacement of hazardous chemicals is low; their political goal is risk reduction at source through the transition to safer alternatives.

Policy and legal definitions combine aspects of both hazard and risk reduction. Important European chemical legislation like REACH uses ‘concern’ and leaves open whether ‘the concern’ should be reduced by risk or hazard related measures.

Researchers (Lohse / Lissner) emphasize and describe the process of substitution focusing on hazards or risks and the need to achieve a functional equivalent by chemical or non-chemical measures, for the replaced substance.

Text 3.2: Why do we want to substitute?

There are 4 greatest barriers in substitution are:

- not defining all relevant stakeholders and their interests
- too narrow perspective in looking for solutions
- not knowing where to look for new ideas
- too narrow perspective on economy.

Text 3.3: The substitution process

Many good substitutions can be done by getting inspired by the examples of others. The training should also include the concept of learning from each other and start with less complex cases: Get started now. “Pick the low hanging fruits”, even if it is not your most hazardous chemical. Use both a systematic and a quick-and-easy approach to substitution. Look in substitution databases for experiences. It is better to get started than to aim too high and never really start.

4 Identification of Hazardous Chemical Agents at Work

The purpose of this activity is to introduce participants to the different criteria for defining substances of high concern that should be subject to elimination or substitution due to their environmental and health hazards.

Participants are given the hazard phrases of 4 substances that are common ingredients in professional cleaning products. They should check different criteria and decide which substances they would prioritize for elimination or substitution.

During the introduction the trainer should demonstrate on the screen how to access and use some criteria, e.g. SUBSPORTPlus compilation of criteria or the hazard lists in pharos.net. **The participants can search the lists and identify which lists contain which substances.**

Notes for discussion:

Formaldehyde is the substance of most concern, as it is a carcinogen, mutagen, causes sensitization by skin contact and is toxic. It is included in many regulations and restriction lists.

Sodium hypochlorite is also a substance to prioritize as it is very toxic to aquatic organisms and of concern. It is included in several restriction lists.

Table 1. Ingredients used as disinfectants in cleaning products.

Substance	CAS	H statements
acetic acid	64-19-7	H226: Flammable liquid and vapour H314: Causes severe skin burns and eye damage
formaldehyde	50-00-0	H301+H311+H331: Toxic if swallowed, in contact with skin or if inhaled. H314: Causes severe skin burns and eye damage. H317: May cause an allergic skin reaction. H335: May cause respiratory irritation. H341: Suspected of causing genetic defects. H350: May cause cancer. H370: Causes damage to organs.
ethanol	64-17-5	H225: Highly flammable liquid and vapour. H319: Causes serious eye irritation.
sodium hypochlorite	7681-52-9	H290: May be corrosive to metals. H314: Causes severe skin burns and eye damage. H335: May cause respiratory irritation. H410: Very toxic to aquatic life with long lasting effects

5 How and Where to Identify Alternatives

The trainer should introduce the activity using the introductory text in combination with text 5.1. and explain the tasks that should be done. Afterwards the trainer should give a short explanation on different sources of information on alternatives (Text 5.2.) and introduce shortly into the SUBSPORT and OECD SAAT databases.. This introduction should last about 10 minutes.

Participants shall carry out task 5.1., including the discussion of possible alternatives before beginning the website search of task 5.2. The trainer may remember participants to follow the search tips of text 5.2.

Text 5.1: Define use, function and need

The main goal of this exercise is to show the need to have a wide and holistic view in order to find alternatives. The trainer should reminded the participants during the wrap up.

BPA in polycarbonate of baby bottles

Function: BPA is a structural constituent of polycarbonate

Use: manufacture of beverage containers and bottles. Ultimate purpose is to feed babies.

Need: Light, shock resistant bottles.

Examples of possible alternatives:

- Alternative substances: BPA free plastic bottles: PE, PP.
- Alternative materials: glass bottles
- Alternative process: breastfeeding

Trichloroethylene as ingredient of a metal parts degreaser

Function: solvent

Use: degreaser

Need: Cleaning of metal pieces for further use or treatment.

Examples of possible alternatives:

- Alternative substances: fatty acid esters based on vegetable oils.
- Alternative process: CO2 dry ice blasting, vapor degreasing
- Organizational change: producing clean metal pieces

DecaBDE used as flame retardant in computer casings

Function: flame retardant

Use: computer casings

Need: Fire safety in appliances (computers)

Examples of possible alternatives:

- Alternative substances: resorcinol bis(diphenylphosphate) (RDP)
- Alternative casing material that avoid the need for flame retardants: aluminium.

6 Assessment of Alternatives

The purpose of this activity is to make the participants familiar with different methods to assess and compare alternatives.

The trainer shall introduce the criteria to accept or to reject alternatives established by different organisations (Text 6.1: Define criteria).

The trainer should also explain different methods to assess and compare alternatives. The trainer can use text 6.2: Assess and compare alternatives, and also the SUBSPORTPlus section on substitution tools and OECD SAAT section on case studies.

Afterwards the trainer shall explain the use of the Column Model and the Green Screen methodology for assessing alternatives. Both methods are included in the annexes.

Depending on the time availability, the trainer may choose the activities to carry out (see following table).

Table 2: Kind of activity depending of the time availability

Time frame	Mark of the training	Activity
half-day training		-
1-day training		Example A
2-days training		Example B
2-days training		Example C

Example A 

Example A uses the column model and may be better for participants from SMEs or with limited knowledge on chemical risks. Participants should only use the table on risks from the Column Model.

The trainer may need 15 minutes for introducing this activity. A table with results of Exercise 6.5.A. is presented at the end of this chapter.

Example B 

Example B uses the Column Model and the Green Screen. For the Column Model, participants should only use the table on risks from the Column Model. For the Green Screen method, participants should use the page on benchmarks and on criteria. Participants obtain a sheet with the data required for completing the example.

The trainer may need 15 minutes for introducing this activity. A table with results of Exercise 6.5.B. is provided at the end of this chapter.

In all examples, participants may conlcudethat none of the chemical alternatives presented is valid due to the lack of information on some toxicological endpoints. The trainer may also remind participants of

the poor quality of the information in many SDS / MSDS[1]. In such cases the trainer can point the participants to specific databases, e.g. TOXNET or similar.

Example C 

The Column Model

Elaborated by the Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (IFA, Institute for Occupational Safety and Health of the German Social Accident Insurance) to provide industry with a practical tool for identification of alternative substances.

This is a simplified method to make a preliminary comparison between the risks of the different substances and products and offer a **quick judgment** on the convenience of substitution.

The model is based on 6 columns in which the following hazard categories are described:

- Acute health hazards
- Chronic health hazards
- Fire and explosion hazards
- Environmental hazards
  (the assessment criteria are based on the Water Hazard Class or WGK, can be found in the GESTIS-database or the Rigoletto-database),
- Exposure Potential
- Process hazards

Columns are divided into cells/boxes that contain the criteria to estimate the level of risk based on hazard phrases (H phrases), physical form of the substance, evaporation temperature, German classification of hazards for the aquatic environment and type of process (open, manual, etc.). Cells/boxes correspond to risk levels, ranked from Negligible to Very high. For detailed explanation see the column model documentation in the *Complementary material for participants*, here column 5 and 6 “Hazards from release behaviour (Exposure potential)” and “Process-related hazards”.

The hazards for the aquatic environment are based on the classification in the German Water Hazard class regulation (WGK) which contains a list of substances hazardous to water. A database on substance and mixtures (in English) is accessible here. Beside a no-hazard level (previously 0) three hazard levels exist:

- WGK 1: Low hazard to waters
- WGK 2: Hazard to waters
- WGK 3: Severe hazard to waters

Users can compare risk levels of the substance in use and the alternatives by placing/ assigning both agents in their respective boxes in the table. The necessary information to use this model can be obtained from Safety Data Sheets, and information on the process in which the given chemical is used.

Products and substances are compared by columns, i.e. by type of hazard. The acute health hazards and chronic health hazards must be evaluated jointly: products are only assessed for similar hazards. Conditions of product use must be considered. According to the hazard levels identified by this tool, the preferred substitute will be the one with the lowest hazard level.

[1] The official European terminology is **SDS**. In many parts of the world the term **MSDS** is used. In the training materials both terms are used because in some cases the user only disposes only of MSDS from outside EU.

However, an alternative will hardly have the lowest level in all the hazard endpoints, so users must set their own criteria to decide which alternative is preferable. Users must decide which potential hazards are more relevant for the workplace where the product is used taking into consideration the company's possibilities to control or manage the different hazards.

For instance, if an alternative substance has a lower level of toxicity than the product in use, but the environmental hazards are higher, the user must decide whether use conditions in the company allow an adequate control of environmental hazards or not, in order to choose that alternative.

The Columns Model includes criteria for the evaluation of hazards in case of lack of information on toxicity. The method advises against the use of substitutes for which there is no information about skin, toxic, mutagenic or sensitizing effects.

Reliability

The main sources of information for this method are Safety Data Sheets. Several studies conducted in Europe have shown important shortcomings of these sheets, especially regarding classification. It is recommendable to double-check H phrases assigned to products and chemicals using additional sources as the C&L Inventory which is published at the ECHA website.

Applicability

Applicability is restricted to single cases of substitution of one product or chemical by another. It is not possible to compare products with alternative procedures or technologies. This method is aimed at SME's and non-specialized users. It is applicable only to chemical hazards and risks.

User friendliness

The model is easy to handle by non-professional users and does not require special expertise if Safety Data Sheets are available.

Limitations

The most important advantage of this method is that is very easy to handle by non-professional users and facilitates a quick assessment on possible substitutes and alternatives.

Source: Column Model, see ***Complementary Material or here***

Example C uses the Green Screen Methodology. Participants should use the page on benchmarks and on criteria. Participants have also to search for specific SDSs and the data on some toxicological endpoints needed for completing the example.

The trainer may need 15 minutes for introducing this activity.

GreenScreen for Safer Chemicals

GreenScreen for Safer Chemicals, developed by Clean Production Action (CPA), is a hazard-based screening method. GreenScreen is designed to inform decision-makers in businesses, governments, and individuals concerned with the risks posed by chemicals and to advance the development of green chemistry. Green Screen defines four benchmarks on the path to safer chemicals, with each benchmark defining a progressively safer chemical:

- Benchmark 1: Avoid. Chemicals of high concern.
- Benchmark 2: Use but search for safer substitutes.
- Benchmark 3: Use but still opportunity for improvement.
- Benchmark 4: Safe chemical.

Each benchmark includes a set of hazard criteria - including persistence, bioaccumulation, ecotoxicity, carcinogenicity, and reproductive toxicity - that a chemical, along with its known and predicted breakdown products and metabolites, must pass.

Green Screen assesses chemicals based on intrinsic hazards determined by their potential to cause acute or chronic human and environmental effects and on certain physical and chemical characteristics of interest for human health. Table 1 shows the hazards and assessment criteria used by this method.

For a chemical to improve from benchmark 1 to benchmark 2, it must pass all the criteria of benchmark 1. And so on for going from 2 to 3 and from 3 to 4 all specific criteria must be met. Criteria become progressively more challenging in terms of human and environmental safety. Criteria in benchmark 4 represent the safest chemicals.

Reliability

Very reliable method due to the wide variety of parameters assessed and its highly reliable sources of information: Hazardous Substances Data Bank (HSDB), Integrated Risk Information System (IRIS), International Uniform Chemical Information Database (IUCLID), High Production Volume International System (HPVIS), Organization for Economic Cooperation and Development (OECD), Screening Information Dataset (SIDS).

Applicability

Only used to assess and compare individual chemicals, not products, processes or alternative technologies. Most suitable for use by policy decisions, chemical formulators and products and articles manufacturers. It is applicable only to chemical hazards and risks.

User friendliness

It requires expertise and dedication to obtain the necessary information.

Limitations

The method requires specific training since it becomes necessary to consult databases and scientific literature. Probably less suitable for SMEs or consumers.

Availability

The method can be downloaded here: https://www.greenscreenchemicals.org/

List of available Green Screen assessments (free or priced): https://pharosproject.net/assessments

Source: GreenScreen for safer chemicals, see also ***Complementary Material***

Text6.5: Alternatives Assessment Example A.

Trichlorethylene: H315, H319, H336, H341, H350, H412; WGK 3

Risk	Acute health hazards	Chronic health hazards	Environmental hazards	Physico-chemical effects (Fire & Explosion)	Hazards from release behaviour (Exposure potential)	Process-related hazards
Very High Risk		H350	WGK 3			
High Risk		H341			Vapor pressure: 77,6 hPa (at 20°C)	
Moderate Risk			H412			
Low Risk	H315 H319 H336					
Negligible risk						
COMMENTS						

DBE dibasic esters: Dimethyl succinate (H 319), Dimethyl glutarate (no H-phrase), Dimethyl adipate (no H-phrase)
All three: WGK 1 = Low hazard to waters

Risk	Acute health hazards	Chronic health hazards	Environmental hazards	Physico-chemical effects (Fire & Explosion)	Hazards from release behaviour (Exposure potential)	Process-related hazards
Very High Risk						
High Risk						
Moderate Risk						
Low Risk	H319 (only for DBE succinate)		WGK1	Not classified, Flash point app 100°C.		
Negligible risk					Vapor pressure app 0,06 to 0,3 hPa (20° C)	
COMMENTS						

Dry ice blasting (Carbon dioxide)

Risk	Acute health hazards	Chronic health hazards	Environmental hazards	Physico-chemical effects (Fire & Explosion)	Hazards from release behaviour (Exposure potential)	Process-related hazards
Very High Risk				H280: Contains gas under pressure; may explode if heated.	Physical state at 20 ° C: gas; Vapor pressure [20 ° C]: 57.3 bar gas	Open processing Possibility of direct skin contact
High Risk						
Moderate Risk	Not classified, Non-toxic gases that can cause suffocation due to air displacement					
Low Risk						
Negligible risk			Not classified, NWG, Non-water hazardous substances / Mixtures	Not classified Non-flammable or very flammable Chemicals / mixtures		
COMMENTS			(Global warming potential: 1)			

Summary table Example A – Column Model

	Acute health hazards	Chronic health hazards	Environmental hazards	Physico-chemical effects (Fire & Explosion)	Hazards from release behaviour (Exposure potential)	Process-related hazards
Trichloroethylene	Low Risk: H319, 315, 336	Very High Risk: H350 High Risk: H341	Very High Risk: H412		High Risk: 50-250hPa (depending on temperature)	
DBE dibasic esters	Low Risk: H319		Low Risk : Not classified, WGK1	Low Risk : Not classified, Flash point 100°C. Heavy flammable chemicals / mixtures	Negligible Risk : Vapor pressure 0.3 hPa	
Dry ice blasting	Moderate Risk : Not classified, Non-toxic gas Asphyxiate in high concentrations. Contact with the evaporating liquid can cause frostbite on skin.		Negligible Risk: Not classified, NWG, Non-water hazardous substances / Mixtures	Negligible Risk Not classified Non-flammable or very flammable Chemicals / mixtures	Very High Risk: Physical state at 20 ° C: gas; Vapour pressure [20 ° C]: 57.3 bar gas	Very High Risk: Open processing Possibility of direct skin contact

Text 6.5: Alternatives Assessment Example B – Green Screen (with sufficient time participants can also compare the Green Screen data with the Column Model and the Safety Data Sheets information (update February 2021)

	Carcinogenicity	Mutagenicity / genotoxicity	Reproductive toxicity	Developmental toxicity
Formaldehyde	H (high)	M (moderate)	DG (data gap)	M (moderate)
Furfuryl alcohol	H (high)	pC (potential concern)	DG (data gap)	DG (data gap)
Methyl meth acrylate	L (low)	DG (data gap)	DG (data gap)	M – L (moderate to low)

	Endocrine activity	Neurotoxicity (single exposure)	Acute Toxicity (mammalian)	Skin Irritation/ Eye irritation
Formaldehyde	M (moderate)	vH (very high)	vH (very high)	vH (very high) vH (very high)
Furfuryl alcohol	DG (data gap)	DG (data gap)	H (high)	H (high) H (high)
Methyl meth acrylate	H – M (high to moderate)	DG (data gap)	M (moderate)	H (high) H (high)

7 Cost Assessment

Trainers should introduce the activity and explain the task, based on the brake cleaning case description in the participants' material. The participants should try to fill the table with their estimations of costs, influencing factors, a final evaluation and remarks. The calculation is nothing more than an approximation and can significantly differ from case to case.

Comparison of annual costs (example):

Cost category	Hydrocarbons (VOC)	Hot-water washer
Costs (1) **1500 break cleaning processes p.a.**	**Hydrocarbons (VOC)**	**Hot-water washer**
1. Input material costs Auxiliary materials and consumables	2.250 € (1.50 € x 1500)	30 € (Water, 7 cbm) 30 € (Decalcification)
2. Storage costs	100 €	0 €
3.Transport costs e.g. costs for packaging, freight tariffs, etc.	200 €	0 € (under investment)
4. **Disposal costs e.g. costs for material** recycling, waste, waste water and exhaust air treatment	100 € (empty cans)	70 € (additional waste water) 50 € (maintenance separator)
5. Energy costs	30 € (energy for ventilation)	30 €
6. Insurance costs etc.	100 € (additional fire risk)	50 €
Costs (1), annually	**2.780 €**	**260 €**
Costs (2)		
7. Research and development costs	0 €	0 €
8. Investment costs Maintenance	0 €	300 € (3.000 € / 10 years) 200 € Annually
9. Personnel costs Direct costs	1.250 € (2.5 min x 1.500 x 20 €)	1.250 € (2.5 min x 1.500 x 20 €)
10. Risk management costs Additional instructions and measures against fire risks / hot water risks	200 € Fire risk	200 € Accident risk: hot water (95°)
11. Costs for occupational health care	0 €	0 €
12. Costs of legal/certification requirements e.g. lists	100 €	0 €
13. Additional costs to guarantee technical performance	0 €	0 €
Costs (2), annually	**1.450 €**	**1.950 €**
Total Cost	**4.230 €**	**2.210 €**

Influencing factors	Hydrocarbons (VOC)	Hot-water washer
14. Public perception corporate image	0	+
15. Employees satisfaction, motivation	0	0
16. Advantageous product labelling	0	0
17. Life cycle assessment	-	+
18. Specific Case related factors	--	-
Final evaluation	**Hydrocarbons (VOC)**	**Hot-water washer**
Alternative solution not suitable		
Substitution initiated		
Check until		
Free text	- Brake dust hast to be removed later from the ground	+ Reduces fibres and dust in the air

Notes for discussion:

Can you think of any other hidden costs?

Ideas and thoughts why the hot-water washer is still a niche application?