Risk Assessment for Occupational Dermal Exposure to Chemicals

RISKOFDERM

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Deliverable 48

Toolkit for Dermal Risk Assessment and Management

Work Part 4

Responsible partner: MILJOE (Eurofins)

Partners involved: TNO, HSE, HSL, FOBIG, BAU-BG, AUVA, INSHT

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Deliverable 48:

Toolkit for Dermal Risk Assessment and Management

1. Introduction

This is a toolkit for assessment and management of hazard, exposure and risk from dermal exposure to hazardous chemicals at the workplace.

This tool attempts to help you in estimating whether there might be any health problem from skin exposure to chemicals at your workplace.

This document explains the structure of the toolkit to experts in the field of dermal exposure and risk management. There is also an electronic version that is meant for use in the field.

1.1 Basics

1. Intention of the toolkit

The Toolkit for Dermal Exposure Risk Assessment and Management is designed to improve management of health risks from occupational dermal exposure to hazardous chemicals.

That toolkit was constructed by analysing the major determinants of dermal hazard and dermal exposure. The results were combined in the form of a decision-tree that leads the user of the toolkit through a number of questions on the hazardous properties of the chemical in use, and on the exposure situation.

The toolkit translates the answers into broad data categories of hazard and exposure that lead to a rough estimate of health risk from dermal exposure. This is done separately for local skin effects and skin allergy on the one hand, and systemic effects after skin penetration on the other hand.

After going through the decision-tree the user is advised to consider an action to control the risk. Also, the user should read general information on dermal exposure, and a statement describing the uncertainty of the risk estimate that is produced by the toolkit.

The final version of the toolkit executes the decision algorithms behind the scene so that the non-expert user only observe? the judgements, the recommendations and the general information. Before final release the toolkit was evaluated by experts on the various elements included in the toolkit, and by field experts in practical use.

The toolkit is an attempt to adapt elements of exact science to a situation where the necessary input data are of limited quality and a rather rough estimate. The toolkit does not claim to give precise answers based on imprecise information. The purpose is to enable the user to estimate the order of magnitude of hazard, exposure, and risk, and to encourage the user to deal with the issues of dermal hazard, exposure and control.

2. Application of the toolkit

The toolkit applies to health risks from occupational dermal exposure to both single substances and mixtures (products, preparations) and can be used for a number of purposes:

- Comparison of the skin related hazardous properties of chemical products: Assessment and comparison of the skin damaging or skin penetrating potency of chemical substances or preparations.

- Recommendation of safety precautions for typical patterns of use for a specific chemical product, after an estimate of typical exposure and risk at various applications, without knowledge of exposure conditions at one specific single workplace.

- Assessment of a specific single workplace in the field, for skin exposure, for resulting risk, and for necessary control actions. This includes an estimate of the effectiveness of possible control actions (e.g. substitution, technical protection, organisational changes, use of personal protection) for reduction of dermal exposure to chemicals, of skin damage and of skin penetration.

3. User groups

The toolkit is intended to be used especially by employers, safety officers, technical staff and consultants in companies of any size, but particularly by small and medium sized enterprises that should have access to

- Hazard labels on the packages (according to directive 67/548/EU),

- Safety Data Sheets (according to directive 2001/58/EU),

- Supplementary basic information usually available upon request from the supplier of the chemicals in question,

- Supplementary basic information usually available in easily accessible media, e.g. in handbooks,

- Supplementary basic information contained in the final version of the toolkit itself,

- Information on the specific exposure at the workplaces.

Also health and safety professionals at trade associations or at health surveillance services may use the toolkit when they define generic safety precautions for typical workplaces in specific trades and industries such as car painters, hairdressers and asphalt paving workers. In these cases, there is no information available on exposure at a specific workplace, only at typical workplaces. That information may be collected from a number of sources, including inspections of numerous workplaces, from work simulation experiments, or from a literature survey.

The toolkit is not targeted at experts in occupational hygiene, physicians, toxicologists, or enterprises with the capability to carry out more detailed dermal risk assessments. Moreover, these experts may find the toolkit useful as an initial rough estimate of dermal hazard, dermal exposure and dermal health risk.

4. Limitations of use

The disadvantage of the risk assessment and management tool as presented here is the same as for most simple tools - a high uncertainty of the input data and of the algorithms within the toolkit.

The legal labelling and the risk phrases are only very rough indications of the possible hazard of a chemical substance or preparation, and several investigators have found that the quality of the assignment of these labels, and of supplementary information in Safety Data Sheets, is not satisfactory in many cases.

If the user supplies the toolkit with very rough and imprecise information then the toolkit will encourage the user to get more information, such as a (updated) Safety Data Sheet. But even updated and carefully prepared Safety Data Sheets may fail to provide all necessary information on the chemical product. In these cases, the toolkit shall encourage and help the user to obtain more information. This can be done, e.g., if the user

- Requests the supplier of the chemical product to deliver specific information on hazardous properties,

- Consults any lists of physico-chemical properties of chemicals,

- Consults any lists of irritating or sensitising properties of chemicals,

- Requests the respective suppliers for the effectiveness of personal protection devices in specific circumstances,

- Carries out quantitative exposure monitoring.

The same limited precision applies to the quality of the exposure data that depends on the observation skills of the assessor. Many users of the toolkit will not have specific knowledge or be familiar with methods of exposure and risk assessment.

Therefore the toolkit is designed for giving a rough estimate of dermal risk in very broad categories. In case of doubt, and for scientific purposes, a more detailed investigation of the respective working situation is preferred. It should be noted that the toolkit is designed for application to liquids and solids only, not to gases and vapours.

As the quality of the given information might vary significantly, depending on the knowledge and the expertise of the respective user, the toolkit is designed in such a way that the output will depend on the level of information provided; the more detailed the information, the more reliable the output.

In case of mixing or dilution, the toolkit cannot be used in a reliable manner if the hazard information of the new formulation (e.g. the new solution) is not given by the supplier and cannot be calculated by the user. And, as hazard information can only be determined for the products in use, risks from exposure to new substances generated by the process cannot be assessed in most cases.

With the given limitations in mind it is not recommended that the toolkit is used for chemicals that constitute the severest health hazards. The possibility of failing in the risk assessment with the low quality input data would have too serious, possibly fatal, consequences for the concerned persons. The toolkit contains a list of chemicals for which the toolkit is rated as not suitable if any of these chemicals are an ingredient of the product under investigation. In these cases the toolkit shall not be applied.

5. Electronic version

This version is also given as a programmed decision tree in an EXCEL file where the user is led through the decision logic without seeing any details of assignment, calculation and ranking of the values in between. This can be downloaded from http://www.eurofins.com/Research_occ_hygiene.

6. Basic structure of the toolkit

Hazard

The possible harm to human health in case of significant exposure is an intrinsic property of a chemical substance or preparation and needs to be assessed in a first step. If two chemicals with very different hazards can be used for a specific working procedure then the hazard assessment alone can already lead to a recommendation of substitution without any exposure assessment, assuming all other relevant variables to be the same. And when specific exposure conditions are unknown, or when exposure conditions vary greatly, the selection of alternative products may be based on hazard considerations alone.

The toolkit estimates the Intrinsic Toxicity and by that the Hazard Score of the chemical product in use. The Hazard Score is assessed separately both for local skin hazards and for hazards that are relevant after uptake of the chemical through skin. The Hazard Score equals the Intrinsic Toxicity for local skin hazards. But for hazards that take place only after uptake through the skin, it is relevant to check whether the chemical product in use has properties that indicate a low uptake through the skin and thus a limited availability for causing health effects. In these cases, the Intrinsic Toxicity is modified when being transformed into the Hazard Score.

Exposure

The exposure level determines whether a given hazard leads to a significant health risk. Therefore, exposure needs to be estimated and then combined with the hazard to the resulting risk as soon as not only the hazard is of interest, but also the risk under field conditions.

The Toolkit estimates the specific exposure for a specific situation. In the first step, an exposure default value from typical exposure in a similar situation is assigned, after which the specific exposure is estimated by application of some modifying factors.

Exposure is basically independent of hazard. But the impact of a given exposure on health risk is different for local health effects on the skin or for systemic health effects after percutaneous uptake. For local skin health effects, the key parameter for risk assessment is the height of the peak values of actual exposure dose on the skin. For systemic health effects after dermal uptake, the key parameter for risk assessment is the height of the integrated internal exposure inside the body.

Risk

Health risk is the combination of hazard and exposure. As these are independent of each other, it may occur that a high hazard chemical at low exposure and a low hazard chemical at high exposure can result in comparable risk levels. Especially if one considers substituting a hazardous chemical with another one of lower toxicity, then it is essential to take into account whether the use pattern of the new substance would result in higher exposures, which would more than offset the benefit of lower

toxicity, giving a higher overall risk.

Control

If the assessed hazard, exposure, or risk showed to be unacceptable, then, in the following step, control actions are suggested for reducing the hazard (by substitution) or the exposure (by technical, organisational or personal protection). If these actions are effective, a new and lower risk will be the result of a new hazard and exposure assessment.

The structure of dermal risk assessment and management in the toolkit is shown in Figures 1 and 2.
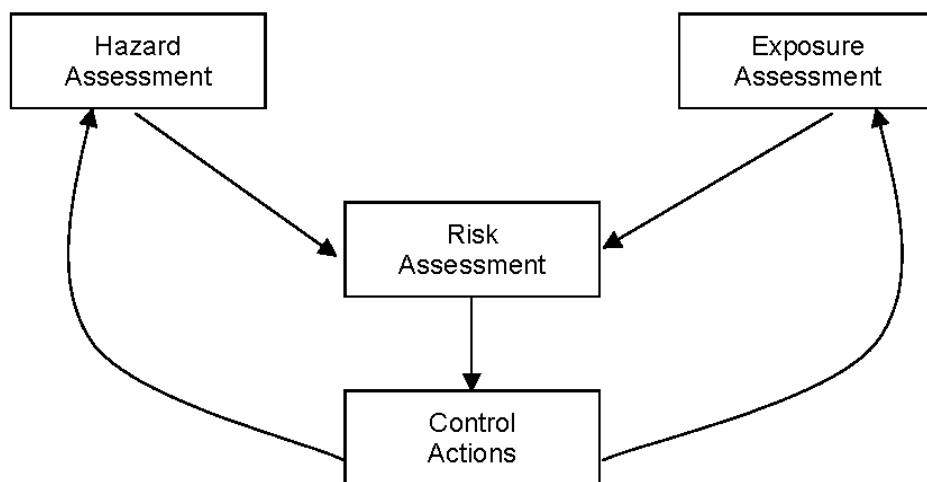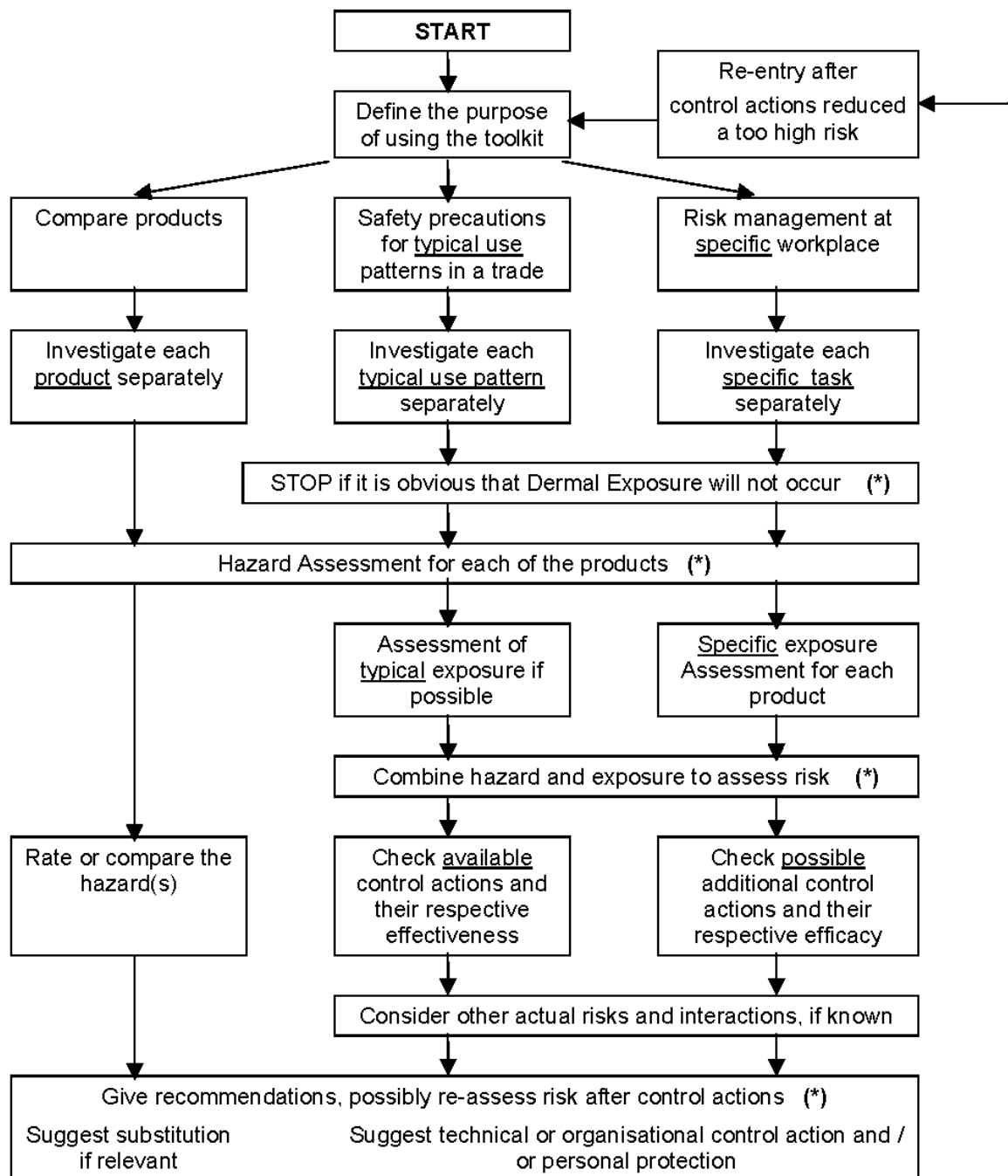

Figure 1   Basic steps of dermal risk assessment and management in the toolkit

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                        ┌──────────────────────┐
                        │        START         │
                        └──────────┬───────────┘
                                   │
                        ┌──────────▼───────────┐      ┌─────────────────────────┐
                        │  Define the purpose  │◀─────│   Re-entry after        │◀───
                        │  of using the toolkit│      │ control actions reduced │
                        └──────────────────────┘      │   a too high risk       │
              ┌─────────────┬────────────┬──────────┐ └─────────────────────────┘
              ▼                          ▼                        ▼
┌──────────────────────┐  ┌──────────────────────┐  ┌──────────────────────┐
│  Compare products    │  │  Safety precautions  │  │  Risk management at  │
│                      │  │  for typical use     │  │  specific workplace  │
│                      │  │  patterns in a trade │  │                      │
└──────────┬───────────┘  └──────────┬───────────┘  └──────────┬───────────┘
           ▼                          ▼                         ▼
┌──────────────────────┐  ┌──────────────────────┐  ┌──────────────────────┐
│  Investigate each    │  │  Investigate each    │  │  Investigate each    │
│  product separately  │  │  typical use pattern │  │  specific task       │
│                      │  │  separately          │  │  separately          │
└──────────┬───────────┘  └──────────┬───────────┘  └──────────┬───────────┘
           │              ┌───────────────────────────────────────────────────┐
           │              │ STOP if it is obvious that Dermal Exposure will not│
           │              │ occur    (*)                                       │
           │              └──────────┬──────────────────────────┬─────────────┘
           │   ┌─────────────────────────────────────────────────────────────┐
           │   │ Hazard Assessment for each of the products   (*)            │
           │   └──────────┬──────────────────────────┬─────────────────────┘
           │              ▼                           ▼
           │  ┌──────────────────────┐  ┌──────────────────────┐
           │  │  Assessment of       │  │  Specific exposure   │
           │  │  typical exposure if │  │  Assessment for each │
           │  │  possible            │  │  product             │
           │  └──────────┬───────────┘  └──────────┬───────────┘
           │  ┌───────────────────────────────────────────────────┐
           │  │ Combine hazard and exposure to assess risk    (*) │
           │  └──────────┬──────────────────────────┬─────────────┘
           ▼             ▼                           ▼
┌──────────────────────┐  ┌──────────────────────┐  ┌──────────────────────┐
│  Rate or compare the │  │  Check available     │  │  Check possible      │
│  hazard(s)           │  │  control actions and │  │  additional control  │
│                      │  │  their respective    │  │  actions and their   │
│                      │  │  effectiveness       │  │  respective efficacy │
└──────────┬───────────┘  └──────────┬───────────┘  └──────────┬───────────┘
           │              ┌───────────────────────────────────────────────────┐
           │              │ Consider other actual risks and interactions, if  │
           │              │ known                                             │
           │              └──────────┬──────────────────────────────────────┘
           ▼                         ▼
┌─────────────────────────────────────────────────────────────────────────────┐
│ Give recommendations, possibly re-assess risk after control actions   (*)   │
│ Suggest substitution        Suggest technical or organisational control     │
│ if relevant                 action and / or personal protection            │
└─────────────────────────────────────────────────────────────────────────────┘
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(*) means: Exit of the toolkit is possible if the Hazard or the Risk is accepted. In this case information is provided about limitations of the toolkit and some general advice.

Figure 2   Main steps in the decision tree of the toolkit

1.2 Required information

The quality and reliability of the information that you will receive depends strongly on the quality of the information given.

We ask you to answer all questions with care. If you do not know most of the answers, then it can be worthwhile to read the Safety Data Sheet, or to ask the supplier of the chemical products in use, or to ask for expert advice.

The toolkit only can handle one chemical product and only one exposure-scenario at a time.

If you need to assess several products used in parallel then you have to use the toolkit for each of these products separately. If you need to assess several working situations occurring during one working day then you should use the toolkit for each of these situations separately. Using the toolkit can help identifying the major problem, since this will be assigned the highest risk.

If you just want to compare two products then you should use the toolkit for each of these. The product with the lower hazard will give lower risk - assumed that exposure remains the same.

1.3 Disclaimer

This tool cannot be used safely without basic knowledge on how skin contamination occurs and how health risks can arise from skin exposure to chemicals. The user is therefore advised urgently to read an accompanying document "Skin Exposure - Worth to Know".

This toolkit is designed to give a very rough estimate of hazard, exposure and risk. Over- or under-estimation cannot be excluded completely. The user is asked to use the results with care. He is told that the results can indicate whether there is higher or lower priority of action. The results cannot always replace an expert assessment of the specific workplace.

1.4 Copyright and translation

Although there is a copyright reserved for formal reasons, and held by the project group, the toolkit may be used, spread and even translated free of costs for any non-commercial purpose.

2. Input Data for Using the Toolkit and Decision Logic

Please give the requested data as good as possible. When not knowing precisely, please read the Safety Data Sheet, or ask the supplier of the chemical products in use, or ask for expert advice.

The required information shall refer to one chemical product and to one specific situation.

In the electronic version there is no manual reading from tables, and no use of abbreviations.

2.1 General Questions

Question G 1

Type the identification for the working situation under investigation.

Action of the Toolkit:

- Saves the identification for printout.

Go to G2.

Question G 2

Type the name of the product in use.

Action of the Toolkit:

- Saves the name for printout.

Go to G3.

Question G 3

Read from the Safety Data Sheet (chapter 2 and 8) the chemical names of the ingredients. Compare with the list of chemicals in Table 1.

If any of these is found in Table 1 then DO NOT apply the toolkit for this chemical.

Action of the Toolkit:

- Recommends use of expert knowledge for assuring appropriate high-level protection.

Go to H1.

2.2 Questions on Hazard

Question H 1

a) Read all R phrases from the Label, or from the Safety Data Sheet (chapter 3).

Read also the single figures from combinations of R phrases, if relevant.

Tick all applicable boxes both in Table 2 and in Table 3.

b) Read the pH value if given in chapter 9 of the Safety Data Sheet. Tick the appropriate box in Table 2 if the pH value is equal to or lower than 2, or equal to or higher than 11,5.

Action of the Toolkit:

- Assigns two Intrinsic Toxicity Scores IT, one for local effects (IT_L) and one for systemic effects (IT_S).

- If the answer is "Don't know": The toolkit stops the procedure and recommends the user to provide at least this very basic information. The user then is provided with general advice on skin protection from the accompanying document "Skin Exposure - Worth to Know".

Go to H2.

Question H 2

Is the product diluted with water before use? If yes - Tick all applicable boxes in Table 4. Else go to H3

Action of the Toolkit:

- Re-assigns the IT_L score.

Go to H3.

Question H 3

Investigate the items in Table 5 and Table 6 and tick all that are relevant. If non is relevant - go to H4.

Action of the Toolkit:

- Re-assigns the IT_L score.

Go to H4.

Question H 4

For estimating the availability for uptake through the skin, check the following:

- Is the chemical in question a solid or dust?

- Is the chemical in question a gas?

- If the chemical in question is a liquid - read chapter 9 of the Safety Data Sheet -

  - Is the Partition octanol/water below -1?
  - Is the Partition octanol/water higher than 5?
  - Is the molecular weight higher than > 500?
  - Is the Skin permeability constant below < 0.0001?

Answer YES to this question if you see that information and any of these items is true. Else go to H5.

Action of the Toolkit:

- Re-assigns the IT_S score from Table 7.

- Renames the corrected IT_S score as Hazard Score (systemic) HS_S.

- Renames the corrected IT_L score as Hazard Score (local) HS_L.

Go to H5.

Question H 5

Do you want to assess the hazard of a chemical only, without dealing with exposure?

If NO then go to H6.

Action of the Toolkit:

- If YES then the results are read from Table 8 and given to the user, separately for local and for systemic effects.

Go to H6.

Question H 6

Do you want to compare the hazard of two chemicals, without dealing with exposure? - Then run the toolkit for two chemicals separately and type in the Hazard Scores (local) and the Hazard Scores (systemic). Else go to E1.

Action of the Toolkit:

- If YES then the results are read from Table 9 and given to the user, separately for local and for systemic effects.

Go to E1.

2.3 Questions on Exposure

Question E 1

Read a list of typical workplace and activity descriptions from Table 10.

Select that one that fits best to the working situation under investigation and tick one of these. The toolkit needs just and only one selection made by you.

Action of the Toolkit:

- Assigns the default potential exposure rates DEP_{BODY} and DEP_{HANDS} following Table 10.

- Assigns the contributions factors from Table 11.

Go to E2.

Question E 2

Read a list of additional descriptions of the working situation under investigation and tick those descriptions that fit best in Table 12a, Table 12b, and Table 12c. If any item is not relevant - don't make any tick in those fields.

Action of the Toolkit:

- Assigns the modifying factors MF_{DC}, MF_{SC}, and MF_{DEP} following Table 12a, Table 12b, and Table 12c.

- Assigns the modified and workplace-specific potential exposure rates PER_{BODY} and PER_{HANDS} by applying the modifying factors from Table 12a, Table 12b, and Table 12c (along with Table 13) to the default values in Table 10 as described in detail in chapter 5.1.

- Assigns qualitative scores to the workplace-specific potential exposure rates PER_{BODY} and PER_{HANDS} following Table 14.

- Assigns the actual exposure rates AER_{BODY} and AER_{HANDS} following Table 15.

Go to E3.

Question E 3

Read the following list of how long time the working situation under investigation will last typically and tick those descriptions that fit best:

Tick Box	**Duration of working task**, h/day, sum of identical tasks per day
	< 0.1
	0.1 - < 0.5
	0.5 - < 1
	1 - 4
	> 4
	Frequent Immersion of skin or other body parts

Action of the Toolkit:

- Assigns the Activity Time AT scores and the Actual Exposure AED scores following Table 17 and Table 18 for local health effects.

- Assigns the Activity Time AT scores and the Actual Exposure AED scores following Table 21 and Table 22 for systemic health effects after percutaneous uptake.

Go to E4.

Question E 4

Read the list in Table 16 on how many body parts are contaminated typically during the working situation under investigation and tick those descriptions that fit best.

Action of the Toolkit:

- Assigns the Exposed Body Area EBA in cm² following Table 16.

- Assigns the Exposed Body Area EBA scores following Table 19 for local health effects, and Table 23 for systemic health effects after percutaneous uptake.

- Assigns the Actual Exposure scores for local health effects following Table 20.

- Assigns the Internal Exposure scores for systemic health effects after percutaneous uptake following Table 24.

- Assigns the Health Risk scores and the related recommendations following Table 25 for local health effects, and Table 26 for systemic health effects after percutaneous uptake.

Read the report (see page 15).

<u>Reporting</u>

The toolkit reports to its user:

- The health risk scores and the recommendations from following Table 25 and Table 26.

- The hazard scores from Table 8 and the exposure scores from Table 20 and from Table 24.

- A recommendation to read general information on skin protection.

- A recommendation to consider control actions if any of both risk scores is 3 or higher.

The toolkit then leads the user to Question C 1.

2.4 Questions on Controls

Question C 1

There are a number of possible control actions - but the efficiency in reducing hazard, exposure, and risk, will differ significantly. This is described in Control Efficiency Classes as given in Table 27.

European and national directives and laws on hazardous substances request that control for risk reduction must be considered in the following order:

1. Substitution of a hazardous chemical with a less hazardous one.

2. Technical protective measures such as use of tools or encapsulation of the source of contamination.

3. Organisational protective measures such as cleaning or work organisation.

4. Personal protective measures such as protective gloves.

Do you want to investigate possibilities of how to reduce hazard, exposure, and risk?

Action of the Toolkit:

- If YES - continue.

- If NO - the toolkit goes back to the report as described above (see page 15).

Question C 2

Please take a look at Table 28 and assess whether one of these control actions by doing substitution can be applied to the working situation under investigation. If you apply substitution then you need to re-assess both hazard and exposure for seeing the impact on risk reduction.

Did you try one of these actions, and did this reduce the risk to an acceptable level?

Action of the Toolkit:

- If YES - congratulate and exit.

- If NO - leads its user to C3.

Question C 3

Please take a look at Table 29 and assess whether one of these technical control actions can be applied to the working situation under investigation.

Did you try one of these actions, and did this reduce the risk to an acceptable level?

Action of the Toolkit:

- If YES - congratulate and exit.

- If NO - leads its user to C4.

Question C 4

Please take a look at Table 30 and assess whether one of these organisational control actions can be applied to the working situation under investigation.

Did you try one of these actions, and did this reduce the risk to an acceptable level?

Action of the Toolkit:

- If YES - congratulate and exit.

- If NO - leads its user to C5.

Question C 5

Please take a look at Table 31 and assess whether one of these personal protection control actions can be applied to the working situation under investigation.

Did you try one of these actions, and did this reduce the risk to an acceptable level?

Action of the Toolkit:

- If YES - congratulates and exits.

- If NO - recommends using expert support for a more deep-going investigation and for establishing an effective control plan.

- Returns to report on page 15.

3. Chemicals for Which the Use of the Toolkit is Not Recommended

Table 1 Hazardous substances to which the Toolkit should not be applied
(all the substances are toxic or very toxic <u>and</u> corrosive)

name of substance	CAS-number	remarks
Ammonium gas	7664-41-7	cooling agent
Ammonium hydrogen difluoride	1341-49-7	laboratory chemical
Arsene trioxide	1327-53-3	
Bor tribromide	10294-33-4	
Bor trichloride	10294-34-5	
Bor triflouride	7637-07-2	
Bromocyan	506-68-3	
Bromoacetic acid	79-08-3	
2-Butin-1,4-diol	110-65-6	
Butyl chloro formiate	592-34-7	
tert-Butyl hydroperoxide		
Chloro acetaldehyde		
Chloro aceticacid		
n-Butyl isocyanate	79-11-8	
Chloroaceticacid-anhydride	541-88-8	
2-Chloroethan-sulfonylchloride	1622-32-8	
3-Chloro-4-methyl-phenylisocyanate	28479-22-3	
O-(4-Chlorophenyl)-chlorothioformiate	937-64-4	
3-Chloropropionicacid chloride	625-36-5	
Chrome(VI)oxide	1333-82-0	
Chromosulphuric acid		
1,3-Diamino-propane	109-76-2	
1,2-Dibromethylene	540-49-8	
Dibutyl tin chloride	683-18-1	
2,3-Dichloro malealdehydacid	87-56-9	
1,2,7,8-Diepoxy-ethane	2426-07-5	

to be continued

Table 1**, continued**

name of substance	CAS-number	remarks
Diethyl cyano phosphonate	2942-58-7	
N,N-Diethyl-1,4-phenylene diamine	93-05-0	
Diisopropyl fluoro phosphate	55-91-4	
Dimethyl-N-cyano-dithio imino carbonate	10191-60-3	
Dimethyl dicarbonate	4525-33-1	
N,N-Dimethyl hydrazine	57-14-7	
2,4-Dimethyl phenol	105-67-9	
2,5-Dimethyl phenol	95-87-4	
2,6-Dimethyl phenol	576-26-1	
3,4-Dimethyl phenol	95-65-8	
3,5-Dimethyl phenol	108-68-9	
N,N-Dimethyl sulphamoyl chloride	13360-57-1	
Dimethyl sulphate	77-78-1	
Epichlorhydrine	106-89-8	
Ethylchloro formiate	541-41-3	
Ethylhexyl amine	104-75-6	
2-Fluoro benzylchloride	345-35-7	
3-Fluoro benzylchloride	456-42-8	
4-Fluoro benzylchloride	352-11-4	
Formaldehyde > 35%		disinfectant
Furfuryl amine	617-89-0	
Glutar dialdehyde > 25%		disinfectant
Hydrazinium hydroxide	7803-57-8	
Hydroflouric acid		etching reagent; even small burns can lead to death
Hydrogenchloride, gas	7647-01-0	
(2-Hydroxyethyl)-acrylate	818-61-1	
Iodacetic acid	64-69-7	
Isobutyl-chloroformiate	543-27-1	
Isovalerianic acid	503-74-2	

to be continued

Table 1**, continued**

name of substance	CAS-number	remarks
m-Cresol	108-39-4	
o-Cresol	95-48-7	
p-Cresol	106-44-5	
Lithium hexafluoro phosphate	21324-40-3	
Mercaptoethanol	60-24-2	
3-Mercapto propionic acid	107-96-0	
Mercury dichloride	7487-94-7	
Methane sulfonyl chloride	124-63-0	
4,4´-Methylenbis (2-methyl cyclohexyl amine)	6864-37-5	
Methyl isothiocyanate	556-61-6	
Methylvinyl ketone	78-94-4	
Nitrogen dioxide	10544-72-6	
Nitrosyl chloride	2696-92-6	
Osmium	7440-04-2	
Osmiumtetroxide	20816-12-0	
Oxalyl chloride	79-37-8	
N,N,N´,N´´,N´´-Pentamethyl diethylen triamine	3030-97-8	
Phenol	108-95-2	may cause severe poisoning even on small contact area
1,2-Phenylen trichloro phosphate	2007-97-8	
Phenylisocyanate	103-71-9	
N-Phenylpiperazine	92-54-6	
Phenylmercury acetate	62-38-4	
Phenylmercury nitrate	8003-05-2	
2-Propin-1-ol	107-19-7	
Sodium borhydride	16940-66-2	
Tetramethyl ammonium hydroxide > 25%		
Thioglycolic acid	68-11-1	
Trichloro acetylchloride	76-02-8	
2-Vinyl pyridine	100-69-6	

Note: This list is open for review

4. Decision Tables for Hazard Assessment

Table 2   Scores for Intrinsic Toxicity
(for substances with local health effects: skin damaging, carcinogenic or sensitising properties)

Tick Box	Reading	Intrinsic Toxicity IT_L Score
	Don't know	Negligible
	No R phrases at all	No IT
	None of below	Low
	R 66 R 38	Moderate
	R 34 pH $\leq$ 2 or pH $\geq$ 11.5 *	High
	R 35 R 43	Very high
	R 45	Extreme

*: applicable only to aqueous dilutions or mixtures

Table 3   Scores for Intrinsic Toxicity IT
(for substances with systemic health effects after percutaneous uptake)

Tick Box	Reading	Intrinsic Toxicity IT_S Score
	Don't know	Negligible
	No R phrases at all	No IT
	None of below R67	Low
	R20, R21, R22 R40 with 20,21 or 22 R48 with 20, 21 or 22 R62, R63	Moderate
	R23, R24, R25, R29 R31, R33, R40, R41, R64 R39 with 23, 24 or 25 R48 with 23, 24 or 25	High
	R26, R27, R28, R32 R39 with 26, 27 or 28	Very high
	R60, R61, R45, R46	Extreme

Table 4   Scores for Intrinsic Toxicity
(for substances that are diluted with water)

If the product is diluted with water before use, then determine the IT score from the resulting concentration of the original chemical product in water					
Tick Box	Risk Phrase	No change of IT score	IT score = high	IT score = moderate	IT score = low
	R 66	$\geq 20\ \%$			$< 20\ \%$
	R 38	$\geq 20\ \%$			$< 20\ \%$
	R 34	$\geq 10\ \%$		$\geq 5\ \%$	$<\ 5\ \%$
	pH $\leq$ 2 or pH $\geq$ 11.5	IT score = High, if the diluted product still shows one of these pH values			
	R 35	$\geq 10\ \%$	$\geq 5\ \%$	$\geq\ 1\ \%$	$<\ 1\ \%$
	R 43	$\geq\ 1\ \%$		$\geq\ 0.1\ \%$	$<\ 0.1\ \%$
	R 45	$\geq\ 0.1\ \%$	$\geq\ 0.01\ \%$	$\geq\ 0.001\ \%$	$<\ 0.0001\ \%$

Table 5   Plausibility Check for the Data on Intrinsic Toxicity
(for substances with local health effects)
- in this stage the IT_L score can only increase, not decrease.

Tick Box	Reading	Intrinsic Toxicity IT_L Score
	Measure pH (if aqueous dilution), if the pH is $\leq$ 2 or pH $\geq$ 11.5 then assign IT_L:	High
	If the Safety Data Sheet contains remarks like "irritating" for the preparation (not for single ingredients) then assign IT_L as for R 38	Moderate
	If the Safety Data Sheet contains remarks like "sensitising" for the preparation (not for single ingredients) then assign IT_L as for R 43	Very high
	If no R phrases are given, ask the supplier to guarantee this is true and not due to lack of knowledge	Depending on answer
	If the product contains organic peroxides - assign IT_L as for R 38	Moderate
	If the product contains organic hydro peroxides - assign IT_L as for R 34	High

To be continued

Table 5, continued

Tick Box	Reading	Intrinsic Toxicity IT_L Score
	If R phrases of single compounds differ from those of the whole preparation: check carefully whether the product was labelled correctly	Depending on result
	If any of the ingredients above certain concentration levels is listed in a database on substances with (a) irritating and (b) sensitising properties, then assign the respective R phrase to this substance and re-assign the labelling of the preparation	Re-assign the IT_L score accordingly
	If there is any empirical knowledge on irritation potency then assign the respective R phrase to this substance and re-assign the labelling of the preparation	Depending on result

Table 6   Plausibility Check for the Data on Intrinsic Toxicity
(for substances with systemic health effects)
- in this stage the IT_L score can only increase, not decrease.

Tick Box	Reading	Intrinsic Toxicity IT_S Score
	Check correctness of labelling compared to directive 67/548/EU	Depending on result
	If no R phrases are given: check for qualitative information on toxicity in Safety Data Sheet and assign related R phrase	Depending on result
	If no R phrases are given, ask the supplier to guarantee this is true and not due to lack of knowledge. If no guarantee is given, assign IT_S = high, else IT_S = Negligible	Depending on result

Table 7   Reduction of Intrinsic Toxicity for Low Availability
(for substances with systemic health effects)
- in this stage the IT_L score can only decrease, not increase.

Risk Phrases	Original IT_S	Reduced IT_S
R67	Low	Negligible
No relevant risk phrases	Low	Low
R20, R22, R62, R63, R40 or R 48 with 20 or 22	Moderate	Low
R21, R40 or R48 with 21	Moderate	Moderate
R23, R25, R29, R31, R33, R40, R64, R39 or R 48 with 23 or 25	High	Moderate
Not tested or no sufficient information in SDS	High	High
R24, R41, R39 or R48 with 24	High	High
R26, R28, R32, R60, R61, R39 with 26 or 28	Very high	High
R27, R39 with 27	Very high	Very high
R45, R46	Extreme	Extreme

Table 8   Hazard Scores - Recommendations given to user
This table is applied separately for local and for systemic health effects.
The latest values of IT_L resp. IT_S from the above tables are assigned the
Hazard$_{LOCAL}$ Score and the **Hazard$_{SYSTEMIC}$ Score**.

Hazard Score	Urgency of exposure assessment	Suggested action
Negligible	None	None
Low	Low	None
Moderate	Moderate	Skin care is recommended - no further assessment without specific reasons - improve information
High	High	The user should be advised to do an exposure assessment
Very high or extreme	Very high	Look for substitutes, until then: exposure assessment is urgently advised

Table 9   Comparison of Hazard Scores - Recommendations given to user
This table is applied separately for local and for systemic health effects.

Hazard Score - chemical 1	Hazard Score - chemical 2	Urgency of exposure assessment	Suggested action
Low	Low	Low	None
Moderate	Low	Low	Increase expert level
High	Low	Moderate	Candidate for substitution, increase expert level
High	Moderate	High	Candidate for substitution, if used at similar exposure conditions, increase expert level
Very high	Low or moderate	High	Candidate for substitution even if exposure conditions differ, increase expert level
Very high	High	High	Candidate for substitution, if used at similar exposure conditions, increase expert level
Extreme	High or moderate or low	Moderate	Urgent substitution advised
Extreme	Very high	High	Substitution advised

5. Decision Tables and Calculations for Exposure Assessment

5.1 Potential Dermal Exposure Rate

5.1.1 Default Values for Potential Exposure Rate

Table 10   Default exposure values by task group

Tick Box	Task group (Dermal Exposure Operational DEO Unit)	Default Potential Body Exposure Rate DPE_{BODY}	Default Potential Hands Exposure Rate DPE_{HANDS}
	Handling contaminated objects (exposure to solids)	0.50 (high)	21.63 (very high)
	Handling contaminated objects (exposure to liquid)	0.2 (high)	0.656 (high)
	Manual dispersion of solids	0.32 (high)	80.2 (very high)
	Manual dispersion of liquids	0.32 (high)	80.2 (very high)
	Hand tool dispersion of solids	0.096 (medium)	1.09 (high)
	Hand tool dispersion of liquids	0.096 (medium)	1.09 (high)
	Spray dispersion of solids	0.625 (high)	3.28 (high)
	Spray dispersion of liquids	0.625 (high)	3.28 (high)
	Immersion (exposure to solids)	0.019 (medium)	3.76 (high)
	Immersion (exposure to liquids)	0.019 (medium)	3.76 (high)
	Mechanical treatment (exposure to liquids)	0.434 (high)	2.5 (high)
	Mechanical treatment (exposure to solids)	0.032 (medium)	0.25 (medium)

The unit of the Default Potential Exposure Rate DPE is (mg cm^{-2} h^{-1}).
Future investigation after conclusion of the RISKOFDERM project may lead to further improvement of default values.

Table 11   Relative contributions to dermal exposure from each route
The values in the table are the contribution factors CFB_{DC}, CFB_{SC}, ... CFH_{DEP}

Tick Box	Task Group (DEO Unit)	Body Exposure (CFB, in %)			Hands Exposure (CFH, in %)		
–	**Route of Exposure**	**DC**	**SC**	**DEP**	**DC**	**SC**	**DEP**
–	Factor	CFB_{DC}	CFB_{SC}	CFB_{DEP}	CFH_{DC}	CFH_{SC}	CFH_{DEP}
	Handling contaminated objects (exposure to solids)	0	60	40	25	50	25
	Handling contaminated objects (exposure to liquid)	0	100	0	0	100	0
	Manual dispersion of solids	40	40	20	50	50	0
	Manual dispersion of liquids	50	50	0	50	50	0
	Hand tool dispersion	20	50	30	30	40	30
	Spray dispersion	0	30	70	0	60	40
	Immersion	50	50	0	50	50	0
	Mechanical treatment	0	30	70	0	60	40

DC: Direct Contact to the challenge chemical (e.g. immersion, splashes).
SC: Surface contact - exposure by touching exposed surfaces (e.g. machinery, tools, wetted parts).
DEP: Deposition Contact - exposure by the challenge chemical dispersed in air and landing on the skin (e.g. dust, oil mist).

5.1.2 Exposure Modifiers

Table 12a Correction factors for Substance-related modifiers
describing the transfer of a chemical from the source to the skin.
The values in the table are the modifier factors MF_{DC}, MF_{SC}, MF_{DEP}

Modifier (Description)	DEO	Tick Box	Value (Answer) Factor	Route of exposure		
				DC MF_{DC}	SC MF_{SC}	DEP MF_{DEP}
Liquid is best described as	All		Like water	1	1	1
			Like solvent	1	0.3	3
			Like oil, grease	3	3	0.3
			Like solvent suspension (thick but volatile)	3	3	3
Moistness / Adherence (applies to solids only)	All		Dry (Like dry sand, flour or pellets)	1	1	1
			Moist (Like moist flour or sand)	3	3	1
Wetness / contamination of objects	1		Touch dry / small areas of contamination (<20%)	1	0.1	1
			Damp / moderate to extensive areas of contamination (20-80%)	1	1	1
			Saturated / complete contamination (>80%)	1	10	1
Particle size (applies to solids only)	All		Like (dry) course sand	1	1	1
			Like (dry) flour	3	3	3
			Like (dry) granules/pellets	0.3	0.3	0.3

Table 12b Correction factors for Workplace-related modifiers
describing the character of the source for contaminations.
The values in the table are the modifier factors MF_{DC}, MF_{SC}, MF_{DEP}

Modifier (Description)	DEO	Tick Box	Value (Answer) Factor	Route of exposure		
				DC MF_{DC}	SC MF_{SC}	DEP MF_{DEP}
Temperature of process / substance	6		Handling / processing temperature of liquids / solids at room temperature or slightly elevated temperatures	1	1	1
			Handling / processing temperature: liquids are heated; solids are melted	1	3	3
Spraying of liquids (droplet size) [2]	4		Spraying or fogging of liquids causing small airborne droplets	1	0.3	0.1
			Spraying at very low pressure causing large droplets	1	1	1
Spraying of solids (particle size)	4		Spraying or fogging of powder	1	0.3	0.1
			Spraying or strewing of course solids/granules/pellets (with tools/equipment)	1	1	1
Proximity to source [1]	3, 4, 6		Arms length or less from source	1	1	1
			More than arms length from source (incl. long tool handles)	0.3	0.3	0.3

to be continued

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[1]   proximity to source and segregation cannot be combined

Table 12b, continued

Modifier (Description)	DEO	Tick Box	Value (Answer) Factor	Route of exposure		
				DC MF_{DC}	SC MF_{SC}	DEP MF_{DEP}
Restricted workspace	1, 2, 3, 4, 6		Unrestricted workspace	1	1	1
			Restricted workspace: small, restricting (for body movement), confined space	3	3	3
Orientation of worker	2, 3, 4		Work positioned at waist level	1	1	1
			Work positioned above waist level, shoulders (overhead)	3	1	3
			Work positioned below waist level	0.3	1	0.3
Application rate [1]	2, 3, 4		Typical application rate for scenario	1	1	1
			Low application rate (< 5 times less)	0.4	0.4	0.4
			High application rate (> 5 times)	2.5	2.5	2.5

1 A 'typical' application rate (amount/min or hr) has been derived for a number of scenarios of DEOs 2, 3 and 4. This value is directly linked with the modifier and with the respective scenarios. A lower and upper limit is determined by calculating, respectively, a value 5 times less and 5 times above the 'typical application rate' of a given scenario. These values are given to the user as a guideline.

Some typical application rates per DEO are: DEO2 - 0.15 l/min, DEO3 - 0.05 l/min, DEO4 - 0.3 l/min.

Table 12c Correction factors for Control-related modifiers
describing the typical effectiveness of control actions applied.
The values in the table are the modifier factors MF_{DC}, MF_{SC}, MF_{DEP}

Modifier (Description)	DEO	Tick Box	Value (Answer)	Route of exposure		
				DC	SC	DEP
			Factor	MF_{DC}	MF_{SC}	MF_{DEP}
Degree of automation	1, 5		No automation - fully manual	1	1	1
			Partially automated, partially manual	0.3	0.3	0.3
			Fully automated, - manual tasks replaced by control panels, etc	0.1	0.1	0.1
Segregation*	4, 6		No segregation	1	1	1
			Segregation in terms of screens, cabins, walls between worker and source	0.1	0.1	0.3
Containment *	6		No containment	1	1	1
			Containment - source completely contained / enclosed	0.001	0.001	0.001
Ventilation	1, 3, 4, 6		Natural / general ventilation	1	1	1
			Local exhaust ventilation	1	0.3	0.3

*   containment and segregation cannot be combined

DC: Direct Contact to the challenge chemical (e.g. immersion, splashes).
SC: Surface contact - exposure by touching exposed surfaces (e.g. machinery, tools, wetted parts).
DEP: Deposition Contact - exposure by the challenge chemical dispersed in air landing on the skin (e.g. dust, oil mist).

Table 13   Lowest / Highest permitted values for Total Workplace Modifiers

Modifier group (MFG)	Lowest value	Highest value
Substance-related modifiers, MFG (a)	0.1	10
Workplace-related modifiers, MFG (b)	0.1	30
Control-related modifiers, MFG (c)	0.001	1
Total modifier value (MFT)	0.001	50

Note: values are open for review

5.1.3 Estimation of Potential Dermal Exposure – Formulas and examples

5.1.3.1 Default Values

The selection of the best fitting Task group (DEO unit) by the user of the toolkit gives the following default values (see Table 10 and Table 11):

- Default potential exposure rates for body (DPE_{BODY}) and for hands (DPE_{HANDS})

- Relative contributions from each route of exposure:

  - Contribution of Direct Contact to Body Exposure $CFB_{DC,}$
  - Contribution of Surface Contact to Body Exposure $CFB_{SC,}$
  - Contribution of Deposition to Body Exposure $CFB_{DEP,}$

  - Contribution of Direct Contact to Hands Exposure $CFH_{DC,}$
  - Contribution of Surface Contact to Hands Exposure $CFH_{SC,}$
  - Contribution of Direct Contact to Hands Exposure CFH_{DEP}

Example:

The user selects the task group "Manual dispersion (e.g. wiping) of a liquid".

The toolkit assigns:

Default potential exposure rate for body DPE_{BODY} = 0.05 mg cm^{-2} h^{-1}
Default potential exposure rate for hands DPE_{HANDS} = 0.117 mg cm^{-2} h^{-1}

Contribution of Direct Contact to Body Exposure CFB_{DC} = 50 % = 0.5
Contribution of Surface Contact to Body Exposure CFB_{SC} = 50 % = 0.5
Contribution of Deposition to Body Exposure $CFBDEP$ = 0 %   = 0.0

Contribution of Direct Contact to Hands Exposure CFH_{DC} = 50 % = 0.5
Contribution of Surface Contact to Hands Exposure CFH_{SC} = 50 % = 0.5
Contribution of Direct Contact to Hands Exposure CFH_{DEP} = 0 %   = 0.0

5.1.3.2 Modifying Factors

The selection of the best fitting modifying descriptions by the user of the toolkit gives the Modifying Factors MF_{DC}, MF_{SC}, and MF_{DEP} for each Modifier from Table 12a, Table 12b, and Table 12c. These are grouped within each of the three tables.

All Modifying Factors and all results of calculations and combinations can only have the values 1 and 3 and decimal multiples of these. This shall help to avoid an overestimation of precision. Small differences shall not appear because they are not rated as significant.

Example:

The user selects the Modifiers "volatility - like solvent", " amount of product - large amounts", and " restricted workspace - restricted/confined". The other modifying factors each have the value 1 and thus do not change anything in the calculation.

The toolkit assigns:

- Modifier Group (a) - volatility

  for direct contact MF_{DC} = 1

  for surface contact MF_{SC} = 0.3

  for deposition MF_{DEP} = 3

- Modifier Group (b) - amount of product

  for direct contact MF_{DC} = 3

  for surface contact MF_{SC} = 3

  for deposition MF_{DEP} = 3

- Modifier Group (b) - restricted workplace

  for direct contact MF_{DC} = 3

  for surface contact MF_{SC} = 3

  for deposition MF_{DEP} = 3

- Modifier Group (c) - No modifier selected

5.1.3.3 Combination of Modifying Factors

Integrated Modifying Factor MFI

The Integrated Modifying Factor MFI is calculated firstly by multiplication of each single Modifying Factor MF with the applicable relative contribution (CFB or CFH) of the respective route of exposure, and then by summing up. This is done separately for body exposure (MF_{BODY}) and for hands exposure (MF_{HANDS}):

MFI_{BODY} = $(MF_{DC} \times CFB_{DC}) + (MF_{SC} \times CFB_{SC}) + (MF_{DEP} \times CFB_{DEP})$

MFI_{HANDS} = $(MF_{DC} \times CFH_{DC}) + (MF_{SC} \times CFH_{SC}) + (MF_{DEP} \times CFH_{DEP})$

Modifying factor per group MFG

Next, the Group Modifying Factors MFG are calculated by multiplication for each of the three groups of modifiers (a), (b), and (c), again once for body exposure (MFG_{BODY}) and once for hands exposure (MFG_{HANDS}):

$MFG(a)_{BODY} = MFI_{BODY - MODIFIER\ 1}$ x $MFI_{BODY - MODIFIER\ 2}$ x $MFI_{BODY - MODIFIER\ 3}$ x …

$MFG(a)_{HANDS} = MFI_{HANDS - MODIFIER\ 1}$ x $MFI_{HANDS - MODIFIER\ 2}$ x $MFI_{HANDS - MODIFIER\ 3}$ x …

This is repeated for $MFG(b)_{BODY}$, $MFG(b)_{HANDS}$, $MFG(c)_{BODY}$, $MFG(c)_{HANDS}$.

If more than one of the Modifying Factors automation, containment, and segregation apply then the lowest (per route) of the assigned modifier factors is used.

These values may not be higher than the highest or than the lowest permitted values in Table 13 - else the MFG values are taken from that table instead, and used for the further calculations.

Total modifying factor MFT

Subsequently the Total Modifying Factors (MFT) are calculated by multiplication of the MFG values, again once for body exposure (MFT_{BODY}) and once for hands exposure (MFT_{HANDS}):

$MFT_{BODY} = MFG(a)_{BODY}$ x $MFG(b)_{BODY}$ x $MFG(c)_{BODY}$

$MFT_{HANDS} = MFG(a)_{HANDS}$ x $MFG(b)_{HANDS}$ x $MFG(c)_{HANDS}$

Also these totals may not be higher than the highest or than the lowest permitted values in Table 13 - else the MFT values are taken from that table instead, and used for the further calculations.

Example, continued:

The Modifying Factors are calculated as follows.

- Integrated Modifying Factors MFI and Group Modifying Factors MFG in group (a)

$MFI_{BODY - VOLATILITY} = 1$ x $0.5 + 0.3$ x $0.5 + 3$ x $0 = 0.65$

$MFI_{HANDS - VOLATILITY} = 1$ x $0.5 + 0.3$ x $0.5 + 3$ x $0 = 0.65$

As only one modifier is selected, the group (a) modifier gives

$MFG(a)_{BODY} = MFI_{BODY - VOLATILITY} =$ rounded to 0.3

$MFG(a)_{HANDS} = MFI_{HANDS - VOLATILITY} =$ rounded to 0.3

These values are permitted according to Table 13.

- Integrated Modifying Factors MFI and Group Modifying Factors MFG in group (b)

$MFI_{BODY - AMOUNT}$ = 3 x 0.5 + 3 x 0.5 + 3 x 0 = 3

$MFI_{HANDS - AMOUNT}$ = 3 x 0.5 + 3 x 0.5 + 3 x 0 = 3

$MFI_{BODY - RESTRICTED}$ = 3 x 0.5 + 3 x 0.5 + 3 x 0 = 3

$MFI_{HANDS - RESTRICTED}$ = 3 x 0.5 + 3 x 0.5 + 3 x 0 = 3

As two modifiers are selected, the group (b) modifier gives

$MFG(b)_{BODY}$ = $MFI_{BODY - AMOUNT}$ x $MFI_{BODY - RESTRICTED}$ = 3 x 3 = 9

$MFG(b)_{HANDS}$ = $MFI_{HANDS - AMOUNT}$ x $MFI_{HANDS - RESTRICTED}$ = 3 x 3 = 9

These values are permitted according to Table 13.

- Integrated Modifying Factors MFI and Group Modifying Factors MFG in group (c)

As no modifier is selected, the group (c) modifier gives

$MFG(c)_{BODY}$ = 1

$MFG(c)_{HANDS}$ = 1

These values are permitted according to Table 13.

- Total modifying factors MFT

MFT_{BODY} = $MFG(a)_{BODY}$ x $MFG(b)_{BODY}$ x $MFG(c)_{BODY}$ = 0.3 x 9 x 1
           = 2.7, rounded to 3

MFT_{HANDS} = $MFG(a)_{HANDS}$ x $MFG(b)_{HANDS}$ x $MFG(c)_{HANDS}$
           = 2.7, rounded to 3

5.1.3.4 The Modified Potential Exposure Rate

The total modifying factor (MFT) is used for an estimate of the potential exposure rate PER in the situation under investigation, for body exposure and for hands exposure separately. This is done by multiplication of the MFT values with the default potential exposure rate DPE from chapter 5.1.3.1. The result is assigned a qualitative rating using Table 14.

PER_{BODY} = MFT_{BODY} x DPE_{BODY}

PER_{HANDS} = MFT_{HANDS} x DPE_{HANDS}

Example, continued:

The potential exposure rates PER are calculated as follows.

PER_{BODY} = MFT_{BODY} x DPE_{BODY} = 3 x 0.05 mg cm^{-2} h^{-1}
           = 0.15 mg cm^{-2} h^{-1} – high, according to Table 14

PER_{HANDS} = MFT_{HANDS} x DPE_{HANDS} = 3 x 0.117 mg cm^{-2} h^{-1}
           = 0.35 mg cm^{-2} h^{-1} – medium, according to Table 14

Table 14   Qualitative Rating of Dermal Exposure Rates

Rating	Potential body exposure rate (mg cm^{-2} h^{-1})	Potential hands exposure rate (mg cm^{-2} h^{-1})
Very low	0 - 0.001	0 – 0.005
Low	0.001- 0.01	0.005 – 0.05
Medium	0.01 - 0.1	0.05 – 0.5
High	0.1 - 1	0.5 – 5
Very High	1 and higher	5 and higher

5.2 Actual Dermal Exposure Rate

The Actual Exposure Rate AER is derived from the Potential Exposure Rate PER as follows.

For body exposure, a reduction by work clothing is assigned following the information given by the user of the toolkit, as given in Table 15. For hand exposure, Actual Exposure Rate AER is assumed to equal Potential Exposure Rate PER because hands are not clothed in most working situations.

Chemical Protective Clothing or Gloves are not considered here, but they are dealt with later when dealing with control actions, see Table 31.

Table 15   Transformation of Potential into Actual Dermal Exposure Rate

Tick Box	Type of clothing worn	AER_{BODY} (mg cm^{-2} h^{-1})	AER_{HANDS} (mg cm^{-2} h^{-1})
	Summer clothing (e.g. T-shirts, shorts)	$= 0{,}5 \times PER_{BODY}$	$= PER_{HANDS}$
	Heavy work clothing	$= 0{,}1 \times PER_{BODY}$	$= PER_{HANDS}$

PER: Potential Dermal Exposure Rate
AER: Actual Dermal Exposure Rate

The value without units of the Actual Exposure Rate of the hands from Table 15 is assigned the **AER scores**

AER score (local effects) = AER_{HANDS} / (mg cm^{-2} h^{-1})

- for further use in Table 20.

AER score (systemic effects) = $(AER_{BODY} + AER_{HANDS})$ / (mg cm^{-2} h^{-1})

- for further use in Table 22.

5.3 Exposed Body Area

Table 16   Body Parts and Typical Exposure

Tick Box	Exposed Body Parts	Typical Area (cm²)
	Small Area like piece of coin	10
	One hand or less	900
	Hands	1,800
	Lower arms	1,400
	Upper arms	1,400
	Head	1,400
	Chest	3,000
	Back	3,000
	Legs and Feet	7,800
–	TOTAL = Sum of ticked areas, rounded	…….

The exposed body area is read from information given by the user.

The area values were calculated from the Final Report of Working Group 1 within the Riskofderm project.

Similar values can be obtained from: US OSHA Internet guidance on dermal dosimeters, see www.osha-slc.gov/SLTC/dermalexposure/tables.html#Table%202

5.4 Handling of Exposure - for Hazards with Local Effects

Table 17   Scores for Activity Time AT
            (for substances with local health effects)

Duration of working task, h/day	**Corrosive chemicals,** R34 or R35 or pH $\leq$ 2 or pH $\geq$ 11.5 apply	**Other risk phrases** from Table 2 apply
< 0.1	1	0.1
0.1 - < 0.5	3	0.1
0.5 - < 1	3	0.3
1 - 4	3	1
> 4	3	3

Time (duration) of exposure and the hazard information are read from information given by the user (see Question E 3).

Table 18   Scores for Actual Exposure Dose AED
            (for substances with local health effects)

AER score x AT score	**AED score**
< 0.01	0.1
0.01 - < 0.1	0.3
0.1 - 3	1
> 3	3

AER: Dimensionless value of the Actual Exposure Rate of the hands, see Table 15.
AT: Activity Time, see Table 17.

Table 19   Scores for Exposed Body Area EBA
(for substances with local health effects)

Exposed Body Area EBA, cm²	EBA score
< 10 (size of a large coin; small splashes)	0.1
10 - 1000 (one hand or less)	0.3
1001 - 3000 (hands and lower arms, or hands and head)	1
> 3000 (more than hands & head)	3

The exposed body area is read from Table 16.

Table 20   Actual Exposure AE Scores
(for substances with local health effects)

AED score x EBA score	Actual Exposure AE scores
> 0.01	Low
> 0.02 - 0.2	Moderate
> 0.2 - 2	High
> 2	Very high

AED: Actual Exposure Dose, see Table 18.
EBA: Exposed Body Area, see Table 19.

5.5 Handling of Exposure - for Hazards with Systemic Effects after Uptake

Table 21   Scores for Activity Time AT
         (for substances with systemic health effects after percutaneous uptake)

Duration of working task, h/day	**AT score**
< 0.5	0.1
0.5 - < 4	0.3
> 4	1
Frequent immersion	3

Time (duration) of exposure is read from information given by the user (see Question E 3).

Table 22   Scores for Actual Exposure Dose ED
         (for substances with systemic health effects after percutaneous uptake)

ER score x AT score	**ED score**
< 0.01	0.01
0.01 < (ER score x AT score) < 6	= (ER score x AT score)
> 6	6

ER: Dimensionless value of the Actual Exposure Rate of the hands, see Table 15.
AT: Activity Time, see Table 21.

Table 23   Scores for Exposed Body Area EBA
         (for substances with systemic health effects after percutaneous uptake)

Exposed Body Area EBA, cm²	**EBA score**
Any area	= EBA / cm²

The exposed body area is read from Table 16.

The absolute **Internal Exposure score IE** is calculated by multiplication of ED (from Table 22) and EBA (from Table 23):

IE_{abs} = ED x EBA

The relative **Internal Exposure score RIE** is calculated by division of IE_{abs} by 70:

IE_{rel} = IE_{abs} / 70

The **Internal Exposure score IE** is read from Table 24.

Table 24   Internal Exposure IE scores
    (for substances with systemic health effects after uptake)

Absolute **Internal Exposure score**	Relative **Internal Exposure score**	**Internal Exposure IE score**
0.5 or less	0.007 or less	Negligible
> 0.5 – 5	> 0.007 - 0.07	Low
> 5 – 50	> 0.07 - 0.7	Moderate
> 50 - 500	> 0.7 - 7	High
> 500 – 5,000	> 7 - 70	Very high
> 5,000	> 70	Extreme

6. Decision Tables for Risk Assessment

6.1 Risk Assessment for Hazards with Local Effects

The hazard score is read from Table 8.

The actual exposure score is read from Table 20.

Table 25   Health risk scores
     – for substances with local health effects

Actual Exposure score (local)	Hazard score (local)				
	Low (no risk)	Moderate	High	Very high	Extreme
Negligible	1	1	2	5	6
Low	1	2	5	6	8
Moderate	2	3	6	8	9
High	3	6	8	9	10
Very high	6	8	9	10	10
Extreme	7	9	10	10	10

Meaning of the risk scores:

  1.   No action
  2.   No special measures to be taken, basic skin care
  3.   Exposure reduction, if easily accomplished
  4.   Action necessary: primarily exposure reduction to be considered
  5.   Hazard reduction desirable
  6.   Action necessary: mixture of measures, priority for detailed analyses
  7.   Exposure reduction urgent
  8.   Only exceptionally tolerable, substitute, if any possible
  9.   Reduce exposure drastically in any case, stop working
 10.   Substitute in any case, stop working

6.2 Risk Assessment for Hazards with Systemic Effects

The hazard score is read from Table 8.

The internal exposure score is read from Table 24.

Table 26   Health risk score
         – for substances with systemic health effects after uptake

Internal Exposure score (systemic)	Hazard score (systemic)				
	Low (no risk)	Moderate	High	Very high	Extreme
Negligible	1	1	2	5	6
Low	1	2	5	6	8
Moderate	2	3	6	8	9
High	3	6	8	9	10
Very high	6	8	9	10	10
Extreme	7	9	10	10	10

Meaning of the risk scores:

1.   No action
2.   No special measures to be taken, basic skin care
3.   Exposure reduction, if easily accomplished
4.   Action necessary: primarily exposure reduction to be considered
5.   Hazard reduction desirable
6.   Action necessary: mixture of measures, priority for detailed analyses
7.   Exposure reduction urgent
8.   Only exceptionally tolerable, substitute, if any possible
9.   Reduce exposure drastically in any case, stop working
10.   Substitute in any case, stop working

7. Planning Of Control Actions

7.1 Control Efficiency

Table 27   Efficiency Classes of Control Actions

Control Efficiency Class	Potential Exposure (as assessed by applying the toolkit) is multiplied by factor:	Description
4	0	No remaining exposure / risk
3	0,01	Almost complete control of exposure / risk
2	0,1	Considerable effect
1	0,3	Slight effect
0	1	No effect
-1	3 - 10	Unintended higher overall risk after implementation of an improper measure

7.2 Control Actions

Table 28   Control by Substitution

Control Action	Evaluation	Control Efficiency Class
Substitute the hazardous product, select one with lower hazard score	Apply the tool-kit to the new situation and estimate new hazard and / or new exposure and / or new risk	between 4 and -1
Substitute whole process or working technique, select one with lower exposure score		

It is intended that in the final computerised version the user will be directed via a hot link to the relevant questions in the hazard and/or exposure section.

Table 29   Control by Technical Measures

Control Action	Condition	Examples	Control Efficiency Class
Containment of source	Complete containment, no contact with contaminated objects or tools		4
	Complete containment, BUT occasional contact with contaminated objects or tools	Handling, connecting or dismantling of pipes or containers (canning, taking samples etc.); handling of contaminated parts	2
	Complete containment, BUT regular contact with contaminated objects or tools	Manual taking of samples (which is associated with direct skin contact in many cases)	1
Use of tools instead of hands. Relevant mainly for exposure by direct contact, e.g. immersion	Complete separation, no remaining contamination by surface contact or by deposition	Tongs with long arms	4
	Complete separation, but some contamination from surface contact and / or deposition		2
	Some separation		1
	No significant effect		0

To be continued

Table 29, continued

Control Action	Condition	Examples	Control Efficiency Class
Ventilation Relevant mainly for exposure to dust and aerosols, by deposition from air	Purpose-built local exhaust ventilation with high efficiency, supported by documentation at the specific workplace	Complete extraction is the exception, - but efficient exhaust ventilation can provide almost complete protection against dermal exposure by deposition	2
	Local exhaust ventilation	Complete efficiency is the exception	1
	General mechanical ventilation, laminar flow ventilation systems	General ventilation is fairly ineffective in these case	0
	General natural ventilation (doors, windows)	No improvement	0

Table 30   Control by Organisational Measures

Control Action	Condition	Examples / Evaluation	Control Efficiency Class
Reduction in the amount of chemical in use (compared with Table 12b)	Min 95 % reduction of chemical used	Mass of early skin contamination gives more contact than later contamination => non-linear correlation	2
	Reduction of 20 - 95 %		1
	Less than 20 %		0
Reduction of exposure duration		Apply the tool-kit to the new situation and estimate new exposure	Between 4 and -1
Reduction of exposed area		Apply the tool-kit to the new situation and estimate new exposure	Between 2 and 0

To be continued

Table 30, continued

Control Action	Condition	Examples / Evaluation	Control Efficiency Class
Training, Instructions	Frequent oral instructions (e.g. every month) PLUS regular inspection of work by safety personnel	Considerable effect but there is a significant probability that rules will not be followed outside inspection events	2
	Frequent oral instructions s (e.g. every month)	Low effect without control in most cases	1
	Written instructions	Information will not be read in most cases	0
	Infrequent oral instructions (e.g. annually)	Information will get lost in most cases	0
Cleaning of contaminated surfaces and tools Relevant mainly for exposure by surface contact	Several times a day, high effectiveness	Wet wiping or similar	3
	Several times a day, average effectiveness	No good hygiene practice	2
	Once a day, high effectiveness		2
	Once a day, average effectiveness		1
	Once a weak, average effectiveness		0
	Seldom and / or ineffective	Accumulation of contaminants	-1

Table 31   Control by Personal Protection

Control Action	Condition	Remarks	Control Efficiency Class
Chemical Protective Clothing (Gloves or Suit)	Special rubber or plastic, the barrier effect is well documented (see special information). Discarded after safe protection time is elapsed. Good handling practice*	Some additional risk from allergens in glove and from occlusion effect	3
	Special rubber or plastic, the barrier effect is well documented (see special information). Discarded after safe protection time is elapsed. Untrained handling.	Some remaining skin exposure by inside contamination, PLUS see above	2
	Special rubber or plastic, the barrier effect is not documented. Discarded max. 5 minutes after first contamination occurred.	Risk of enhanced skin exposure if gloves are not discarded in good time, PLUS see above	1
	Textile or leather, discarded or cleaned immediately after exposure ends.	ONLY true for exposure to dry solids.	1
	Special rubber or plastic, the barrier effect is well documented (see special worksheet). Wearing time is longer than the safe protection time.	Accumulation of contaminants, extended contact, PLUS see above	0
	Special rubber or plastic, the barrier effect is not documented. Worn longer than max. 5 minutes after first contamination occurred	Accumulation of contaminants, extended contact, PLUS see above	-1
	Textile or leather. Worn even after contamination	Accumulation of contaminants, extended contact, PLUS see above	-1

To be continued

Table 31   - continued

Control Action	Condition	Remarks	Control Efficiency Class
Cleaning of contaminated clothing / gloves	Immediately after each single exposure ends	Does not avoid, but shortens exposure	1
	At every break	Avoids accumulation of contaminants	0
	Once a day	Accumulation of contaminants, extended contact	-1
	Never	Accumulation of contaminants, extended contact	-1
Head Shield, face and eyes	Worn during exposure	Low rating because the protected area is relatively small	2
Protective Glasses, protecting eyes	Worn during exposure	Low rating because the protected area is only small	1
Cleaning of hands with water + soap	Immediately after exposure ends		1
	At every break		0
	Once a day	Accumulation of contaminants	-1
	Never	Extended contact, oral exposure	-1
	Abrasive cleaning	Skin damage	-1
	Solvent cleaning	Skin damage and penetration	-1

To be continued

Table 31   - continued

Control Action	Condition	Remarks	Control Efficiency Class
Skin Care Creams, applied before work starts. Relevant only if the local effects determine the hazard.	Selected for the specific workplace	Contact of chemical to skin is not excluded - but the skin barrier is fortified	0
	Usefulness for the specific workplace is unclear	Contact of chemical to skin is not excluded, sometimes even expanded	-1
Skin Protection Creams, applied before work starts. Relevant only if the local effects determine the hazard.	Selected for the specific workplace	Contact of chemical to skin is not excluded - but skin is fortified against hazard	0
	Usefulness for the specific workplace is unclear	Contact of chemical to skin is not excluded, sometimes even expanded	-1
	Cream does not help with the chemicals in use	W/O creams with organic solvents, O/W creams with aqueous solutions	-1