Department 4
Planning and Development

GTZ Chemical Management Guide for Small and Medium Sized Enterprises

Improve Chemical Management to Gain Cost Savings, Reduce Hazards and Improve Safety

October 2006

gtz

Commissioned by:
Federal Ministry
for Economic Cooperation
and Development

The method of linking Risk Phrases (R-Phrases) with classification into hazard bands and the identification of needed control approaches described in Tool 7 of this Guide is based wholly on the approach of the ILO Safework Chemical Control Toolkit © 2001 produced by the Geneva-based International Labour Organisation working in collaboration with the International Occupational Hygiene Association (IOHA) and Health and Safety Executive (HSE) in the UK.

The integration of this approach into the Guide is gratefully acknowledged.

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Layout: Kerria Geller and www.design-werk.com

The Convention Project Chemical Safety is implemented by GTZ on behalf and with the funding of the German Ministry for Economic Cooperation and Development (BMZ)

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Preface

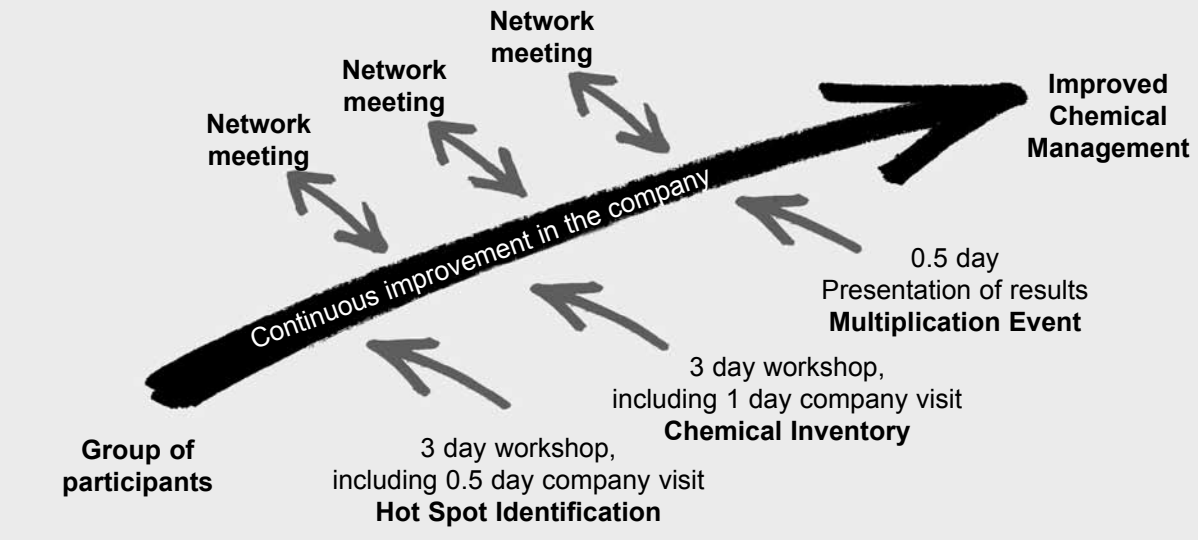
This Guide is of interest to companies who want to gain cost savings and reduce risks in the workplace. It is especially relevant for companies where chemicals represent a major portion of their running costs. By improving the management of chemicals, companies can lower production costs, improve product quality, reduce their environmental impact, and improve the health & safety conditions for workers and thereby their motivation and productivity.

This Guide describes a step-by-step approach to identify and reduce costs and risks related to the use of chemicals. The approach is based on identifying 'hot spots' as a first step, and making a chemical inventory as a second step. The two steps provide the necessary information to observe and calculate potential losses, assess risks, consider substitutes (in terms of form and/or alternative substances), determine improvement measures and adequate controls, implement measures in a systematic way, and monitor and evaluate the results obtained.

The Guide was developed as part of a modular training approach for small and medium sized enterprises. This interactive training program is designed for representatives of companies, for representatives of intermediary institutions and for consultants / trainers. In between the different training modules, moderated network meetings are held with the group of participants. The work with groups of participants / companies has proved to be very efficient by sharing experiences and supporting each other through the whole process.

A chemical management training program can be outlined as follows:

Figure 1: Programme "Arrow" Chemical Management Training



The duration of a complete training program is about 6 months, foreseeing about one month's time in between the different activities (training modules and network meetings).

The approach outlined in this Guide considers the specific operating conditions of companies in developing countries. It is intended to guide companies towards implementing a framework for effective and preventive Chemical Management, enabling enterprises to move in the direction of continuous improvement.

Activities undertaken to improve the management of chemicals will support companies in fulfilling government legislation related to chemical management. This Guide does not replace legal requirements. It is intended to help companies improve their practices with respect to chemical storage, handling, use, and labelling.

This Guide has been developed by the GTZ Convention Project Chemical Safety in collaboration with the Indonesian-German Environmental Programme (ProLH), the German Federal Institute for Occupational Safety and Health (BAuA) and the Pilot Programme for the Promotion of Environmental Management in the Private Sector of Developing Countries (P3U).

The concepts presented in this Guide have been implemented in small, medium, and large-sized companies in the textile and leather sectors in Indonesia as well as in an Indonesian company which produces paint for the domestic market. These experiences provided insights into the obstacles that companies typically face in undertaking chemical management.

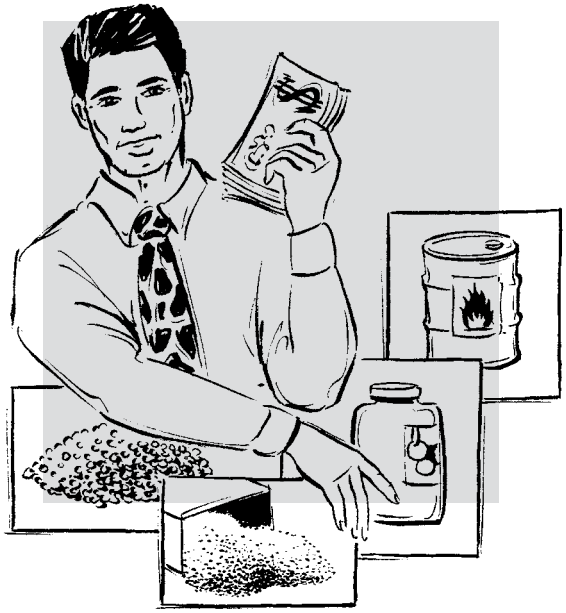
Success stories from the actual application of this Guide in Indonesian companies have been included to demonstrate the value and benefits for companies of improving chemical management.

Part I - How can you benefit by improving chemical management?

Part I – How can you benefit by improving chemical management?

1. Why should companies manage chemicals?

Of the 5-7 million known chemical substances, more than 80,000 are used by companies in their production processes and operations. Numerous new chemicals are discovered and produced each year. Today, almost every company uses some type of chemical. Those enterprises that effectively manage chemicals can gain concrete benefits.



1.1 Benefit by reducing costs and environmental impact

Chemicals can represent a major part of the production cost for companies. Any measures that can be taken to reduce the loss, waste, contamination, and expiry of these substances will bring cost savings to companies and at the same time, reduce their environmental impact.

1.2 Benefit by becoming more competitive

While chemicals are often used to achieve certain characteristics and qualities in a product – consumers do not want harmful chemicals in the products they buy or in the environment. Companies that avoid using banned and restricted substances can avoid having their products rejected in the marketplace.

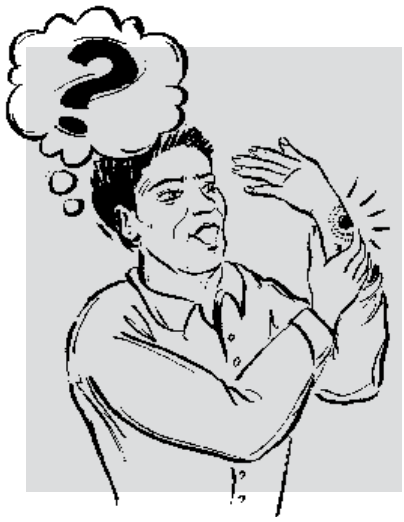
Growing consumer consciousness of environmental and social issues has led to the creation of buyers' requirements that suppliers must increasingly fulfil to have their products accepted in many international markets. By identifying and reducing the use of banned chemicals and hazardous substances, companies can improve their competitive position and make the communities where their operations are located safer. Moreover, by improving the management of chemicals, companies that are working to achieve certification under management system standards such as ISO 9000 (quality) and 14000 (environment) will gain synergies. Many of the activities required for Environmental Management Systems (EMS) certification are aimed at reducing the use of hazardous substances, protecting the health of workers and reducing negative effects on the natural environment.

1.3 Benefit from improving workers' health & safety

Chemicals alone or mixed with other substances can cause injury, disease, or even death for people handling these materials. The misuse of chemicals may result in fires and explosions. Accidents involving chemicals create additional costs for companies in terms of lost materials, damaged equipment and facilities, and personal injury.

Reducing health and safety risks for employees improves their motivation and productivity and reduces absenteeism due to injury and illness.

2. What does chemical management involve?



To effectively manage chemicals, you need to:

- know the characteristics/hazardous properties of all chemical substances that are stored and in use in your enterprise;
- know the amounts of frequently used chemicals kept at hand;
- give your workers information on the harmful nature of the substances they use at work;
- train them on handling chemicals safely and economically, on using controls correctly, and what to do if something goes wrong;
- calculate the amounts of chemicals that are actually being used in production;
- evaluate the amounts of chemicals that are contaminated, lost, wasted, and/or expired – and therefore no longer available for use;
- identify situations where hazards are present (hazard means anything that has the potential to cause harm to people and/or the environment);
- investigate whether alternative, less hazardous substances/approaches can be used to achieve a similar effect in production and product quality;
- undertake measures to use chemical substances more efficiently and more safely;
- monitor the implementation of actions and undertake improvements on a continuous basis;
- measure the results achieved.

3. What stops companies from doing chemical management?

Companies operating in developing countries typically have limited financial and skilled human resources. Faced with a daily struggle for existence, their main focus is on producing and selling the end product. The idea of managing chemicals is often at the bottom of the list of organisational priorities.

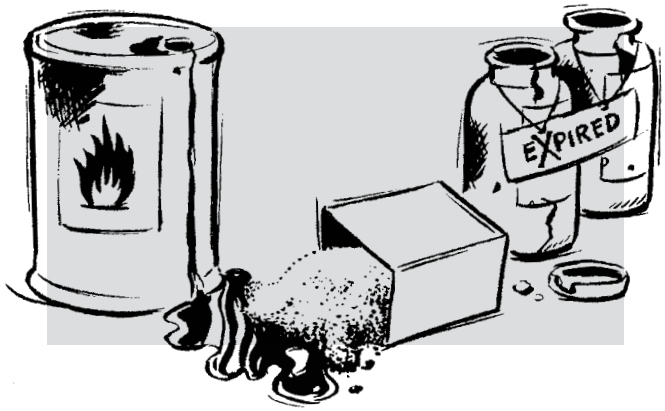
Moreover, in family-run enterprises where expertise tends to be passed from one generation to the next, gaining access to the most current information

What obstacles do companies face?

- **Lack of information about the quality, quantity, characteristics and hazards of chemical substances being used;**
- **low quality or inadequate characteristics of purchased chemicals to achieve the desired effect in production;**
- **poor labelling; unknown substances;**
- **limited financial and human resources;**
- **absence of systematic organisational procedures & documentation;**
- **lack of priority and responsibility given to managing chemicals.**

about the proper storage, handling, use, and risks of chemicals is a challenge.

Due to these limitations, companies tend to take a reactive approach. Attention is often only put on managing chemicals after accidents or problems in the production process have occurred.



However, a preventive strategy can help avoid accidents and the significant costs related to such occurrences. A preventive approach helps companies to spot weaknesses and problems at an early stage. Any measures that companies can take to prevent problems in the first place will avoid the significant costs related to such occurrences.

4. Taking a step-by-step approach to chemical management

The preventive approach to managing chemicals that is described in this Guide will help you identify opportunities to gain cost savings, lower the environmental impact of your operation, and reduce health risks to which workers are exposed in daily operations.

This Guide describes a step-by-step approach for achieving the economic and safe management of chemicals.

First Module – Identifying 'hot spots'

This first step is intended to trigger thinking about chemical management. It enables companies to quickly spot opportunities to:

- gain cost savings from more efficient use, handling, storage, waste management and disposal of chemicals;
- identify especially hazardous situations where chemicals are stored and used;
- determine the necessary approaches to reduce the potential for harm;
- act, monitor and evaluate the results achieved.

This step is appropriate for companies of any size where, until now, little attention has been placed on managing chemicals.

Second Module – Making a comprehensive inventory

This step helps companies get their whole house in order. It involves:

- systematically identifying all chemical substances stored and in use;
- creating a structured information base (through the creation of a Chemical Inventory Table) that can be used to make improvements on a continual basis.

This step is appropriate for companies that have already undertaken some basic measures to optimise the use of chemicals and address 'hot spots'. It lays out a framework for companies to continually reduce the use and risk of chemicals kept at hand.

Part II – Going into action

First Module – Identifying 'hot spots'

- **Step 1** Fact finding / Identification of possible 'hot spots'
- **Step 2** Analysis of effects related to costs, hazards and environmental impacts
- **Step 3** Analysis of causes – Why are chemicals being wasted?
- **Step 4** Development of measures
- **Step 5** Action / Implementation of measures (chemical management action plan)
- **Step 6** Evaluation and integration into the company structure

Second module – Making a comprehensive inventory

- **Step 1** Fact finding / Inventory of chemicals
- **Step 2** Risk and cost assessment
- **Step 3** Analysis of causes
- **Step 4** Development of measures
- **Step 5** Action / Implementation of measures
- **Step 6** Evaluation and integration into the company structure

Part II – Going into action

First Module – Identifying 'hot spots'

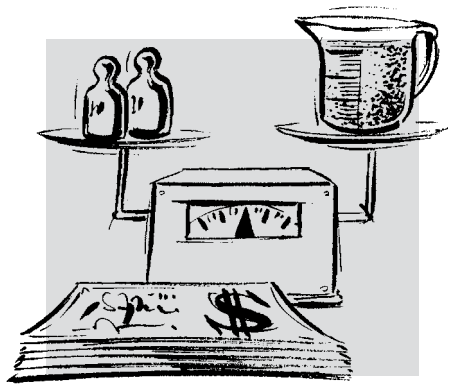
Companies which have given little attention to chemical management have told us that they need to see the short-term benefits of such efforts before they will be convinced of its merit. For this reason, the identification of 'hot spots' can be a practical first step for improving chemical management in your operation.

To identify 'hot spots', you need to look at your operations in a different way. Rather than focusing on the end product, you need to look in a detailed way at the storage, handling and use of chemicals in the production process.

Look specifically at how chemicals are being treated in the steps involving their purchase, storage, handling, and processing with the aim of spotting inefficiencies, waste, losses, and risks.

The output of chemicals in products and their disposal in waste should also be considered. The inefficient use of materials often leads to an unnecessarily high level of chemicals used (which are expensive to buy in the first place!) which end up in the final products and waste.

"Achieving continuous improvement by working in cycles"



Chemical management is not just another "change project", where an external consultant comes into the company, asks a lot of questions and delivers a report full of suggestions that will never be implemented.

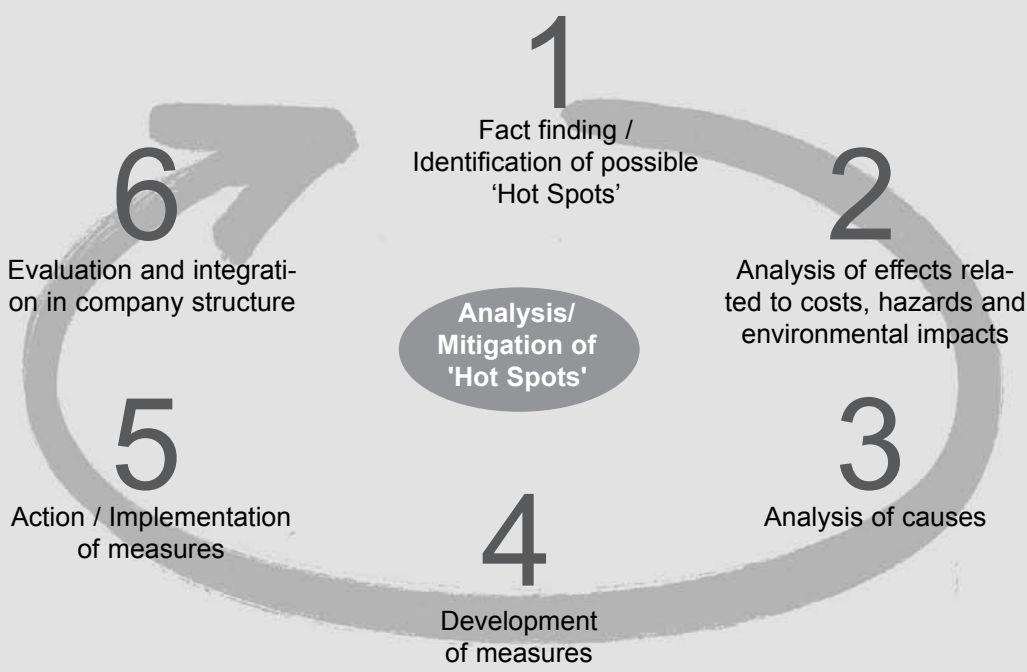
Chemical management means a change in the company culture, which leads to a process of continuous improvement. In order to introduce such a continuous improvement, working in "cycles" is the appropriate approach. A series of six implementation steps – building on each other – is the appropriate framework for the application of successful and sustainable procedures in a company. Repeating these steps again and again is equal to working in circular processes and is the basis for continuous improvement.

For the success of chemical management, it is important that the company completes each and every step of the cycle. In the case of 'Identifying Hot Spots', these steps can be formulated as shown on the next page.

'Hot spots' are defined as places where you observe:

- **economic losses due to inefficient storage, handling, use and/or disposal of chemicals and where improved practices could lead to cost savings;**
- **risks for workers' health and / or the environment linked to the handling of chemicals and where potential harm to the workers and / or the environment can be reduced.**

Figure 2: The Chemical Management Cycle – 'Hot Spots'

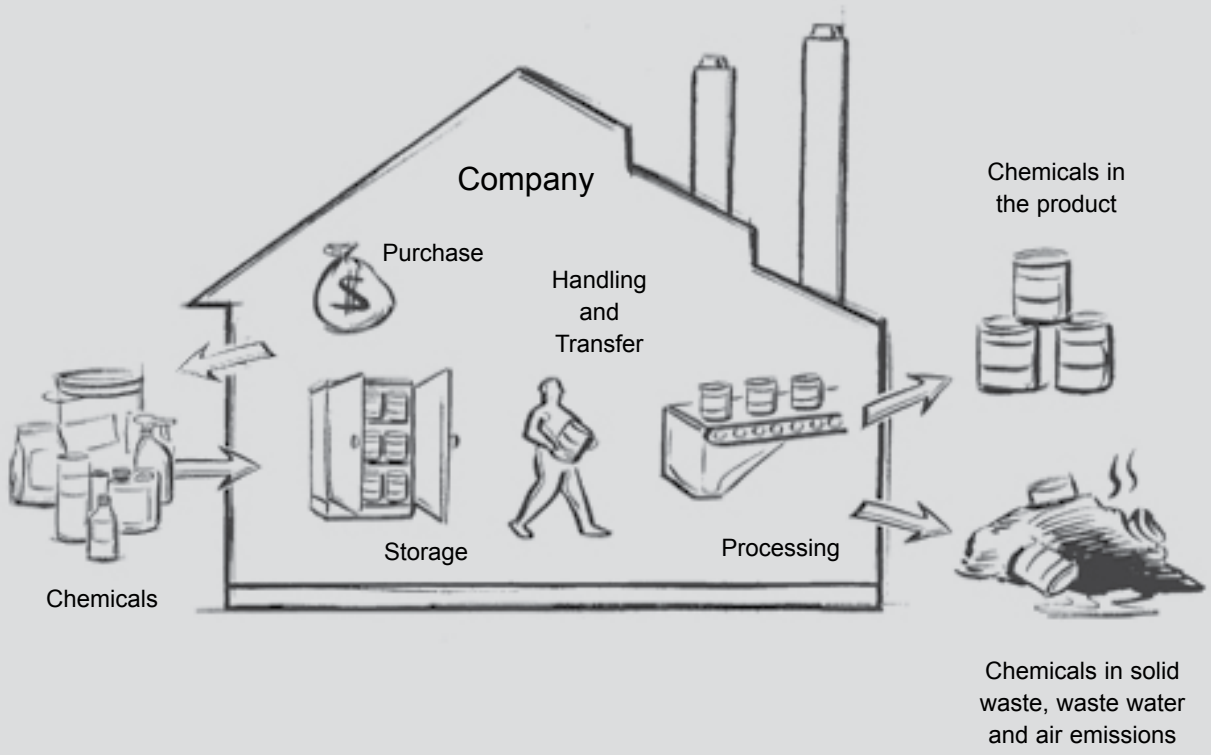


Step	Action	Benefit
Step 1	Fact finding / Identification of possible 'hot spots'	Knowing the 'hot spots'.
Step 2	Analysis of effects related to costs, hazards and environmental impacts	Learning about the quantity of losses and the hazards for workers and the environment and being able to select the most important 'hot spots' for further action.
Step 3	Analysis of causes	Having a sound basis for the development of appropriate measures (you can only develop effective measures if you know the exact causes).
Step 4	Development of measures	Knowing exactly the positive effects of a measure with respect to saving costs and hazard reduction (you have to be convinced of a positive outcome before you are motivated to act).
Step 5	Action / Implementation of measures	Carrying out the positive measures.
Step 6	Evaluation and integration into the company structure	Aiming for continuous improvement / changing procedures in a sustainable manner.

Step 1: Fact finding / Identification of possible 'hot spots'

To identify 'hot spots', we suggest that you do a good walk-through of your entire operation, following the flow of chemicals (see Figure 3) through the different steps of purchasing, delivery, storage, handling, processing, and disposal.

Figure 3: Simplified Flow of Chemicals in an Enterprise



Only if you know the deficiencies you can change habits or processes!!

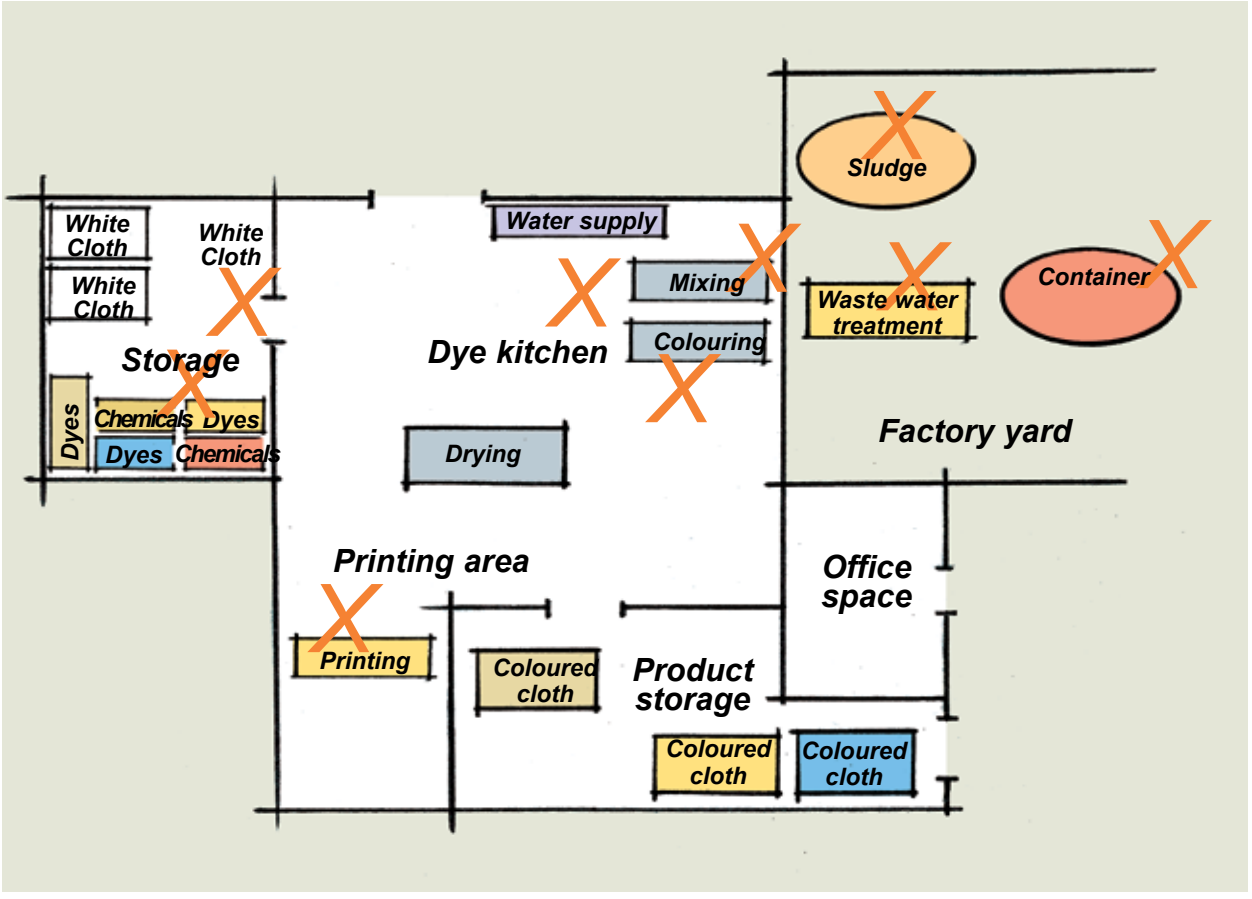
1. Draw a simple ground plan of the company (see Figure 4) – you can also use an existing company floor plan:

- note the main areas and departments;
- mark where chemical substances are used, stored and transported;
- indicate possible 'hot spots'

2. With your drawn ground plan conduct a walk-through in the company and write down your observations on a work sheet, (see Figure 5) noting all situations where you see:

- the waste, loss, contamination, or expiry of a substance;
- potential hazards created in the way that chemicals are stored, mixed, transported, and used.

Figure 4: Simplified Ground Plan of the Textile Company Beautiful Colours



What should you look for during the walk-through?

In order to identify potential opportunities for cost savings and for reducing risks (i.e. 'hot spots') – as you walk around your operations – look for:

- places where you see chemical substances spilled on the floor;
- places where you see dust clouds created during transferring or weighing operations;
- lids that are not tightly sealed where the contents are exposed to air, humidity, etc.;
- containers that are partially or completely uncovered where fumes may escape;
- chemical containers such as bags, drums, bottles, tins or others that are dented, damaged or defective;
- chemical packaging that is deteriorating due to leakage, damage, floor water, humidity, etc.;
- containers that have no labels or where the labels are damaged;
- chemical containers that are being used for other purposes, e.g., storing water, storing and transferring other materials;
- situations where workers have created and are using makeshift personal protection devices (e.g. a towel wrapped around face);
- places in the factory where workers complain about health effects, loss of consciousness, etc.;
- incidents of fire, explosion, or accident in the past year;
- leaking roofs;
- ignition sources such as heat / sparks / open flames in the neighbourhood of flammable liquids / gases / dusts
- containers that are labelled with hazard symbols;
- situations where the skin of workers is contaminated with chemicals;
- spoiled or expired chemicals;
- situations where workers do not have appropriate tools for mixing, weighing, transportation, etc.

Step 2: Analysis of effects related to costs, hazards and environmental impacts

Having written down your observations about inefficiencies, waste, losses, and hazards in all areas where chemicals are stored and used, you now need to assess the risks. These include losing money from the poor utilisation of chemicals, lower product quality, poor worker motivation and low productivity.

It might cause harm, if you continue with present practices.

Use the work sheet (Figure 5) with your observations to determine losses and to evaluate the potential for cost savings and reducing risks.

Figure 5 : Example Worksheet

Area in Factory	Observations / Hot Spots	Quantities, costs, estimated losses, etc.	Possible hazard	Hazard symbols
Delivery & Chemical Store	The packaging of some calcium carbonate bags is damaged before and during their unloading into the chemical store	How much material could be saved by changing procedures to minimise losses? How much could product quality be improved by reducing chances that raw material has impurities or becomes contaminated?		
Dye Kitchen	Spillage of dyestuffs around mass balance	How much material could be saved by avoiding accidental mixtures?	Can the direct contact (with skin, by inhalation) with these dye-stuffs cause damage to workers' health?	Some containers are labelled with the hazard symbol Xn (harmful)
Production Area	Storage of flammable liquids close to machines Solvent containers where the lids are off Spillage of materials during mixing	What costs/losses in machinery can be caused by potential fires? How much solvent is lost by evaporation? How much material is spilled? What are the related losses?	Are possible fires directly affecting human health? Is the use of this substance causing serious harm to human health and/or the environment?	

Go through each of your observations, asking yourself these questions:

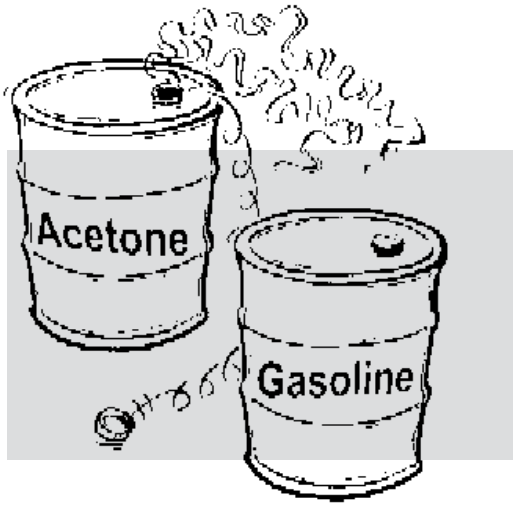
- What quantity of a particular chemical substance is actually needed for the production process?

(For the estimation of quantities refer to figure 12).

- Do you have any recipes, specifications, or guidelines from suppliers that provide this information?
- What quantity of substances is actually being used?
- Do you have records that you can use to accurately verify the amounts of substances received and withdrawn from your stock?
- Can you observe transfer & handling processes and measure exactly what amounts are used?
- If not, can you make assumptions about the amounts of substances actually being used in your production process?
- Are the amounts of chemicals actually being used more than the amounts specified in your recipes, specifications?
- How much material (= costs) is lost due to accidents?
- Do you have records for worker injury/accident in order to know the frequency of such occurrences?
- Is material lost due to poor labelling and accidental mixtures?
- Could product quality be enhanced by avoiding situations where raw material has impurities or becomes contaminated on site?
- Is a substance seriously harmful to human health or the environment?
- Can this harm be minimised or even prevented entirely by:
  - using a less hazardous substance?
  - changing the form of the substance (e.g. granule dyestuffs instead of powdery dyestuffs)?
  - applying engineering control (e.g. ventilation)?
  - ensuring that the most effective chemicals are used in the production process? (e.g. fixation degree of dyestuff)
  - using personal protective equipment (PPE)?

For all estimations, be guided by the following principle:

Better be roughly right, then precisely wrong



Step 3: Analysis of causes – Why are chemicals being wasted, which risks exist?

With respect to the 'hot spots' identified, ask the following questions and document the answers:

- Can you identify the causes for losses of chemicals during delivery and in your storage area?
- Do you observe any practices or activities that lead to losses during handling and weighing operations?
- Do you ensure that only the needed quantity of chemicals is premixed?
- Do you make sure that the appropriate quantity and mixtures of chemicals are used in the production process?
- Do you know the expiry dates of all chemicals kept at hand?
- Do you use materials first which you bought first (fifo: first in – first out)?
- Can you find out the hazardous properties of the used substances?
- Are your workers informed about the hazardous properties of the substances?
- Is personal protective equipment used and kept in good working order?
- Is ventilation appropriate?

Step 4: Development of measures

Having analysed your observations and found that chemicals are indeed being lost, wasted, contaminated, expired and/or are causing harm to human health or the environment – you now need to think about measures that can be undertaken to reduce losses and potential harm.

Having thoroughly analysed in step 3 the causes and the 'causes behind the causes' for observed 'hot spots' and hence knowing exactly what is wrong / can be optimised, you know the right base for developing appropriate measures by 'turning the causes into measures'.

Example: Causes and Measures-

Hot Spot	Causes	Measures
Eating and drinking in the workplace	No notices prohibiting eating or drinking are visible	Introduce notices / signs / work instructions
	Workers are not aware of the related risks	Provide in-house training
	The workers have no place to eat and drink outside the production area	Provide a suitable place for break times

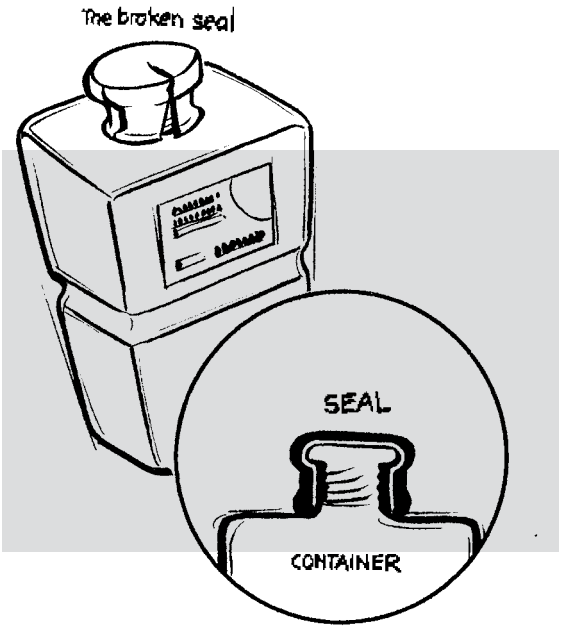
Formulate corrective measures by asking yourself the following questions about observations you made during the walk-through:

- Could you change working practices or procedures?
- Could you make repairs (to floors, roofs, etc.) to avoid contamination, accidents, and losses?
- Can you improve storage conditions?
- Can you establish a stock control system in order to strictly monitor and record the receipt and withdrawal of chemicals?
- Can you keep only the amounts of chemicals in the production area that are needed for daily use?
- Can you provide more suitable tools to facilitate the transfer of chemicals and avoid losses?
- Can you ensure that transfer containers are dedicated for use in handling a single substance to avoid contamination?
- Have you provided sufficient ventilation to reduce the concentration of mist, vapours, gases, and dust in the air?

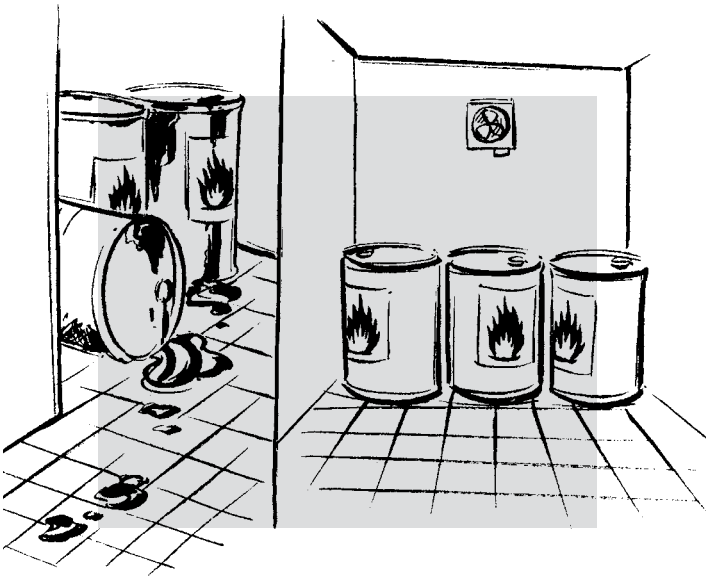
The following illustrates several "**good practices**", which you should be sure to include with your first set of improvement measures.

Several "good practices" for getting started

- Repair all broken seals to avoid vapours from escaping.
- Make sure that the packaging of materials is not damaged during delivery and storage.
- Return poorly packaged or deteriorated materials to suppliers.
- Regularly inspect and keep the storage area clean to avoid any contamination of materials.
- Store containers with hazardous chemicals on catch pits to contain any accidental spillage.
- Place chemical drums on an elevated rack and insert a metal or plastic spout to safely transfer materials to smaller containers.
- Immediately clean up any spillage to prevent accidental mixtures that could lead to ignition or an explosion.
- Provide sufficient ventilation to keep humidity, temperature, and the concentration of fumes and vapours at a low level.
- Ensure that the floor where chemicals are stored is made from non-permeable material (e.g. cement, concrete) to prevent the contamination of soil and ground water in the case of spillage.
- Limit and control access to the storage area in order to monitor the reception and withdrawal of chemicals.
- Ensure that the lids of all chemical containers are tightly closed.



- Stock chemicals in compatible groups to avoid the possibility that vapours could react together and lead to fire/explosion.
- Ensure that flammable substances (e.g. organic solvents) are not exposed to direct sunlight to avoid auto-ignition from occurring.
- Store chemicals in designated areas that are physically separated from production areas & workshops that contain ignition sources (e.g. generators, transformers, equipment).
- Provide appropriate personal protection equipment to workers and instruct them in its proper use, storage, and maintenance.
- Instruct workers to avoid using the same tools (e.g. cups, scoops, buckets) for measuring and removing different materials in order to avoid contaminating stored chemicals.
- Transfer chemicals in a closed system to avoid the distribution of vapours, spillage, and accidents.
- Provide carts, trolleys, and other simple transport devices to move materials in order to avoid accidents and spillage that can easily occur during manual carrying. Provide appropriate personal protection equipment. Use granular forms instead of fine powders to reduce 'dustiness'.
- Post warning signs describing precautionary measures in areas where hazardous chemicals are handled.
- Post safety instructions describing precautionary measures in areas where hazardous chemicals are handled.



Step 5: Action / Implementation of measures (chemical management action plan)

To ensure that the improvement measures you identified are actually implemented and that you achieve the anticipated benefits, it is important to have documentation and a procedure to follow.

In this respect, we suggest that you create a chemical management action plan. This allows you to document the observations that you made during the walk-through and to translate the results of your analysis about potential cost savings and reduction of risks into concrete actions. These include giving individuals the responsibilities to implement the necessary activities or modifying processes within a given time.

Create a chemical management action plan, which contains the following elements:

Chemical Management Action Plan	
Hot Spot/ Observation/Area	Describes the 'hot spots' you identified; refer to the notes you made during the walk-through. Specifies the area in your factory where you made a particular observation.
Proposed measure	Describe the measure that you propose (How will you deal with the 'hot spot'?).
Objective of the proposed measure	Define a clear and realistic objective that you want to achieve with this measure, indicating the anticipated improvement or benefit in terms of optimising chemical use, reducing health risks for workers, reducing environmental damage, improving product quality, etc.
Actions to be implemented	Lays out specific activities to be undertaken in order to achieve the desired improvement or benefit.
Responsible person	Indicates the person who is responsible for taking action and monitoring the results.
Time-frame	Specifies the time period within which action should be completed.
Results	Indicates the eventual benefits achieved vis-à-vis cost savings, risk reduction, improved competitiveness, etc.

What makes an action plan effective?

The creation of a chemical management action plan establishes the basis for implementing measures, making improvements, and evaluating the results achieved.

To develop and implement an **effective action plan** (for example, see Figure 6), be sure to:

- Consult the people who are directly involved in handling chemicals about proposed actions in order to understand the implications for changing procedures.
- Think about all possible consequences – also negative ones – before implementing action.
- Set ambitious, but achievable objectives.

Figure 6: Example for an Action Plan

Hot Spot / Observation (Area)	Measure	Objective	Measure(s)	Responsible person(s)	Time-frame	Results
Chemicals spoiled by water (storage)	Repair the roof	Avoid future losses	Obtain offers from construction companies	Production manager	1st January (one month)	
			Sign contract with construction company		15th January	
			Supervise the repairs		20 - 31st January	Roof repair

- Check that the proposed actions are sufficient to meet the stated objectives.
- Verify that the actions to be undertaken are clearly understood by those who are making the changes.
- Give the responsibility for taking action to specific individuals. If no individual is responsible, nothing will happen!
- Make sure that those designated as responsible have the needed expertise and authority to carry out the proposed action.
- Be specific about who must do what, in which different way, etc.
- Establish a realistic time-frame for who should do what by when.
- Make sure that all workers affected by changes to the current way of doing things are informed and trained in the new procedures.
- Give workers incentives (e.g. monetary reward or other schemes) for reducing the waste of chemicals.
- Check that progress that was made, was achieved by the deadlines that were set.
- Measure the results achieved concerning:
  - cost savings;
  - reduced harm and improved safety standards for workers;
  - improvement in product quality and competitiveness;
- Determine if additional improvement measures are needed to meet the desired objectives.

Step 6: Evaluation and integration into the company structure

A company will only obtain the benefits of chemical management by successfully implementing the appropriate measures. Proposed actions need to be regularly monitored in order to identify and remove the obstacles to implementation in due time.

Chemical management is a process of continuous improvement. Once initial goals are met, new goals need to be set and worked towards. Results need to be evaluated on a systematic basis in order to evaluate the benefits achieved, and remedial actions need to be put in place where the anticipated benefits have not yet been fully achieved.

To create a system of continuous improvement, you need to:

- evaluate the actions undertaken to determine if the set objectives were achieved;
- communicate and reward results;
- monitor results to ensure that improvements are maintained;
- establish new targets and areas for action in order to make further improvements in the company's operations.

Our main advice for getting started on chemical management and achieving concrete benefits is

just do it!

Success story from an Indonesian textile company

Meeting international eco-criteria to expand market opportunities

Established in 1978, this family-run company employs 185 people who work in three 8-hour shifts, around-the-clock. The company acts as a "job shop", dyeing and printing polyester fabrics for other Indonesian companies. The final products are destined for both the local market and for export. The company wants to create a reputation as a high quality supplier. The management believes this will increase the interest of international buyers in its products.

"Hot Spot" in the dye kitchen

One of the company's important customers specified the use of a particular dyestuff for its orders. The company liked the effect of this dyestuff in production and began using it in large quantities. In using this Guide to identify 'hot spots', it was discovered that this dyestuff is an azo-dye formulation, according to the Material Safety Data Sheet (MSDS) provided by the chemical supplier. Certain azo-dyes are carcinogenic and therefore present a serious health risk to humans. The company was informed that the use of certain azo-dyes can lead to its products being rejected by international buyers because the fabric does not fulfil eco-criteria set out under various label schemes. International standards such as Öko-tex 100 – which specify testing parameters for final products – have been created to assure customers that textiles are free of harmful substances.

Actions taken by company

After consulting with the chemical supplier, the company determined that banned amines were present and could be detected in the final product. The company initiated a discussion with the customer who specified the use of this dyestuff and informed them about the risks of continued use (i.e. the risk that international buyers of its garments could reject shipments). The company investigated and found an alternative dyestuff with the same generic colour index number. This substance provided an almost equivalent effect in production and was not a restricted azo-dye.

Result

By demonstrating awareness of the chemicals being used and the implications down the whole value chain, the company's reputation as a high quality supplier increased in the eyes of its direct customer. Within 6 months, word had spread and the company began receiving additional orders for fabrics destined for the export market.

Second Module – Making a comprehensive inventory'

Having undertaken a set of basic measures to address 'hot spots' and to optimise the use of chemicals, companies have an opportunity to gain further benefits from improved chemical management by getting their whole house in order.

This second module of chemical management involves:

- systematically identifying all chemical substances that are stored and in use in the factory;
- creating a structured information base that can be used to identify and make improvements on a continual basis.

What is the benefit of doing such an inventory?

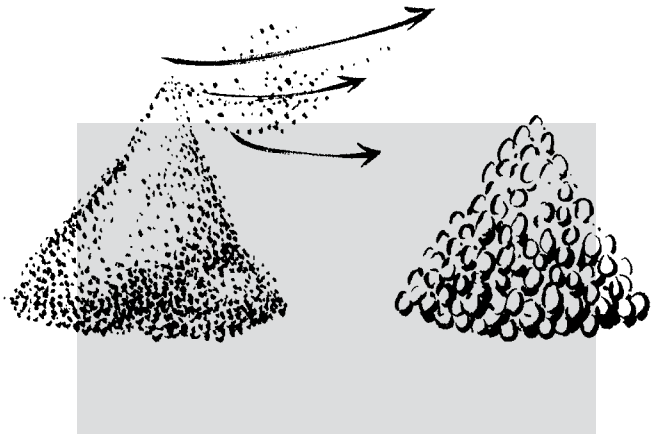
If chemical substances can be identified in a precise and complete manner, then the whole operating context and production of products can be considered and improved by undertaking targeted measures to reduce chemical use and risks throughout your operation.

Further you will improve:

1. your ability to perform first in, first out (FIFO) or just in time (JIT) inventory control
2. your chemical inventories are up to date and can be used to lower chemical purchase costs

By making a comprehensive inventory of all chemicals at hand, you will be able to:

- identify redundant products (i.e. different chemicals being used for the same purpose); less material is wasted/ lost by having fewer containers open at the same time;
- identify unknown substances, which can then be used before they expire, or can be properly disposed of;
- reduce losses due to the expiry of stored substances;
- improve product quality by investigating the technological properties of the used chemicals (e.g. wash fastness and color variation of dyestuffs) and being aware of inherent impurities, contamination on site, etc.;
- know the present state of the materials' packaging (if in good condition, damaged, wet, leaking, etc.);
- enhance competitiveness by becoming aware of the use of banned or restricted chemicals that customers in international markets will not accept;
- avoid rejection of your products because of failure to meet certain buyer requirements (which often specify chemicals that can not be used);
- discuss with suppliers the possibility of providing substances in less hazardous forms (e.g. granular forms are less hazardous than fine powders);



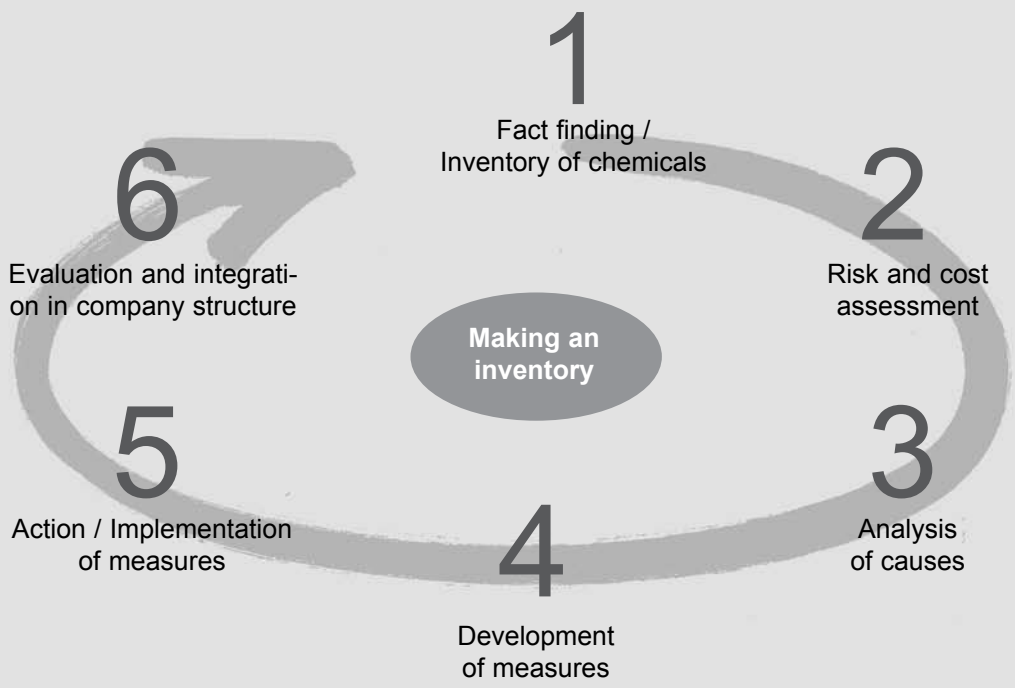
- discuss with suppliers the possibility of providing chemicals/formulations with higher boiling points (a substance with a higher boiling point is less volatile than one with a lower boiling point; but avoid substituting chemicals that, although less volatile, have a higher hazard rating);
- investigate with chemical suppliers what kind of substitutes are available for particularly hazardous substances;
- consider how to modify working practices to reduce the potential harm for those involved in handling certain substances;
- avoid accidents, fire, explosion from incompatible materials stored together or mixed inappropriately;
- support work towards implementing management standards, such as ISO 14 000, etc.

Once a comprehensive chemical inventory is completed, this can be used as a benchmark for making improvements on a continual basis.

The „inventory cycle“ is also based on six steps similar to the ‘hot spots cycle’ in order to develop and implement the appropriate measures and to make progress in the direction of continuous improvement.

In summary the making of a comprehensive inventory is a very important preliminary step for doing chemical management

Figure 7: The Chemical Management Cycle – 'Inventory'



Step	Action	Benefit
Step 1	Fact finding/ Inventory of chemicals	Knowing about hazard and technological properties of chemicals / Having an overview of all chemicals used / stored in the company.
Step 2	Assessment of costs and risks	Learning about cost saving potentials. Knowing the risks (hazards to workers and to the environment) linked to used / stored chemicals. Being able to select the most important chemicals / losses / situations for further action.
Step 3	Analysis of causes	Knowing why expensive and / or hazardous chemicals are handled in a certain way (identifying lack of knowledge / need for information with respect to possible alternatives).
Step 4	Development of measures	Updating knowledge / information on alternative chemicals / procedures. Identifying the positive effects of a measure with respect to saving costs and reducing hazards.
Step 5	Action / Implementation of measures	Implementing the positive measures.
Step 6	Evaluation and integration in company structure	Aiming for continuous improvement / implementing sustainable procedures.

Step 1: Fact finding / Inventory of chemicals

To create a chemical inventory, first investigate what information already exists within the company regarding chemicals (e.g. purchasing records, stock control cards, etc.). This documentation provides a good place to start. It gives you some indication of the type and amounts of chemicals at hand.

If this information is not up-to-date or insufficient to give you an accurate picture of all chemicals that are on the premises and how they are being used, we suggest that you systematically map out all chemicals, department by department, using the following method.

- Continue work on the 'hot spot' ground plan (see Figure 4) of the company or use another existing company floor plan.
- Mark where chemical substances are stored and/or used.
- Specify all chemical substances in an inventory table.

Be aware that chemicals are:

- individual substances or mixtures (formulations);
- released as vapours during the handling of formulations or products;
- generated during work activities (e.g. dust, fumes from welding);
- used as auxiliaries (e.g. fats, liquors, dyes, paints, adhesives);
- used for other purposes, such as cleaning workplaces and maintaining machinery (e.g. detergents, disinfectants, solvents, greases);
- found in final products (e.g. leather, textiles, panels, bricks, etc.).

Do you have further information about the hazardous and / or technological properties of the used chemicals?

In case you do not have this supplementary information contact your chemical supplier; he will deliver it.

Document chemicals in an inventory table

1. List the chemicals that you have identified in an inventory table
2. Example table (see Figure 8)
3. Begin with one department and proceed on a step-by-step basis until you have a complete inventory for your whole operation. This process will begin during the second training module and be completed in about two to three weeks time.

The inventory table should include the following information:

1. The place where the chemicals are found
2. The chemical name, trade name / CAS number*
3. MSDS** availability in the company (refer to Tool 6)
4. R-Phrases (refer to Tool 4)
5. Hazard Groups (refer to Tools 7and 9)
6. Amount in use (refer to Figure 12)
7. Dustiness/Volatility (refer to Figures 13 and 14)
8. Control Approach (refer to Tools 7 and 8)
9. Dermal control measures (refer to Tool 9)
10. Notes about handling, use, storage, disposal conditions, etc. (refer to Tool 10)

* Is a unique identifier that tells you, for example, that acetone and dimethyl ketone are actually the same substance. From a safety and inventory perspective, this is a terrific idea.

** This document is of central importance for considerations regarding occupational safety, transport safety and environment.

What about unknown substances?

For substances that can not be immediately identified, assign them a name (e.g. Unknown 1, Unknown 2) in the inventory table and be sure to specify their physical location within the factory.

Write this assigned name down on a tag, and attach it to the chemical container in the factory to allow for follow-up at a later stage.

Most of the companies visited during the development of this guide stored chemicals within the actual production area. These chemicals could be identified either from the label or by asking the workers who handle these substances on a daily basis.

Working from an existing floor plan, the location of chemicals stored throughout the premises was mapped out.

The amounts of chemicals kept at hand were counted and listed in the inventory table, together with information gathered from various sources (e.g. label, Material Data Safety Sheet) about the risk/ hazard level and recommended conditions for adequate storage, handling, and use.

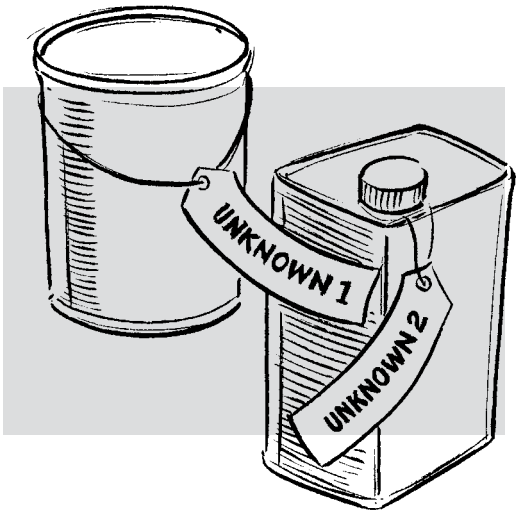


Figure 8: Example Inventory Table Textile Company „Beautiful Colours“

Area	Chemical Name	MSDS available	R-Phrases	Hazard Group	Amount in use (g,kg,t/ml,l,m³) per batch / task	Dustiness / Volatility	Control Approach	S-Phrases (add. advice for proper handling)
Dye kitchen	Acetic acid	Yes	R 10 R35	C	8 l Medium	Liquid[2] Medium (118°C)	3	S 23 S 26 S 45
Dye kitchen	Rucogal ene	Yes	R 41 R 43	C	15 l Medium	Fluid[2] Medium (100°C)	3	S 24 S 26 S 28 S 37/39 S 60
Dye kitchen	Verolan NBX	Yes	R 35	C	25 l Medium	Fluid[2] Medium (100°C)	3	S 20 S 26 S 30 S 36/37/39 S 45 S 60
Dye kitchen	Rucogen WBL	Yes	R 22 R 41	C	20 l Medium	Fluid[2] Medium (100°C)	3	S 26 S 36/39 S 60
Dye kitchen	C.I. Basic Yellow 28, acetic acid	Yes	R 22 R 41 R 50/531	C	7 kg Medium	Liquid[2] Medium (100°C)	3	S 23 S 26 S 39 S 61
Dye kitchen	C.I. Basic Violet 16, phosphate	Yes	R 22 R 25 R 26 R36 R 41 R 50/53[1]	D	6 kg Medium	Solid Low (solid)	3	S 22 S 45 S 24/25 S 60

[1] These R-Phrases are not relevant for the determination of the hazard group (only concern environment, flammability, etc.)

[2] Both expressions are used alternatively in MSDS

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Figure 8: Example Inventory Table Textile Company „Beautiful Colours“

Area	Chemical Name	MSDS available	R-Phrases	Hazard Group	Amount in use (g,kg,t/ml,l,m³) per batch / task	Dustiness / Volatility	Control Approach	S-Phrases (add. advice for proper handling)
Dye kitchen	C.I. Direct Orange 40	Yes	R 22	B	4 kg Medium	Solid High (powder)	2	S 22
Dye kitchen	C.I. Reactive Black	Yes	R 42/43	E	3 kg Medium	Solid Medium (granules)	4	S 22 S 24 S 37
Dye kitchen	C.I. Basic Green 4	Yes	R 21/22 R 38 R 41 R 50/531	C	6 kg Medium	Solid High (powder)	3	S 26 S 37/39 S 61 S 16
Printing	Toluene	Yes	R 11[1] R 20	B	100 l Medium	Clear liquid[2] Medium (100°C)	2	S 25 S 29 S 33 S 22
Printing	2-Naphthol	Yes	R 20/22 R 50[1]	B	85 kg Medium	Solid Medium (crystalline)	2	S 24/25 S 26 S 36/37/39
Printing	Sodium hydroxide (caustic soda)	Yes	R 35[1]	C	10 kg Medium	Solid Low (solid/ pellets)	2	S 26 S 37/39 S 45
Printing	White spirit - Stoddard solvent	Only safety card	R 45 R 65	E	15 l Medium	Liquid[2] Medium (130°C)	4	S 53 S 45
Yard	Citric acid	Yes	R 36/37/38	C	250 g Medium	Solid Medium (crystals)	1	S 26 S 37/39

[1] These R-Phrases are not relevant for the determination of the hazard group (only concern environment, flammability, etc.)

[2] Both expressions are used alternatively in MSDS

Step 2: Risk and cost assessment

Having listed all chemical substances kept at hand in a precise and complete manner, you are now in a position to consider how your whole operating context and production process could be improved. To evaluate the potential for cost savings and reducing risks, consider each chemical in your inventory list, asking yourself these questions:

With respect to costs:

- What are the costs of the substance?
- What quantity of the substance is needed for the production process?
- What quantity of the substance is actually being used (per batch / task)?
- How much of this substance is wasted or lost (estimation)?
- Are the most effective substances used for the production process?

Now you are able to calculate / estimate losses in the current procedures.

With respect to potential risks:

- What is the hazard group of the substance?
- What is the exposure potential of the substance? Please refer to Tool 3 “Basic concepts for doing risk assessment” and Tools 8 and 9 " Description of Control Approaches...“."
- Is this substance banned or restricted for use according to any eco-criteria or national or international legislation?

Now you can identify which substances / chemicals require priority measures in order to reduce risks for your company, your workers and the environment.

Step 3: Analysis of causes

Having identified the most costly and most hazardous chemical substances as well as the most dangerous situations occurring in your company, you can analyse the causes either for the use or for the improper handling of hazardous chemicals in the company.

In order to identify possible information / knowledge gaps, ask the following questions:

- Can a smaller quantity of this substance be kept in stock?
- Can a different handling approach be used to reduce spillage, waste?
- Can a less hazardous substance be used?
- Can a different form of this substance (e.g. granular or liquid instead of fine powder) be used that is less hazardous?

Step 4: Development of measures

First simple measures can be developed from the analysis of causes by applying the principle “turning causes into measures”, similar to what you did according to step 4 in the ‘hot spots cycle’, e.g., reduce the amount in stock or reduce spillage by better handling, etc.

Other measures require greater effort, especially when it comes to substances assigned to hazard groups 1 to 4 (analysed within step 2) which demand the application of so-called “control approaches”.

There are four control approaches, that are determined by the hazard and the exposure potential of the substance. The choice of a control approach will indicate the measures to be taken in order to reduce possible hazards for a specific hazard group. Refer for details to Tool 2 :"Description of control approaches for chemicals causing harm when breathed in“.

Step 5: Action / Implementation of measures

Put the results of your analysis and proposed measures into an action plan (use the same structure as for the ‘hot spots’ action plan, see Figure 6). In your action plan, be sure to:

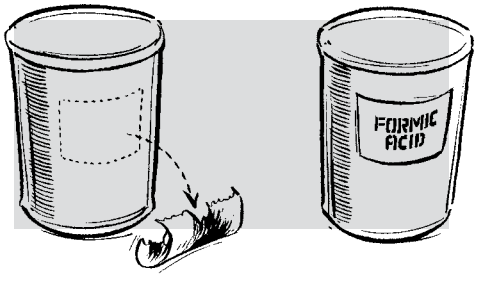
- assign responsibilities to individuals;
- be specific about who must do what, in which different ways
- establish realistic time-frames for who should do what by when
- check the progress that was made by those deadlines, and take remedial action as needed
- provide the workers with training on: handling chemicals safely, using controls correctly, and, what to do if something goes wrong
- measure the results achieved!

Step 6: Evaluation and integration into the company structure

Having listed all chemical substances kept at hand in a precise and complete manner, you are now in a position to consider how your whole operating context and production process could be improved. To evaluate the potential for cost savings and reducing risks, consider each chemical in your inventory list, asking yourself these questions:

- What quantity of the substance is needed for the production process?
- What quantity of the substance is actually being used?
- Why are some quantities wasted or lost?
- Can a smaller quantity of this substance be kept in stock?
- Can a different handling approach be used to reduce spillage, waste?
- Could an alternative substance be used (a less hazardous chemical)?
- Is this substance banned or restricted for use according to any eco-criteria or national or international legislation?
- Can a different form of this substance (e.g. granular or liquid instead of fine powder) be used that is less hazardous?

Ensuring proper labelling of chemicals that are stored and used in your operation is a critical aspect for achieving optimal use and determining the steps to take in case of accident or emergency.



- The purpose of a label is to inform anyone handling the chemical substance about hazards and suitable precautions. The main parts of an adequate label are illustrated in Figure 9 in the example of 2-Naphtol.

- Labels containing the chemical name, R-Phrase (refer to **Tool 4** "List of R-Phrases"), and S-Phrase (refer to **Tool 5** "List of S-Phrases") should be affixed to all chemical packaging or containers that are stored, in either temporary or permanent locations to allow for easy identification and to prevent accidental mixtures.

Further relevant information about the substance 2-naphtol is also available on the Material Safety Data Sheet provided by chemical suppliers (refer to **Tool 6** "MSDS and its use").

Training workers on understanding labels, on handling chemicals safely and what to do if something goes wrong are crucial prerequisites for any progress in the proper handling of chemicals.

Figure 9: Elements of a Proper Label[1]

2-Naphthol (D)

- Gesundheitsschädlich beim Einatmen und Verschlucken.
- Sehr giftig für Wasserorganismen.
- Staub nicht einatmen.
- Berührung mit den Augen und der Haut vermeiden.
- Bei Berührung mit den Augen sofort gründlich mit Wasser abspülen und Arzt konsultieren.
- Bei der Arbeit geeignete Schutzkleidung, Schutzhandschuhe und Schutzbrille/Gesichtsschutz tragen.

2-naftolo (I)

- Nocivo per inalazione e ingestione.
- Altamente tossico per gli organismi acquatici.
- Non respirare le polveri.
- Evitare il contatto con gli occhi e con la pelle.
- In caso di contatto con gli occhi, lavare immediatamente e abbondantemente con acqua e consultare un medico.
- Usare indumenti protettivi e guanti adatti e proteggersi gli occhi/la faccia.

2-naphthol (GB)

- Harmful by inhalation and if swallowed.
- Very toxic to aquatic organisms.
- Do not breathe dust.
- Avoid contact with eyes and skin.
- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- Wear suitable protective clothing, gloves and eye/face protection.

2-naftol (NL)

- Schadelijk bij inademing en opname door de mond.
- Zeer vergiftig voor in het water levende organismen.
- Stof niet inademen.
- Aanraking met de ogen en de huid vermijden.
- Bij aanraking met de ogen onmiddellijk met overvloedig water afspoelen en deskundig medisch advies inwinnen.
- Draag geschikte beschermende kleding, handschoenen en een beschermingsmiddel voor de ogen / voor het gezicht.

2-naphtol (F)

- Nocif par inhalation et ingestion.
- Très toxique pour les organismes aquatiques.
- Ne pas respirer les poussières.
- Eviter le contact avec la peau et les yeux.
- En cas de contact avec les yeux, laver immédiatement et abondamment avec de l'eau et consulter un spécialiste.
- Porter un vêtement de protection approprié, des gants et un appareil de protection des yeux/du visage.

2-naftol (E)

- Nocivo por inhalación y por ingestión.
- Muy tóxico para los organismos acuáticos.
- No respirar el polvo.
- Evítese el contacto con los ojos y la piel.
- En caso de contacto con los ojos, lávense inmediata y abundantemente con agua y acúdase a un médico.
- Úsense indumentaria y guantes adecuados y protección para los ojos/la cara.

Numbers according to the MSDS:

R-Phrases = R20/22, R 50, S-Phrases = S22, S24/25, S26, S36/37/39

[1] Adapted from The Complete Idiot's Guide to CHIP, Chemical Hazard Information and Packaging for Supply, (1999). Suffolk: Health and Safety Executive

Success story from an Indonesian tannery

Chemical Inventory gives clues for reducing production cost

Established in 1951, this company employs 60 people to process locally purchased cow hides into leather which is then sold to other Indonesian companies for making shoe uppers. The company estimates that chemicals represent 25-40% of its production cost. Since an economic crisis, most of its dyestuffs are purchased from international suppliers through local distributors and must be paid for in US dollars. As the price for raw hides is also increasing, the company is under a lot of pressure to continue to make a profit.

Cataloguing the storage & use of chemicals

After completing the chemical inventory, the management was surprised to learn that more than 130 different chemicals were being kept at hand. Additionally, there were a large number of unknown substances. While visually inspecting the chemicals – which were mostly stored in the production area – the Production Manager (one of the owners) realised that many materials, especially expensive dyestuffs, were deteriorating in the hot, humid conditions of the beamhouse. During the rainy season, the leaky roof and flooding in the factory led to further contamination of the stored materials.

Actions taken by the company

A central storage area was created near the office. This required the construction of two walls to enclose the space. There was already a cement floor and some natural ventilation due to an open-bricked roof. All dyestuffs and powdery substances were then moved into this area, and access was restricted. A stock room manager was appointed and given responsibility for recording the receipt and withdrawal of all materials.

Result

By calculating the theoretical cost (based on recipes) of its processes – soaking/ liming, tanning, retanning, finishing – and comparing this to the amount of chemicals actually being used in production, the company discovered the extent of chemicals being lost, wasted, and over-used. By tracking the amounts of chemicals actually being used versus the amounts specified in recipes and identifying the causes of these variances on a daily basis, the company succeeded in reducing its chemical costs by 5% within one year. For the soaking / liming process alone, this reduction in chemical use (from reducing loss waste, loss, etc.) represented savings of $ 3,100 (US) each week!

Part III – Tools

Part III – Tools

Tool 1 - Basic Principles of Prevention when dealing with hazardous substances

When dealing with hazardous chemical substances as a first step you should follow some basic principles of prevention. These principles consist of four control levels or principles of operational control.

Each principle has an increasing level of control!

They are listed here by priority. This means that you should first apply the first priority and if not possible then apply the second priority and so on. Here the basic principles:

- Elimination of the hazard
- Enclosure / isolation of the hazard
- Ventilation of the area where the hazard is
- Use personal protection equipment (PPE)

First priority = Elimination / substitution of hazard

Avoid toxic substances or other substances that pose a risk of fire or explosion ; reduce risk by eliminating or replacing chemicals with less hazardous ones

Second priority = Enclosure / isolation of the hazard

Put distance or shielding between chemicals & workers:

- Use enclosed processing equipment
- Separate hazardous processes from other processes
- Ensure the safe storage of hazardous chemicals; restrict the amount of chemicals kept at the workplace

Third priority = Ventilation of the area where hazardous substances are used

Provide general and local ventilation to remove or reduce the concentration of fumes, gases, vapours, mists.

In case of airborne chemicals, ventilation is regarded as one of the best forms of control, apart from substitution & enclosure; should not be used to justify a lower standard of control than that which may be required for process control or to control other risks.

Fourth priority = Use Personal Protective Equipment

Avoid exposure by following safe practices such as using protective equipment

PPE includes:

- respirators
- safety glasses, goggles, face shields
- gloves, aprons, boots, overalls
- protective creams/lotions

The PPE should:

- only supplement other types of control measures
- be appropriate to the hazard
- fit perfectly to the worker

Further principles of prevention when dealing with hazardous substances

+ Personal hygiene

Basic rules for using chemicals at work:

- Thoroughly wash exposed parts of the body - after work - before eating, drinking, smoking
- Do not carry contaminated items around
- Remove and separately wash any contaminated item of personal protective clothing daily
- Replace PPE at recommended intervals

+ Chemical emergency procedures

Every workplace should have an emergency plan:

- covering emergency exits & an alarm system for evacuation
- outlining duties & responsibilities for first-aid + firefighting in the company

+ Organizational control

- Identify all hazardous chemicals on hand
- Labeling / record-keeping
- Provide & use Material Safety Data Sheets
- Safe storage & transfer
- Safe practices for handling & use
- Good housekeeping measures and disposal routines
- Medical surveillance / exposure control
- Training & education

Tool 2– Symbols used for labelling hazardous substances

Symbols used for labelling		
Dangerous characteristics	**Label**	**Meaning**
Explosive (E)	E 	This symbol with the word “explosive” denotes a substance which may explode under the effect of a flame or subjected to shocks of friction.
Oxidising (O)	O 	The symbol with the word “oxidising” refers to a substance which releases a lot of heat while it reacts with other substances, particulary flammable substances.
Highly flammable (F)	F 	This symbol (F) with the words “highly flammable” denotes a substance which may become hot and finally catch fire in contact with air at ambient temperature or is a solid and may readily catch fire after brief contact with the source of ignition and which continues to burn/ to be consumed by chemical reaction after removal of the source of ignition. If it is gas it may burn in air at normal pressure. If it is liquid it would catch fire with slight warming and exposure to a flame. In contact with water or damp air the substance may release highly flammable gases in dangerous quantities.
Extremely flammable (F+)	F+ 	The same flammable symbol as above with words “extremely flammable” denotes e.g. a liquid which would boil at body temperature and would catch fire if vapours are exposed to a flame.
Toxic (T)	T 	This symbol with skull and crossed bones with the word “toxic” denotes a highly hazardous substance.
Very toxic (T+)	T+ 	This symbol as above with the word “very toxic” is used to label a substance, which, if inhaled or ingested or, if it penetrates the skin, may involve extremely serious immediate or long term health risks and even death.
Corrosive (C)	C 	The symbol with word “corrosive” will be found on a label of a substance which may destroy living tissues on contact with them. Severe burns may result from splashes of such substance.

Harmful (Xn) (less than T)	Xn 	The symbol with word “harmful” denotes to substances which may cause health hazards less than toxic. It could refer to other types of risks e.g. to allergic reactions.
Irritant (Xi) (less than C)	Xi 	The same symbol as above with the words “irritant”.
Dangerous for the environment (N)	N 	Can cause damage to fauna or flora or can cause pollution in natural water.
Sensitising by inhalation	R 42 	Combination of Symbol and R-Phrase see here below some R-Phrases that are linked with hazards. These R-Phrases can be combined with the described symbols.

Type of Hazard	**Linked R-Phrases**
Explosive	R1, R2, R3, R4, R5, R6, R9, R18, R19
Flammable	R10, R11, R12, R17, R18
May cause fire	R7, R8
Reacts violently with water or oxidising substances	R14, R14/15, R15, R16

Source: International Labour Organisation, International Occupational Safety and Health Information Centre (CIS/ILO), Information compiled from (last update September 1999):

http://www.ilo.org/public/english/protection/safework/cis/products/safetytm/classify.htm

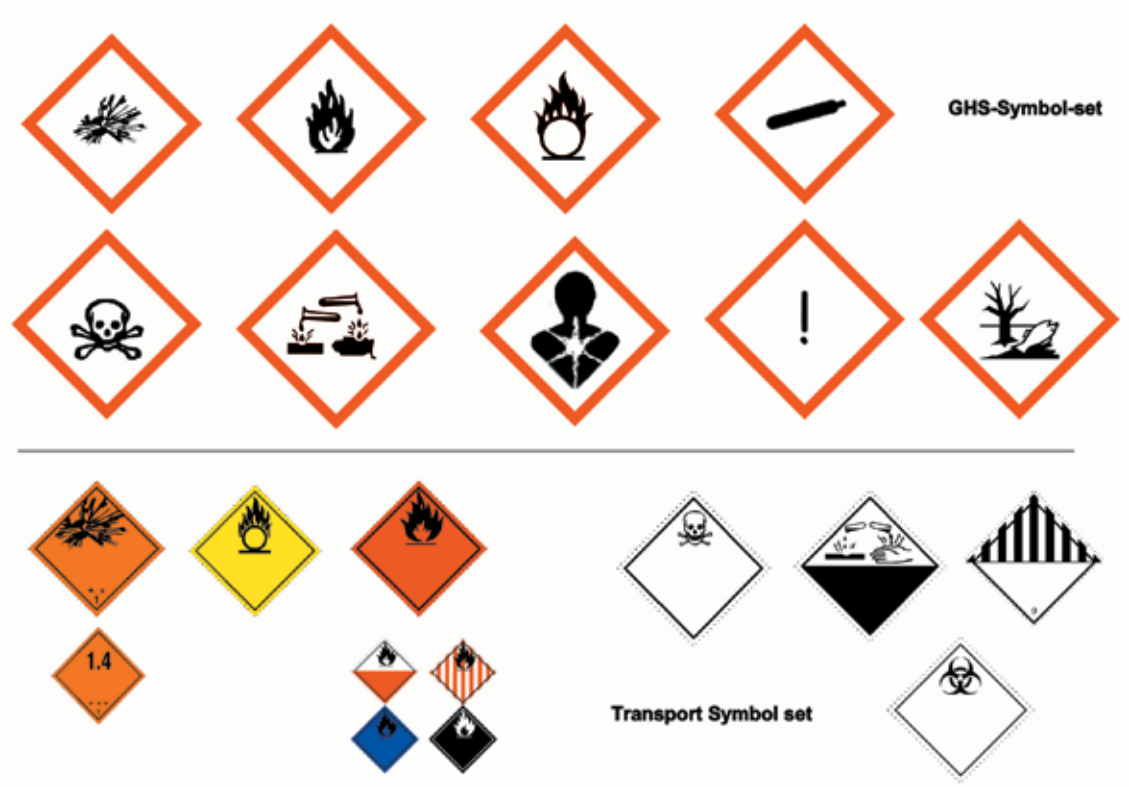
A new system for classification and labelling for dangerous substances, the "Globally Harmonised System" (GHS) has been developed by the United Nations Economic Commission for Europe (UNECE) but will not come into force before 2008/2010.

Several examples for the new GHS elements and symbols are given below.

Visit the GHS site in the internet at:

http://www.unece.org/trans/danger/publi/ghs/pictograms.html

New Symbols for Labelling According to GHS



Tool 3 - Basic concepts for doing risk assessment

To improve the management of chemicals, it is important to understand some basic concepts and sources of information for doing risk assessment.

In simple terms, risk assessment means carrying out a careful examination of the substances and situations in the workplace that could cause harm to workers and/or the environment.

Why do a risk assessment?

Such an investigation provides the basis for determining which precautions can be taken to ensure that no one gets hurt or becomes sick from handling chemicals at the workplace.

Many materials are purchased by companies for use in the production process (e.g. dyes, pigments, inks, coatings, fuels, varnishes, degreasing solvents, cleaning products, pesticides, fungicides, etc.). If not handled correctly, these types of substances and formulations (which contain chemicals) may cause harm.

In addition to significantly affecting the lives and livelihoods of workers, accidents and poor health can negatively affect the company through, for example lowered productivity, loss of motivation, increased insurance costs, poor quality of final products, damaged machinery, loss of materials, etc.

What are hazard and risk?

- **"Hazard" means anything that can cause harm to people and/or the environment.**
- **"Risk" is the probability (high or low) that human health, property, or the environment will actually be harmed.**

A simple relationship can help to understand the meaning of risk.

RISK is proportional to HAZARD x EXPOSURE

The risk (the probability of harm) is proportional to hazard times exposure.

In other words: If there is no hazard there is no risk; and there is no risk if there is no exposure.

Exposure
is the possibility of coming into contact.

The probability of harm occurring is influenced by several factors:

1. Toxicity of the chemical to humans and / or the environment
2. The chemical's physical and chemical properties (such as flammability, explosivity, reactivity)
3. Type & extent of exposure to the substance (e.g. inhalation of gases, vapours, or airborne particles; absorption through skin; ingestion by mouth, splashing of eyes, etc.).

R-Phrases and S-Phrases

Hazard, risk, and the probability of a chemical causing harm are reflected in an internationally accepted system of risk phrases (R-Phrases) and safety phrases (S-Phrases).

Many **R-Phrases** refer to health effects on humans (e.g. R34 means that the chemical "causes burns"). Other R-Phrases describe environmental effects (e.g. R50 means that a substance is very toxic to aquatic organisms).

Certain R-Phrases also indicate that certain chemicals can be explosive, or flammable, or react violently with water or oxidising substances. It is important to know this and take special care during the handling or storage of these chemicals.

S-Phrases provide first advice for the safe handling of hazardous chemical substances and formulations (e.g. S34 means “avoid shock and friction")

R-Phrases and S-Phrases can appear alone or in combination. This is indicated by a “/” between the numbers; e.g. R36/37 means that the chemical is both “irritating to eyes” and “irritating to respiratory system”.

R-Phrases indicate hazards!

S-Phrases provide first advise for the safe handling!

Where are R-Phrases and S-Phrases found?

These phrases are normally found on the product label (with or without the corresponding number) (see Figure 10a) and on the Material Safety Data Sheet (MSDS) (see Figure 10b).

Material Safety Data Sheet (MSDS)

An MSDS of a chemical substance contains details of the hazards associated with this specific substance and gives information on its safe use. Your chemical supplier should always include this information when delivering the chemical.

Sources of further information

Tool 6 describes the uses of a Material Safety Data Sheet (MSDS) and includes the entire MSDS for 2-Naphtol 98% as an example.

Tool 4 lists all commonly used R-Phrases and their meanings.

Tool 5 lists all commonly used S-Phrases and their meanings.

R-Phrases, MSDS, and the link with hazard groups

Different substances can cause harm in different ways. Some chemicals are more hazardous and can cause more harm than others. Some substances cause only minor irritation of the skin while others can cause severe burns, greatly damage the respiratory system or even result in death. Some effects on health appear immediately (e.g. cyanide poisoning) while others may only be apparent after several years (e.g. lung cancer caused by asbestos).

Hazard Symbols

There are also different symbols used for labelling hazard chemicals (see all symbols in Tool 2). You and your workers should know the meaning of these symbols.

Figure 10a: Locating the R-Phrase on a Product Label

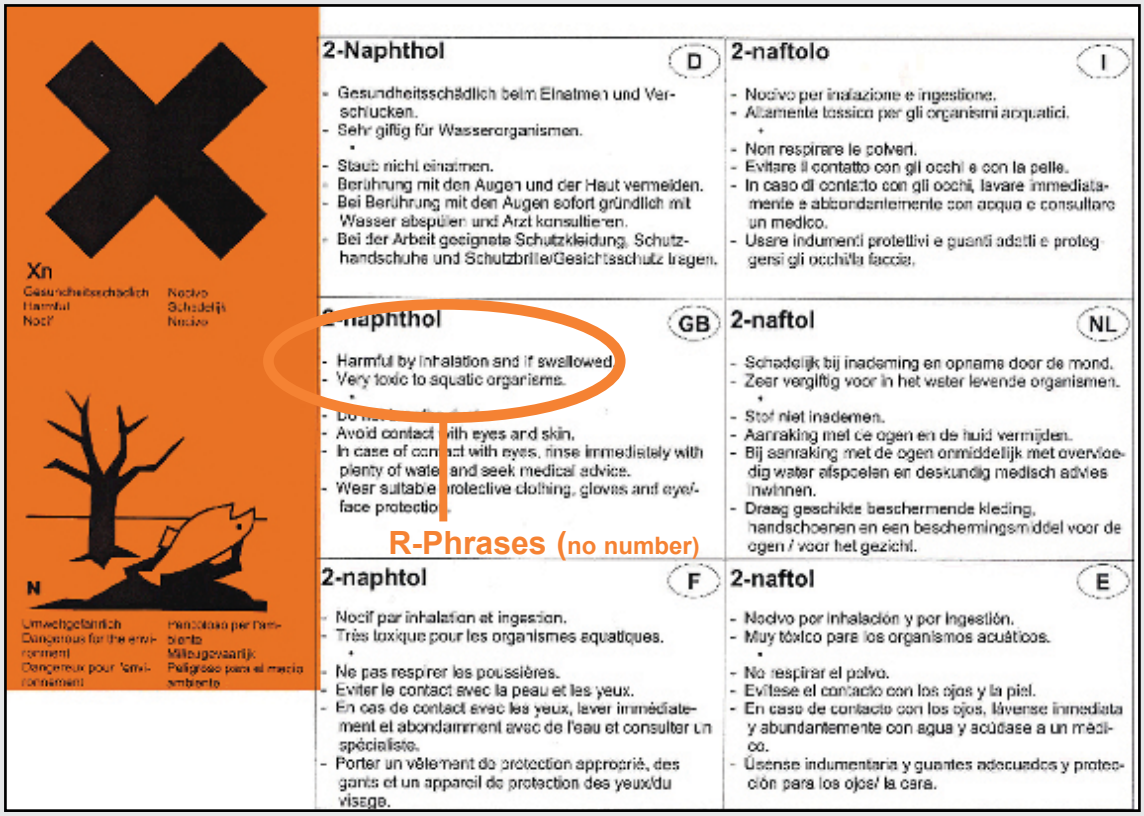


Figure 10b: Locating the R-Phrase on a MSDS (2-Naphtol 98%)

MSDS for 2-Naphthol, 98%

**** MATERIAL SAFETY DATA SHEET ****

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name:	2-Naphthol, 98%
Catalog Numbers:	15697-0000, 15697-0010, 15697-0025
Synonyms: 2-Hydroxynaphthalene;	beta-naphthol
Company Identification (Europe):	Acros Organics BVBA Janssen Pharmaceuticalaan 3a 2440 Geel, Belgium

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
135-19-3	2-Naphthol	98%	205-182-7

Hazard Symbols: XN N
Risk Phrases: 20/22 50

R-Phrases
with correponding numbers

Tool 4 – Risk Phrases (R-Phrases) for hazardous substances

Changes of the 28th Adaptation to the Technical Progress (ATP 28) on 6 August 2001 are indicated.

Risk Phrases	
R 1	Explosive when dry.
R 2	Risk of explosion by shock, friction, fire or other sources of ignition.
R 3	Extreme risk of explosion by shock, friction, fire or other sources of ignition.
R 4	Forms very sensitive explosive metallic compounds.
R 5	Heating may cause an explosion.
R 6	Explosive with or without contact with air.
R 7	May cause fire.
R 8	Contact with combustible material may cause fire.
R 9	Explosive when mixed with combustible material.
R 10	Flammable.
R 11	Highly flammable.
R 12	Extremely flammable.
R 13	Extremely flammable liquefied gas. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 14	Reacts violently with water.
R 14/15	Reacts violently with water, liberating extremely flammable gases.
R 15	Contact with water liberates extremely flammable gases.
R 15/29	Contact with water liberates toxic, extremely flammable gas.
R 16	Explosive when mixed with oxidising substances.
R 17	Spontaneously flammable in air.
R 18	In use, may form flammable/explosive vapour-air mixture.
R 19	May form explosive peroxides.
R 20	Harmful by inhalation.
R 20/21	Harmful by inhalation and in contact with skin.
R 20/21/22	Harmful by inhalation, in contact with skin and if swallowed.
R 20/22	Harmful by inhalation and if swallowed.
R 21	Harmful in contact with skin.
R 21/22	Harmful in contact with skin and if swallowed.
R 22	Harmful if swallowed.
R 23	Toxic by inhalation.
R 23/24	Toxic by inhalation and in contact with skin.
R 23/24/25	Toxic by inhalation, in contact with skin and if swallowed.

R 23/25	Toxic by inhalation and if swallowed.
R 24	Toxic in contact with skin.
R 24/25	Toxic in contact with skin and if swallowed.
R 25	Toxic if swallowed.
R 26	Very toxic by inhalation.
R 26/27	Very toxic by inhalation and in contact with skin.
R 26/27/28	Very toxic by inhalation, in contact with skin and if swallowed.
R 26/28	Very toxic by inhalation and if swallowed.
R 27	Very toxic in contact with skin.
R 27/28	Very toxic in contact with skin and if swallowed.
R 28	Very toxic if swallowed.
R 29	Contact with water liberates toxic gas.
R 30	Can become highly flammable in use.
R 31	Contact with acids liberates toxic gas.
R 32	Contact with acids liberates very toxic gas.
R 33	Danger of cumulative effects.
R 34	Causes burns.
R 35	Causes severe burns.
R 36	Irritating to eyes.
R 36/37	Irritating to eyes and respiratory system.
R 36/37/38	Irritating to eyes, respiratory system and skin.
R 36/38	Irritating to eyes and skin.
R 37	Irritating to respiratory system.
R 37/38	Irritating to respiratory system and skin.
R 38	Irritating to skin.
R 39	Danger of very serious irreversible effects.
R 39/23	Toxic: danger of very serious irreversible effects through inhalation.
R 39/23/24	Toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R 39/23/24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R 39/23/25	Toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R 39/24	Toxic: danger of very serious irreversible effects in contact with skin.
R 39/24/25	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R 39/25	Toxic: danger of very serious irreversible effects if swallowed.
R 39/26	Very toxic: danger of very serious irreversible effects through inhalation.

R 39/26/27	Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R 39/26/27/28	Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R 39/26/28	Very toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R 39/27	Very toxic: danger of very serious irreversible effects in contact with skin.
R 39/27/28	Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R 39/28	Very toxic: danger of very serious irreversible effects if swallowed.
R 40	Limited evidence of a carcinogenic effect. The phrase has been changed by ATP 28 (6 August 2001). The corresponding phrase used in earlier cards reads: Possible risk of irreversible effects.
R 40/20	Harmful: possible risk of irreversible effects through inhalation. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/20/21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/20/21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/20/22	Harmful: possible risk of irreversible effects through inhalation and if swallowed. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/21	Harmful: possible risk of irreversible effects in contact with skin. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/21/22	Harmful: possible risk of irreversible effects in contact with skin and if swallowed. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 40/22	Harmful: possible risk of irreversible effects if swallowed. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 41	Risk of serious damage to eyes.
R 42	May cause sensitization by inhalation.

R 42/43	May cause sensitization by inhalation and skin contact.
R 43	May cause sensitization by skin contact.
R 44	Risk of explosion if heated under confinement.
R 45	May cause cancer.
R 46	May cause heritable genetic damage.
R 47	May cause birth defects. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
R 48	Danger of serious damage to health by prolonged exposure.
R 48/20	Harmful: danger of serious damage to health by prolonged exposure through inhalation.
R 48/20/21	Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R 48/20/21/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R 48/20/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R 48/21	Harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R 48/21/22	Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R 48/22	Harmful: danger of serious damage to health by prolonged exposure if swallowed.
R 48/23	Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R 48/23/24	Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R 48/23/24/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R 48/23/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R 48/24	Toxic: danger of serious damage to health by prolonged exposure in contact with skin.
R 48/24/25	Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R 48/25	Toxic: danger of serious damage to health by prolonged exposure if swallowed.
R 49	May cause cancer by inhalation.
R 50	Very toxic to aquatic organisms.
R 50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 51	Toxic to aquatic organisms.

R 51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 52	Harmful to aquatic organisms.
R 52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 53	May cause long-term adverse effects in the aquatic environment.
R 54	Toxic to flora.
R 55	Toxic to fauna.
R 56	Toxic to soil organisms.
R 57	Toxic to bees.
R 58	May cause long-term adverse effects in the environment.
R 59	Dangerous for the ozone layer.
R 60	May impair fertility.
R 61	May cause harm to the unborn child.
R 62	Possible risk of impaired fertility.
R 63	Possible risk of harm to the unborn child.
R 64	May cause harm to breast-fed babies.
R 65	Harmful: may cause lung damage if swallowed.
R 66	Repeated exposure may cause skin dryness or cracking.
R 67	Vapours may cause drowsiness and dizziness.
R 68	Possible risks of irreversible effects.
R 68/20	Harmful: possible risk of irreversible effects through inhalation.
R 68/20/21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R 68/20/21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R 68/20/22	Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R 68/21	Harmful: possible risk of irreversible effects in contact with skin.
R 68/21/22	Harmful: possible risk of irreversible effects in contact with skin and if swallowed.
R 68/22	Harmful: possible risk of irreversible effects if swallowed.

Updated by AS. Approved by EC. Last modification: 21.03.2002

Source: International Labour Organization, International Occupational Safety and Health Information Centre (CIS/ILO), information compiled from (last update September 1999):

http://www.ilo.org/public/english/protection/safework/cis/products/safetytm/classify.htm

Tool 5 – Safety Phrases (S-Phrases) for hazardous substances

Changes of the 28th Adaptation to the Technical Progress (ATP 28) on 6 August 2001 are indicated.

	Safety Phrases
S 1	Keep locked up.
S 1/2	Keep locked up and out of the reach of children.
S 2	Keep out of the reach of children.
S 3	Keep in a cool place.
S 3/7	Keep container tightly closed in a cool place.
S 3/7/9	Keep container tightly closed in a cool, well-ventilated place. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
S 3/9	Keep in a cool, well-ventilated place. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
S 3/9/14	Keep in a cool, well-ventilated place away from (incompatible materials to be indicated by the manufacturer).
S 3/9/14/49	Keep only in the original container in a cool, well-ventilated place away from ... (incompatible materials to be indicated by the manufacturer).
S 3/9/49	Keep only in original container in a cool, well-ventilated place.
S 3/14	Keep in a cool place away from ... (incompatible materials to be specified by the manufacturer).
S 4	Keep away from living quarters.
S 5	Keep contents under ... (appropriate liquid to be specified by the manufacturer).
S 6	Keep under ... (inert gas to be specified by the manufacturer).
S 7	Keep container tightly closed.
S 7/8	Keep container tightly closed and dry.
S 7/9	Keep container tightly closed and in a well-ventilated place.
S 7/47	Keep container tightly closed and at a temperature not exceeding ... °C (to be specified by the manufacturer).
S 8	Keep container dry.
S 9	Keep container in a well-ventilated place.
S 10	---
S 11	---
S 12	Do not keep the container sealed.
S 13	Keep away from food, drink and animal feedingstuffs.
S 14	Keep away from ... (incompatible materials to be indicated by the manufacturer).
S 15	Keep away from heat.
S 16	Keep away from sources of ignition -- No smoking.
S 17	Keep away from combustible material.
S 18	Handle and open container with care.

S 19	---
S 20	When using do not eat or drink.
S 20/21	When using do not eat, drink or smoke.
S 21	When using do not smoke.
S 22	Do not breathe dust.
S 23	Do not breathe gas/fumes/vapour/spray (appropriate wording to be specified by the manufacturer).
S 24	Avoid contact with the skin.
S 24/25	Avoid contact with skin and eyes.
S 25	Avoid contact with eyes.
S 26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 27	Take off immediately all contaminated clothing.
S 27/28	After contact with skin, take off immediately all contaminated clothing, and wash immediately with plenty of … (to be specified by the manufacturer).
S 28	After contact with skin, wash immediately with plenty of ... (to be specified by the manufacturer).
S 29	Do not empty into drains.
S 29/35	Do not empty into drains; dispose of this material and its container in a safe way.
S 29/56	Do not empty into drains, dispose of this material and its container at hazardous or special waste collection point.
S 30	Never add water to this product.
S 31	---
S 32	---
S 33	Take precautionary measures against static discharges.
S 34	Avoid shock and friction. The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
S 35	This material and its container must be disposed of in a safe way.
S 36	Wear suitable protective clothing.
S 36/37	Wear suitable protective clothing and gloves.
S 36/37/39	Wear suitable protective clothing, gloves and eye/face protection.
S 36/39	Wear suitable protective clothing and eye/face protection.
S 37	Wear suitable gloves.
S 37/39	Wear suitable gloves and eye/face protection.
S 38	In case of insufficient ventilation, wear suitable respiratory equipment.
S 39	Wear eye/face protection.
S 40	To clean the floor and all objects contaminated by this material, use ... (to be specified by the manufacturer).
S 41	In case of fire and/or explosion do not breathe fumes.

S 42	During fumigation/spraying wear suitable respiratory equipment (appropriate wording to specified by the manufacturer).
S 43	In case of fire, use ... (indicate in the space the precise type of fire-fighting equipment. If water increases the risk, add 'Never use water').
S 44	If you feel unwell, seek medical advice (show label where possible). The phrase has been deleted by ATP 28 (6 August 2001), but may still appear in cards not modified since then.
S 45	In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 46	If swallowed, seek medical advice immediately and show container or label.
S 47	Keep at temperature not exceeding ... °C (to be specified by the manufacturer).
S 47/49	Keep only in the original container at a temperature not exceeding ... °C (to be specified by the manufacturer).
S 48	Keep wet with ... (appropriate material to be specified by the manufacturer).
S 49	Keep only in the original container.
S 50	Do not mix with ... (to be specified by the manufacturer).
S 51	Use only in well-ventilated areas.
S 52	Not recommended for interior use on large surface areas.
S 53	Avoid exposure -- obtain special instructions before use.
S 54	---
S 55	---
S 56	Dispose of this material and its container to hazardous or special waste collection point.
S 57	Use appropriate container to avoid environmental contamination.
S 58	---
S 59	Refer to manufacturer/supplier for information on recovery/ recycling.
S 60	This material and its container must be disposed of as hazardous waste.
S 61	Avoid release to the environment. Refer to special instructions/safety data sheets.
S 62	If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.
S 63	In case of accident by inhalation: remove casualty to fresh air and keep at rest.
S 64	If swallowed, rinse mouth with water (only if the person is conscious).

Updated by AS. Approved by EC. Last modification: 21.03.2002.

Source: International Labour Organisation, International Occupational Safety and Health Information Centre (CIS/ILO), Information compiled from (last update September 1999):

http://www.ilo.org/public/english/protection/safework/cis/products/safetytm/classify.htm

Tool 6 – Using Material Safety Data Sheets (MSDS)

An MSDS provides valuable information that companies can use to optimise chemical use and improve workplace health & safety standards.

An MSDS:

- Helps you determine the effect of the chemical on end products (e.g. intended characteristics, quality, etc.).
- Allows you to determine chemical compatibility and do proper mixing.
- Gives information about proper storage & handling (e.g. ventilation).
- Enables you to prevent losses from the expiry of materials.
- Indicates appropriate security precautions and needed controls, including the use of personal protection equipment.
- Spells out emergency procedures in case of spills, fire, explosion.
- Indicates steps for first-aid.
- Specifies the hazard level, which gives clues about the possible effects on water, soil, human health.
- Specifies the flashpoint (the lowest temperature at which a chemical releases flammable vapour). The lower the flashpoint, the more hazardous the chemical is as a source of fuel for fire or explosion.
- Specifies the boiling point, which is used to determine volatility. The lower the boiling point, the higher the volatility.

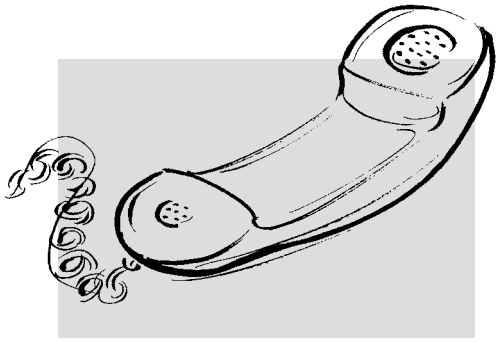
Where should MSDSs be kept?

An MSDS for every chemical substance used in your operation should be kept in a central place and be available for consultation by workers and supervisors.

The information provided on the MSDS serves as the basis for providing oral and written instructions to workers (see Tool 10), and for training workers and supervisors in the safe use of chemicals. This training should include instructions for workers on how to obtain and use the information provided on the Material Safety Data Sheet.

Where can you obtain MSDSs?

Contact the supplier of the chemical:

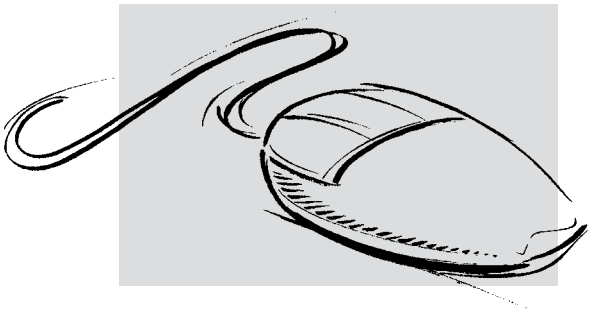


- All chemical providers are legally obliged to prepare and provide information to buyers regarding the hazardous properties of substances.
- Ask your chemical supplier if the MSDS can be provided in the local language currently used by the workers of your factory.

Do an Internet search:

- The Internet can be a practical source of information on pure substances (e.g. sodium sulfide, nitric acid, etc.) as the characteristics of these substances do not vary by manufacturer.

www.chemexper.com is a source of information on pure substances (MSDSs can be found and printed from this site in English).



- For formulations made from multiple components (e.g. a lacquer is composed of solvents, pigments, and additives), the supplier of the particular substance is the only source of information about its actual hazards and characteristics.

MSDSs usually contain the following information in 16 sections:

Section 1 gives details of the company issuing the data sheet and further identification of the substance.

Section 2 identifies the material and gives the CAS and other registration numbers.

Section 3 summarizes the major hazards associated with use of the chemical. The R- and S - Phrases in this section are followed by explanatory text.

Section 4 outlines first aid measures.

Section 5 covers fire fighting and protecting equipment.

Section 6 outlines the procedures to be followed in case of accidental release of the chemical, including methods to be used to clean up spills.

Section 7 is self explanatory. This is an important section for handling and storage.

Section 8 provides information on regulatory standards for exposure, in other words, the maximum permitted concentration of the material in the environment to which you are allowed to be exposed. It also usually contains information of suitable types of PPE.

Section 9 is self explanatory about physical and chemical properties of the substance.

Section 10 is also largely self explanatory about stability and reactivity.

Section 11 outlines the risks to which you may be exposed when using the chemical. It is therefore a section of crucial importance.

Section 12 is largely self explanatory about ecological information.

Section 13 which deals with disposal, is often not sufficiently detailed for you to be able to undertake disposal yourself. If you need to dispose the chemical after use, ensure that you know how to do this safely. (see Tool 11 for some basic principles).

Section 14 gives transport information, generally as a list of codes indicating the dangers associated with the chemical (flammable, radioactive, very toxic, etc.) and the type of transport which may be used.

Section 15 lists the hazard codes which indicate the principle hazard associated with the chemical and the precautions which should be taken when working with it.

Section 16 is for an additional information such as the name of the person preparing the MSDS, a list of references from which data has been drawn, etc.

MSDS internet sites:

http://www2.hazard.com/msds/index.php

http://www.msds.com/

another source of information about safe use of chemicals is at the ILO website for for international safety cards.

The ICSCs are available on the World Wide Web in many languages at:

http://www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/a_index.htm

International safety cards (ICSC):

An ICSC summarizes essential health and safety information on chemicals for their use at the "shop floor" level by workers and employers in factories, agriculture, construction and other work places. ICSCs are not legally binding documents, but consist of a series of standard phrases, mainly summarizing health and safety information collected, verified and peer reviewed by internationally recognized experts, taking into account advice from manufacturers and Poison Control Centres.

Pesticide Data Sheets (PDSs) contain basic information for safe use of pesticides and can be found under http:// www.inchem.org/pages/pds.html.

The Pesticide Data Sheets are prepared by WHO in collaboration with FAO and give basic toxicological information on individual pesticides. Priority for issue of PDSs is given to substances having a wide use in public health programmes and/or in agriculture, or having a high or an unusual toxicity record. The data sheets are prepared by scientific experts and peer reviewed. The comments of industry are provided through the industrial association, GIFAP. The data sheets are revised from time to time as required.

The MSDS shall enable the employer to determine whether any hazardous chemical agents are present at the workplace and to assess any risk to the health and safety of workers arising from their use.

Example of the Material Safety Data Sheet of 2-naphtol

Note: The following example is a Material Safety Data Sheet obtained from the Internet (www.chemexper. com). This site is a useful source of information on pure substances. For formulations made from multiple components, you need to contact the supplier of that particular substance and request information about its actual hazards and characteristics (ideally in the form of an MSDS)

MSDS for 2-Naphthol, 98%

**** MATERIAL SAFETY DATA SHEET ****

2-Naphthol, 98%

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 2-Naphthol, 98%
Catalog Numbers: 15697-0000, 15697-0010, 15697-0025
Synonyms: 2-Hydroxynaphthalene; beta-naphthol
Company Identification (Europe): Acros Organics BVBA
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
Company Identification (USA): Acros Organics
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies in Europe, call: 0032(0) 14575299

*** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
135-19-3	2-Naphthol	98%	205-182-7

Hazard Symbols: XN N
Risk Phrases: 20/22 50

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Harmful by inhalation and if swallowed. Very toxic to aquatic organisms. Light sensitive.

Potential Health Effects
Eye: Causes moderate eye irritation.
Skin: Causes mild skin irritation. May be harmful if absorbed through the skin.
Ingestion: Harmful if swallowed. May cause irritation of the digestive tract.
Inhalation: May be fatal if inhaled. Harmful if inhaled. May cause respiratory tract irritation.
Chronic: Prolonged or repeated exposure may cause permanent eye damage.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.
Ingestion: Do NOT induce vomiting. Get medical aid. Wash mouth out with water.
Inhalation: Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Notes to Physician:

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.

Extinguishing Media:
Use water spray, dry chemical, carbon dioxide, or chemical foam.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information:
Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:
Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions.

**** SECTION 7 - HANDLING AND STORAGE ****

Handling:
Minimize dust generation and accumulation. Do not get on skin and clothing. Do not breathe dust, vapor, mist, or gas. Use only in a chemical fume hood.

Storage:
Store in a cool, dry place. Do not store in direct sunlight. Store in a tightly closed container.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use adequate ventilation to keep airborne concentrations low.

Personal Protective Equipment

Eyes:	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin:	Wear appropriate protective gloves to prevent skin exposure.
Clothing:	Wear appropriate protective clothing to prevent skin exposure.
Respirators:	Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Flakes
Appearance:	light brown - beige
Odour:	phenol-like - weak odor
pH:	Not available.
Vapor Pressure:	7 hPa at 145 deg C
Viscosity:	Not available.
Boiling Point:	285 - 286 deg C at 760.00mm Hg
Freezing/Melting Point:	120 - 124 deg C
Autoignition Temperature:	Not available.
Flash Point:	160 deg C (320.00 deg F)
Explosion Limits, lower:	Not available.
Explosion Limits, upper:	Not available.
Decomposition Temperature:	400 deg C
Solubility in water:	Not available.
Specific Gravity/Density:	Molecular Formula: C10H7OH
Molecular Weight:	144.17

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials, light.
Incompatibilities with Other Materials:
Strong oxidizing agents, strong bases, acid chlorides, nitric acid, phenols, sulfuric acid, ferric salts, potassium permanganate, acid anhydrides, antipyrine.
Hazardous Decomposition Products:
Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 135-19-3: QL2975000
LD50/LC50:
CAS# 135-19-3:
Draize test, rabbit, eye: 100 mg Moderate;
Draize test, rabbit, skin: 500 mg/24H Mild;
Inhalation, rat: LC50 = >770 mg/m3/1H;
Oral, rat: LD50 = 1960 mg/kg;
Skin, rabbit: LD50 = >10 gm/kg.
Carcinogenicity: 2-Naphthol - Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Other:

See actual entry in RTECS for complete information.

*** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:

Fish toxicity: LC50 fathead minnow 3.5 mg/L/96HLC50 rainbow trout 0.12 mg/L/27day
Invertebrate toxicity: LC50 Daphnia magna 3.5 mg/L/48HEC50 Selenastrum capricornutum 19 mg/L/4HEC50
Photobacterium phosphoreum 0.275 ppm/5-30 min Microtox test (The Dictionary of Substances and their Effects, 1992).

Other

Avoid entering into waters or underground water.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.

**** SECTION 14 - TRANSPORT INFORMATION ****

IATA

Shipping Name: TOXIC SOLID, ORGANIC, N.O.S.*
Hazard Class: 6.1
UN Number: 2811
Packing Group: III

IMO

Shipping Name: TOXIC SOLID, ORGANIC, N.O.S.
Hazard Class: 6.1
UN Number: 2811
Packing Group: III

RID/ADR

Shipping Name: TOXIC SOLID, ORGANIC, N.O.S.
Hazard Class: 6.1
UN Number: 2811
Packing group: I

* see glossary for MSDS on page 88

**** SECTION 15 - REGULATORY INFORMATION ****

European/International Regulations
European Labeling in Accordance with EC Directives
Hazard Symbols: XN N
Risk Phrases:
R 20/22 Harmful by inhalation and if swallowed.
R 50 Very toxic to aquatic organisms.
Safety Phrases:
S 24/25 Avoid contact with skin and eyes.
S 61 Avoid release to the environment. Refer to special instructions/Safety data sheets.
WGK (Water Danger/Protection)
CAS# 135-19-3: 2
United Kingdom Occupational Exposure Limits

Canada
CAS# 135-19-3 is listed on Canada's DSL List.
CAS# 135-19-3 is listed on Canada's Ingredient Disclosure List.
Exposure Limits
CAS# 135-19-3: OEL-RUSSIA:STEL 0.1 mg/m3

US FEDERAL
TSCA
CAS# 135-19-3 is listed on the TSCA inventory.

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 9/03/1996 Revision #2 Date: 11/02/1999

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if the company has been advised of the possibility of such damages.

See glossary for MSDS on page 88

Tool 7 - Identify the appropriate control approach

Distinguishing between increasing levels of hazard for human health

To help you determine the potential for harm of different chemicals, the International Labour Organisation (ILO) has categorized R-Phrases **(see Figure 11)** into five hazard groups based on increasing hazard (Groups A to E).

A substance with an R-Phrase and/or its combinations that leads the chemical to be categorized in Group C is more hazardous than a substance that falls in Group A or B. Group E substances are the most hazardous.

In order to prevent serious harm to people and/or the environment, chemical substances that have the potential to cause more serious harm require a greater level of control than less harmful substances.

Figure 11: ILO Classification of Hazard Groups A to E for Chemicals causing harm when breathed in, is based on their links to certain R-Phrases

Hazard Group	Linked R-Phrases
A	R36, R36/38, R38, R65, R66 and all chemicals with no R-Phrases*
B	R20, R20/21, R20/21/22, R20/22, R21, R21/22, R22, R33, R67, R68/20, R68/20/21, R68/20/21/22, R68/20/22, R68/21, R68/21/22, R68/22 and all chemicals with unsufficient known characteristics**
C	R23, R23/24, R23/24/25, R23/25, R24, R24/25, R25, R34, R35, R36/37, R36/37/38, R37, R37/38, R39/23, R39/23/24, R39/23/24/25, R39/23/25, R39/24, R39/24/25, R39/25, R41, R43, R48/20, R48/20/21, R48/20/21/22, R48/20/22, R48/21, R48/21/22, R48/22
D	R26, R26/27, R26/27/28, R26/28, R27, R27/28, R28, R39/26, R39/26/27, R39/26/27/28, R39/26/28, R39/27, R39/27/28, R39/28, R40, R48/23, R48/23/24, R48/23/24/25, R48/23/25, R48/24, R48/24/25, R48/25, R60, R61, R62, R63, R64
E	R42, R42/43, R45, R46, R49, R68

* If there is no R-Phrase in the label of the chemical, this substance should be classified under Hazard Group A

** Chemicals with insufficient known characteristics as stated in the MSDS should be classified under Hazard Group B

The following R-phrases have been deleted by the Adaptation to the Technical Progress (ATP 28) from 6 August 2001, but may still appear in older MSDS:

R40/20/21, R40/20/22, R40/21/22, R40/20/21/22, R40/21/22 belong to Hazard Group B.

Carc cat 3 R40 belongs to Hazard Group D.

Muta cat 3 R40 belongs to Hazard Group E.

The R-Phrases guide you to the Hazard Groups

Identifying unacceptable risks

To determine if significant risks exist in your operation through the use of a particular chemical substance or formulation, you need to look at two factors:

- amount of the substance used (Factor 1);
- ability to become airborne (Factor 2).

Both of these factors – scale of use and the ability to become airborne – influence the level to which people are exposed to the substance and are therefore in a potentially harmful situation.

Factor 1: What amount of the substance is being used?

First, you need to decide if the amount of the substance in solid or liquid form that is used in each batch (or daily for continuous operations) can be described as small, medium or large.

Figure 12 can help you make this determination based on the weight / volume of the substance and the form in which it was delivered to you by the supplier.

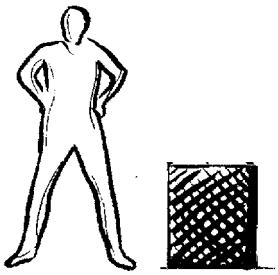
Factor 2: How much of the substance is airborne?

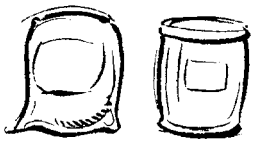
The physical form of a substance influences how likely it is to become airborne. In this respect, you need to consider the level of “dustiness” for solids. For liquids, you need to look at the substance’s “volatility”

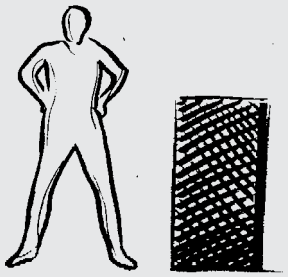
Figure 13 help you determine the level of dustiness of a particular chemical substance and Figure 14 help you determine the level of volatility of a particular chemical substance.

Figure 12: Determining the amount of chemicals required for the production process

Quantity	Weight	Volume	How received from supplier
Small	Grams (g)	Millilitres (ml)	Packet or bottles
Medium	Kilograms (kg)	Litres (l)	Kegs or drums
Large	Tonnes (t)	Cubic metres (m^3)	Bulk







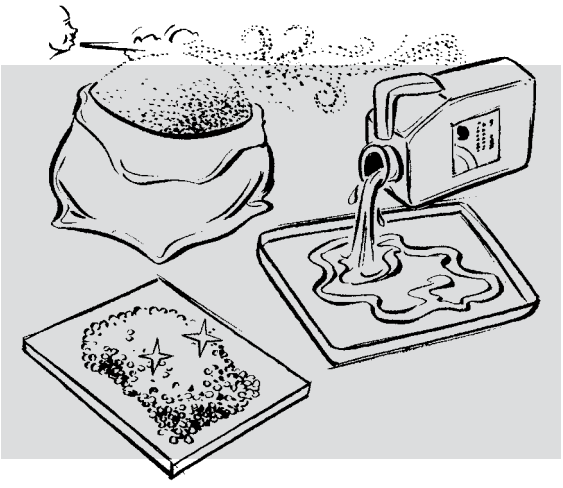
If you are in doubt about the amount, choose the larger quantity

Figure 13: Determining the dustiness of substances

Solids	The dustiness of a solid is determined as follows:
Low	Pellet-like solids that don't break up. Little dust is seen during use (e.g. PVC pellets, waxed flackes).
Medium	Crystalline, granular solids. When used, dust is seen but settles down quickly. Dust is left on surfaces after use (e.g. detergents)
High	Fine, light powders. When used, dust clouds can be seen to form and remain in the air for several minutes (e.g. cement, carbon black, chalk dust)

Figure 14 Determining the level of volatility of substances

Liqulids	Volatility refers to the ability of a liquid to turn into a vapour and therefore get into the air. To determine the volatility of a liquid, you need to find its boiling point (i.e. look on the MSDS available from the chemical supplier). Compare the boiling point against the descriptions below in order to determine the level of volatility:
Low	Boiling point above 150°C
Medium	Boiling point between 150°C and 50°C
High	Boiling point below 50°C
•	For processes being carried out above room temperature (approximately 20° C), this will typically increase the volatility (i.e. increase the risk of the liquid to turn into a vapour (see Figure 14b).
•	If you are using a preparation made up of two or more substances with different boiling points, use the lowest boiling point to determine the level of volatility



Determining the necessary approach to control hazardous situations for chemicals causing harm by inhalation

The previous sections outlined the steps to determine:

- the hazard group;
- scale of use (amount) of a substance;
- its ability to become airborne (dustiness or volatility).

Once you have evaluated this information, you can then identify the approach (see **Figure 15**) needed to prevent or control exposure to significant hazards that may arise during the storage, use, handling, and disposal of a particular chemical substance.

Use **Figure 15** to identify the necessary control approach by matching the hazard group with the amount of the substance used (in a batch or daily) and its level of dustiness (for a solid) or volatility (for a liquid).

The four different control approaches in Figure 15 are indicated by the numbers 1 to 4 in the box and by four different colors.

Figure 15: Determining the necessary Control Approach

Amount used	Low dustiness or low volatility	Medium volatility	Medium dustiness	High dustiness or high volatility
Hazard Group A				
grams or millilitres	1	1	1	1
kilograms or litres	1	1	1	2
tonnes or cubic metres	1	1	2	2
Hazard Group B				
grams or millilitres	1	1	1	1
kilograms or litres	1	2	2	2
tonnes or cubic metres	1	2	3	3
Hazard Group C				
grams or millilitres	1	2	1	2
kilograms or litres	2	3	3	3
tonnes or cubic metres	2	4	4	4
Hazard Group D				
grams or millilitres	2	3	2	3
kilograms or litres	3	4	4	4
tonnes or cubic metres	3	4	4	4
Hazard Group E				
	For all substances in hazard group E control approach is required			

This method of linking R-Phrases with hazard classification in the identification of needed control approaches is based wholly on the approach of the ILO International Chemical Control Toolkit (see http://www.ilo.org/public/english/protection/safework/ctrl_banding/toolkit/main_guide).

The numbers 1-4 in the box indicate the recommended control approach

What does “control approach” mean?

A control approach is the sum of measures you need to take to reduce hazards from a specific chemical.

The numbers 1 to 4 shown in Figure 15 indicate four control approaches that can be implemented at the workplace to provide the adequate level of protection to prevent or minimize the risk of exposure to hazardous substances.

The four control approaches for chemicals causing harm when breathed in (described in more detail in **Tool 8**) include general ventilation, engineering control, containment and special measures.

Control approach 1
A good standard of general ventilation and good working practices are required.

Control approach 2
Engineering control i g. local exhaust ventilation ranging from a single point extract close to the source of hazard to a ventilated partial enclosure is required.

Control approach 3
The hazard should be contained / enclosed.

Control approach 4
Expert advice is needed to choose necessary control measures.

The measures recommended in control approach 3 are included in the measures described for control approach 1 and 2.

The 4 control approaches give recommendations for:

- Acces
- Design & Equipment
- Maintenance
- Examination & Testing
- Cleaning
- Personal Protective Equipment (PPE)
- Training and Supervision

Each approach has an increasing level of control for each of these aspects!

You can find more details on these control approaches by visiting the ILO internet site for the

International Chemical Control Toolkit

at

http://www.ilo.org/public/english/protection/safework/ctrl_banding/toolkit/icct/index.htm

Tool 8 – Description of four control approaches for chemicals causing harm when breathed in

These control sheets are part of the ILO **International Chemical Control Toolkit** and should be used when the toolkit indicates that a control approach 1, or 2 or 3 or special solution is appropriate.

Control Approach 1:

General ventilation

Scope

The sheet gives good practice advice on the application of general ventilation at the workplace and includes working outside of a building. General ventilation is suitable for a range of small, medium and large scale tasks involving solids and liquids. This sheet identifies the minimum standards you need to apply to protect your health. It should not be used to justify a lower standard of control than that which may be required for process control or control of other risks.

Access

Try to keep away people whose presence is not required in the work process from the work area. Ensure that no one is working close by or downwind.

Design and equipment

- Ensure that there is unrestricted access to fresh air. This can be done by working outdoors. When working indoors, doors and windows may need to be opened or a fresh air supply can be ensured using powered fans.
- If you work in a factory building, you will normally require a wall mounted fan to remove the dirty air and airbricks or louvers or ceiling vents to allow fresh, clean air into the workroom.
- Do not release dirty air near the clean air intake.
- Ensure, where possible, that clean air flows past the worker and then past the work area. In the open, use the wind to blow dirty air away from you.
- For factories, ensure that the size and number of fans is sufficient to remove the dirty air from the workplace (more than one fan may be needed). A minimum of 5 air changes per hour is recommended.

Maintenance

Keep any fans or extractors in good working order.

Examination and testing

Every day, check that the fans are working when they are switched on. A ribbon strip attached to the exhaust side of the fan cage can be used as an indicator that the fan is working.

Cleaning

- Clean the work equipment and work area daily.
- Clean up spills immediately.
- Don't clean up dust with a brush/ broom or compressed air. Use a damp cloth or vacuum where possible.
- Put lids on containers immediately after use.
- Store containers in a safe place where they will not get damaged.
- Store volatile liquid containers away from direct sunlight.

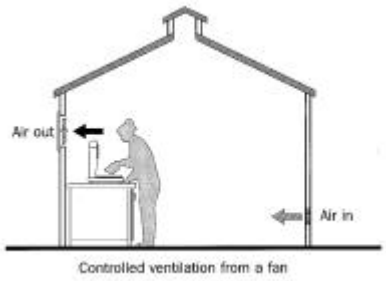
Personal Protective Equipment (PPE)

- Check the material safety data sheet or ask your supplier to find out what PPE is needed.

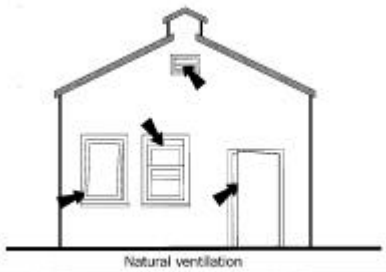
- Ask your protective equipment supplier for written recommendations on the PPE that is suitable for your operations. Ask the supplier to train you and your workers in how to use, maintain and store the equipment.
- Look after your protective equipment. When not in use, keep it clean and store it in a clean, safe place.
- Change your protective equipment at recommended intervals or when it is damaged.

Training and supervision

- Tell your workers about the harmful nature of the substances they are working with and why they must use the controls and personal protective equipment (PPE) provided.
- Teach them to handle chemicals safely. Check that controls (e.g. fans) are working and what to do if something goes wrong.
- Have a system to check that the precautions you have put in place are being followed.



Controlled ventilation from a fan


Natural ventilation

Control Approach 2:

Engineering Control

Scope

The sheet gives good practice advice on the application of local exhaust ventilation, which is the most common form of engineering control. Local exhaust ventilation can be applied to a range of small, medium and large scale tasks involving solids and liquids. This sheet identifies the minimum standards you need to apply to protect your health. It should not be used to justify a lower standard of control than that which may be required for process control or control of other risks.

Access

Try to keep away people whose presence is not required in the work process from the work area.

Design and equipment

- Apply local exhaust ventilation (LEV) at the source of the exposure. There should be a sufficient airflow to capture the dust or vapour before it disperses in the workplace. For dust, airflows greater than 1 m / sec will generally be needed and for vapours, airflows greater than 0.5 m / sec. The airflow should be measured at the origin of the dust or vapour.
- Contain the source of dust or vapour as much as possible to help stop it from spreading.
- Don’t allow the worker to get in between the source of exposure and the LEV, or they will be in the path of the contaminated air.
- Where possible, locate the work away from doors and windows to stop draughts from interfering with the LEV and spreading dust or vapours.

- Keep extraction ducts short and simple and avoid long sections of flexible duct.
- Provide an easy way of checking that the LEV is working such as a ribbon strip attached to the output side.
- Discharge extracted air in a safe place away from doors, windows and air inlets. Be careful that extracted air does not affect neighbours.

Maintenance

Keep the LEV system in good working order.

Examination and testing

- Every day, check that the extraction system is working when it is switched on.
- Check ducts once a week for signs of damage and repair when necessary.
- Have the system thoroughly examined and tested at least once a year.

Cleaning

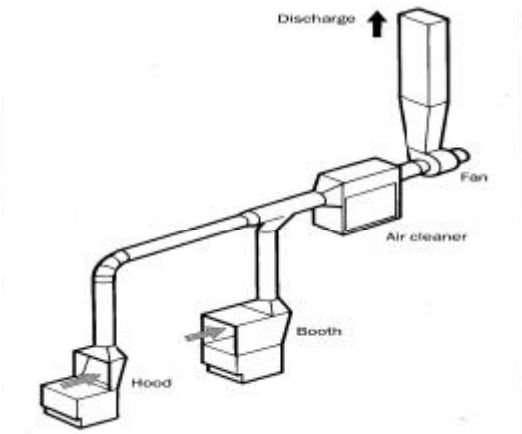
- Only keep the amount of material which will be used that day in the workplace.
- Clean the work equipment and work area daily.
- Spills are the major cause of dust or vapour in the workplace. Clean up all spills immediately.
- Don’t clean up dust with a brush/ broom or compressed air. Use a damp cloth or vacuum where possible.
- Put lids on containers immediately after use.
- Store containers in a safe place where they will not get damaged.
- Store volatile liquids away from direct sunlight.

Personal Protective Equipment (PPE)

- Check the Material Safety Data Sheet or ask your supplier to find out what personal protective equipment is needed.
- Look after your protective equipment. When not in use, keep it clean and store it in a clean, safe place.
- Change your protective equipment at recommended intervals or when it is damaged.

Training and supervision

- Tell your workers about the harmful nature of the substances they are working with and why they must use the controls and PPE provided.
- Teach them to handle chemicals safely. Check that controls are working and what to do if something goes wrong.



Control Approach 3:

Containment

Scope

The sheet gives good practice advice on containment and describes the key points you have to follow to reduce exposure to an adequate level. Containment can be applied to a range of small, medium and large scale tasks involving solids and liquids. This sheet identifies the minimum standards you need to apply to protect your health. It should not be used to justify a lower standard of control than that which may be required for process control or control of other risks.

Access

- The work area and equipment should be clearly marked.
- Control entry to the work area. Only workers actually needed and trained for that work process should be allowed into hazardous work areas.

Design and equipment

- Material handling should take place in a closed system that separates the worker from the hazardous material by a solid barrier
- Limited breaches of the close system are permitted under controlled conditions, i.e., where exposure times are only a few minutes and the quantity of material handled is small. For example, quality control sampling.
- Design the closed system, so it can be easily maintained.
- Where possible, keep the equipment under negative pressure to reduce leakage.
- Vent any exhaust air in a safe place away from doors, windows, walkways and air inlets. Care should be taken that the exhaust air does not affect neighbours.
- Provide a sump or separate drainage system to prevent leaks and spills from contaminating communal drains and waterways.

Maintenance

- Ensure all equipment used is well repaired if necessary and maintained in good and efficient working order.
- Adopt a “permit to work“ system for all maintenance work.
- Document and follow any special procedures that are needed before the system is opened or entered, e.g., during purging or washing.
- Don’t enter any closed vessel until it has been checked for hazardous or flammable substances and sufficient oxygen (between 19.5% and 23.5%).

Examination and testing

- Check all the equipment once a week for signs of damage and repair when necessary.
- Have the system thoroughly examined and tested at least once a year.

Cleaning

- Clean the work equipment and work area daily.
- Clean up spills immediately.
- Don’t clean up dust with a brush/ broom or compressed air. Use a damp cloth or vacuum where possible.
- Put lids on containers immediately after use.

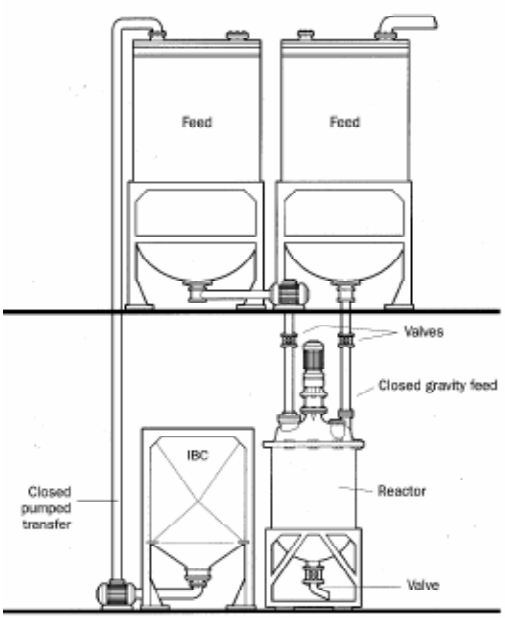
- Store containers in a safe place where they will not be damaged.
- Store volatile liquid containers away from direct sunlight.

Personal Protective Equipment (PPE)

- Check the Material Safety Data Sheet or ask your supplier to find out what personal protective equipment is needed.
- Respiratory Protective Equipment (RPE) should not be needed for routine tasks, but may be necessary for cleaning and maintenance activities and when dealing with spills.
- Be aware that some maintenance tasks may involve entry into confined spaces where supplied air RPE may be needed.
- Look after your protective equipment. When not in use, keep it clean and store it in a clean, safe place.
- Change your protective equipment at recommended intervals or when it is damaged.

Training and supervision

- Tell your workers about the harmful nature of the substances they are working with and why they must use the controls and PPE provided.
- Teach them to handle chemicals safely, check that controls are working and what to do if something goes wrong.
- Have a system to check that the precautions you have put in place are being followed.



Control Approach 4:

Special

Control approach 4 – special – means you have a situation where you need more specific, and specialist advice than provided in the other three control approaches.

The advice may come from a more detailed Health/Safety/Environment Guidance document, or you may need to involve an expert, such as a qualified occupational hygienist. An occupational hygienist can give you site-specific advice on your risk assessment, the possibility of substituting the chemical you are using for a less hazardous one, and control measures.

It is important that you seek further advice.

Here we refer you to the electronic version of COSHH- Essential (www.coshh-essentials.org.uk) for further details.

Tool 9 - Description of three control measures for chemicals causing harm via skin and eye contact

The simplest way for chemicals to harm the body is through direct contact with the skin, or eyes. Skin contact with a chemical may result in a local reaction, such as a burn, or rash, or absorption into the bloodstream. Absorption into the bloodstream may then allow the chemical to cause toxic effects on other parts of the body. Local reactions as well as toxic effects caused by absorption can be very painful and can damage both work and social life. How quickly a disease caused by skin contact develops, depends on the hazardous properties of the substance and how much/how often it touches the skin.

To categorise the hazardous properties of chemicals the German Federal Institute for Occupational Safety and Health (BAuA) has linked R-Phrases of chemicals causing harm when in contact or absorbed by skin into 5 different hazard groups (Skin A – Skin E) based on increasing hazard. Group Skin E substances are the most hazardous. The least hazardous are in hazard group A.

C

Examples of pictograms remembering the use of PPE when workling with chemicals absorbed by skin and eyes




Figure 16: BAuA classification of Skin Hazard Groups (Skin A-E) for chemicals causing harm via skin and eye contact

Skin hazard group	Linked R-Phrase
Skin A	R66
Skin B	R21, R21/22, R20/21, R20/21/22, R38, R37/38, R36/38, R36/37/38, R48/21, R48/20/21, R48/21/22, R48/20/21/22, R68/21, R68/21/22, R68/20/21, R68/20/21/22
Skin C	R24, R34, R39/24, R39/24/25, R39/23/24, R39/23/24/25, R40, R48/24, R48/23/24, R48/24/25, R48/23/24/25, R62*, R63*, R68* and chemicals with insufficient known characteristics
Skin D	R43, R42/43
Skin E	R24 and R34, R24 and R35, R27, R27/28, R26/27, R26/27/28, R35, R39/27, R39/27/28, R39/26/27, R39/26/27/28, R45, R46, R60*, R61*

* only classified in the group, if the substance is absorbed by the skin. The MSDS usually includes information regarding whether or not skin absorption is significant. In case of doubt skin absorption should be assumed

Identifying Control Measures for Skin Hazard Groups A-E

When handling substances which belong to the skin groups A-E you first need to consider how the chemicals can come into contact with the skin and eyes. This can occur:

- When the skin comes into direct contact with a liquid or solid, e.g. by immersion
- When dust or vapours/spray settle on the skin
- By touching dirty surfaces
- By touching or removing dirty clothing or gloves
- By splashing or swallowing

Once hands are contaminated, contamination may be spread to other parts of the body by rubbing or scratching.

For determining which control measures are suitable for the 5 skin hazard groups you need to take into account two other factors:

Factor1: Quantity of substance on the skin (small or large quantity of chemical)

Quantity of substance	Criteria
Small quantity	Splashes
Large quantity	Immersion and / or large-area wetting of hands and forearms

Factor 2: Duration of the skin contact (short or long duration)

Duration of the effect	Criteria
Short Duration	Below 15 minutes / day
Long Duration	Over 15 minutes / day

Figure 17 shows you which level of control measures to choose. In principle there are three levels of control:

- BASIC control measures
- ADVANCED control measures and
- SPECIAL control measures..

Figure 17: Determination of control measures

Skin Hazard Groups	Small quantity + Short duration	Small quantity + Long duration	Large quantity + Short duration	Large quantity + Long duration
A	basic	basic	advanced	advanced
B	basic	basic	advanced	special
C	advanced	advanced	advanced	special
D	special	special	special	special
E	special	special	special	special

Basic control measures

When handling chemical agents which may harm the skin it should be ensured that:

- the workplace is tidied up and equipment is kept clean
- the splashing of liquids, the release of dusts or mists as well as skin injuries resulting from cuts or perforations are avoided by means of proper working techniques
- contamination caused by leaked or spilled chemical agents is removed immediately by suitable means
- chemical-agent residues on the outer surfaces of containers or packaging are removed, above all, in the case of dust-forming, liquid or sticky products
- wastes and used cleaning cloths are collected in the containers provided for that purpose
- the utilized long- sleeved working clothes sufficiently ensure the necessary protection against skin contact
- distinguishable cleaning cloths for machines and the hands are made available and used
- good washing facilities are provided. Workers should wash their hands before and after eating, drinking and using the lavatory
- prior to using new chemical agents, workers must be instructed with regard to the necessary protection and hygiene measures during handling. If necessary, instruction must be repeated on a regular basis (see also Tool 10)
- information on the risk to skin and on the use of skin-protection, skin-cleansing and skin-care

products is summarised in a skin-protection plan which should be part of the work instructions. (Tool 10)

Advanced control measures

In addition to the measures listed above the following measures should be implemented if an advanced level of control is needed (this is for instance true for corrosive substances as well as for toxic substances which can be absorbed by the skin):

- Eliminate or substitute harmful substances
- If you can't avoid exposure by substitution, you will need to use suitable tools, instruments, devices or work techniques to prevent or at least reduce significantly any contact of the skin with the hazardous substances
- If this is not possible, personal protective equipment must be used (chemical protective gloves, protective aprons and protection suits). Information on the nature, type and material of the protective equipment must be provided in the Material Safety Data Sheet. The procurement, maintenance, storage and disposal of personal protective equipment in the enterprise should be well organised and documented in the work instructions (Tool 10). If protective gloves are used, care should be taken to ensure they offer sufficient protection from the hazardous substance in question. The use of gloves not suitable for chemicals (for example gloves made from leather) can have fatal consequences
- the utilized protective gloves are low in allergenic substances, durable and impermeable to the particular chemical agent for the period of their use and are always stored under clean conditions; Glove selection is a complicated process and employers should always seek expert advice from the manufacturer or supplier of the chemical agent or glove.

Special control measures

Special indicates that a particular harmful situation is prevailing. In these cases the advice of an occupational hygienist should be sought.

If very hazardous substances are handled (e. g. substances which may be very corrosive, carcinogenic or harmful to fertility) particularly intensive efforts should be made to look for alternative substances and technical means (for example closed systems) for preventing exposure. The advice of an occupational hygienist should be sought in this regard. In Figure 17 these situations are indicated by special.

Eye protection control measure

In some cases safety splash goggles or face shields should be worn when carrying out operations in which there is any danger from splashing chemicals or flying particles. This holds especially for those activities involving hazardous substance with the R phrases R 36, R 41, R 34 and R 35 (consult the Material Safety Data Sheet). If necessary eye douches should be available in the vicinity of the working area.

Tool 10 - Work Instructions

Instruction and Training are at the core of any chemical management program. It enables the workers to recognize health and safety hazards, and to prevent accidents and injuries. Work instructions are an essential element in worker information.

Using a simple layout and a straightforward language, the work instructions should inform workers of the hazardous substances occurring at the workplace, the hazards to health, the relevant protection measures and how to act in case of an accident. It also serves as the basis for an oral instruction which workers must receive annually or before taking up a new activity. It is recommended, that instructed workers should confirm the received and understood instructions / training by signature.

In general the following points should be included in a work instructions:

- name (product identification)
- hazards identification
- safety measures and safe handling
- accidental release measures
- first-aid
- appropriate disposal

The data needed for the content of the work instructions can be found generally in the MSDS of the respective substance. Important technical and operational requirements found in the ILO task-specific control guidance sheets (see http://www.ilo.org/public/english/protection/safework/ctrl_banding/toolkit/icct/index.htm) should also be reflected in the work instructions. The legal framework should be considered and can be integrated in the work instructions. The writing of work instructions may be sometimes too complex. This will depend on substances, required operation, corresponding risks and safety requirements. An external consultant should be involved in such cases and he/she should work closely with the concerned employees to adapt the work instructions to the reality of the company.

To visualise hazards and for recommending control measures pictograms should be used. You can download pictograms from http://forum.cptec.org/index.php?showtopic=305. (see different pictogram examples below in the work instructons for oxystop and for glutaraldehyde).

It is a great benefit for the employer to have work instructions for hazardous substances, dangerous processes and important steps during the operation in the company. Work instructions must be followed and should be regarded as a powerful instrument to (a) inform the workers, (b) document the training and the special handling of certain substances and (c) avoid serious injuries. The work instructions should be in a place in the company where it can easily be seen and read. Further, the work instructions should be delivered to the worker when working for the first time with these chemicals, or during a routine training. An oral instruction must be given in a simple and straightforward language and after this the worker must sign that he/she was instructed and knows how to behave during routine activities and in the case of an incident / accident. They have to understand that disregarding the work instructions can result in accidents and serious injuries.

ACCIDENT: An undesired, unexpected event resulting in death, injury, damage to health, damage to property or other form of loss.

INCIDENT: A distinct event, often one that disrupts the normal operation procedure. Others than an accident! Sometimes an incident is referrred as a near-miss, too

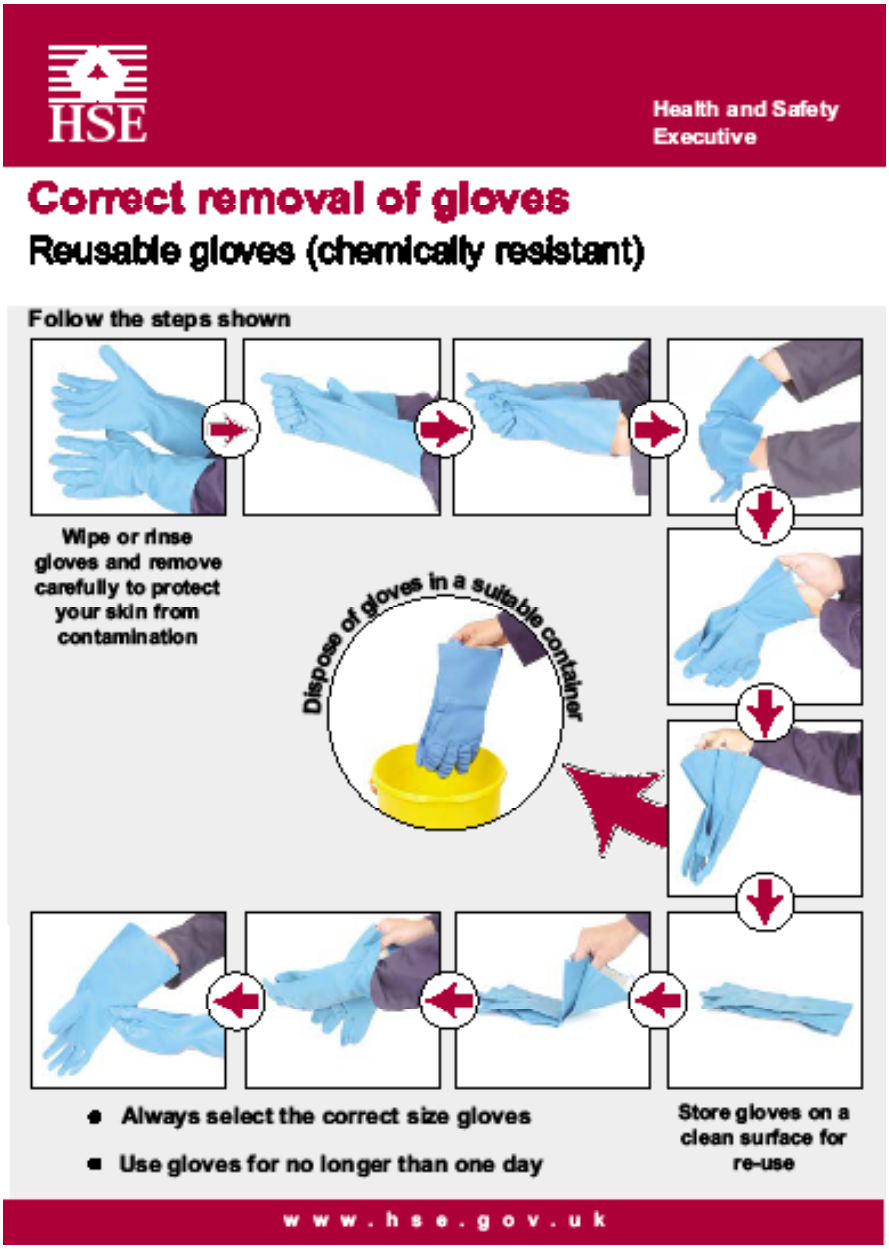
Three examples of work instructions are presented here.

The first work instruction example shows the correct removal of gloves when using corrosive chemicals.

The second example is for Oxystop. Oxystop is applied for the conditioning of boiler water. The dosage system is located in a boiler house. Barrels are connected to the dosage device by a feed pipe. The dosage device is connected to the batching tank by a dosing valve. The barrel, the feed pipe, the dosage device and the batching compose a closed system. Hazards can arise by spillage of the substance when changing the barrels, which shall be encountered with the measures listed in the work instructions.

The third example is for the safe use of glutaraldehyde, a hazardous chemical.

Example of a work instruction for correct removal of gloves



Example of work instructions for Oxystop

WORKAREA **Boiler house**	**WORKPLACE:** **Activity:**	**Water treatment** **Change of barrel: Dosage**
Name (product identification)	OXYSTOP Organic oxygen binder, Basis: Supplier:	 Diethylhydroxylamin (DEHA) Elfa-Oxy-Chemie
Hazards identification	 Irritant	Irritates the eyes, the respiratory organs and the skin Hazardous for water, class of risks for water 2 Must not be delivered into sewage water!
Safety measures and safe handling	 	Transport barrel onto the working platform only with hoisting basket and hoisting equipment! When connecting the container to the feed pipe wear rubber gloves (gloves for protection of acids) and protective goggles!
Accidental release measures		Leakages in the dosage system have to be reported immediately to the general management! At escape of large amounts of Oxystop (e.g. for the upset of the container) wear a mask for full protection with composite filter A2-P3 (brown)! Treat spilled liquid with Hydroperls!
First aid		At getting in touch with the eyes rinse the eyes thoroughly and call on a works doctor! Take off draggled, soaked clothes immediately, clean moistened skin thoroughly with water! If swallowed call on works doctor and show label or MSDS (material safety data sheet)!
Appropriate disposal		Oxystop must not get into the canalisation! Treat leakages with Hydroperls and call the fire brigades for disposal! Give back empty containers to the storehouse!

Ref. No.: ... .
Date: .....
Responsible: .....
Department: .....

Work Instruction
Hazardous Chemicals

Workplace/Operation: .....

1. NAME (PRODUCT IDENTIFICATION)

1.5% AQUEOUS GLUTARALDEHYDE SOLUTION (ACTIVATED)

2. HAZARDS IDENTIFICATION

Routes of Entry: Inhalation, Skin, Ingestion
Effects of Overexposure:
Eye: Contact with eyes causes damage.
Skin: Can cause irritation, sensitization or allergic contact dermatitis, avoid skin contact.
Inhale: Vapors may be irritating and cause headache, chest discomfort, symptoms of bronchitis or asthma.
Ingest: May cause nausea, vomit, and general systemic illness.

3. SAFETY MEASURES AND SAFE HANDLING

Handling and Storage Precautions: Use normal storage & handling requirements.
Other Precautions: None specified by Manufacturer.
Respiratory Protection:
Routine: None required.
Emergency: Organic vapor cartridge mask or self-contained breathing apparatus.
Ventilation:
Routine: Should be used in cover containers with tight fit lid. Use with standard room ventilated (air conditioning) with minimum of 10 air changes/hr (supply)
Protective Gloves:
Routine: Natural latex, nitrile, butyl (other products equivalent); Caution: Don't use neoprene rubber or Vinyl as Glutaraldehyde may rapidly permeate through material.
Eye Protection:
Routine: Safe glass (goggles)
Emergency: Safe glass (goggles), Face shield
Other Protective Equipment:
plastic apron
Work Hygienic Practices: Avoid contamination of food.
Emergency: gloves - listed above, protective clothing, rubber boots

4. ACCIDENTAL RELEASE MEASURES

Spill Release Procedures:
Large spills: Use ammonium carbonate to "neutralize" glutaraldehyde odor. Collect liquid & discard it.
Small spills: Wipe with sponge or mop down area with equal mixture of household ammonia & water.
Flush with Large quantities of water.

5. FIRST AID

First Aid:
Eye: Flush thoroughly with water. Get medical attention.
Skin: Flush thoroughly with water. If irritation persists get medical attention.
Inhale: Remove to fresh air. If symptoms persist get medical attention.
Ingest: Do not induce vomiting. Drink copious amounts of milk. Get medical attention.

6. APPROPRIATE DISPOSAL

Waste Disposal Methods: Triple rinse empty container with water. Dispose in incinerator or landfill approved for pesticide containers. Discard solution With Large Quantity of water.

Date:
Prepared/Revised:
Signature:

Checked:
Signature:

Tool 11 – Hazardous substances that can cause harm to the environment and basic recommendations

The following R-Phrases indicate that these chemicals are hazardous to the environment:

R50, R50/53, R51, R51/53, R52, R52/53, R53, R54, R55, R56, R57, R58, R59

See here below some general control measures for these chemicals. These general recommendations are based on the ILO Toolkit.

Recommendations for Control of Emissions as waste chemicals

Your local authority or environment control authority will have rules, and paper audit procedures for disposing of waste chemicals. Ask them for details.

- **Solid waste:** Some solid wastes can be recycled, e.g. metal swarf, wood dust, slag. These can be collected in open skips or wagons. It is important to protect the waste from rainwater, and from wind stripping. Fly ash, and boiler ash may be contaminated with dioxins, and these substances should not be recycled. Other solid wastes should be sealed in drums, or lidded skips and labelled clearly.
- **Sludge:** Sludge is not normally suitable for recycling, often being contaminated with heavy metals, pesticides or solvent residues. Special tankers may be available to collect sludge. Otherwise it has to be dug from the sump manually and sealed into clearly labelled drums.
- **Liquid waste:** Liquid hydrocarbon and flammable solvent waste is recycled by distilling, incinerated, or used as fuel (co-processing), e.g. in making cement. Waste chlorinated hydrocarbons are not suitable for incineration. Liquid acid and alkali, or metal salt waste is sealed in drums, or held in a tank until collected by waste tanker for specialist disposal.
- **Waste articles:** Articles such as deformed drums, broken glass, pallets, etc. can, once decontaminated, be disposed as non-dangerous waste.

General precautions

- Dispose of solids, sludge and waste solvents as special waste.
- Do not dump waste except in a specified tip.
- Check with your local environment authority how to classify the collected waste for disposal.
- Make sure the waste is clearly labelled and disposed through an authorised waste contractor.
- Do not reuse chemical drums or containers for food or water storage.
- Do not mix incompatible wastes (e.g. oxidising agents with solvents, chlorinated solvents with ketones, metal dusts or alkalis).
- Make sure the waste container is suitable – acids can attack metal drums.
- Never use a flame or mechanical cutter to cut up scrap metal drums unless they have been filled with water first.
- Waste may be flammable, corrosive or poisonous – wear protective equipment and wash it off your skin.

Recommendations for Control of emissions into water systems, and ground-water

Your local authority, or environment control authority will have limits for environmental emissions to water. Ask them for details. The degree of control needed is a matter for local regulation. Emission limits set boundaries for the quantity of pollutant emitted, the concentration emitted, and/or the duration of the emission per day.

Control of chemicals that accumulate in ground-water

You need to know something about the geology of your site. Chemicals entering aquifers present a long-term risk, and may reappear in drinking water. It is particularly important to prevent any release of chemicals to the soil if your company is situated above an aquifer, particularly if the rock is porous.

It is also important to keep industrial chemicals away from soil, if there is any likelihood of leaching into the water compartment of the environment. Means for doing this include: bunding chemical storage areas, with the bund of a sufficient size to contain any foreseeable spillage, including the failure of storage tanks, an impermeable barrier (e.g. concrete), with collection of rainwater run-off secure storage of products and wastes stopping vehicle tyres dragging chemical out of the plant, e.g. using a tyre wash.

Control of chemicals that damage waste water systems

Some chemicals can generate dangerous gases in waste water systems, and must not be passed directly to waste water. These need to be collected for special disposal. Waterborne waste can be treated on site through: settling ponds, to remove suspended solids interceptors, to collect oil, and immiscible organic fluids from water aeration ponds, to oxidise the liquid waste, and precipitate sludge, prior to release into the waste system reed beds, to prepare liquid wastes for release to surface water drainage (streams, etc.)

Suspended solids, sludge, and intercepted oil, and solvent should be disposed separately. Water treatment systems need to be designed by experts for the expected chemicals in the waste water.

Control of chemicals that run off into streams and poison wildlife

Chemicals entering streams present a short term risk to wildlife and stream organisms. There is also a long term risk if the chemicals accumulate in the sediment. It is particularly important to prevent any release of chemicals if your firm is situated on a watercourse. Means for doing this include: bunding chemical storage areas, with the bund of a sufficient size to contain any foreseeable spillage, including the failure of storage tanks an impermeable barrier (e.g. concrete), with collection of rainwater run-off secure storage of products, and wastes.

Control of chemicals that poison organisms in sewage treatment works

Some chemicals are particularly toxic to organisms in sewage treatment works, for example chlorinated hydrocarbons and metal salts. Unless these can be treated in an on-site treatment plant, such wastes should be collected in drums or tanks, for specialist disposal.

Control of other dilute bio-degradable chemical wastes

Where it is the chemical's concentration that gives rise to environmental risk, it is acceptable to discharge waste solution to the waste water system, so long as the chemical has been diluted enough. For example, soluble sulphates can damage concrete pipes, and need to be well diluted.

One way of doing this is to schedule the discharge at a time of peak water flow (e.g. around breakfast

time). Another is to pipe the waste some distance offshore, and you need to contact your local environment authority for permission.

General precautions

- Check the bunds and concrete surfaces from time to time, to make sure these are not damaged. Monitor the quantities of chemicals on site.
- Prepare plans to deal with spills and fires.
- Dispose of sludge and waste solvents as special waste.
- Do not dump waste except in a specified tip.
- Check with your local environment authority how to classify the collected waste for disposal.
- Make sure the waste is clearly labelled and disposed through an authorised waste contractor.
- Don't enter sludge pits or any other confined space without making sure that the air is fit to breathe until it is safe to do so. Check for hazardous or flammable substances and sufficient oxygen (between 19.5% and 22%). Note that entry or the work may give rise to a hazardous situation, e. g. disturbing sludge, welding may deplete oxygen. Sludge may be corrosive or poisonous – wear protective equipment and wash it off your skin . Intercepted organic liquids may require you to use a respirator. You may need to shower after working with sludge.

Recommendations for Control of Emissions into the air

Your local authority or environment control authority will have limits for environmental emissions to air. Ask them for details. The degree of control needed is a matter for local regulation. Emission limits differ from occupational exposure limits. Emission limits set boundaries for the quantity of pollutant emitted, the concentration emitted, and/or the duration of the emission per day.

Control of corrosive mists

Corrosive mists arise from processes that emit acid, or alkali vapours. These can be arrested in wet scrubbers, and spray towers. However, the scrubber, or spray fluid will become a waste material, and needs to be disposed safely.

Control of smoke

Smoke results from incomplete burning, when it can contain harmful pollutants such as sulphur dioxide, oxides of nitrogen, Polycyclic Aromatic Hydrocarbons (PAH) and dioxins. Emission of dark or black smoke shows an urgent need to improve the combustion process.

Control of dust and fume

Dust results from a very wide range of processes, and in a range of particle sizes from grit (around 100 microns) to dust (above 1 micron). Fume is solid condensed vapour, and can be taken as particles below 5 microns. Depending on the particle size and corrosive properties of the dust, and its potential for harm to the environment, there is a range of air cleaner devices available: cyclone, electrostatic precipitator, wet scrubber, fabric bag filter.

All of these require power to run, and vigilance to make sure they remain working properly.

Control of solvent vapours (volatile organic compounds, VOC)

Solvent vapours result from coating and drying processes, and from making large fibreglass structures. Spray towers, using water with a surfactant, will remove soluble and reactive vapours. Absorbers, such as charcoal towers, can be useful, but have a limited life and the exhausted charcoal needs disposal. Another method is combustion,

where the vapour passes into an incinerator or over a heated catalyst bed

Disposal of collected waste

The collected waste (dust or liquid sludge) will need special considerations for disposal. The people emptying dust collectors and sludge pits will require personal protective equipment.

General precautions

- Check the emission stack from time to time, to make sure it is working.
- Monitor the pressure drop across air cleaners, to check they are working efficiently.
- Prepare a schedule for maintaining the air cleaners – and keep to it.
- Dispose of dust and sludge as special waste.
- Dust is harmful to health – use a respirator.

Glossary – Chemical Management Guide

BAuA	Federal Institute for Occupational Safety and Health (Dortmund), Bundesanstalt für Arbeitsschutz und Arbeitsmedizin
BMZ	Federal Ministry for Economic Co-operation and Development (Bonn), Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung
CAS	Chemical abstract service registry number
CHS	Convention Project Chemical Safety (Bonn), Konventionsvorhaben Chemikaliensicherheit
e.g.	For example
EMS	Environmental Management System(s)
etc.	and so on / and others
g / kg / t	grams / kilograms / tons
GHS	Global Harmonised system
GTZ	German Agency for Technical Co-operation (Eschborn), Deutsche Gesellschaft für Technische Zusammenarbeit GmbH
HSE	Health and Safety Executive (UK)
ILO	International Labour Organisation (Geneva)
ILO/CIS	International Occupational Safety and Health Information Centre
IOHA	International Occupational Hygiene Association (UK)
ISO	International Organisation for Standardisation
LEV	Local Exhaust Ventilation
ml / l /m3	Millilitre / litre / cubic meter
MSDS	Material Safety Data Sheets
NPO	Non Product Output
PPE	Personal Protection Equipment
PVC	Polyvinyl chloride
RPE	Respiratory Protection Equipment
R-Phrases	Risk-Phrases
S-Phrases	Safety-Phrases
UK	United Kingdom
$US	United States Dollars
%	Percent
&	And
°C	Degrees Celsius

Glossary for MSDS

ACGIH	American Conference of Governmental Industrial Hygienists
CAS	Chemical Abstracts Service Registry Number
CFR	Cooperative Fuel Research Committee
CIS	International Health and Occupational Health Centre
DSL/NDSL	Domestic Substances List/No-DSL (Canada)
EINECS	European Inventory of Existing Chemical Substances
EN	European Norm
IARC	International Agency for Research of Cancer
IATA	International Air Transport Association
ILO	International Labour Organization
IMO	International Maritime Organization
IPCS	International Programme of Chemical Safety
IUPAC	International Union of Pure and Applied Chemistry
LC	Lethal concentration
LD	Lethal doses
MSHA	US Department of Labour, Mine Safety and Health Administration
NFPA	National Formulary Pharmaceutical Association
NIOSH	National Institute for Occupational Safety and Health Administration
NTP	National Toxicology Programme
OHSAS	Organization of Health and Safety Administration Series
OSHA	Occupational Safety and Health Administration
RID/ARD	European Agreement for the transport of dangerous goods on railway/on road
RTECS	Registry of Toxic Effects of Chemical Substances
TDG	Transport Dangerous Goods, Canada
TSCA	Toxic Substances Control Act, US
US DOT	US Department of Transportation
WGK	Class of risks for water, (Wassergefährdungsklasse, Germany)

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