



Chemical Management Guide for Small and Medium Sized Enterprises

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

August 2008

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 Tools 4a and 4b 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 permission to integrate this approach into the guide is gratefully acknowledged.**

Tool 7 is based on following references: Safe Storage of Hazardous Chemicals; University of California, Berkeley; Office of Environment, Health & Safety; April 2001; Occupational Safety and Health Aspects of Leather Manufacture – Guidelines and Recommendations for Managers and Effluent Treatment Plants. Buljan, J., Sahasranaman, A. & Hannak, J.; Regional Programme Office United Nations Industrial Development Organization and Council for Leather Exports, Chennai, India; 1999

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Photos: Cover photo from stone images, photos on pages 27 and 41 from Wolfgang Schimpf; Photos in Figures 16 a, b and c and page 90 are courtesy of Dräger, Germany

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 aims to assist companies who want to gain cost savings and reduce risks in the workplace with respect to chemicals used during production. 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 the environmental impact of chemicals used and improve the health & safety conditions for workers. In doing so, the workers' motivation and productivity can be substantially increased.

This guide describes a step-by-step approach to identify risks and reduce costs related to the use of chemicals. The approach is based on identifying 'hot spots' and making a 'chemical inventory'. The two steps provide the necessary information to observe and calculate potential losses, assess risks, consider substitutes (in terms of form and/or

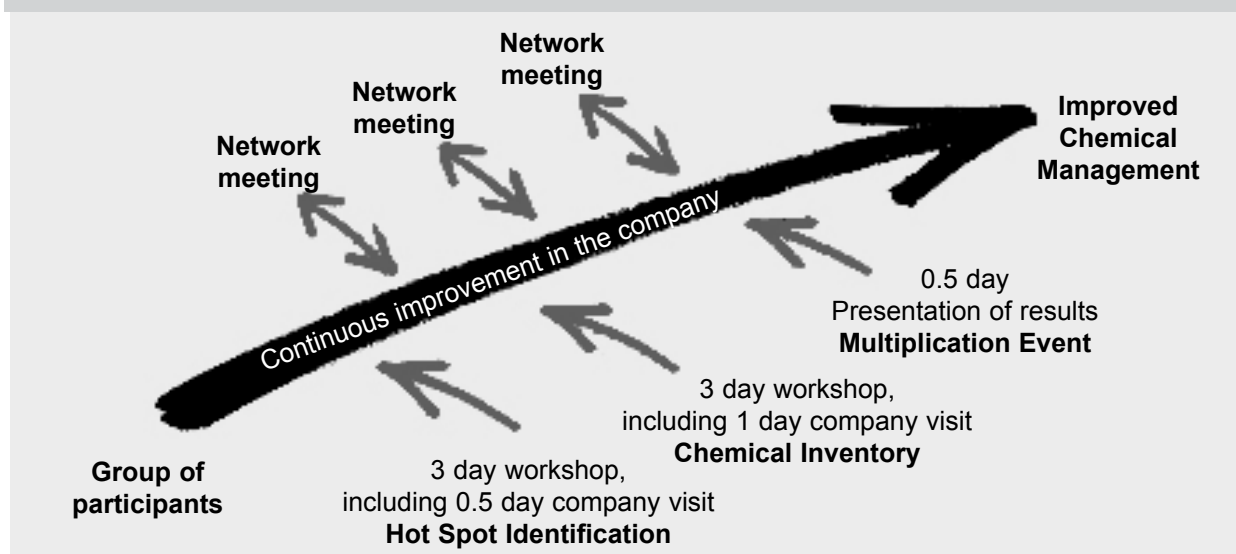
alternative substances), determine measures for improvement and adequate control approaches, implement these measures in a systematic way and finally monitor and evaluate the results obtained.

The guide was developed as part of a modular training approach for small and medium sized enterprises. This interactive training program is designed for technical staff, employees and/or management of companies, for representatives of intermediary institutions and for consultants/trainers. 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 typical chemical management training program is outlined in figure 1:

The duration of a complete training program/cycle is about 6 months, foreseeing about one month's

Figure 1: Programme 'Arrow' Chemical Management Training



time in between the different activities (2 workshop-modules, 1 multiplication event and 3 network meetings).

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 interactive training approach used was developed on the base of the CEFE (Competency based Economies through Formation of Enterprises) and PREMA© (PRofitable Environmental Management) methodologies, tailor-made to fit the specific needs of small and medium sized enterprises (SMEs) in developing countries. It is designed to help them implement measures/ actions to improve their economic, environmental and organisational performance (triple win), based on the idea of continuous improvement (cycle of change).

This guide will support SMEs in the application of the International Labour Organisation (ILO) risk assessment approach, the so-called 'control banding' and provide an introduction on how to implement the International Chemical Control Toolkit.

The concepts presented in this guide have been implemented in SMEs in Indonesia, India, Vietnam, South-Africa and Morocco. These experiences provided insights into the obstacles that companies typically face in undertaking chemical manage-

ment. 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.

The central idea is to support SMEs in a way that responds to their needs and helps them to enhance their productivity/competitiveness by saving costs/ reducing Non-Product-Output (NPO). At the same time their performance with respect to environmental impact, internal organisation, social aspects and workers' health & safety will be improved.

PREMA© was developed by the GTZ programme P3U and is the basis for a family of training tools, using a similar action driven approach, working directly from the beginning on the individual companies' cases/problems.

The following PREMA© tools are available (for more details see www.premanet.net):

- Good Housekeeping (GHK©)
- Environment Oriented Cost Management (EoCM©)
- Profitable Social Management (PSM©)
- Profitable Agricultural Management (PAM)
- Sustainable Management for Industrial Areas (SMIA)
- Chemical Management (CM).

Companies can choose out of this range of tools in order to adapt their companies' performance to their specific needs/requests. This helps them to improve continuously, which creates the sound and profitable basis for the application of international standards/procedures up to a certification.

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

- 1. Why should companies manage chemicals?**
 - 1.1 Benefit from reducing costs and environmental impact**
 - 1.2 Benefit from becoming more competitive**
 - 1.3 Benefit from improving worker health & safety**
- 2. What does chemical management involve?**
- 3. What hinders companies from doing chemical management?**
- 4. Taking a step-by-step approach to chemical management**

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

1. Why should companies manage chemicals?

Out of the 5-7 million known chemical substances, more than 100,000 are used by companies in their production processes and operations. It is estimated that around 8,000 commercial chemicals are hazardous. Numerous new chemicals are developed and produced each year. Today, almost every company uses some type of chemical. Those enterprises which effectively manage chemicals can gain concrete financial and ecological benefits.



1.1 Benefit from reducing costs and environmental impact

Chemicals can represent a major part of the production costs 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 from becoming more competitive

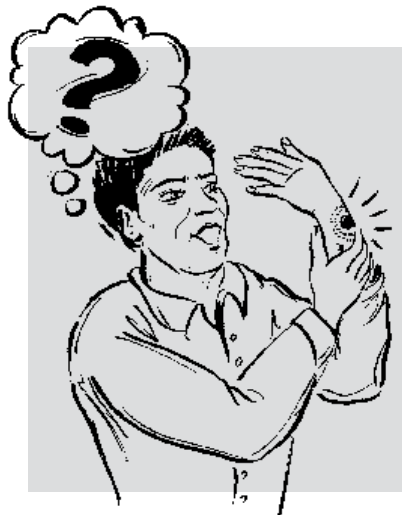
While chemicals are often used to achieve certain characteristics and qualities in a product – consumers do not want harmful chemicals in the products they buy or in the environment. Companies that avoid using banned and restricted substances can avoid having their products rejected in the marketplace.

Growing consumer consciousness towards 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 (e.g. organic food,

EurepGAP). By identifying and reducing the use of banned chemicals and hazardous substances, companies can improve their competitive position, e.g. through the Responsible Care initiative. Thus, companies are contributing positively to improve safety, health and environmental performance of their products and processes. Moreover, the management of chemicals provides valuable information for those companies that are working to achieve certification under management system standards such as ISO 9000 (quality) and 14000 (environment). This chemical management approach covers vital parts of the certification process and is hence of much help. 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 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 & 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 control measures correctly and what to do in case of an emergency

- 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 hinders companies from doing chemical management?

Many 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/management priorities.

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

What obstacles do companies face?

- Lack of information about the quality, quantity, characteristics and hazards of all chemical substances used
- Low quality or inadequate characteristics of purchased chemicals
- Poor labelling, unknown substances
- Limited financial and human resources
- Absence of systematic organisational procedures & documentation
- Lack of priority and responsibility given to managing chemicals.

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 module is intended to trigger awareness 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 specific hazardous situations and circumstances under which chemicals are stored and used
- Determine the necessary approaches to reduce the potential for harm
- Implement chemical management approaches
- Monitor and evaluate the results achieved.

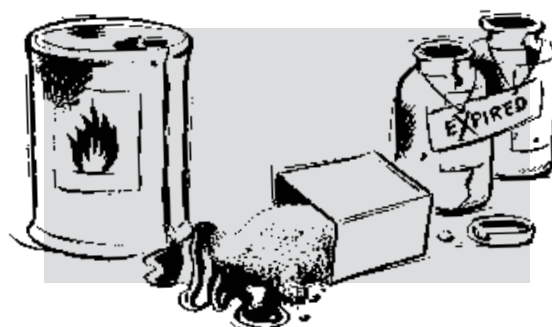
This module is appropriate for companies of any size where, until now, little attention has been placed on managing chemicals.

Second Module – Making a comprehensive inventory

This module helps companies getting a structured overview of the use of chemicals in the company. 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 module 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 potential ‘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’

Some owners of 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 the merits to invest in chemical management. 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, non-conform products and waste should also be considered. The inefficient use of materials often leads to an unnecessarily high level of chemicals used.

‘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 may never be implemented.

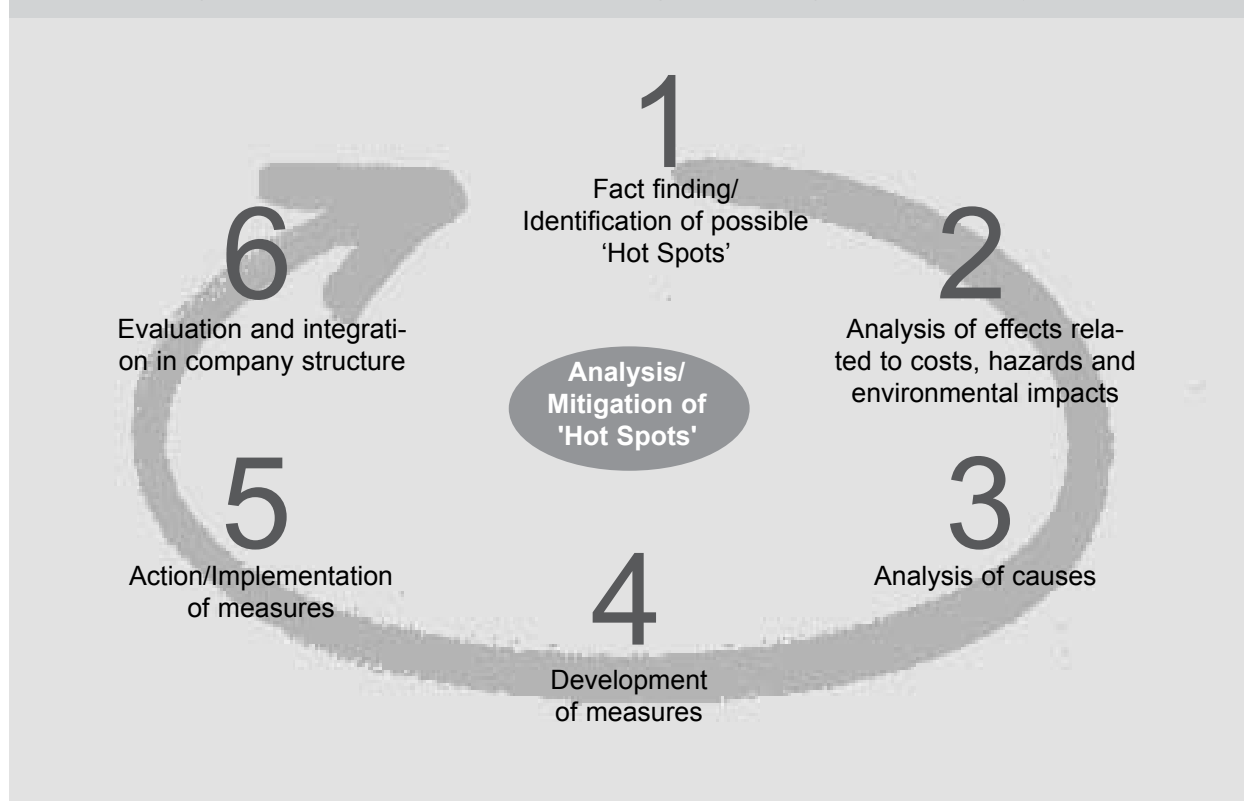
Chemical management means a change in the company culture, which leads to a process of continuous improvement. In order to introduce such a continuous improvement, working in ‘cycles’ is the appropriate approach. A series of six implementation steps – building on each other – is the appropriate framework 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’

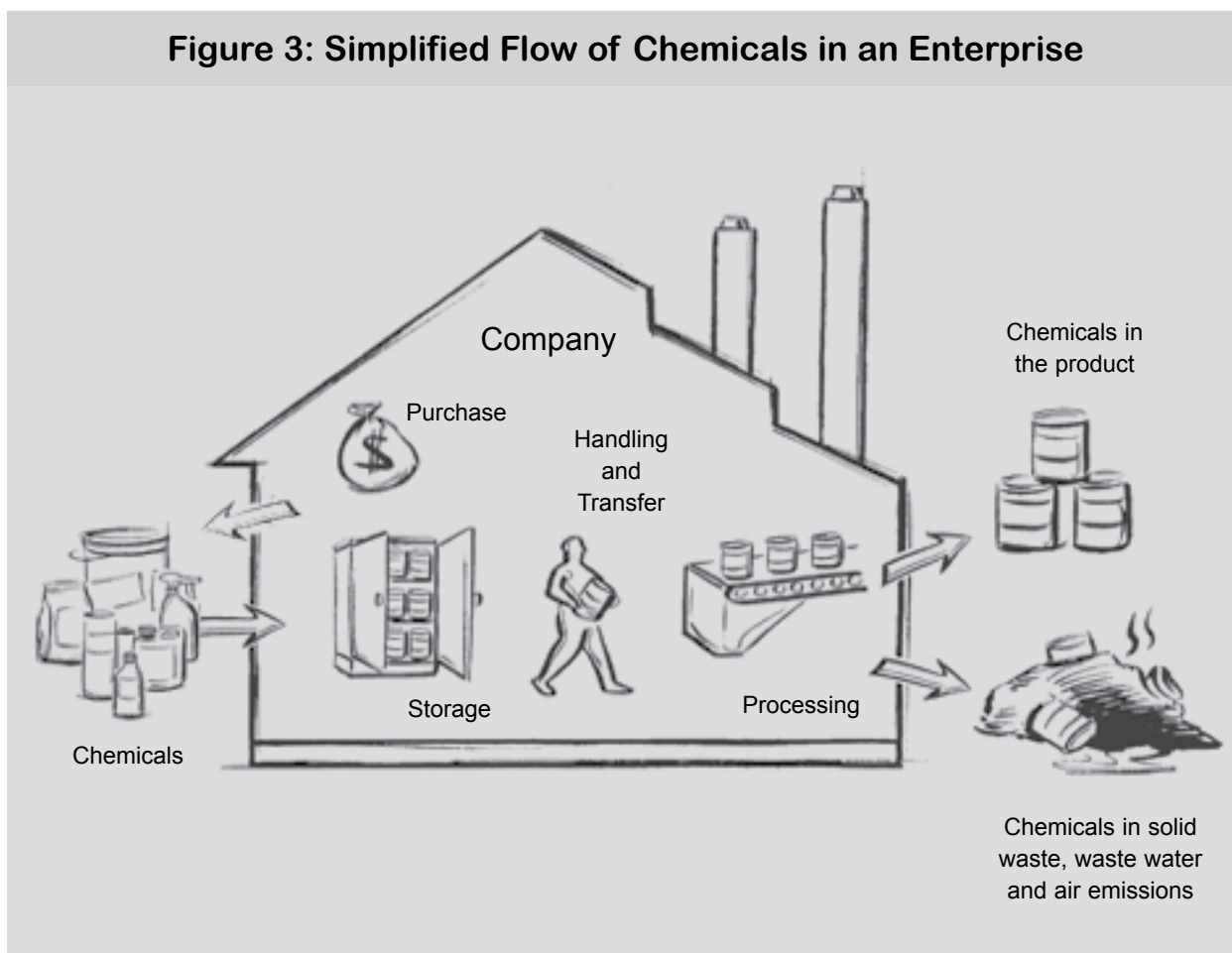


Step	Action	Benefit
Step 1	Fact finding/identification of possible 'hot spots'	Knowing the 'hot spots'
Step 2	Analysis of effects related to costs, hazards and environmental impacts	Learning about the quantity of losses and the hazards for workers and the environment and being able to select the most 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 measures that will improve the situation
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 potential 'hot spots'

To identify 'hot spots', we suggest that you do a 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 !!**

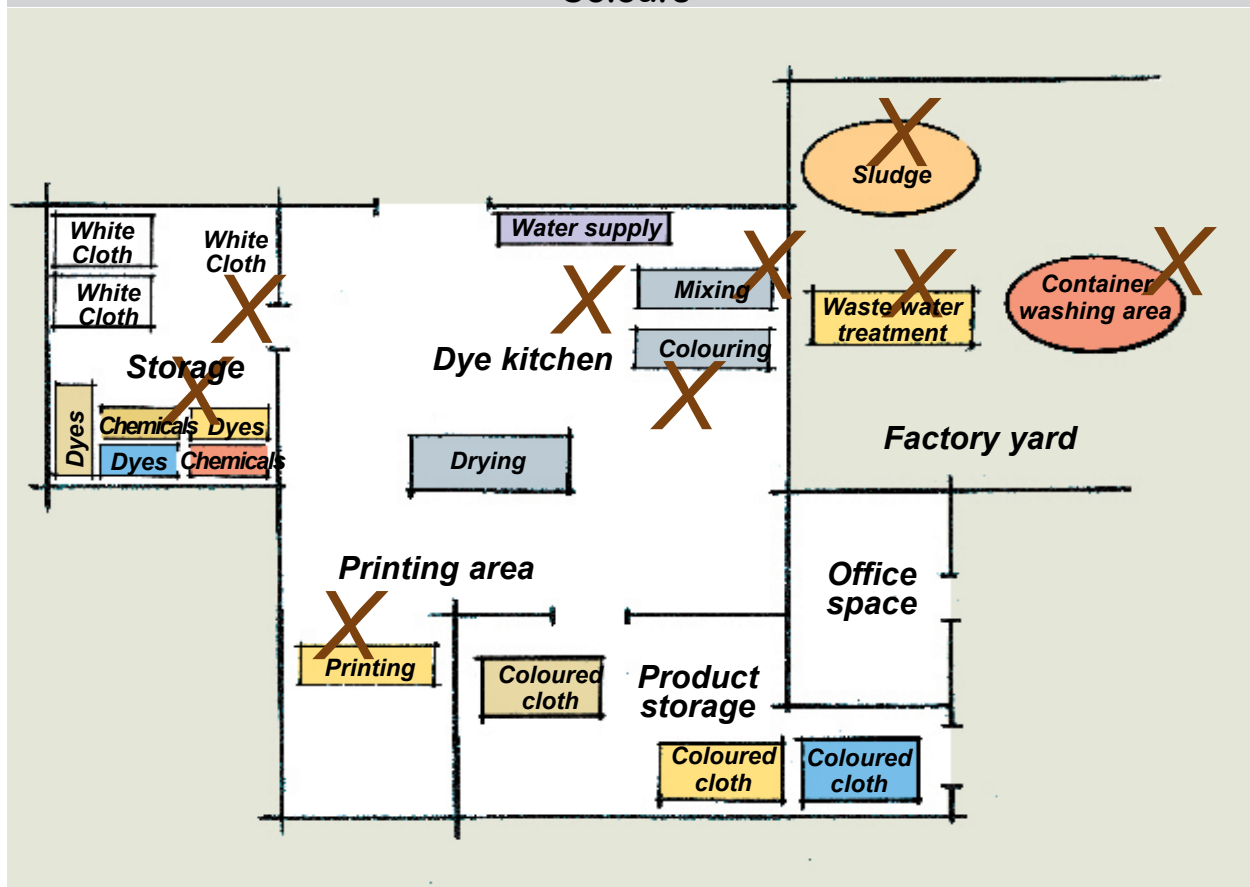
1. Draw a simple ground plan of the company (see figure 4) – you can also use an existing company floor plan:

- 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:

- 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 or where you smell strong odour of chemicals
- Places where you see dust clouds created during transfer or weighing operations
- Lids that are not tightly sealed and 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 (e.g. 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 (these include losing money resulting from the poor utilisation of chemicals, lower product quality, poor worker motivation and low productivity) you now need to **assess the risks**.

It might cause harm if you continue with the present inappropriate 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

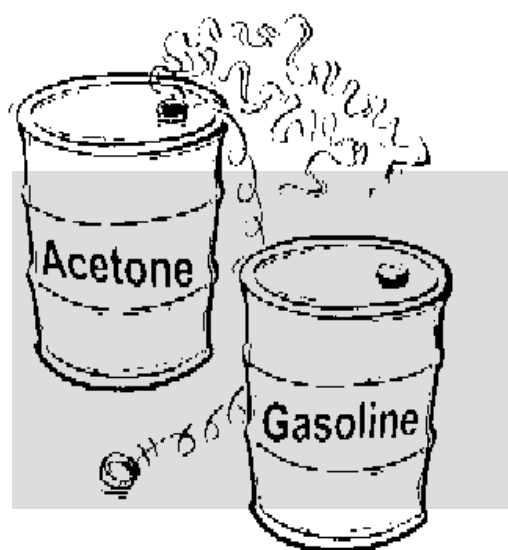
Area in Factory	Observations/ Hot Spots	Quantities, costs, estimated losses, etc.	Possible hazard	Hazard symbols
Delivery & Chemical Store	Some calcium carbonate bags are damaged before and during their unloading into the chemical store	How much material could be saved by changing procedures to minimise losses? By 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 with no lids 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 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?
 - Do you have any recipes, specifications or guidelines from suppliers that provide the information about quantities?
 - What quantity of substances is actually being used?
 - Do you have records 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? How about other incidents?
 - Do you have records for worker injury/accident in order to know the frequency of such occurrences?
 - Is material lost due to poor labelling (wrong use) 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. granular dyestuffs instead of powdery dyestuffs)?
 - applying control measures (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,
than precisely wrong**



Step 3: Analysis of causes – Why are chemicals being wasted, why do 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 transfer, 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 now have 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 and eating

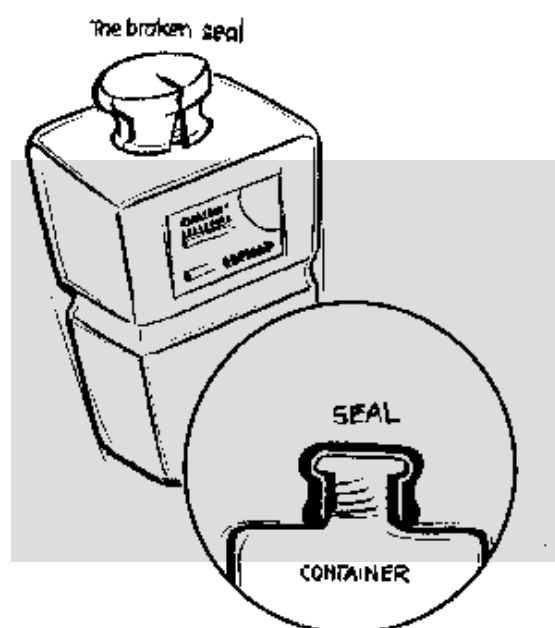
Formulate corrective measures by asking yourself the following questions about observations you made during the walk-through:

- Could you change working practices or procedures?
- Could you make repairs (of 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 only keep 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?
- Regularly inspect and keep the storage area clean to avoid any contamination of materials.
- Store containers with hazardous chemicals on catch pits/trays 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 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.

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:

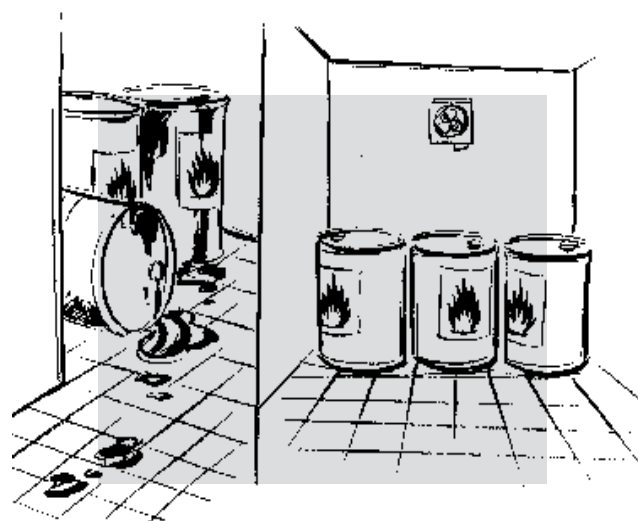
- Repair all broken seals to avoid vapours from escaping.
- Make sure that the packaging of materials is not damaged during delivery and storage.
- Return poorly packaged and/or deteriorated chemicals to suppliers.



- Ensure that the lids of all chemical containers are tightly closed.
- Stock chemicals only in compatible groups (segregation of chemical families) to avoid the possibility that vapours could react together and lead to fire/explosion (see **Tool 8**).
- Ensure that flammable substances (e.g. organic solvents) are not exposed to direct sunlight to avoid auto-ignition.
- 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 hazardous 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.
- Use granular forms instead of fine powders to reduce 'dustiness'.
- Post warning signs describing precautionary measures in areas where hazardous chemicals are handled.

Examples of organisational measures:

+ Minimise the number of workers exposed



- Physical segregation of areas for carrying out certain operations
- Restrict access to certain areas, which prevents the unnecessary exposure of workers carrying out other jobs

+ Minimise the duration and intensity of exposure

- Provide sufficient ventilation of workplaces
- Modify/adapt process variables without reducing efficiency

+ Reduce the quantity of chemical agents

- Making available the quantity of chemical agents needed for the work in the workplace

+ Appropriate hygiene measures

- Provide suitable eating and smoking areas
- Thoroughly wash exposed parts of the body; after work and before eating, drinking and smoking
- Do not carry contaminated items around
- Remove and wash separately any contaminated item of work clothing daily

- Replace PPE (Personal Protective Equipment) at recommended intervals
- Remove splashes/spills immediately
- + Provide suitable equipment and establish safe maintenance procedures**
- Establish standards/specifications of equipment and machinery before purchase and draw up maintenance operation protocols
- + Design and organisation of processes, layouts and workplaces**
- Eliminate or adapt operations where workers may come into contact with agents when contact is not necessary
- + Suitable safe work procedures**
- Written guidelines (work instructions) for carrying out tasks detailing, step by step, safety requirements to be taken into account
- Enforce and monitor the correct application of these written guidelines (see **Tool 6**)
- + Chemical emergency procedures**

Every workplace should have an emergency plan comprising the following information:

- Covering emergency exits and an alarm system for evacuation
- Outline duties and responsibilities for first-aid and fire fighting in the company

Provision of equipment such as

- Fire extinguisher
- First aid kit
- Spill kits

+ Additional organizational control

- Identify all hazardous chemicals on hand

- Labeling/record-keeping
- Obtain from chemical suppliers Material Safety Data Sheets (MSDS)
- Inform on and display hazard information
- Safe storage & transfer of chemicals
- Safe practices for handling & use of chemicals
- Good housekeeping measures and disposal routines
- Medical surveillance of workers and exposure monitoring
- Periodical training & education of management and workforce
- Sufficient fire and explosion prevention and protection

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 actions 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	Describe the 'hot spots' you identified; refer to the notes you made during the walk-through. Specify 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	Lay out specific activities to be undertaken in order to achieve the desired improvement or benefit.
Responsible person	Indicate the person who is responsible for taking action and monitoring the results.
Time-frame	Specify the time period within which action should be completed.
Results	Indicate 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 an example, see figure 6), be sure to:

- Consult the members of staff 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)	Proposed Measure	Aim of the pro- posed measure	What the measure involves	Responsible person(s)	Time-frame	Results
Chemicals spoiled by water (storage)	Repair the roof	Avoid future losses	Obtain offers from construction companies	Production manager	2 weeks	
			Sign contract with construction company		1 week	
			Supervise the repairs		3 weeks	Roof repair
Restricted azo-dye preparation is being used (dye kitchen)	Remove all dyes with restricted/banned chemicals from the production process	Avoid that products are rejected by customers in international markets	Ask chemical supplier to provide a certificate that the dyestuff does not contain banned or restricted chemicals	Purchasing manager	Within one month	
			If no information is available, check with local labs if certain amines are present		One month	
			Investigate alternatives (dyestuffs with same colour index)		One month	Reputation as a high quality supplier Additional orders from international buyers

- 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. 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 when splitted in aromatic amines 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 aromatic 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 him about the risks of continued use (i.e. the risk that international buyers of its garments could reject shipments). The company 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 now have an opportunity to gain further benefits from improved chemical management. A step-by-step approach of systematically identifying all chemicals found in the company helps to implement the chemical management.

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/data base that can be used to identify and make improvements on a continual basis.

What is the benefit of doing such an inventory?

After chemical substances have been identified in a precise and complete manner, the whole operating process can be addressed. Improvements can be achieved by targeted measures to reduce chemical use and risks throughout your operation.

Further you will improve:

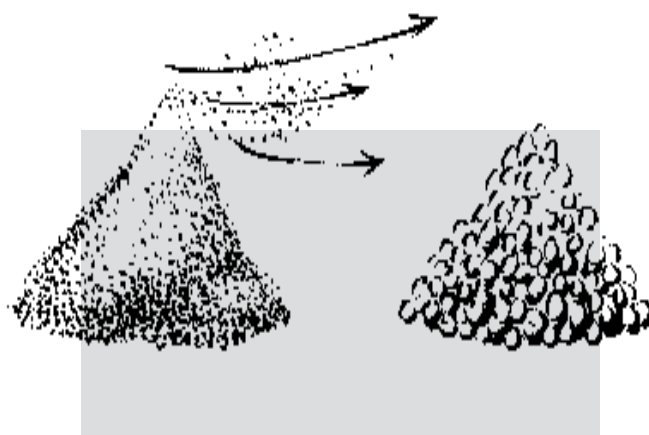
1. Your ability to perform first in, first out (FIFO) and/or just in time (JIT) inventory control
2. Your chemical inventories; they will be kept up-to-date and can be used to lower chemical purchase costs

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 in use (open) at the same time;

- Identify unknown substances, which can then be used before they expire, or properly disposed of
- Reduce losses due to the expiry of stored substances (over-stock)
- 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 should not be used)



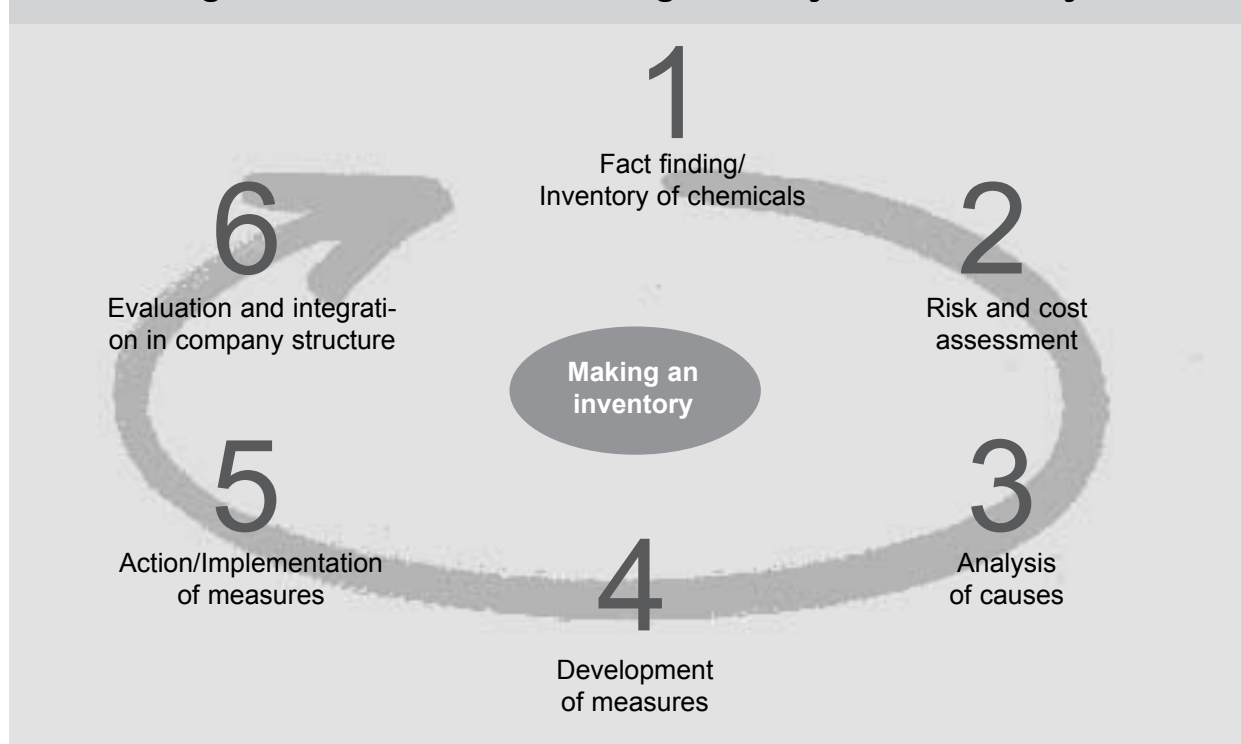
- Discuss with suppliers the possibility of providing substances in forms that may generate less dust (e.g. granular forms are less dusty than fine powders)
- Discuss with suppliers the possibility of providing chemicals/formulations with higher boiling points (a substance with a higher boiling point 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 system standards, such as ISO 14 000, OHSAS 18000, 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 (see figure 7).

**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.

This information may not be 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 (MSDS) 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 3)
4. R-Phrases (refer to Tool 2)
5. Hazard Groups (refer to Tools 4 and 5)
6. Amount in use (refer to figure 12)
7. Dustiness/Volatility (refer to figures 13, 14a and 14b)
8. Inhalation control approach (refer to Tool 4b)
9. Dermal control approach (refer to Tool 5b)
10. Notes about handling, use, storage, disposal conditions (refer to Tool 7 and 8)

* 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 great 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.

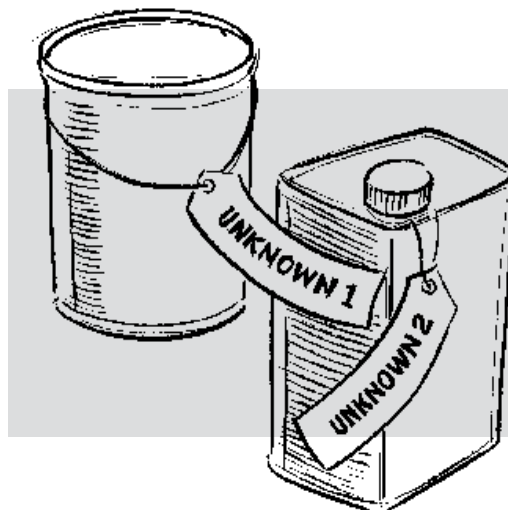


Figure 8: Example inventory table textile company 'Beautiful Colours'

Area	Chemical Name	MSDS available	R-Phrases	Hazard Group	Amount in use (g,kg,t/ml,l,m ³) per batch/task	Dustiness /Volatility	Control Approach	S-Phrases (advice for pro-handling)
Dye kitchen	Acetic acid	Yes	R 10 R 35	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 50/53 ¹	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 R 36 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,m ³) per batch/task	Dustiness /Volatility	Control Approach	S-Phrases (advice for 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 50/53 ¹	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
Storage	Aniline	Yes	R 20/21/22 R 40 R 48/23/24/25 R 50	D	10 l remaining stock	Liquid Low (183.5°C)	3	S 28-36/37-45-61
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?
- Is this substance banned or restricted for use according to any eco-criteria or national or international legislation?

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.

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.

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.

Risk and Hazard

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.

RISK is proportional to HAZARD x EXPOSURE

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

EXPOSURE to chemical agents is any work situation in which a chemical agent is present and the worker comes into contact with this agent, normally through the skin or via inhalation. Exposure is usually quantified by substance concentration, amount of chemical used, duration and frequency of contact.

Successful hazard communication in the form e.g. of R-Phrases alerts the user to the presence of a hazard and the need to minimise exposure and thus the resulting risks.

Sources of information for risk assessment

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). See **Tool 2**.

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. See **Tool 3**.

Determination of Hazard Groups (refer to **Tools 4 and 5**)

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).

Hazardous substances enter the body through the lungs (inhalation), the skin (absorption) and/or the mouth (ingestion).

To help you determine the potential for harm of different chemicals that can be inhaled, the International Labour Organisation (ILO) has categorized the existing R-Phrases (see **Tool 4** and figure 11) into five hazard groups.

For determining the potential harm of different chemicals that can be absorbed by the skin refer to **Tool 5**.

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

Step 3: Analysis of causes

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

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

- Is too much of the substance kept at once in stock?
- How are substances spilled and wasted in the production process?
- Are there any hazardous substances being used?
- Are there other forms of this substance (e.g. granular or liquid instead of fine powder) on the market which are 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'. These are 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'.

Basics on Control Approaches

After a hazard has been recognised and evaluated, the most appropriate methods of control (interventions) for the particular hazard must be determined. Control methods are usually classified as follows:

- Engineering controls
- Administrative controls
- Personal protective equipment

Engineering controls are changes to the process or equipment that reduce or eliminate exposures to an agent. Substituting a less toxic chemical in a process or installing exhaust ventilation to remove vapours generated during a process step are examples of engineering controls.

Another type of engineering control is changing the process itself. An example of this type of control would be the removal of one or more degreasing steps in a process that originally required several degreasing steps. By removing the need for a task producing exposure, the overall exposure for the worker has been controlled. The advantage of engineering controls is the relatively small involvement of the worker, who can go about the job in a more controlled environment. Compare two control

approach applications. In the engineering control, contaminants are automatically removed from the air whereas when the selected method of control is personal protective equipment, i.e. a respirator to be worn by the worker while working, the workplace remains 'uncontrolled'.

In addition to actively installing engineering controls on existing equipment, new equipment can be purchased that contains other, sometimes more effective, controls. A combination approach has often been proven effective (i.e. installing some engineering controls now and using personal protective equipment until new or modified equipment is bought with more effective controls that will eliminate the need for personal protective equipment). Some common examples of engineering controls are:

- Substitution (substitute less toxic, less flammable material, etc.)
- Change of the process (eliminate hazardous steps)
- Ventilation (both general and local exhaust ventilation)
- Isolation (place a barrier between the worker and the agent).

Engineering controls are the most effective methods of reducing exposures. Even though they are effective they are usually also very expensive. Hence, it is important to maximize the involvement of the workers in the selection and design of the controls. This should result in a greater likelihood that exposures will be reduced.

Administrative controls involve changes in how a worker accomplishes the necessary job tasks for example, how long the work in an area where exposures occurs lasted, or changes in work practices such as improvements in body positioning to reduce exposures.

Personal protective equipment (PPE) consists of devices provided to the worker and required to be worn while performing certain job tasks.

PPE includes:

- Respirators
- Chemical goggles and safety glasses, face shields
- Protective gloves, aprons, boots, coveralls,
- Protective creams/lotions.

The use of PPE should be regarded as a last resort option !

Personal protective equipment is commonly used in cases where engineering controls have not been effective in controlling the exposure to acceptable levels or where engineering controls have not been found to be feasible (for cost or operational reasons). Personal protective equipment can provide significant protection to workers if worn and used correctly. In the case of respiratory protection, protection factors (ratio of concentration outside the respirator to that inside) can be 1,000 or more for supplied air respirators or ten for half-face air-purifying respirators. Gloves (if selected appropriately) can protect hands for hours from solvents. Goggles can provide effective protection from chemical splashes.

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 4b**: 'Description of control approaches for chemicals causing harm when inhaled'.

Step 5: Action/implementation of measures

Put the results of your analysis and proposed measures into an action plan (use the same struc-

ture 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 way
- 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!

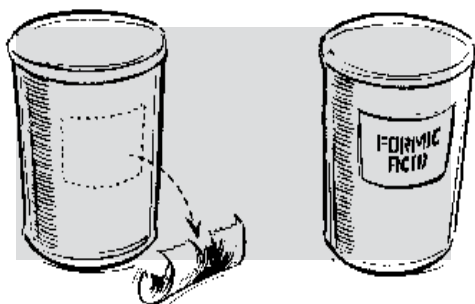
Step 6: Evaluation and integration into the company structure

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?
- 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 2** 'List of R-Phrases'), and S-Phrase (refer to **Tool 2** 'List of S-Phrases') should be affixed to all chemical packaging or containers that are stored, in either temporary or permanent locations to allow easy identification and to prevent accidental mixtures.

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.



Training of workers on understanding labels, 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 Label¹

	<p>2-Naphthol (D)</p> <ul style="list-style-type: none"> - 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. 	<p>2-naftolo (I)</p> <ul style="list-style-type: none"> - 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.
	<p>2-naphthol (GB)</p> <ul style="list-style-type: none"> - 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. 	<p>2-naftol (NL)</p> <ul style="list-style-type: none"> - 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 afspelen en deskundig medisch advies inwinnen. - Draag geschikte beschermende kleding, handschoenen en een beschermingsmiddel voor de ogen / voor het gezicht.
	<p>2-naphthol (F)</p> <ul style="list-style-type: none"> - Nocif par inhalation et ingestion. - Très toxique pour les organismes aquatiques. - Ne pas respirer les poussières. - Éviter 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. 	<p>2-naftol (E)</p> <ul style="list-style-type: none"> - 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 inmediatamente y abundantemente con agua y acúdase a un médico. - Usense 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 costs

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 become more profitable.

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 was 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, and other loss, etc.) represented savings of \$ 3,100 (US) each week!






Part III – Chemical Safety Tools

- Tool 1 Symbols used for classification and for labelling hazardous substances in the EU
- Tool 2 EU Risk and Safety Phrases for hazardous substances and GHS hazard statement codes
- Tool 3 Using Material Safety Data Sheets (MSDS)
- Tool 4a Identifying inhalation hazard groups of chemicals
- Tool 4b Description of control approaches for chemicals causing harm when inhaled
- Tool 4c Respiratory Protection Program
- Tool 4d Selection of respirators
- Tool 4e Filter selection for respirators
- Tool 5a Identifying skin hazard groups of chemicals
- Tool 5b Description of control measures for chemicals causing harm via skin and eye contact
- Tool 5c Use of gloves, aprons, goggles and boots for Skin and Eyes protection
- Tool 5d Gloves selection criteria
- Tool 6 Written and oral work instructions
- Tool 7 Safe storage of hazardous chemicals
- Tool 8 Fire prevention and extinguishers
- Tool 9 Hazardous substances that can cause harm to the environment and basic recommendations for disposal

Tool 1

Symbols used for classification and for labelling hazardous substances in the EU until 2010

There are different symbols used for labelling hazardous chemicals. You and your workers should know the meaning of these symbols.

Classification letter symbol and Symbols used for labelling in the EU		
Letter symbol	Label	Meaning
Explosive (E)	E 	This symbol with the word 'explosive' denotes a substance which may explode under the effect of a flame or if subjected to shocks or 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, particularly flammable substances.
Highly flammable (F)	F 	This symbol 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 the 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 the 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 but with the words 'irritant'.

Dangerous for the
environment (N)

N



Can cause damage to fauna or flora or can cause pollution in natural water.

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>

Globally Harmonised System of Classification and Labelling of Chemicals (GHS) starting from 2008 in the EU

Chemicals, through the different steps from their production to their handling, transport and use, can be a real danger for human health and the environment. People of any age, including children and elderly, coming from various social and cultural backgrounds, are confronted daily to dangerous products (chemicals, pesticides, etc.)


To face this danger, and given the extensive global trade in chemicals and the need to develop national programs to ensure their safe use, transport and disposal, it was recognized that an internationally-harmonized approach to classification and labelling would provide a foundation. **All countries should have consistent and appropriate information on the chemicals they import or produce.** Once this is obtained, the infrastructure to control chemical exposures and protect people and the environment can be established in a comprehensive manner.

The new system, called UN '**Globally Harmonized System of Classification and Labelling of Chemicals (GHS)**', addresses classification of chemicals by types of hazard and proposes **harmonized hazard communication elements, including labels and safety data sheets.** It aims at ensuring that information on physical hazards and toxicity from chemicals are available in order to enhance the protection of human health and the environment during handling, transport and use. The GHS also provides a basis for harmonization of rules and regulations on chemicals at national, regional and worldwide level. **This is an important factor for trade facilitation.**

The Plan of Implementation of the World Summit on Sustainable Development (WSSD), adopted in Johannesburg in 2002, encourages countries

to implement the GHS as soon as possible with a view to having the system fully operational by 2008.

Implementation of effective chemical hazard communication based on GHS provides benefits for governments, companies, workers and consumers. The GHS has maximum value if accepted in all major regulatory systems for chemical hazard communication worldwide.



Chemicals are manufactured and traded globally and their hazards are the same around the world. Therefore the description of hazards should not differ between countries if the product is the same.

Visit the GHS site in the internet at: <http://www.unepce.org/trans/danger/publi/ghs/pictograms.html>

EU legislation site on GHS:

http://ec.europa.eu/enterprise/reach/ghs_en.htm

Some examples for GHS symbols for physical hazards, health and environment hazards are given in the next page.

Pictograms for labelling hazardous substances according to GHS that will be used in the EU from 2011 onwards and the corresponding hazard classes



GHS 01

Explosives, Self
Reactives, Organic
Peroxides



GHS 02

Flammables, Self Reactives,
Pyrophorics, Self Heating,
Organic Peroxides



GHS 03

Oxidizers



GHS 04

Gases under
pressure



GHS 05

Corrosives



GHS 06

Acute Toxicity (severe)



GHS 07

Irritant, Dermal sensitiser,
Acute toxicity (harmful),
Respiratory tract irritation



GHS 08

Carcinogenic, Respiratory
Sensitizer, Reproductive
toxicity, Mutagenicity,
Target organ toxicity,
Aspiration toxicity



GHS 09

Environmental Toxicity

Tool 2 - EU Risk and Safety Phrases for hazardous substances

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 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 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 advice for the safe handling!

Where are R-Phrases and S-Phrases found?

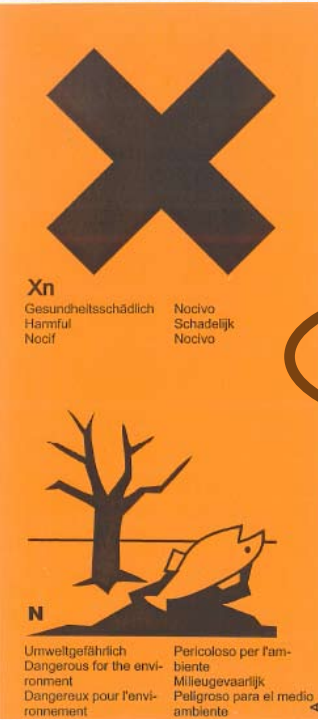
These phrases are normally found on the product label (with or without the corresponding number code) (see Figure 10a) and on the Material Safety Data Sheet (MSDS) (see Figure 10b).

In the tables on the next pages you will find R-Phrases and the corresponding hazard groups for inhalation and skin absorption.

Sources of further information

Tool 3 describes the uses of a Material Safety Data Sheet (MSDS) and includes the entire MSDS for 2-Naphtol 98% as an example.

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



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-naphthol (F) - Nocif par inhalation et ingestion. - Très toxique pour les organismes aquatiques. - Ne pas respirer les poussières. - Éviter 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 inmediatamente y abundantemente con agua y acúdase a un médico. - Úsense indumentaria y guantes adecuados y protección para los ojos/ la cara.

R-Phrases (no number)

Figure 10b: Locating the R-Phrase on a MSDS (2-Naphthol 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 Pharmaceuticaaan 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 corresponding numbers

EU Risk Phrases for hazardous substances

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

EU Risk Phrases R1 to R 19 indicating risk of fire or explosion in use in the EU until 2007		GHS hazard statement codes for use in EU from 2008*
Physical hazards		
R 1	Explosive when dry.	EUH 001
R 2	Risk of explosion by shock, friction, fire or other sources of ignition.	no translation possible
R 3	Extreme risk of explosion by shock, friction, fire or other sources of ignition.	no translation possible
R 4	Forms very sensitive explosive metallic compounds.	
R 5	Heating may cause an explosion.	
R 6	Explosive with or without contact with air.	EUH 006
R 7	May cause fire.	H 242
R 8	Contact with combustible material may cause fire.	H 270
R 9	Explosive when mixed with combustible material.	H 271
R 10	Flammable.	H 226
R 11	Highly flammable.	H 225
R 12	Extremely flammable.	H 242
R 14	Reacts violently with water.	EUH 014
R 14/15	Reacts violently with water, liberating extremely flammable gases.	
R 15	Contact with water liberates extremely flammable gases.	no translation possible
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.	H 250
R 18	In use, may form flammable/explosive vapour-air mixture.	EUH 018
R 19	May form explosive peroxides.	EUH 019

	EU Risk Phrases R 20 to R 68 indicating risk for human health and the environment in use in the EU until 2007	Human Inhalation Hazard Groups (ILO)	Human Skin Hazard Groups (BAuA)	GHS hazard statement codes for use in EU from 2008*
R 20	Harmful by inhalation.	B		H 332
R 20/21	Harmful by inhalation and in contact with skin.	B	SKIN B	
R 20/21/22	Harmful by inhalation, in contact with skin and if swallowed.	B	SKIN B	
R 20/22	Harmful by inhalation and if swallowed.	B		
R 21	Harmful in contact with skin.	B	SKIN B	H 312
R 21/22	Harmful in contact with skin and if swallowed.	B	SKIN B	
R 22	Harmful if swallowed.	B		H 302
R 23	Toxic by inhalation.	C		H 331
R 23/24	Toxic by inhalation and in contact with skin.	C	SKIN D	
R 23/24/25	Toxic by inhalation, in contact with skin and if swallowed.	C	SKIN D	
R 23/25	Toxic by inhalation and if swallowed.	C		
R 24	Toxic in contact with skin.	C	SKIN D	H 311
R 24/25	Toxic in contact with skin and if swallowed.	C	SKIN E (R24 + R34) SKIN E (R24 + R35)	
R 25	Toxic if swallowed.	C		H 301
R 26	Very toxic by inhalation.	D		H 330
R 26/27	Very toxic by inhalation and in contact with skin.	D	SKIN E	
R 26/27/28	Very toxic by inhalation, in contact with skin and if swallowed.	D	SKIN E	
R 26/28	Very toxic by inhalation and if swallowed.	D		

EU Risk Phrases R 20 to R 68 indicating risk for human health and the environment in use in the EU until 2007

		Human Inhalation Hazard Groups (ILO)	Human Skin Hazard Groups (BAuA)	GHS hazard statement codes for use in EU from 2008*
R 27	Very toxic in contact with skin.	D	SKIN E	H 310
R 27/28	Very toxic in contact with skin and if swallowed.	D	SKIN E	
R 28	Very toxic if swallowed.	D		H 300
R 29	Contact with water liberates toxic gas.			EUH 029
R 30	Can become highly flammable in use.			EUH 030
R 31	Contact with acids liberates toxic gas.			EUH 031
R 32	Contact with acids liberates very toxic gas.			EUH 032
R 33	Danger of cumulative effects.	B		
R 34	Causes burns.	C	SKIN E	H 314
R 35	Causes severe burns.	C	SKIN E (R24 +R34)	
			SKIN E	H 314
R 36	Irritating to eyes.	A	SKIN E (R24 +R35)	
				H 319
R 36/37	Irritating to eyes and respiratory system.	C		
R 36/37/38	Irritating to eyes, respiratory system and skin.	C	SKIN B	
R 36/38	Irritating to eyes and skin.	A	SKIN B	
R 37	Irritating to respiratory system.	C		H 335
R 37/38	Irritating to respiratory system and skin.	C	SKIN B	
R 38	Irritating to skin.		SKIN B	H 315
R 39	Danger of very serious irreversible effects.			EUH 070

	EU Risk Phrases R 20 to R 68 indicating risk for human health and the environment in use in the EU until 2007t	Human Inhalation Hazard Groups (ILO)	Human Skin Hazard Groups (BAuA)	GHS hazard statement codes for use in EU from 2008*
R 39/23	Toxic: danger of very serious irreversible effects through inhalation.	C		H 370
R 39/23/24	Toxic: danger of very serious irreversible effects through inhalation and in contact with skin.	C	SKIN D	
R 39/23/24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.	C	SKIN D	
R 39/23/25	Toxic: danger of very serious irreversible effects through inhalation and if swallowed.	C		
R 39/24	Toxic: danger of very serious irreversible effects in contact with skin.	C	SKIN D	H 370
R 39/24/25	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed.	C	SKIN D	
R 39/25	Toxic: danger of very serious irreversible effects if swallowed.	C		H 370
R 39/26	Very toxic: danger of very serious irreversible effects through inhalation.	D		H 370
R 39/26/27	Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin.	D	SKIN E	
R 39/26/27/28	Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.	D	SKIN E	
R 39/26/28	Very toxic: danger of very serious irreversible effects through inhalation and if swallowed.	D		
R 39/27	Very toxic: danger of very serious irreversible effects in contact with skin.	D	SKIN E	H 370
R 39/27/28	Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed.	D	SKIN E	
R 39/28	Very toxic: danger of very serious irreversible effects if swallowed.	D		H 370
R 40	Limited evidence of a carcinogenic effect.	D	SKIN D	H 351/EUH 070
R 41	Risk of serious damage to eyes.	C		H 318/EUH 070
R 42	May cause sensitization by inhalation.	E		H 334

EU Risk Phrases R 20 to R 68 indicating risk for human health and the environment in use in the EU until 2007	Human Inhalation Hazard Groups (ILO)	Human Skin Hazard Groups (BAuA)	GHS hazard statement codes for use in EU from 2008*
R 42/43 May cause sensitization by inhalation and skin contact.	E	SKIN C	
R 43 May cause sensitization by skin contact.	C	SKIN C	H 317
R 44 Risk of explosion if heated under confinement.			EUH 044
R 45 May cause cancer.	E	SKIN E	H 350
R 46 May cause heritable genetic damage.	E	SKIN E	H 340
R 48 Danger of serious damage to health by prolonged exposure.	A		
R 48/20 Harmful: danger of serious damage to health by prolonged exposure through inhalation.	C		H 373
R 48/20/21 Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.	C	SKIN B	
R 48/20/21/22 Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.	C	SKIN B	
R 48/20/22 Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.	C		
R 48/21 Harmful: danger of serious damage to health by prolonged exposure in contact with skin.	C	SKIN B	H 373
R 48/21/22 Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.	C	SKIN B	
R 48/22 Harmful: danger of serious damage to health by prolonged exposure if swallowed.	C		H 373
R 48/23 Toxic: danger of serious damage to health by prolonged exposure through inhalation.	D		H 372
R 48/23/24 Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.	D	SKIN D	
R 48/23/24/25 Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.	D	SKIN D	

EU Risk Phrases R 20 to R 68 indicating risk for human health and the environment in use in the EU until 2007	Human Inhalation Hazard Groups (ILO)	Human Skin Hazard Groups (BAuA)	GHS hazard statement codes for use in EU from 2008*
R 48/23/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.	D	H 372
R 48/24	Toxic: danger of serious damage to health by prolonged exposure in contact with skin.	D	H 372
R 48/24/25	Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.	D	H 372
R 48/25	Toxic: danger of serious damage to health by prolonged exposure if swallowed.	D	H 372
R 49	May cause cancer by inhalation.	E	H 350
R 50	Very toxic to aquatic organisms.		H 400
R 50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.		H 400/H 410
R 51	Toxic to aquatic organisms.		
R 51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.		H 412
R 52	Harmful to aquatic organisms.		
R 52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.		H 412
R 53	May cause long-term adverse effects in the aquatic environment.		H 413
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.		EUH 059

EU Risk Phrases R 20 to R 68 indicating risk for human health and the environment in use in the EU until 2007	Human Inhalation Hazard Groups (ILO)	Human Skin Hazard Groups (BAuA)	GHS hazard statement codes for use in EU from 2008*
R 60 May impair fertility.	D	SKIN E*	H 360
R 61 May cause harm to the unborn child.	D	SKIN E*	H 360
R 62 Possible risk of impaired fertility.	D	SKIN D	H 360
R 63 Possible risk of harm to the unborn child.	D	SKIN D*	H 360
R 64 May cause harm to breast-fed babies.	D		H 362
R 65 Harmful: may cause lung damage if swallowed.	A		H 304
R 66 Repeated exposure may cause skin dryness or cracking.	A	SKIN A	EUH 066
R 67 Vapours may cause drowsiness and dizziness.	B		H 336
R 68 Possible risks of irreversible effects.	E	SKIN D*	H 341
R 68/20 Harmful: possible risk of irreversible effects through inhalation.	B		H 371
R 68/20/21 Harmful: possible risk of irreversible effects through inhalation and in contact with skin.	B		
R 68/20/21/22 Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.	B	SKIN B	
R 68/20/22 Harmful: possible risk of irreversible effects through inhalation and if swallowed.	B		
R 68/21 Harmful: possible risk of irreversible effects in contact with skin.	B	SKIN B	H 371
R 68/21/22 Harmful: possible risk of irreversible effects in contact with skin and if swallowed.	B	SKIN B	
R 68/22 Harmful: possible risk of irreversible effects if swallowed.	B		H 371

Updated by AS. Approved by EC. Last modification: 21 March 2002

Source: ILO

* These R Phrases have to be only classified in the group if the substance is absorbed by the skin.

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/safety-work/cis/products/safetytm/classify.htm>

Key to GHS hazard statement codes in the EU from 2011

H 200	Unstable explosive
H 201	Explosive; mass explosion hazard
H 202	Explosive; severe projection hazard
H 203	explosive; fire, blast or projection hazard
H 204	Fire or projection hazard.
H 205	May mass explode in fire.
H 220	Extremely flammable gas.
H 221	Flammable gas.
H 222	Extremely flammable aerosol.
H 223	Flammable aerosol.
H 224	Extremely flammable liquid and vapour.
H 225	Highly flammable liquid and vapour.
H 226	Flammable liquid and vapour.
H 228	Flammable solid.
H 240	Heating may cause an explosion.
H 241	Heating may cause a fire or explosion
H 242	Heating may cause a fire.
H 250	Catches fire spontaneously if exposed to air.
H 251	Self-heating: may catch fire.
H 252	Self-heating in large quantities; may catch fire.
H 260	In contact with water releases flammable gases which may ignite spontaneously.
H 261	In contact with water releases flammable gas.
H 270	May cause or intensify fire; oxidizer.
H 271	May cause fire or explosion; strong oxidizer.
H 272	May intensify fire; oxidizer.
H 280	Contains gas under pressure; may explode if heated
H 281	Contains refrigerated gas; may cause cryogenic burns or injury.
H 290	May be corrosive to metals.
H 300	Fatal if swallowed.
H 301	Toxic if swallowed.
H 302	Harmful if swallowed.
H 304	May be fatal if swallowed and enters airways.
H 310	Fatal in contact with skin.
H 311	Toxic in contact with skin.
H 312	Harmful in contact with skin.
H 314	Causes severe skin burns and eye damage.
H 315	Causes skin irritation.
H 317	May cause an allergic skin reaction.
H 318	Causes serious eye damage
H 319	Causes serious eye irritation.
H 330	Fatal if inhaled.
H 331	Toxic if inhaled.

H 332	Harmful if inhaled.
H 334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H 335	May cause respiratory irritation.
H 336	May cause drowsiness or dizziness.
H 340	May cause genetic defects <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 341	Suspected of causing genetic defects <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 350	May cause cancer <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 351	Suspected of causing cancer <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 360	May damage fertility or the unborn child <state specific effect if known > <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 361	Suspected of damaging fertility or the unborn child <state specific effect if known> <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 362	May cause harm to breast-fed children.
H 370	Causes damage to organs <or state all organs affected, if known> <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 371	May cause damage to organs <or state all organs affected, if known> <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 372	Causes damage to organs <or state all organs affected, if known> through prolonged or repeated exposure <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 373	May cause damage to organs <or state all organs affected, if known> through prolonged or repeated exposure <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
H 400	Very toxic to aquatic life.
H 410	Very toxic to aquatic life with long lasting effects.
H 411	Toxic to aquatic life with long lasting effects
H 412	Harmful to aquatic life with long lasting effects.
H 413	May cause long lasting harmful effects to aquatic life.
EUH 001	Explosive when dry
EUH 006	Explosive with or without contact with air.
EUH 014	Reacts violently with water.
EUH 018	In use may form flammable/explosive vapour-air mixture
EUH 019	May form explosive peroxides.
EUH 029	Contact with water liberates toxic gas.
EUH 030	Can become highly flammable in use.
EUH 031	Contact with acids liberates toxic gas.
EUH 032	Contact with acids liberates very toxic gas.
EUH 044	Risk of explosion if heated under confinement.
EUH 059	Hazardous to the ozone layer.

- EUH 066 Repeated exposure may cause skin dryness or cracking
- EUH 070 Toxic by eye contact
- EUH 071 Corrosive to the respiratory tract.
- EUH 201 Contains lead. Should not be used on surfaces liable to be chewed or sucked by children.
Warning! Contains lead
- EUH 202 Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of the reach of children.
- EUH 203 Contains chromium (VI). May produce an allergic reaction.
- EUH 204 Contains isocyanates. See information supplied by the manufacturer.
- EUH 205 Contains epoxy constituents. See information supplied by the manufacturer
- EUH 206 Warning! Do not use together with other products. May release dangerous gases (chlorine).
- EUH 207 Warning! Contains cadmium. Dangerous fumes are formed during use. See information supplied by the manufacturer. Comply with the safety instructions.
- EUH 208 Contains (name of sensitising substance). May produce an allergic reaction.
- EUH 209 Can become highly flammable in use or can become flammable in use.
- EUH 210 Safety data sheet available on request
- EUH 401 To avoid risks to human health and the environment, comply with the instructions for use.

EU Safety Phrases for hazardous substances

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

EU 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 3/9/14	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 March 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 3 – Material Safety Data Sheets (MSDS)

1. MSDS:

- Provides valuable information that you can use to optimise chemical use and improve workplace health & safety standards.
- Indicates characteristics, properties and quality of the chemical having influence on the end product.
- 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 (PPE).
- 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 and 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.

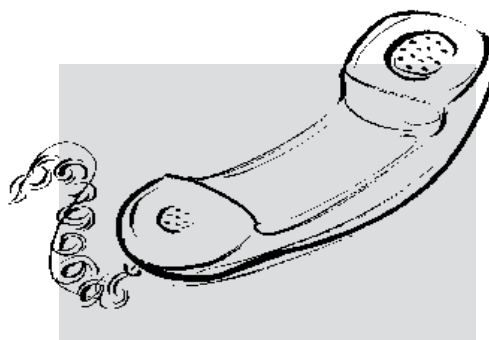
Where should MSDSs be kept?

An MSDS for every chemical substance used in your operation should be kept in a central place and be readily 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 6**), 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.

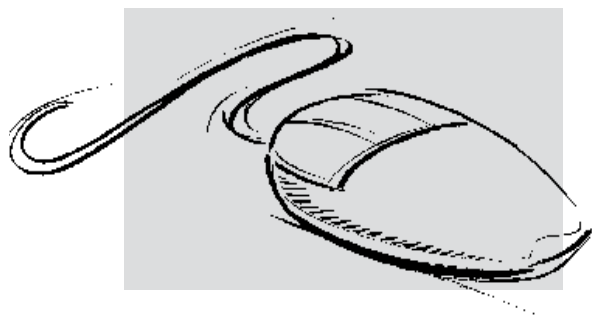


- All chemical providers are legally obliged to prepare and provide information to buyers regarding the hazardous properties of substances.
- Ask your chemical supplier if the MSDS can be provided in the local language currently used by the workers of your factory.

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.

The extensive information included in **MSDS usually contains the following information in 16 sections** in accordance with the model specified in Directive 91/155/EEC as amended by Directive 2001/58/EC (MSDS from other countries may have a different structure):

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 the use of this 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 procedures** 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 an important section indicating appropriate **handling and storage** (see **Tool 8**).

Section 8 provides information on regulatory standards for **exposure limits**, in other words, the maximum permitted concentration of the material in the work 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 about **stability and reactivity** of the substance.

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

Section 12 is largely self explanatory about **ecological information**.

Section 13 which deals with **disposal considerations**, 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 9** for some basic principles).

Section 14 gives **transport information**, generally as a list of codes indicating the dangers associated with the chemical (e.g. 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.

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 & safety of workers arising from their use and how to control them.

Selection of MSDS internet sites:

- <http://www2.hazard.com/msds/index.php>
- <http://www.msds.com/>
- <http://www.ncsu.edu/ehs/MSDS.htm>
- In a search machine such as Google type msds followed by the name of the chemical or product

In the next five pages you will find an

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.

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 Pharmaceuticaaan 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/4HEC50Photobacterium 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 abbreviations for MSDS on page 111

**** 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.

2. International Chemical Safety Cards (ICSC):

Another source of information about safe use of chemicals is at the ILO website for international chemical safety cards. (ICSC)

Since MSDSs are not universally available in small and medium sized enterprises, ILO/WHO has devised an equivalent polyglot tool, the ICSC.

An **ICSC summarises** 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 & safety information collected, verified and peer reviewed by internationally recognized experts, taking into account advice from manufacturers and Poison Control Centres.

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

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

3. Pesticide Data Sheets (PDS)

When using pesticides special precautions have to be taken due to their very hazardous nature if they are not handled appropriately. The tool of choice are the PDS. They contain basic information for safe use of pesticides and can be found under:

[http:// www.inchem.org/pages/pds.html](http://www.inchem.org/pages/pds.html).

The Pesticide Data Sheets are prepared by the World Health Organisation (WHO) in collaboration with the Food and Agricultural Organization (FAO) and give basic toxicological information on individual pesticides. Priority for issue of PDS 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, the Global Crop Protection Federation (GCPF). The data sheets are revised from time to time as required.

Tool 4a - Identifying inhalation hazard groups

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 the existing 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 lead to 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.

Depending on the level of potential harm (high to low) of hazardous substances/chemicals different control approaches have to be chosen.

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: The ILO Classification of Hazard Groups A to E for Chemicals causing harm when inhaled is based on their links to certain R-Phrases

Hazard Group	Linked R-Phrases
A	R36, R36/38, R38, R65, R66 and all chemicals (if the R-Phrases characterization is applied) not allocated to another band
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 insufficient 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

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

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

- R40/20, R40/20/21, R40/20/22, R40/21, R40/21/22, R40/20/21/22, R40/22, 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 helps you determine the level of dustiness of a particular chemical substance and Figures 14 a and b help you determine the level of volatility of a particular chemical substance.

The more volatile/dusty, the more exposure!

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

If liquid hazardous substances are used on large surface areas (for example when painting or cleaning) no more than 1 litre of the substance per full working day should be used in order to qualify the quantity group 'small'.

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 during use (e.g. PVC pellets, waxed flakes)
Medium	Crystalline, granular solids. Dust settles quickly (e.g. detergents)
High	Fine, light powders. When used, dust clouds form and remain in the air for several minutes (e.g. cement, carbon black, chalk dust)

Figure 14a: Determining the level of volatility of substances

Liquids	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

Processes being carried out above room temperature (approximately 20° C), will typically increase the volatility (i.e. increase the risk of the liquid to turn into a vapour (see Figure 14b) of a chemical. Use therefore Figure 14 b to determine volatility by consideration of boiling and operating temperature.

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.

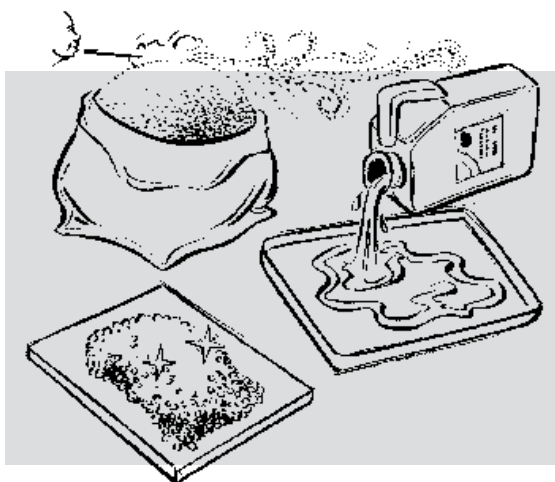
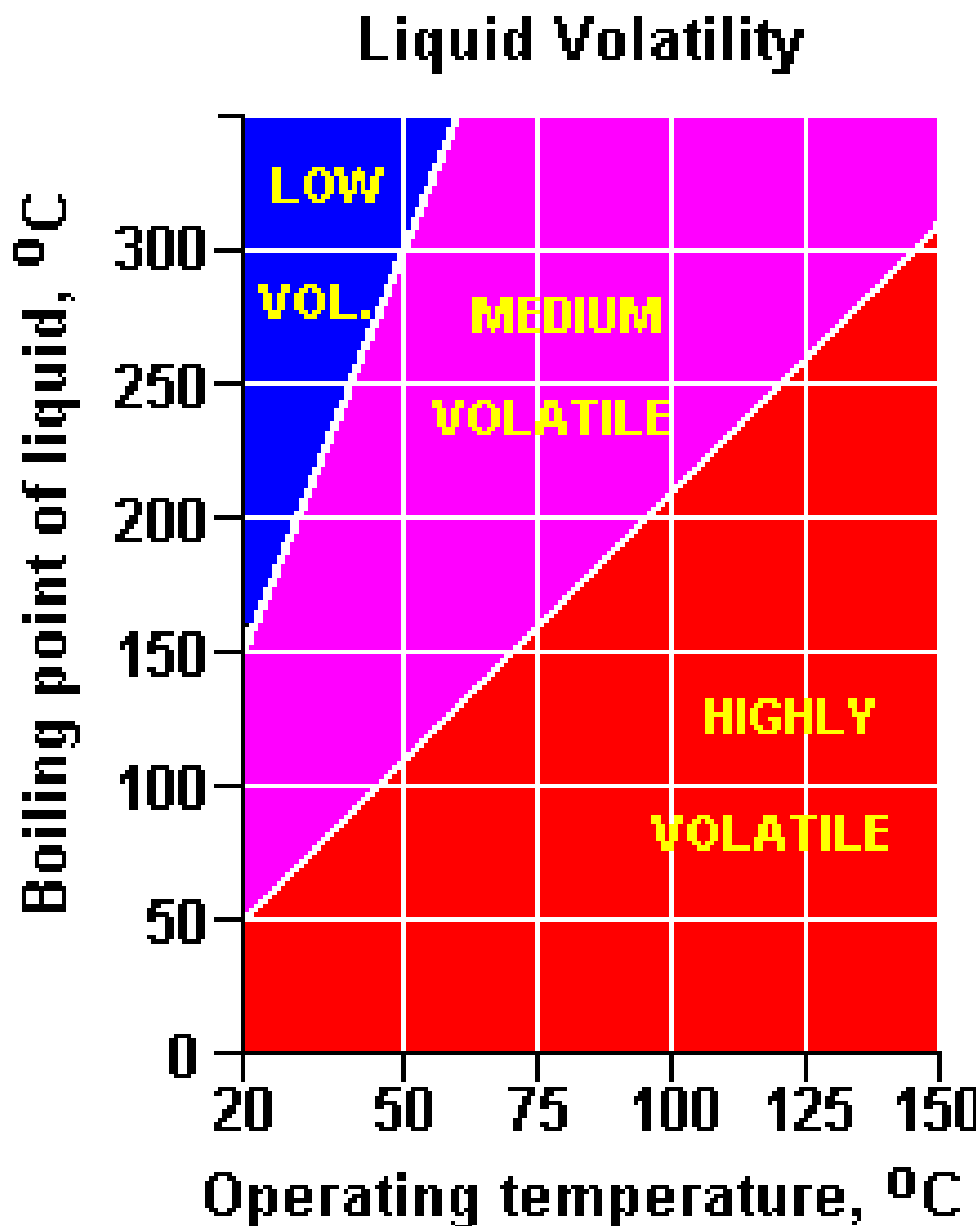


Figure 14b: Determination of volatility under different operating temperatures



For example naphthol has a boiling point of 285°C. When working at 20°C you consider the volatility according to the table in the range of low. When working at 75°C the volatility of naphthol is in the range of medium and when working at 150°C the volatility of naphthol is in the range of high.

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**) nee-

ded to prevent or control exposure to significant hazards that may arise during the storage, use, handling, transport 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 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 4 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.

Tool 4b – Description of control approaches for chemicals causing harm when inhaled

What does ‘control approach’ mean?

A **control approach** or **control strategy** or **control level** of exposure is the sum of measures you need to apply 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 an adequate level of protection to prevent or minimize the risk of exposure to hazardous substances if inhaled.

The four control approaches for chemicals causing harm when breathed in include general ventilation, local exhaust ventilation (the most common form of engineering control), containment or putting a distance or shielding between the hazardous chemical and the worker and special advice measures.

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 **Coshh Essential** website at:

<http://www.coshh-essentials.org.uk>

or the ILO internet site for the **International Chemical Control Toolkit** at

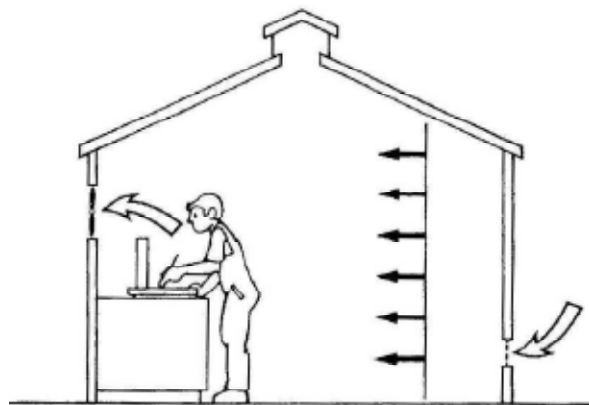
http://www.ilo.org/public/english/protection/safework/ctrl_banding/toolkit/icct/index.htm

Control Approach 1:

General ventilation/Housekeeping

In the case of airborne chemicals, general ventilation is regarded as one of the best forms of control.

By means of adequate ventilation, we can trap contaminants released into the air from the process or operation and prevent them from entering the breathing zone of the worker.



Scope

The measure 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 control approach 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 from the work area whose presence is not required in the work process. Ensure that no one is working close by or downwind to the source.

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 fresh air supply can be ensured by 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 firstly flows past the worker and then past the work area. In the open, use the wind to blow dirty air away from you (upwind).
- 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 fans and/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/Housekeeping

- 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 how to handle chemicals safely. Check that controls (e.g. fans) are working and provide measures on what to do if something goes wrong.
- Have a system to check that the precautions you have put in place are being followed.

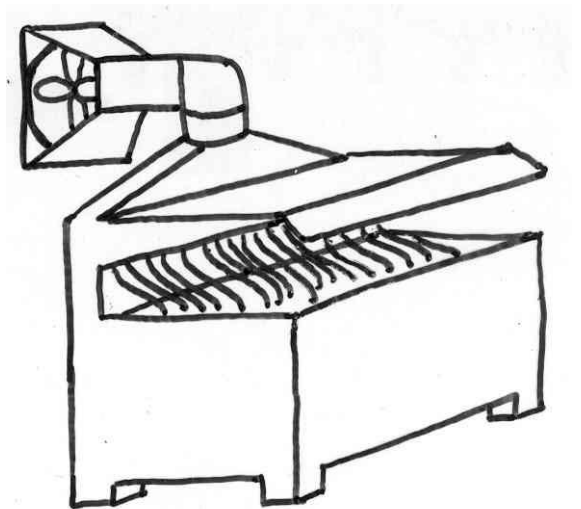
Control Approach 2:

Local exhaust ventilation (LEV), the most common form of engineering control

Scope

The measure gives good practice advice on the application of local exhaust ventilation, which is the most common form of engineering control. The trapped contaminants are conveyed by ducts to a

collector (cyclone, filter house, scrubbers or electrostatic precipitators) where they are removed before the air is discharged into the outside environment. This is accomplished by a special exhaust system or by increasing the general ventilation



Local exhaust ventilation can be applied to a range of small, medium and large scale tasks involving solids and liquids. This measure 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 from the work area, whose presence is not required in the work process.

Design and equipment

- Consider the importance of the appropriate design for an exterior hood. The contaminants have to flow into the hood and be removed before they escape into the general workplace atmosphere. Be aware that other forces (e.g. cross drafts) and the **distance between source and hood** may be hindering the contaminant's proper extraction by the hood. If the contaminant is to be controlled, the velocity of the air

flowing past the source must be high enough to overcome these influences and to capture the contaminant with the moving air. This velocity is referred to as the **capture velocity**. Thus, the proper design of an exterior hood not only needs considerations of local exhaust ventilation such as shape of the hood, unobstructed ductwork and fan capacities but also the determination of the required capture velocity (m/s).

- 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/s will generally be needed and for vapours, airflows greater than 0.5 m/s. The airflow should be measured at the origin of the dust or vapour with an anemometer.
- Contain the source of dust or vapour as much as possible to stop it from spreading.
- Don't allow the worker to get in between the source of exposure and the LEV, otherwise he or she 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.
- Keep the hood as close as possible to the source of exposure.

Maintenance

Keep the LEV system in good working order.

Examination and testing

- Check that the extraction system is working when it is switched on every day.
- 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/Housekeeping

- 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.

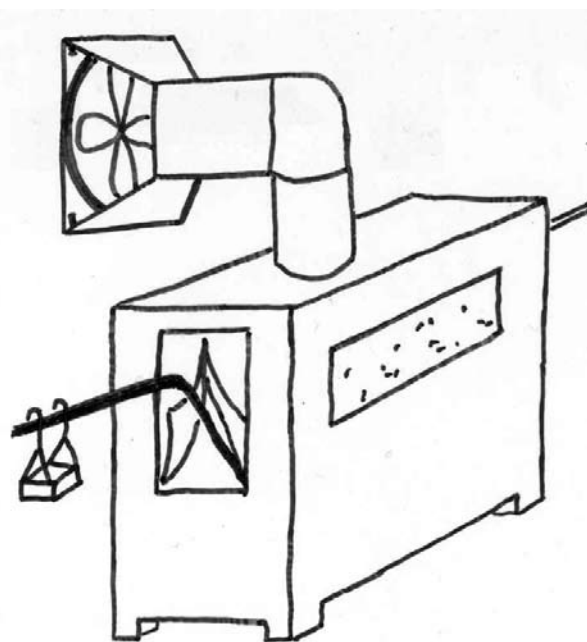
Training and supervision

- 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: Putting distance or shielding/containment between the substance and the worker

Scope

Containment involves enclosing processing equipment in order to restrict spread of air contaminants to the workplace environment and isolating sources of heat (e.g. from open flames, from fuels). It is ideal for processes in which the worker has minimal chances of coming into contact with the chemical in question. Contact with hazardous chemicals can be reduced by isolation, which entails moving the hazardous process or operations to a remote location in the plant or constructing a barrier to separate them from other processes.



An example of isolation is separating a spray painting process from the other processes of the plant by means of a barrier or wall. A similar isolating effect can be obtained by the safe storage of hazardous chemicals and by restricting the amounts of these chemicals in the workplace to that required in a day or a shift. Such restriction is useful if the process can be carried out by a very small number of workers and when control by other methods is difficult or impossible. The workers engaged in this process however, should be given adequate personal protection.

The measure 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 control approach 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 that it can be easily maintained.
- Where possible, keep 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, toxic 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/Housekeeping

- 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 Respiratory Protective Equipment 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.



Personal Protection Equipment should only be used as a last resort and not as an alternative to a control approach.

Control Approach 4:

Special advice

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.

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

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 or the possibility of **substituting** the chemical you are using for a less hazardous one and control measures.



Some remarks on elimination or substitution

Try to reduce the risk by eliminating the chemical hazard or replacing the chemical with a less hazardous one.

The most efficient way to reduce chemical hazards is to avoid using toxic substances or substances that pose a risk of fire or explosion. The selection of the substituting chemical substance should be made at the design and planning stage of the process. For existing processes, the substitution method should be used wherever hazardous substances or processes may be replaced by others that are less hazardous.

The choice of alternative substances may be limited, especially where the use of that particular substance is unavoidable if specific technical and economic requirements are to be met. It is always useful to look for alternative substances by learning from experience in similar circumstances/processes, sectors.

Substitution is nothing else than a certain type of innovation!

Substitution unfortunately is not always chosen by enterprises. Main reasons for this are:

- No priority given at enterprise. Dealing with the existing problems is already too laborious. Companies want no additional problems which might occur with a new, innovative approach
- Uncertainty in risk assessment
- Substitutes are often less tested in practice
- Integration in the production chain makes an innovation beyond enterprise borders necessary
- Technological or economic difficulties

Try to be innovative whenever possible.

Tool 4c

Respiratory Protection Program

This tool advises employers, supervisors and workers on a respiratory protection program prior to the selection of respiratory protective equipment (RPE).

Remember

National regulations and good practice in general require employers to assess the health risks and precautions needed to prevent or control exposure to hazardous substances. The first priority should always be to prevent exposure or, if this is not possible, to control it at source, for example by effective local exhaust ventilation.

The use of a respirator is no substitute for effective control of release/emission of chemicals at source.

Respirators may be needed as an interim measure where engineering controls are being developed and/or modified and for short-term jobs such as cleaning and maintenance. Engineering controls protect everyone in the workplace; a respirator can only help the person who wears it.

What are the things that you should know before you choose a respirator?

Employers should have a written respirator program that describes the proper procedures for selecting and operating respiratory protective equipment. The correct use of a respirator is just as important as selecting the proper respirator or the appropriate filters. The respirator program should describe how to identify the existing hazards and the level of protection needed. It should also describe how to wear and look after the respirator.

Without a complete respiratory protection program, the worker will not receive the best protection from a respirator.

Respiratory Protection Program

The safe and effective use of a respirator requires that at least the following program elements are addressed:

- Written work site specific operating procedures (see box below)
- Exposure assessment (nature of hazardous material, frequency and duration of exposure, route of entry, workers' tasks and workplace design)
- Medical evaluation of respirator wearers (to attest medical and psychological fitness)
- Proper selection of respiratory protective equipment (refer to Tool 4d)
- Proper selection of filters/cartridges for particulates and gases (refer to Tool 4e)
- Training of respirator users and other concerned persons
- Respirator fitting
- Cleaning, inspection, maintenance and storage
- Program evaluation (to documents possible improvements)

Program administration should be assigned to a single individual who is given the authority and responsibility for the overall program and who reports to the facility manager. Others may assist, but final responsibility should remain with the single individual, thereby ensuring that there is coordination and direction for the program. The administrator must have sufficient knowledge and must be up-to-date of current issues, technological advances

and regulatory changes concerning respiratory protection.

The program administrator's responsibilities include the following:

- Conducting an exposure assessment by measuring, estimating or reviewing information on the concentrations of airborne contaminants in the work area. This is done prior to respirator selection and periodically during respirator use to ensure that the proper type of respirator is being used.
- Selecting the appropriate type of respirator to provide adequate protection for all contaminants present or anticipated.
- Maintaining records and written procedures to document the respirator program and allow evaluation of the program's effectiveness (documentation).
- Evaluating the respiratory protection program's effectiveness through ongoing surveillance of the program and respirator use (e.g. by means of walkthroughs using a checklist to verify adherence to the program). Any defects or shortcomings found during the audit should be documented, including plans to correct problem areas and target dates for completion.

Written work site specific procedures must document the entire program. These specify the activity that is to be carried-out, where it will be done, who will perform the activity and how often. Forms should be used to document the completion of required activities and their outcomes.

A physician should examine the medical and psychological fitness of the workers. This should be done before they are assigned to work in areas where respirators may be required. The workers must be physically and psychologically (e.g. not

claustrophobic) fit to carry out the work while wearing respiratory equipment.

Training

Everyone who is involved in the use of RPE should be appropriately trained. They must be aware of why the respirator is being worn, which respirator should be used and how it should be worn properly. Training may be available from the supplier or manufacturer of your RPE.

A qualified person, knowledgeable of respiratory protection and workplace contaminants, must instruct supervisors as well as the person issuing respirators. Adequate training should be provided to ensure proper respirator use. It should also cover other issues such as health hazards, work practices, use of other equipment on site and medical surveillance requirements (especially for emergency and rescue teams). All workers need to be trained prior to the use of a respirator. This training should be repeated at least once a year.

Each respirator wearer should be given training that includes the following.

- An explanation of the need for the respirator, including an explanation of the respiratory hazard and what happens if the respirator is not used properly
- Instructions to inform their supervisor of any problems related to respirator use
- Information of what engineering and administrative controls are being used and why respirators are still needed for protection
- An explanation of why a particular type of respirator has been selected
- Instruction in how to use the respirator and check its fit and operation
- Instruction in respirator maintenance

- Instruction in emergency procedures and the use of emergency escape devices and regulations concerning respirator use

Training on wearing the respirator must include an opportunity to handle the respirator and it should provide instructions for each wearer in the proper fitting of the respirator. This means that demonstrations and practice in how the respirator must be worn, how to adjust it, and how to determine whether it fits properly should be carried out. Respirator manufacturers can provide the required training materials. The training session must also allow time to practice. Supervisory personnel should periodically monitor the use of respirators to ensure they are worn properly.

Care of Respirators

The manufacturer's recommendations should be followed on replacement of filters. Non-disposable RPE should be cleaned and disinfected after each use or at least once every working day. Rubber face pieces can usually be cleaned with soap and lukewarm water but the manufacturer's instructions should always be followed. Disposable respirators should be discarded after each shift or more frequently if exposure is high.

Fit testing

Each respirator wearer must be required to check the seal of the respirator (fit check) by appropriate means before entering a harmful atmosphere. Each respirator manufacturer provides instructions on how to perform these user seal checks.

Facemasks depend on good contact between the skin and the mask for their effectiveness. Many facemasks are available in one size only and cannot be expected to fit all the working population. A good fit and seal are essential - without them the respirator will not give effective protection. It is advisable to obtain a selection of different models of RPE so that masks can be selected to give the

best fit for individual wearers. It will only be possible to get a good seal if the skin in the region of the seal is smooth and without hair. Facial hair or glasses will tend to lift the mask off the face and permit inward leakage of contaminated air. Also, if a worker has facial scars or an acne problem, the facial skin may not be able to form a good seal with a respirator mask.

A simple check on how well a facemask fits can be done in the following way

1. Put on the equipment according to the manufacturer's instructions.
2. For disposable respirators, cup the hands over the whole of the face piece; for respirators with separate filters, cover the inlet to the filter with the hands or with a flat sheet of card or similar material.
3. Inhale sharply so that the mask collapses slightly. Hold the breath.
4. If the mask remains collapsed for a few seconds and no leakage is detected, the mask probably fits adequately.

(Refer also to "respirator donning/seal check instruction" at: http://www.draeger.com/STms/internet/site/MS/internet/UK-en/ms/Products/Protection/APR/air_purifying_respirators.jsp)

If leakage is detected, the head straps should be readjusted and the test repeated. If leakage persists a different size or design of respirator is needed.

Warnings

Do not use any air purifying respirator

- In oxygen deficient atmosphere (see local legislation).
- In poorly ventilated areas, or in confined spaces such as tanks, small rooms, tunnels or vessels (unless the confined space is well ventilated and the concentration of toxic contaminants is known to be below the upper limit recommended for the respirator).
- In atmospheres where the concentrations of toxic contaminants are unknown or are immediate hazard to life or produce an immediate irreversible debilitating effect on health.
- At concentrations of hazards greater than the filter class capacity, stated on the respirators label.

- If a substance has poor warning properties like odour, taste or irritation.

Immediately leave the area and than remove the respirator if

- Breathing becomes difficult.
- Dizziness or other distress occurs.
- You sense irritation, smell or taste the contaminants.
- The respirator becomes damaged.

Be sure that

- There are no harmful particulate substances (i.e. dusts mists, or fumes) present when only gas/vapour filters are fitted to the respirator and no harmful gases/vapours are present when only particulate filters are fitted.
- The respirator selected properly fits the wearer.

The following terms will help you to differentiate the two main types of contaminants (particles and vapour /gas)	
Type of contaminant	Particulate
<i>Particulate</i>	Fine liquid or solid particles such as dust, smoke, mist or fumes found in air or emissions
<i>Mist</i>	Small droplets suspended in air
<i>Dust</i>	Minute solid particles with diameters less than 500 micrometers
<i>Aerosol</i>	Collection of very small particles suspended in air. The particles can be liquid (mist) or solid (dust or fume)
<i>Fume</i>	Vapour carrying suspended solid metal particles or liquid metal droplets
Type of contaminant	Vapour /gas
<i>Vapour</i>	The gaseous form of materials that are normally liquids or solids at room temperature and pressure (e.g. steam)
<i>Gas</i>	Gas is one of the four major states of matter, consisting of freely moving atoms or molecules without a definite shape and without a definite volume

Tool 4d

Selection of Respirators

This tool advises employers, supervisors and workers on the selection of respiratory protective equipment (RPE).

There are two main types of respirators

1-) Air-purifying respirators (APR)

Air-purifying respirators can remove contaminants in the air by filtering out particulates (e.g. dusts, metal fumes, mists etc.) or by purifying air by adsorbing gases on a sorbent (adsorbing material) in a cartridge. A powered APR (PAPR) provides you a high level of comfort because of a low breathing resistance and constant air flow. APRs (for pictures refer to fig 16 a) are tight-fitting and are available in several forms:

Respirators with particulate filters

- Disposable quarter-mask (covering the nose and mouth)
- Half-face mask (covering the face from the nose to below the chin)
- Full-face piece (covering the face from above the eyes to below the chin)

Respirators with gas filters / cartridges

- Half-face mask (covering the face from the nose to below the chin)
- Full-face piece (covering the face from above the eyes to below the chin)

2-) Supplied-air respirators (SAR)

SARs supply clean air from a compressed air tank or through an air-line. This air is not from the workroom area. The air supplied in tanks or from com-

pressors must meet certain standards for purity and moisture content.

- SARs are available in several forms:
- Self-contained breathing apparatus
- Air-line supplied-air respirator
- Protective suits that totally encapsulate the wearer's body and incorporate a life-support system.



How do you select the right respirator?

Choosing a respirator is a complicated matter. Usually, experienced safety professionals or occupational hygienists, who are familiar with the actual workplace environment, are the staff who should select the proper respirator. They can choose a suitable respirator only after they have evaluated all relevant factors (see Tool 4c on respiratory protection program). This includes considering the limitations of each class of respirator. In case a safety professional/occupational hygienist is not available you should request the supplier or manufacturer of

RPE for advice and use the information provided here as a first guidance on selection of right RPE.

Before the proper respirator can be selected for a job, be sure you have already:

- Identified the respiratory hazard (category and source, chemical properties, concentration in the air, oxygen-deficient atmospheres, potential health effects)
- Evaluated the workplace hazard (frequency and magnitude, hot temperatures, confined space, operating time, workload)
- Considered whether engineering controls are feasible (in consideration of monetary and technical aspects).

Respirators with filters for particulates (dust) will give no protection at all against gases and vapours.

RPE used to protect against chemicals must meet two basic requirements:

1. The RPE must be suitable for the purpose for which it is used. This means that it must provide effective protection. It must be capable of providing a sufficient quantity of clean air for the wearer to breathe, it must fit the wearer and the wearer must use it properly in accordance with the manufacturer's instructions. If the respirator is not a disposable 'one shift' type, it must also be cleaned daily and maintained in accordance with the manufacturer's instructions.
2. RPE should be CE marked and/or follow other internationally accepted standards such as ISO, EN, DIN and ANSI. The CE marking signifies that the PPE satisfies certain basic safety requirements and in some cases will have been tested and certified by an independent body.

Figure 16 is designed to help you select suitable respirators. Only the most common types used are

included. This does not mean that other types are not suitable, and guidance on their selection can be found in Respiratory protective equipment: A practical guide (HSE, UK; www.hse.gov.uk) or information provided by the manufacturers. Figures 16a,b and c show some examples of respirators.

Simple masks, known as nuisance dust masks (surgical masks), do not give any reliable protection against substances hazardous to health. These should not be used with chemicals

Personal and work-related factors in selection of RPE (ergonomic considerations)

All types of RPE restrict the wearer to some extent, by imposing extra breathing resistance on the lungs and by restricting visibility or mobility. These restrictions underline the need to control exposures by other means wherever possible. It is also important to remember that effective protection is only given when equipment, which is of the right standard and in good condition, is properly fitted and used. Removal of the RPE, even for short periods, dramatically reduces the level of protection.

A respirator, which is not worn or is hung around the neck, gives no protection at all.

Respirator Selection Non-Routine Use

Three types of hazardous atmospheres require careful consideration for respirator selection because of the unusual nature of the hazard. These are a-) entries into confined spaces, b-) oxygen-deficient atmospheres and c-) emergencies. These scenarios may impose to workers a risk that is immediately dangerous to life and health (IDLH). Here exposure to airborne contaminants is likely to cause death or permanent adverse health effects, or prevent escape from such an environment. IDLH atmospheres affect the worker acutely as opposed to chronically. Thus, if the concentration is above IDLH levels, only highly reliable supplied-air respiratory protective equipment is allowed.

Figure 16 a: Selection of appropriate respirators

Particulate
(dust)

.... with particulate filters

APR Disposable	APR ½ mask + filter	APR Full face + filter	Powered APR + filter
			

.... with gas/vapour filters

Gas/vapour

Figure 16 b: Examples of half-face masks






aerosol masks (dust and liquids)	chemical cartridge respi-rators single filter	chemical cartridge respi-rators double filter
		

Figure 16 c: Example of full-face mask

Full-face mask with cartridge	Detail of the cartridge showing color code
	

Tool 4 e

Filter Selection for respirators

1 Information needed prior to filter selection

The following circumstances have to be checked first, in order to decide on an appropriate filter:

- What are the contaminants?
- What are their concentrations?
- What is the applicable Occupational Exposure Limit (OEL)?
- What is the protection factor of the respirator?
- Are the contaminants gaseous or particulate or a combination of both?
- Do the contaminants have adequate warning properties such as smell and/or taste?
- Are the contaminants immediately dangerous to life and health?
- Does the atmosphere contain enough oxygen?

The expected concentrations of contaminants will help to decide on the needed protection factor and help to learn whether the contaminants are immediately dangerous to life and health. In work situations with restricted fresh air supply an air-supplying respirator must be provided.

If the concentration of workplace contaminants is not known, the likely concentration should be estimated. The parameters used to identify inhalation hazard groups (Tool 4a), will help to decide on the appropriate filter. Wherever control approach 3 or 4 is recommended, a respirator and filter with the highest protection performance is to be selected.

2 Occupational Exposure Limit (OEL)

An OEL is the concentration of an airborne substance, averaged over a reference period (commonly an 8-hours dayshift), at which there is no evidence that it is likely to be harmful to employees. The OEL for a specific chemical can be obtained from its MSDS or information material of respirator manufacturers. This value is needed to calculate the protection factor.

3 The protection factor (PF) of a respirator

The selection of the most suitable respirator for a particular situation depends on two factors: understanding the hazard against which protection is required as well as understanding of the limits of protection of the respirator available. It is necessary to know both the concentration and occupational exposure limits of harmful contaminants that are likely to be encountered in air.

A PF is the expected workplace level of respiratory protection that would be provided by a properly functioning respirator to well-trained users.

Example: How to calculate the required protection factor of a respirator?

Contaminant	Total inhalable dust
Contaminant concentration/m ³ ambient air	500 mg/m ³
OEL	10 mg/m ³

PF = Contaminant Concentration divided by OEL

$$PF = 500/10$$

$$PF = 50$$

The minimum protection factor required is 50.

The following table shows the types of respirators and filters which meet the minimum requirement of the protection factor of 50 if used correctly.

The same method is used for either particulate or gaseous hazards. Where contaminants are present in both forms the protection factor must be established for each one separately. For the selection of respirators and filters the higher one must be applied.

It should be remembered that the performance predicted by the Protection Factor can only be expected of a respirator worn correctly and which has been properly maintained. When a respirator is available in more than one size it is important that the best fit for the individual is worn.

Protection Factors of various respirators (all in combination with filters)		
Respirator	Filter type and filter class#	Protection Factor
<i>Particle filter respirators</i>		
Disposable dust half mask	FFP1	4
	FFP2	12
	FFP3	50
Quarter or half mask	P1	4
	P2	12
	P3	50
Full face mask	P1	5
	P2	20
	P3	1000
<i>Gas filtering respirators</i>		
Quarter or half mask	Depending on the chemical	5
Full face mask	(see manufactures' lists)	2000
#Filter type: P indicates particulate filter in general, FFP indicates particle filtering face piece. For each filter type three classes (1, 2 and 3) do exist. Each class describes the capacity of a filter: small (1), medium (2), large (3) capacity. The higher the capacity of the filter, the higher the protection factor.		

4 Selection of the filter

Filter types

Contaminants are encountered in two different forms, presenting either a particulate or gaseous hazard and therefore different filters are required to protect against particles, specific gases, or a combination of both. A particulate hazard may include dusts, fibres, fumes, mists or micro-organisms. A gaseous hazard may consist of gases or vapours. It is important that the appropriate type of filter is selected for the form of contaminant to be encountered. The following table shows a combination of different colours and filter types. Also it is important to consider the nature of each chemical when selecting the appropriate filter.











Filter recommendation by respirator manufacturers

Please refer to respirator manufactures' brochures, databases and websites to obtain appropriate information on selection of recommended filters. Among other publications the following are quite informative:

3M (<http://www.3m.com>): "2007 respirator selection guide"

Dräger (<http://www.draeger.com>): "Guide for selection and use of filtering devices" and "Take a deep breath. Dräger X-plore® air purifying respiratory protection."

In these publications you will find a list of the most common chemicals and recommendation on appropriate filter type.

<i>The combination of color code and filter type help you select the right filter for the chemical you should get a protection</i>		
Colour code	Filter / cart-ridge type	for which chemicals indicated
	AX	Gases and vapour of organic compounds with boiling point > 65 °C
	A	Gases and vapours of organic compounds with boiling point < 65 °C
	B	Inorganic gases and vapours e.g. chlorine, hydrogen sulphide, hydrogen cyanide
	E	Sulphur dioxide, hydrogen chloride
	K	Ammonia
	CO	Carbon monoxide
	Hg	Mercury vapour
	NO	Nitrous gases including nitrogen monoxide
	Reactor	Radioactive iodine including radioactive methyl iodide
	P1 -P3	Particles

5 Filter life

The period of use of a respiratory filter depends on its size and on the conditions of use. Air consumption by the user, air humidity, air temperature and the concentrations and combinations of the toxic substances involved all influence the lifetime of the filter. For this reason, a precise period of use can only be specified if all these factors are known in advance. Gas filters (cartridges) generally show the user that their capacity is exhausted by way of a perceptible odour. Further use will certainly result in irritation of the mucous membranes. For safety reasons, filters and special filters used to protect against odourless gases must be replaced according to the special guidelines according to local regulations. Continual loading of particulate filters causes them to clog up and the breathing resistance increases noticeably. The worker can then leave the danger area at the correct time. Depending on the mixture of toxic substances, combined filters indicate that their capacity is beco-

ming exhausted either by an odour or by increased breathing resistance.

Unlike particulate filters, cartridges (gas filters) have high removal efficiency and at some point become less efficient and lose the ability to trap the contaminant completely. Therefore, selection of an air-purifying respirator for gases and vapours must consider the service life of the cartridge. To protect workers, the chemical cartridge must be changed before significant breakthrough occurs.

Tool 5a - Identifying skin hazard groups

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, 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 affect adversely 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 comes in contact with the skin.

Chemicals may also provoke sensitisation and allergies by skin contact.

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 allocated to skin hazard group A.

Corrosive

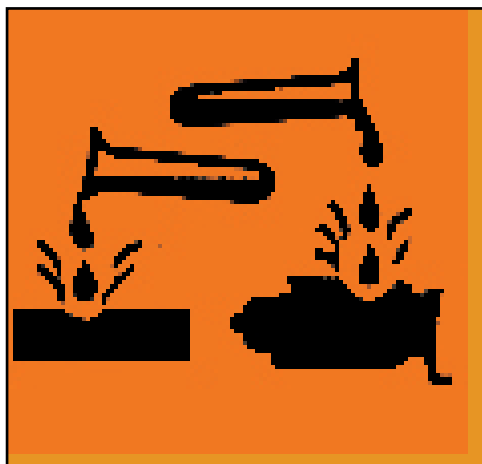


Figure 17: BAuA classification of Skin Hazard Groups (Skin A-E) for chemicals causing harm via skin and eye contact

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	R43, R42/43
Skin D	R24, R23/24, R23/24/25, 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 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*

* These R Phrases have to be 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.

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



wear safety shoes



wear goggles



wear apron



wear face shield

Tool 5b - Description of control measures for chemicals causing harm via skin and eye contact

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:

Factor 1: Quantity of substance on the skin (small or large quantity of chemical)

Quantity of substance on skin	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 18 shows you which level of control measures to choose. In principle there are three levels of control:

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

Figure 18: Determination of control measures

Skin Hazard Groups	Quantity of substance on skin	Duration of the effect on skin	Control measure
A	small	short	Basic
	small	long	Basic
	big	short	Basic
	big	long	Basic
B	small	short	Basic
	small	long	Advance
	big	short	Advance
C	big	long	Special
	small	short	Advance
	small	long	Advance
	big	short	Advance
D	big	long	Advance
	small	short	Advance
	small	long	Advance
	big	short	Advance
E	big	long	Special
	small	short	Advance
	small	long	Special
	big	short	Special
	big	long	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
- 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. Soap and clean towels to be provided.
- 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 6**)

- 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 6**)

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 6**). 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.
- Ensure that 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.

Special control measures

Special control measures 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 intense 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, too. In figure 18 these situations are indicated by '*special*'. In these cases substitution of the hazardous substance is the best solution. It should be considered if skin contact can be avoided by using a close system.

The next two tools deal with general aspects of PPEs and selection criteria for gloves.

Tool 5c - Use of Gloves, Aprons, Goggles and Boots for Skin and Eyes Protection

This tool describes the key points you need to follow to provide adequate control and to help to ensure that exposure is reduced to a safe level.

As a worst-case example, a single unprotected skin exposure to concentrated anhydrous hydrofluoric acid can be fatal. As little as a 5% burn can result in death from both the corrosion and the effects of the fluoride ion. Due to this high risk a more complex strategy is needed when handling hydrofluoric acid rather than only prescribing the use of a PPE.

On the opposite end of the spectrum, inorganic lead is an example of a chemical that is highly toxic to humans but has little skin toxicity. In this case the concern is contamination through ingestion or inhalation, because lead will not permeate intact skin. Washing hands after working with lead, ventilation, housekeeping and no eating or smoking at the workplace are here crucial interventions.

What is PPE?

PPE is commonly defined as 'equipment which is to be worn by the worker and which protects against one or more risks to his health or safety', e.g. safety helmets, gloves, eye protection, respirators, chemical protection suits/coveralls, high-visibility clothing, safety footwear, ear protectors and safety harnesses. Each of these items needs to be compatible with any other PPE provided.

PPE is to be supplied and used at work wherever there are risks to health and safety that cannot be adequately controlled in other ways; considered always as last option.

Before deciding on required PPE you should assess work places, procedures and workers behaviour to understand which parts of the body are likely to be exposed to the chemicals. The four types of

clothing that may be required for skin and eyes protection are:

- Chemical protective gloves (see Tool 5d)
- Coveralls
- Protective footwear
- Face or eye shields.

Your protective equipment supplier should normally be able to tell you the type of protective material to select. Not all materials give protection against all chemicals. Some chemicals pass through protective materials over a period of time. It is important that you also ask your supplier how frequently the protective equipment needs to be changed. Ensure that the equipment is changed when necessary!

Dermal hazards due to chemical exposure

Adverse effects of skin contact with chemicals can be generally categorized as causing:

- Irritation
- Allergic response
- Burns (chemical corrosion)
- Skin toxicity (toxic effects on skin such as rash or irritation)
- Systemic toxicity (permeation through the skin, with target organs such as liver or kidneys)
- Development of skin cancer or other cancers.

These adverse health effects are the most important considerations for determining the need for protective clothing.

Assessing suitable PPE

To allow the right type of PPE to be chosen, carefully consider the different hazards in the workplace. This will enable you to assess which types of PPE

are suitable to protect against a specific hazard. For this, material safety data sheets (MSDS) will provide you with first information on hazardous materials and PPE to select. Ask your supplier for advice on the different types of PPE available and how suitable they are for different tasks. It may be necessary in a few particularly difficult cases to obtain advice from specialist sources and from the PPE manufacturer. Another useful source of information is the British Safety Industry Federation (<http://www.bsif.co.uk>).

Consider the following when assessing whether PPE is suitable:

- Is it appropriate for the risks involved and the conditions at the workplace where exposure to the risk may occur? For example, eye protection designed for providing protection against agricultural pesticides will not offer adequate face protection for someone using an angle grinder to cut steel or stone.
- Can it be adjusted to fit the wearer correctly?
- Has the state of health of those who will be wearing it been taken into account? For example, a wearer with chronic dermatitis who is supposed to wear nitrile rubber gloves over an extended period.
- What are the needs of the job and the demands it places on the wearer? For example, the length of time the PPE needs to be worn, the physical effort required to do the job and the requirements for visibility and communication.

Training

- Make sure anyone using PPE is aware of why it is needed, when it is to be used, repaired or replaced and its limitations.
- Train and instruct people how to use it properly and make sure they are doing this.

- Because PPE is the last resort after other methods of protection have been considered, it is important that users wear it all the time they are exposed to the risk. Never allow exemptions for those jobs which take 'just a few minutes'.
- Check regularly that PPE is being used and investigate fully any reasons why it is not. Safety signs can be useful reminders to wear PPE.

Maintenance

Make sure that equipment is:

- Well looked after and properly stored when it is not being used, for example in a dry, clean cupboard, or in the case of smaller items, such as eye protection, in a box or case;
- Kept clean and in good repair – follow the manufacturer's maintenance schedule (including recommended replacement periods and shelf lives).

Simple maintenance can be carried out by the trained wearer, but more complicated repairs should only be done by specialists. Make sure suitable replacement PPE is always readily available.

CE marking or other ISO/EN and national standards

Ensure that any PPE you buy is 'CE' marked and/or follows applicable ISO/EN or national standards, and complies with requirements of existing regulations. The CE marking signifies that the PPE satisfies certain basic safety requirements and in some cases will have been tested and certified by an independent body.

General precautions

- Check protective equipment for damage both before and after use.
- Clean and maintain all PPE regularly.

- Use disposable protective equipment only once and dispose of it safely after use.
- Wash cotton type overalls on a regular basis.
- Wash overalls at work or at a specialist laundry. They should never be taken home and washed with the 'family' wash.
- Store clean and dirty clothing separately.
- Provide a good standard of personal washing facilities.

Resistance to chemicals

Protective equipment is produced in a variety of materials with varying capacity to resist penetration. The user should seek advice and select the appropriate ones by reading the instructions on the label, on the MSDS or asking the supplier. In general, garments such as gloves made from neoprene, nitrile or viton of at least 0.4 mm in thickness are resistant to most chemicals and chemical formulations. Similarly, boots and aprons, which are intended to resist contamination by concentrated chemicals, should be equally resistant. Coveralls should be impermeable to liquids if subject to high levels of contamination, e.g. when the user is spraying a product/chemical. If exposure is limited to occasional liquid spills or to dry powders or granules, a coverall made of a fabric material such as treated cotton or polyester may be sufficient.

Choice of PPEs made from different materials

Some equipment, such as gloves or hats made from cotton, canvas, felt or leather, are particularly unsafe for use as PPE during work with hazardous chemicals because they absorb liquids. These liquids in turn are absorbed through the skin of the wearer, resulting in poisoning. Clothing may also be unsafe because of repeated use which may wrinkle the protective surface, allowing liquids to seep through: it should be discarded as soon as a defect becomes noticeable. Some gloves are intended for other purposes, such as gloves for protection against detergents at home or in the

kitchen. These gloves may be unsuitable for work with very hazardous chemicals, and advice should be sought.

Correct matching

In practice, several items of protective clothing are often worn at the same time. Each should be a correct match with the other in providing continuity of protection between, for example, a hood overlapping the shoulders of a coverall, the sleeves of the coverall overlapping gloves, and an apron overlapping boot tops.

User friendliness

Protective clothing should not prevent the wearer from carrying out the necessary tasks associated with working with chemicals. Gloves should not be so big or rigid that the fingers cannot manipulate objects. It should be possible for the wearer to move freely without being hindered by the sheer bulk or poor design of any garment. Similarly, garments should not be overly heavy or hot when worn. Those for use in tropical countries should wherever possible be of lightweight material and coloured white or yellow so as to reflect heat. Users should learn how to select the appropriate protective equipment.

Washability

All garments used at work with chemicals should be washable without any substance being retained in "trap points". Absorbent garments such as untreated cotton may be particularly difficult to clean completely.

Making a clean start

Clothing to be worn at the start of each day should be clean, dry and in good condition. The various items should be checked for signs of wear and tear, and repaired or replaced as necessary.

Decontamination after use

Gloves and boots should be washed before removal to avoid self-contamination. They should then be removed and the inside should be thoroughly washed with water and detergent, rinsed and allowed to dry. Goggles and facemasks should be similarly washed and allowed to dry.

Safe storage

Protective clothing should be stored in a clean, dry, well-ventilated room separate from other clothing or living accommodation.

Use of coveralls, aprons

- The material selected should be resistant to the penetration of liquids, dusts or granules as appropriate.
- For corrosive materials such as acids, an impermeable apron gives good protection.
- Coveralls should normally be worn over boots or sleeves rather than be tucked in.

Use of boots

- Protective footwear may be necessary for safety reasons as well as for protection against chemicals. Toecap protection, heat protection and a metal sole plate may be needed.
- Ensure protective footwear complies with an appropriate standard.
- When there is a risk of liquid coming into contact with the lower leg, rubber boots should be worn.
- Wherever a likelihood of occurrence of an explosive atmosphere do exist soles, which do inhibit electrostatic charge should be worn.

Use of goggles, face shields

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). Eye showers should be available in the vicinity of the working area.

- When handling open containers of corrosive liquids, full-face shields should be worn.
- Chemical splash goggles may be more practicable when wearing a respirator.

A final thought

PPE is not a substitute for good work practice like engineering and/or administrative controls. In fact PPE is used as a last resort and, even as it seems quite easy to use, it is a complex and expensive matter if you are intending to deploy PPE in a safe, protective and risk-free manner. Hence, other means than PPE are always more preferable and safer.

Additionally, employer and wearer of PPE should bear in mind that

- The use of PPE signals that the hazard still exists in the workplace
- Unprotected individuals in the same area will be exposed
- Failure of PPE means that the worker will be exposed
- PPE can and should be combined with other controls

Tool 5d - Gloves selection criteria

It is important to know how to choose the correct type of gloves. This tool will help you choose the right glove when working with hazardous substances.

Chemical protective gloves

- The gloves must protect the user against the hazardous chemical, he/she is working with
- The gloves must be sufficiently robust not to tear or cut during work.
- The gloves must suit the various tasks.
- Leather or stitched working gloves are not suitable for working with chemicals.
- Make sure workers don't touch the outside of a contaminated glove with a naked hand when putting gloves on or taking gloves off (refer to page 109, instruction on correct removal of gloves).
- Make sure workers don't touch equipment, machinery, containers etc. with contaminated gloves.

Key points to remember:

- Inspect gloves before use, and ensure that they give the wanted protection
- Gloves are made of natural rubber, synthetic rubber, plastic and other materials. Each material has its own characteristics (there is nothing such all-round protective gloves).
- Gloves could be easily damaged by acids or organic solvents.

Chemical resistance/Glove selection guide

Gloves represent a large portion of the PPE used in industries. Glove selection is a complicated procedure. There are many factors to consider when looking for a protective glove.

Every glove manufacturer provides chemical resistance and permeation information that you should make yourself aware of. It is important to know which glove is right for the chemical you are working with. Be aware that not all chemicals have been tested by glove manufacturers, and most mixtures have not. It is especially important in these situations to contact the manufacturer for further information. There is no glove currently available that is resistant to all chemicals or for an indefinite period of time.

An important factor to consider when selecting gloves is the amount of time you will be exposed to the chemical. Estimate the time you will be in contact with the chemical and choose a glove with an appropriate breakthrough time.

Different glove materials provide varying protection to different chemicals. Some general guidelines to different glove materials follow. This guide is for general reference only, for specific recommendations contact the glove manufacturer and/or refer to MSDS.

Gloves	Material	Chemical Resistance	
		Recommended for	Not Recommended for
Latex	Natural Rubber	weak Acids, weak bases, alcohols, aqueous solutions	Oils, greases and organics
Butyl	Synthetic Rubber	Aldehydes, ketones, esters, glycol ethers, polar organic solvents	Aliphatic, aromatic and chlorinated solvents
Neoprene	Synthetic Rubber	Oxidizing acids, bases, alcohols, oils, fats, aniline, phenol, glycol ethers	Chlorinated solvents
Nitrile	Synthetic Rubber	Oils, greases, acids, caustics, aliphatic solvents	Aromatic solvents, many ketones, esters, many chlorinated solvents
PVA	Poly-Vinyl-Alcohol	A wide range of aliphatic, aromatic and chlorinated solvents, ketones (except acetone), esters, ethers	Acids, alcohols, bases, water
PVC	Poly-Vinyl-Chloride	Strong acids and bases, salts, other aqueous solutions, alcohols, glycol ethers	Aliphatic, aromatic and chlorinated solvents, aldehydes, ketones, nitrocompounds (e.g. nitrobenzene, nitromethane)
Viton	Fluoroelastomer	Aromatic, aliphatic and chlorinated solvents and alcohols, PCBs	Some ketones, esters, amines
Silver shield/ barrier	Laminate Film	Wide range of solvents, acids, bases	

Some other information on chemical resistance of gloves and clothing:

- Best Gloves: www.bestglove.com/aspx/chemrest/Default.aspx
(very good glove selection program)
- Ansell Edmont: <http://www.ansellpro.com/specware/guide.asp>
(HTML glove selection which is easy to use and includes a list of the most common used chemicals)
- Oklahoma State University Chemical Guides: <http://www.pp.okstate.edu/ehs/hazmat/Perm-a.htm>
(impressive compilation of hazardous material data)

The following is a list of common chemicals used and the recommended glove to select for use:

Chemical	Glove Material
Acetone	Butyl, Nitrile, Neoprene, Laminate film
Acetonitril	Butyl
Chloroform*	Viton
Dioxane	Butyl, Laminate film
Ethanol	Nitrile, Neoprene, Butyl, Viton, Laminate film
Ethyl Ether	Nitrile for light exposures (spalshes)
Hexane	Nitrile, Neoprene, Viton
Isopropanol	Nitrile, Neoprene, Butyl, Viton
Methanol	Butyl, Viton, Laminate film
Methylene Chloride*	Nitrile, for light exposures (spalshes), Viton, PVA
Toluene*	Viton, PVA
Xylene	Viton, PVA

*will attack all types of natural and synthetic glove material

Remember to choose a glove that fits properly. Determine your proper hand size before ordering. Use a tape measure to find the circumference of your hand, in inches, around the palm. Measure right on the knuckles. The measurement in inches is your glove size. Sizes may vary among manufacturers but usually XS=size 6-7, S=size 7-8, M=size 8-9, L=size 9-10 and XL=size 10-11.

Natural Rubber Latex

Latex products are manufactured from a milky fluid derived from the rubber tree. Several chemicals are added during the manufacture and several proteins in latex can cause a range of mild to severe allergic reactions.

Latex allergy should be suspected in anyone who develops certain symptoms after latex exposure, including nasal, eye, or sinus irritation, hives, shortness of breath, coughing, wheezing or unexplain

If you do need to use single-use natural rubber latex gloves, they must be 'low-protein, powder-free' gloves

Tool 6 - Written and oral 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 a written and 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 generally found 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 instructions 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. A written and 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.

Three examples of work instructions are presented here:

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

2) The second example is for 'Oxystop'. Oxystop is a chemical 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 bar-

rels, which shall be remediate with the measures listed in the work instructions.

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

Example 1: Work instruction for correct removal of gloves

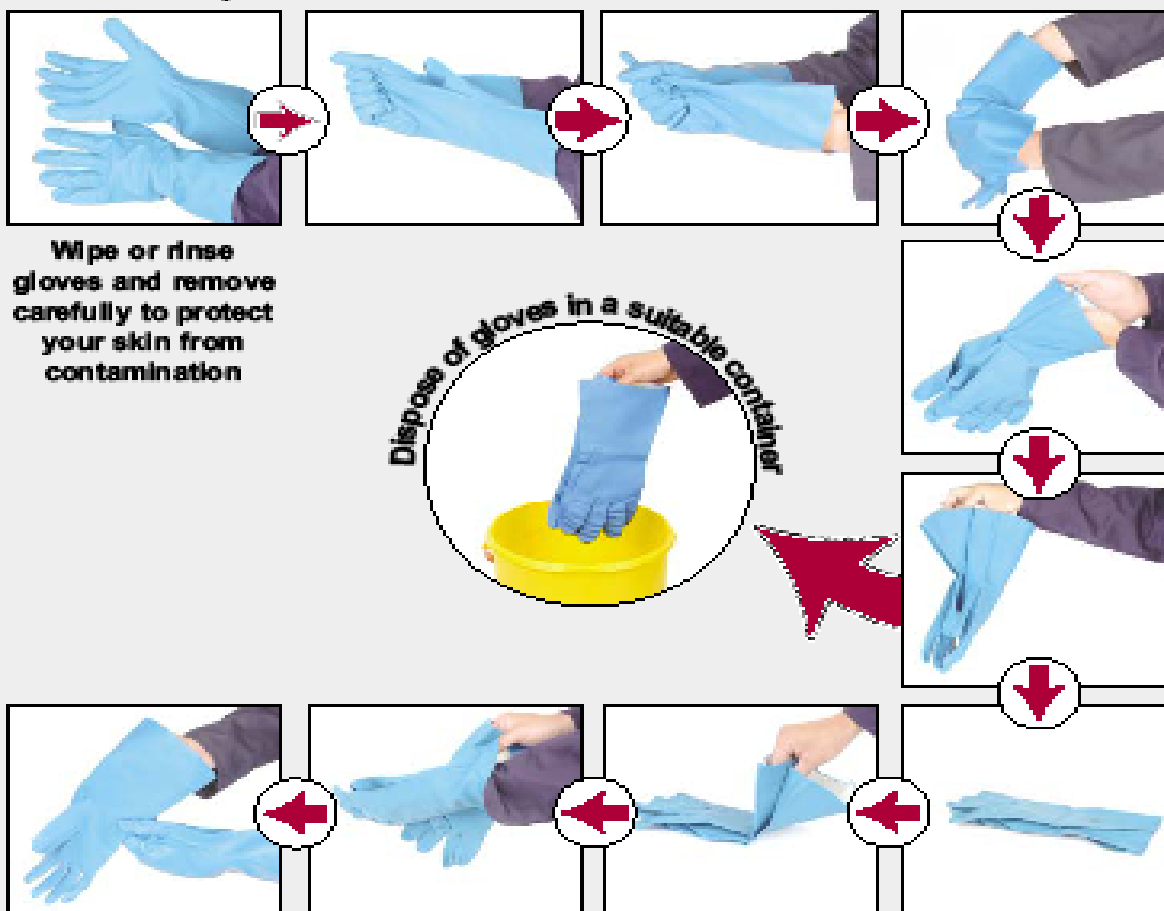


Health and Safety
Executive

Correct removal of gloves

Reusable gloves (chemically resistant)

Follow the steps shown








Wipe or rinse
gloves and remove
carefully to protect
your skin from
contamination

Dispose of gloves in a suitable container

- Always select the correct size gloves
- Use gloves for no longer than one day

Store gloves on a
clean surface for
re-use

Example 2: 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	 <p>Irritant</p>	<ul style="list-style-type: none"> • Irritates the eyes, the respiratory organs and the skin • Hazardous for water, class of risks for water 2 • Must not be delivered into draining/sewage water!
Safety measures and safe handling	 	<p>Transport barrel onto the working platform only with hoisting basket and hoisting equipment!</p> <p>When connecting the container to the feed pipe wear rubber gloves (gloves for protection of acids) and protective goggles!</p>
Accidental release measures		<p>Leakages in the dosage system have to be reported immediately to the general management!</p> <p>In case of release 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)!</p> <p>Treat spilled liquid with Hydroperls, call fire brigade</p>
First aid		<p>When getting Oxystop in touch with the eyes rinse the eyes thoroughly and seek medical advice!</p> <p>Take off dragged, soaked clothes immediately, and clean moistened skin thoroughly with water!</p> <p>If swallowed call on works doctor and show label or MSDS (material safety data sheet)!</p>
Appropriate disposal		<p>Oxystop must not get into the drainage / sewer!</p> <p>Treat leakages with Hydroperls and call the fire brigades for disposal!</p> <p>Give back empty containers to the storehouse!</p>



Example 3: Work instruction for safe use of glutaraldehyde

Ref. No.:	Work Instruction
Date:	Hazardous Chemicals
Responsible:	
Department:	Workplace/Operation:




1. NAME (PRODUCT IDENTIFICATION)

1.5% AQUEOUS GLUTARALDEHYDE SOLUTION (ACTIVATED)

2. HAZARDS IDENTIFICATION

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

3. SAFETY MEASURES AND SAFE HANDLING

	<p>Handling and Storage Precautions: Use normal storage & handling requirements. Other Precautions: None specified by Manufacturer.</p> <p>Respiratory Protection:</p> <p><u>Routine:</u> None required.</p> <p><u>Emergency:</u> Organic vapor cartridge mask or self-contained breathing apparatus.</p>
	<p>Ventilation:</p> <p><u>Routine:</u> 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)</p>
	<p>Protective Gloves:</p> <p><u>Routine:</u> Natural latex, nitrile, butyl (other products equivalent); <u>Caution:</u> Don't use neoprene rubber or Vinyl as Glutaraldehyde may rapidly permeate through material.</p> <p>Eye Protection:</p> <p><u>Routine:</u> Safe glass (goggles)</p> <p><u>Emergency:</u> Safe glass (goggles), Face shield</p> <p>Other Protective Equipment:</p> <p><u>plastic apron</u></p> <p><u>Work Hygienic Practices:</u> Avoid contamination of food.</p> <p><u>Emergency:</u> gloves - listed above, protective clothing, rubber boots</p>

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:

Checked:

Signature:

Signature:

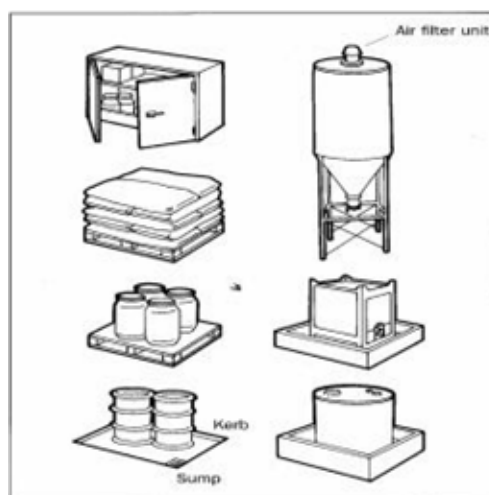
Tool 7 - Safe storage of hazardous chemicals

The safe storage of hazardous chemicals is another important stage of the lifecycle of chemicals. Chemical storage facilities must meet certain minimum standards to ensure a safe handling of chemicals in order to maintain workers health and protect the environment. This tool provides guidelines to help you to meet these standards.

Companies should observe and incorporate several requirements to guarantee a safe storage:

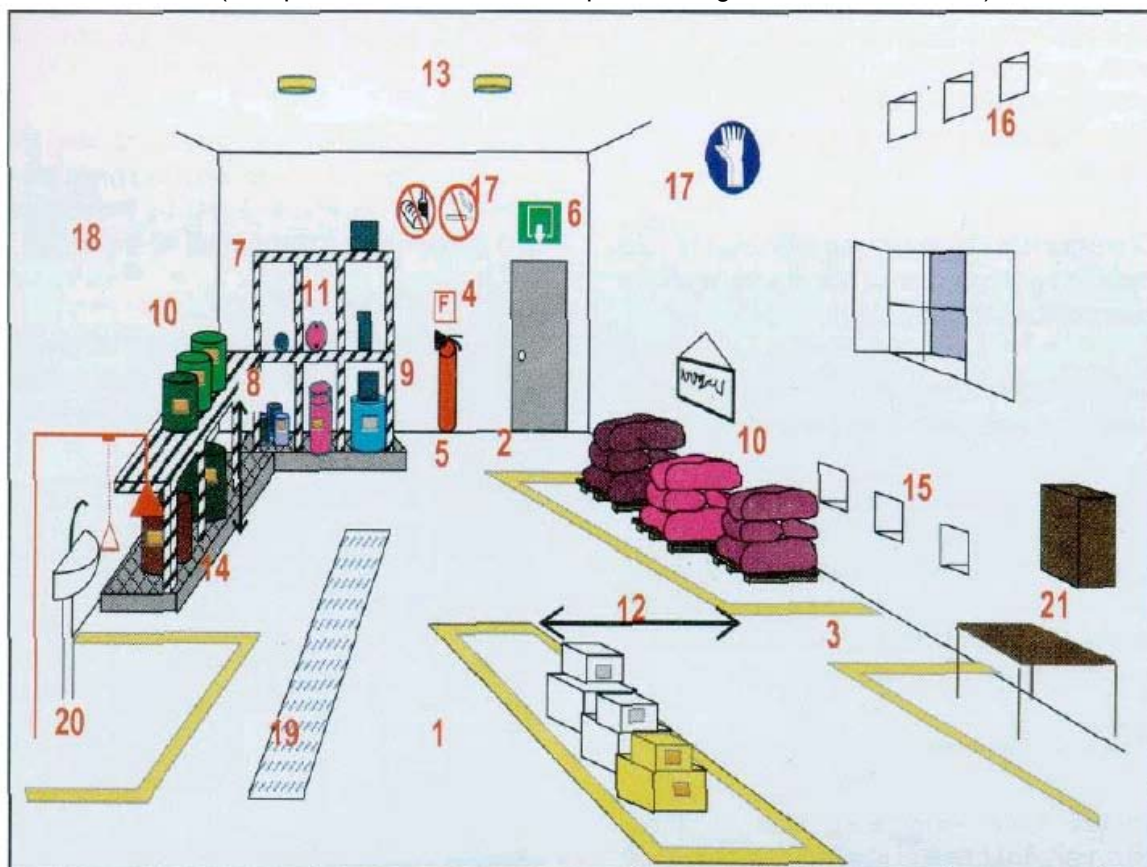
- Keep an up-to-date chemical inventory (refer to module 2)
- Proper chemical labelling (refer to module 1)
- Segregate incompatible chemicals (see below)

- Keep the storage area clean, avoid leaks spreading to the work environment
- Don't store chemicals directly on the floor (use cabinets, pallets, etc.)
- Build a bund around storage unit



Model layout of a chemical store

(Compare the numbers with explanations given in the text below)



Some rules should be followed to ensure safety in the storage of chemicals in companies. (Compare the numbers with the corresponding section in the drawing above!)

Ensure proper structure and layout of chemical store

Adequate storage facilities are a prerequisite for safe storage. Generally, the chemical store should always be physically separated from production areas, occupied buildings, other storage areas (e.g. raw material, semi-finished and finished products), workshops or areas with potential sources of ignition such as generators, electrical control panel or transformers (18).

The floor of the chemical store should be flat (to allow easy handling of chemical containers) and non-permeable to prevent contamination of soil and ground-water from chemical spills (1).

Emergency drains should be available and connected to an effluent treatment plant (19).

The chemical store should have at least two clearly marked emergency exits (e.g. doors, windows). Access to these exits has to be kept free at all times to allow easy escape of personnel trapped inside the store in an emergency (2, 6).

At all times, unauthorised personnel must be prevented from entering the chemical store. The main doors should be locked. In addition, a signboard prohibiting unauthorised entry should be displayed at the entrance to the chemical store.

Fire extinguisher should be kept ready at easily accessible locations. These locations should be clearly marked (4, 5). Ideally, one fire extinguisher should be placed outside the chemical store.

Electrical installations in the store such as switches, switchboards, light fittings, cables have to be

insulated and be 'explosion proof'. Ideally, switches should be placed outside the chemical store.

To keep humidity, temperature or any vapour/fume concentration low, natural and artificial ventilation have to be provided. It is important that exhausts at floor level for removal of heavy vapours and exhausts/vents at a higher wall level for removal of light vapours are provided (13, 14, 16).

The storage area should have an outside ramp to facilitate access and trolleys for easy transfer and movement of chemical containers.

A washbasin, eye/face rinsing station or safety shower should be available in or near the chemical store for personal hygiene and emergencies (20).

Find the right storage space for chemicals

Before actually storing the chemicals in the chemical store, prepare an inventory of all chemicals to be kept in the store.

Identify the hazardous chemicals (with the help of the material safety data sheets - MSDS).

The MSDS contain specific guidelines for storage (e.g. temperature, humidity) as well as information on compatibilities with other chemicals.

Keep incompatible chemicals separately!

Chemicals (or their vapour/gas) can react together and form hazardous mixtures which may possibly generate poisonous gas or heat. The latter can result in ignition of fire or explosion.

For example: Keep acids away from sodium sulphide and ammonia sulphate as any accidental mixture of these results in generation of hydrogen sulphide gas.

Once the minimum, average and maximum storage quantities have been noted, the available storage space can be properly laid out.

Basic rules and principles in the chemical store

No smoking and use of open fire in chemical stores!

Group and store different chemicals according to their type and compatibility. For easier stock keeping, provide tags indicating name, maximum, minimum and current stock for each group (10).

For maintaining better storage discipline, allot the specific storage areas for each group and mark the designated areas with yellow floor markings.

While doing so, sufficient width for movement of persons and material should be ensured (about 0.8 meters for people, more than 1 meter for handling of chemicals, more than 2 meters for movement of pallets or fork lift trucks). The passageways should be marked on the floor (12).

Avoid storage of chemicals directly on the floor. The humidity from the ground can quickly spoil the quality of powdered chemicals (14).

Racks and shelves increase the available storage space. Smaller chemical containers (e.g. samples of dyes, fat-liquors) can be stored on these (7, 11).

Heavier chemical containers - particularly those containing liquid chemicals (e.g. acids) - should be stored on wooden or plastic pallets at the floor level. Lighter chemical containers and powdered chemicals can be stored on upper shelves (10, 14).

Barrels containing hazardous liquid chemicals have to be stored on catch-pits (trays) (9).

If the available space in the company permits, finishing chemicals, particularly dyes, fat-liquors and solvents, could be stored in a separate chemical store.

Information on hazardous chemicals (e.g. one copy of each material safety data sheet) and the chemical inventory list should be kept ready on record either in the chemical store itself or in the company's administrative office. In case of an emergency, such information provide valuable and often life-saving clues on rescuing personnel and emergency measures.

Affix cautionary and warning signs in the chemical store, prescribing certain precautionary and preventive measures (17).

Storage requirements

Basic storage requirements

The following basic storage requirements apply to all hazardous chemicals. Refer to **Tool 2** (R-Phrases e.g. flammables and corrosives).

Storage area requirements

- Label storage areas according to the type of chemical family or hazard classification found there.
- Inspect storage areas at least annually.
- Keep aisles, hallways, doorways, exits, and entryways clear.
- Keep storage areas well lit, appropriately ventilated, and at a consistent, cool temperature.
- Eliminate ignition sources such as open flames, heat sources, or direct sunlight.
- Keep emergency equipment such as fire extinguishers handy and in good working order.
- Confine chemical storage areas so that leaks or spills are controlled. Prevent chemicals from

running down sinks, floors or storm water drains. Clean up spills and drips immediately.

Storage Don'ts

- Don't store chemicals in a sink or fume hood, except for certain toxic gases that are so dangerous they can only be stored in a gas cabinet or fume hood.
- Don't store chemicals on dirt or grass, near a creek or storm drain entrance, where they could contaminate the environment.
- Don't store chemicals on the floor window ledges, or balconies.

Storage cabinets

- Use approved storage cabinets.
- Do not alter a flammable storage cabinet.
- Label cabinets with the hazard class of the chemicals.

Storage shelves

- Shelves should be levelled, stable and secured to the wall or another stable surface.
- In case of an earthquake, shelves should have raised edges or rim guards (minimum height of 5 cm) to prevent containers from falling. Use bungee cords for added security.
- Shelves should be kept free of chemical contamination and dust.
- Shelves should be located away from direct sun, flame and heat sources.
- Containers should not protrude over shelf edges.
- Store large bottles/containers no higher than 60 cm from the floor.
- Store corrosives on lower shelves.

Storage containers

- Keep containers closed unless you are dispensing a chemical or adding to the container.
- Never store an open container with a funnel in it.
- Provide secondary containment for liquids in containers larger than 5 litres in size. Dishpans or polyethylene trays work well.
- Use approved containers for flammable solvents.

Segregate incompatible chemicals

Materials should always be segregated and stored according to their chemical family or hazard classification. Do not store chemicals alphabetically unless they are compatible! The most common hazard classes include the following chemical families:

- Flammables
- Corrosive acids
- Corrosive bases
- Toxics and highly toxics
- Oxidizing agents
- Compressed gases
- Cryogenics
- Pyrophorics
- Water reactives
- Explosives
- Peroxide forming chemicals

Accidental contact between incompatible chemicals can result in a fire, an explosion, and the formation of highly toxic and/or flammable substances or other potentially harmful reactions. For example, oxidizers mixed with flammable solvents can cause

a fire. Acids mixed with metal dust can produce flammable hydrogen gas.

Single hazard classes

Each chemical family should be separated from all other chemical families by an approved non-combustible partition or by a distance of seven meters. Ideally, each hazard class would be kept in a cabinet or on a shelf segregated from other hazard classes. Incompatible chemicals within the same hazard class should also be separated from one another. For example, both nitric and perchloric acids are incompatible with organic acids (such as acetic acid) and should not be stored together.

Most small and medium sized enterprises have limited space, but the following priorities may help you decide how to store the chemicals:

- Do not store chemicals alphabetically unless they are compatible.
- Store flammable liquids in approved safety containers in flammable storage cabinets. Do not store anything but flammable or combustible liquids in these cabinets.
- Segregate acids from bases.
- Segregate most organic acids from mineral acids.
- Keep oxidizers away from other chemicals, especially flammables or combustibles.
- Keep corrosives away from substances that they may react with and release corrosive, toxic, or flammable vapours.

Multiple hazard classes

Many chemicals belong to more than one chemical family or hazard class. In such cases, all storage rules must be strictly observed. For example, acetic acid is both a corrosive acid and a combustible

liquid. It must be stored away from corrosive bases, such as sodium hydroxide and also from oxidizing acids, such as nitric acid.

For more information

For more specific information, use the storage guidelines that follow. You can obtain labels and material safety data sheets (MSDS) from the manufacturer. MSDS provide information on chemical compatibility.

Storage precautions for individual and mixed hazards

Please note that many chemicals have multiple hazard classifications. Consequently, you may need to consult several storage guideline sections to determine how to store a hazardous chemical safely. For example, acetic acid is a corrosive acid and also a combustible liquid. Therefore, you need to follow section 'flammables' and section 'corrosives'.

Storage precautions for flammables

- Keep flammables away from all ignition sources: open flames, hot surfaces, direct sunlight and spark sources.
- Store flammables separate from other hazard classes, especially oxidizers and toxics.
- Separate flammable gases from oxidizing gases with an approved non-combustible partition or by a distance of 7 metres.
- Store flammable liquids in approved safety containers or cabinets.
- Keep a fire extinguisher (appropriate for the hazard) readily available and make sure anyone who may need to use it is properly trained.
- In instances where static electricity may accumulate and ignite flammable vapours, ground and bond flammable liquid containers.

- Keep flammable liquids that require cold storage in safe flammable material refrigerators or freezers to avoid ignition of the materials by sparks or static electricity.
- Limit the quantity of flammable liquids (< 50 litres) stored outside flammable storage cabinets or assigned storage areas (with non-combustible partition).

Storage precautions for corrosives acids and bases

- Segregate acids from bases. Segregate inorganic oxidizing acids (e.g., nitric acid) from organic acids (e.g., acetic acid), flammables and combustibles.
- Segregate acids from chemicals that could generate toxic gases upon contact (e.g., sodium cyanide and iron sulphide).
- Segregate acids from water reactive metals such as sodium, potassium and magnesium. Use tight-fitting goggles, gloves, and closed-toe shoes while handling corrosives.
- Store solutions of inorganic hydroxides in polyethylene containers.
- Store corrosives on lower shelves, at least below eye level and in compatible secondary containers.
- Do not store corrosives on metal shelves. Although ventilation helps, chemicals will still corrode the shelves. Store containers in plastic tubs or trays as secondary containment.
- Follow special handling and use procedures for hydrofluoric acid. Keep calcium gluconate available as an antidote.
- Have spill control pillows or neutralizing agents available in case of a spill. These may be purchased from safety supply companies.

If you notice powder deposits, discoloration and crystallization around the cap of a container, particularly an oxidizing acid, take precautions and contact specialists for assistance immediately. The material may be potentially explosive.

Storage precautions for toxics and highly toxics

- Containers should be tightly sealed to minimize exposure to personnel and contamination of other chemicals.
- Maintain the lowest possible quantities of highly toxics.
- Segregate highly toxic chemicals from other hazard classes and store in an area that is cool, well ventilated and away from light and heat.
- Use highly toxic chemicals only in a designated area or laboratory. Highly toxic chemicals that produce fumes or dust should always be handled within containment such as a chemical fume hood.
- Limits the aggregate amount of highly toxic solids and liquids to 5 kilograms per work area, laboratory or storage area.
- Limit the amount of highly toxic gases to approx. 0.6 m³ per work area, laboratory or storage area.
- Manage toxic gases, highly toxic gases, and pyrophoric gases in accordance with specific requirements (see MSDS). Contact specialist for further assistance. Establish emergency procedures.
- Do not eat, drink or apply cosmetics where highly toxic chemicals are handled.

Storage Precautions for Oxidizing agents (chemical compounds that readily transfer oxygen atoms)

- Segregate oxidizers from flammable and combustible materials (paper, wood). See also storage precautions for Flammables and Combustibles.

- Segregate oxidizers from reducing agents (zinc, alkaline metals, formic acid).
- Segregate inorganic oxidizers from organic peroxides.
- Take care not to contaminate oxidizers. Some oxidizers, such as perchloric acid, can become explosive mixtures if contaminated with trace amounts of organic materials or metals. See also storage precautions for Explosive and Potentially Explosive Chemicals.
- Store in a cool, dry place. Do not store under sink.
- Remember that perchloric acid, nitric acid and hydrogen peroxide are oxidizers and must not be stored on wooden shelves or in cardboard boxes.

Storage precautions for compressed gases

- Segregate incompatible gases as you would other incompatible chemicals.
- Limit the quantity of compressed gas cylinders on site to what will be used within a reasonable period of time.
- Provide sufficient ventilation.
- Store cylinders upright.
- Secure cylinders so they will not fall for any reason.
- An acceptable means includes using two non-combustible restraints, such as chains, one restraint located approximately one-third of the cylinder length from the top and the other restraint one-third from the bottom.
- Keep cylinders away from heat and open flames.
- Leave the valve protection cap on the cylinder unless it is in use.
- Never store cylinders in confined spaces with no ventilation.
- If you suspect that a cylinder is leaking, do not attempt to sniff the leak out. Apply a soap solution to the cylinder and locate the leak by noting where the bubbles appear.
- Manage toxic gases, highly toxic gases and pyrophoric gases in accordance with specific requirements (see MSDS). Contact specialist for further assistance. Establish emergency procedures.

Storage precautions for cryogenics (extremely cold material, -100°C to -270°C)

- Store and handle in a well-ventilated area. When liquid cryogenics are converted to the gaseous phase, they may create an oxygen deficiency. Do not use cryogenics in small-enclosed spaces.
- Use only approved storage vessels (i.e., thermos-like evacuated, double-walled containers) with pressure-relief mechanisms. Non-approved vessels may explode.
- Secure containers so they will not tip over or obstruct an aisle, hallway or corridor during an earthquake.
- Liquid nitrogen and liquid helium are capable of liquefying oxygen from air. This form of oxygen enrichment can become a strong fire or explosion hazard.
- Use appropriate protective equipment for handling cryogenics: insulated holders for carrying vessels; eye protection, goggles, or face shields and aprons. Use cryogenic gloves or leather gloves when handling super cold surfaces.

Storage Precautions for Pyrophorics (Air reactives – substances that ignite spontaneously upon contact with air)

- Store in a cool, dry place. Prevent contact with air.
- Take extreme care to prevent containers of pyrophorics from leaking or breaking. For additional protection, consider keeping the chemicals in the manufacturer's original shipping

package (i.e. surrounded by vermiculite inside a metal can).

- Many pyrophorics are also water reactive.
- Manage toxic gases, highly toxic gases and pyrophoric gases in accordance with specific requirements (see MSDS). Contact specialist for further assistance. Establish emergency procedures.

Storage precautions for water reactives (these substances often react violently with water and may ignite or generate toxic, flammable, or corrosive gases)

- Store in a cool, dry place.
- Keep away from water.
- In case of fire, do not use water. Use a dry chemical extinguisher.

Storage precautions for explosive and potentially explosive chemicals

- Identify all explosive and potentially explosive chemicals in your inventory.
- For chemicals that may degrade to become potentially explosive, record the opening date and discard date directly onto the container or onto a potentially explosive chemical warning label.
- Keep explosive chemicals away from all ignition sources: open flames, hot surfaces, direct sunlight and spark sources.
- Store explosive chemicals in an explosive magazine and inspect areas weekly to comply with the existing Fire Code.
- Consider designating a special area to store and use potentially explosive chemicals.
- Make sure everyone who uses explosive or potentially explosive chemicals is thoroughly trained in safe storage methods, conditions to

avoid (e.g., contamination), the hazards of the chemical and disposal procedures.

- Contact specialists immediately if you suspect a material may have become explosive. Post warning signs so others do not handle or disturb the material.

Note: Most explosions occur while purifying or distilling mixtures. Therefore, use extreme caution before concentrating or purifying any mixture that may contain an explosive chemical (e.g. a peroxide forming chemical or perchlorate).

Storage and disposal of peroxide forming chemicals (these chemicals are a class of compounds that have the ability to form shock-sensitive explosive peroxide crystals)

The chemicals listed below can form explosive peroxide crystals on exposure to air, and therefore require special handling procedures after the container is opened. Some of the chemicals form peroxides that are violently explosive in concentrated solution or as solids, and therefore should never be evaporated to dryness. Others are polymerizable unsaturated compounds and can initiate a runaway, explosive polymerization reaction.

Severe Peroxide Hazard with Exposure to Air (discard within 3 months from opening the following chemicals)

- o diisopropyl ether (isopropyl ether)
- o divinylacetylene (DVA)
- o vinylidene chloride (1,1-dichloroethylene)
- o potassium metal
- o sodium amide (sodamide)
- o potassium amide

Peroxide Hazard on Concentration

Do not distil or evaporate without first testing for the presence of peroxides (discard or test for peroxides the following chemicals after 6 months)

- o acetaldehyde diethyl acetal (acetal)
- o cumene (isopropylbenzene)
- o cyclohexene
- o cyclopentene
- o decalin (decahydronaphthalene)
- o diacetylene (butadiene)
- o dicyclopentadiene
- o diethyl ether (ether)
- o diethylene glycol dimethyl ether (diglyme)
- o dioxane
- o ethylene glycol dimethyl ether (glyme)
- o ethylene glycol ether acetates
- o ethylene glycol monoethers (cellosolves)
- o furan
- o methylacetylene
- o methylcyclopentane
- o methyl isobutyl ketone
- o tetrahydrofuran (THF)
- o tetralin (tetrahydronaphthalene)
- o vinyl ethers

Hazard of Rapid Polymerization Initiated by Internally-Formed Peroxides

Liquids (discard or test for peroxides the following chemical liquids after 6 months)

- o Chloroprene (2-chloro-1, 3-butadiene)
- o vinyl acetate
- o styrene
- o vinylpyridine

Gases (discard the following gases after 12 months)

- o butadiene
- o vinylacetylene (MVA)
- o tetrafluoroethylene (TFE)
- o vinyl chloride

Storage precautions for peroxide forming chemicals

- Identify all peroxide forming chemicals in your inventory.

- Write the opening date and discard date on the containers of chemicals that may degrade to become potentially explosive.
- Store in airtight containers in a dark, cool and dry place.
- Never store peroxide formers in a freezer because a change from a solid to a liquid can cause detonation.
- Discard or test peroxide forming chemicals before the expiration date printed on the container label. Inform on methods of safe disposal.
- If precipitates appear in an organic chemical that may form an explosive peroxide (e.g., crystals around the neck or cap of bottle) or if an oily layer appears, do not move it. Contact specialists immediately.
- Inspect peroxide-forming chemicals often for evidence of contamination, degradation or any change from normal physical or chemical characteristics. Contact specialists immediately if you suspect a material may have become explosive. Post warning signs so others do not handle or disturb the material.

Important points to consider for the prevention of explosions

- Use of non-explosive materials
- No oxygen
- Limiting of oxygen content
- Exclusion of ignition sources

Possible Storage Combinations of Dangerous Goods

Class	Gases	Flammable liquids	Flammable solids	Substances liable to spontaneous combustion	Substances emitting flammable gases when wet	Oxidising agents	Toxic substances	Corrosives
Gases	C	I	I	R	I	R	C	C
Flammable liquids	I	C	I	R	I	R	C	I
Flammable solids	I	I	C	R	R	R	C	I
Substances liable to spontaneous combustion	R	R	R	C	R	R	I	R
Substances emitting flammable gases when wet	I	I	R	R	C	R	C	R
Oxidising agents	R	R	R	R	R	R*	R	R
Toxic substances	C	C	C	I	C	R	C	R
Corrosives	C	I	I	R	R	R	R	C†

C = are likely to be compatible with each other (GREEN)
 I = are likely to be incompatible with each other (YELLOW)
 R = are likely to react dangerously with each other (RED)

R* = All dangerous goods of this class may be regarded as reacting dangerously with other dangerous goods of the same class

C† = Liquids may be regarded as incompatible with other liquids or solids of the same class

Tool 8 – Fire Safety and Extinguishers

Introduction

There is an enormous variety of flammable substances to be found in the workplace. They range from the obvious, e.g. petrol, paint thinners, welding gases and heating fuels, to the not so obvious, e.g. packaging materials, dusts from woodworking and dusts from food stuffs such as flour and sugar etc. The storage and use of such goods can pose a serious hazard unless basic safety principles are followed.

If you use flammable and explosive substances this tool will help you to:

- Be aware of the hazards of various types of flammable substances
 - What is needed to make a fire?
 - What are the different classes of fire?
- Be aware of the basic standards which apply to safe handling and storage of flammable substances
 - How to prevent fire?
 - How to extinguish a fire?
- Introduce procedures to prevent accidents and protect people from the hazards of flammable substances
 - What is to be included in your company's Emergency Response Plan?
 - What to do if you are involved in a real fire?

There is no second chance when it comes to fire. But fires are tragedies that don't have to happen.

Fire safety and EU Risk Phrases




According to the EU classification scheme the following R-Phrases indicate that these chemicals do have an inherent risk of fire and/or explosion:

R1	Explosive when dry
R2	Risk of explosion by shock, friction, fire or other sources of ignition
R3	Extreme risk of explosion by shock, friction, fire or other sources of ignition
R4	Forms very sensitive explosive metallic compounds
R5	Heating may cause an explosion
R6	Explosive with or without contact with air
R7	May cause fire
R8	Contact with combustible material may cause fire
R9	Explosive when mixed with combustible material
R10	Flammable
R11	Highly flammable
R12	Extremely flammable
(R13)	(Extremely flammable liquefied gas)
R14	Reacts violently with water
R15	Contact with water liberates extremely flammable gases
R16	Explosive when mixed with oxidizing substances
R17	Spontaneously flammable in air
R18	In use, may form flammable/explosive vapour-air mixture
R19	May form explosive peroxides

Elements of Fire

Three ingredients are needed for a fire:

1. a fuel at the right concentration
2. a good supply of air (i.e. oxygen)
3. a source of heat (to reach ignition temperature)

	Fuel can be any combustible material - solid, liquid or gas.
Fuel	
	The air we breathe is about 21 % oxygen. Note that fire only needs 16 % oxygen to ignite!
Oxygen	
	Heat is the energy needed for the fuel to generate sufficient flammable vapours for ignition to occur.
Heat	

If you control these factors, fires can be prevented.

Classes of Fire and how to prevent them

Fires are classified according to the types of materials/objects burning:

Class A – Ordinary combustibles such as wood, paper, cloth, rubber and certain types of plastic

Class A fires can be avoided through simple, routine housekeeping:

- Make sure that storage and working areas are free of trash
- Place oily rags and similar debris in covered metal containers away from any heat-producing source (flames or sparks).

Class B – Flammable or combustible gases and liquids such as gasoline, kerosene, paint, paint thinners or propane

Class B fires can be prevented by taking special precautions when working with or around flammable liquids or gases.

- Use flammable liquids only in well-ventilated areas

- Keep flammable liquids stored in tightly sealed, self-closing and spill-proof containers
- Store flammable liquids away from spark-producing sources
- Limit portable storage cans to maximum of 20 litres each
- Never store more than 100 litres of flammable liquid inside a building; unless it is in an approved storage container
- Make sure outside storage of flammables is at least 6.5 metres away from other buildings

Class C – Energised electrical equipment such as appliances, switches or power tools.

Class C fires involving the use or misuse of electrical equipment are the number-one cause of fire in the workplace.

- Check electrical equipment for old/worn wiring or broken/damaged fittings. Report any hazardous conditions to your supervisor
- Prevent electric motors from overheating by keeping them clean and in good working order
- Never install a fuse rated higher than specified for a circuit
- Never overload wall sockets. One outlet should have no more than two plugs
- Don't plug more than one heat-producing appliance into an outlet

- Investigate any appliance or equipment that smells strange. This is often the first sign of a fire
- Use utility lights that have some type of wire guard over them. Direct contact with an uncovered light bulb can ignite combustible material

Class D – Certain combustible metals such as magnesium, titanium, potassium or sodium.

The best way to prevent class D fire is to always follow the material handling guidelines of your organisation (possibly special advice is needed) when handling combustible metals. Failure to do so can result in disaster

Fire Extinguishers

Types of fire extinguishers


Each fire extinguisher displays a rating on the face-plate showing the class of fire (see above) it is designed to put out. Some extinguishers are marked with multiple ratings such as AB, BC or ABC.

Class A Extinguishers

Class A extinguishers are effective on ordinary combustibles. The extinguisher cools the temperature of the burning material below its ignition temperature. The extinguishers use pressurised water, foam or multi-purpose dry-chemical agents. Class A extinguishers carry a numerical rating that

Using a Fire Extinguisher

Know how to use the extinguisher properly - be prepared for the undesired incident. It's easy to remember how to use a fire extinguisher if you remember the acronym PASS:

	P	Pull the pin.
	A	Aim the extinguisher at the base of the flame.
	S	Squeeze the trigger while holding the extinguisher upright.
	S	Sweep the extinguisher from side to side, covering the area of the fire with the extinguishing agent.

indicates how large a fire you can safely put out with that extinguisher.

Class B Extinguishers

Class B extinguishers should be used on flammable liquids or gases. Class B extinguishers may come in several types including foam, carbon dioxide, ordinary dry-chemical, multi-purpose dry-chemical or halon replacements.

Class C Extinguishers

Class C extinguishers are to be used specifically on electrical fires. Class C extinguishers may contain carbon dioxide, ordinary dry-chemical, multi-purpose dry-chemical or halon replacements.

Carbon dioxide or halon replacements, which do not leave a harmful residue, are preferable for computers and other sensitive equipment. Never use water extinguishers or any extinguishing agent capable of conducting electricity on Class C fires. Class C extinguishers carry a letter rating only to indicate that the extinguishing agent will not conduct electricity.

Class D Extinguishers

Class D extinguishers should only be used on combustible metals. Class D extinguishers are made with agents specially designed for the material involved. In most cases, they absorb heat and cool the material below its ignition temperature. Class

D fires react violently to water and other types of chemicals. Class D extinguishers carry only a letter rating to indicate their effectiveness on certain amounts of specific metals.

Sand is an appropriate material to put out small metal fires, if you do not have a class D extinguisher at hand.

Only use a fire extinguisher when it is safe to do so. If the fire is too big, if it is spreading or threatening to block your path to escape leave the area immediately.

If necessary, don't hesitate to use the extinguisher to clear an escape path.

Passive Fire Protection (Location and Building)

- The full site/company, except nominated areas, should be non-smoking.
- Provide suitable access for fire fighting. Clear scrap-yards etc.
- Where possible, confine fires by compartmentation. This measure can only be implemented during construction or renovation phase.
- Evacuation of occupants: Provide sufficient number of fire exits, conduct evacuation drills, maintain fire escapes (no makeshift). Exit paths should be clearly marked, well lighted and unobstructed.
- In locations without a reliable public water hydrant network, a reservoir for fire-fighting water must be provided.
- There should be means to retain any spills and all (contaminated) fire-fighting water.

Emergency Response Plan

A written, up-to-date Emergency Response Plan for your company (covering all workplaces) is essential. It should include detailed instructions on how to evacuate the building and specific individuals in charge of the evacuation.

- Primary and secondary escape routes with simple instructions should be posted at significant spots such as entrances, close to elevators and telephones.
- Emergency Response Leaders should be assigned specific duties, such as verifying that all workers have evacuated.
- Disabled workers and those with a history of certain medical conditions should be assigned an Emergency Response Leader to guide them to safety.
- Stairways should be kept free of materials that could block or hinder an evacuation.
- Regular fire drills should be conducted to identify problems before an actual fire occurs. Treat the drills as if they were the "real thing".
- Important telephone numbers such as emergency, fire department and internal Emergency Response Leaders should be posted close to every telephone.

How to Evacuate

- Know and follow the procedures outlined in your company's Emergency Response Plan.
- During an evacuation, proceed calmly but quickly.
- Never use an elevator. A loss of power can trap you inside.
- Close the door if you are the last one out of the room. Do not lock it. Locking doors can hinder the fire department's search and rescue efforts.
- Once in a stairwell, proceed down to the ground floor and exit the building.
- Keep low to the ground to avoid smoke and toxic gases.
- If possible, cover your nose and mouth with a damp cloth to help you breathe.
- Once you are safely outside the building, report immediately to predetermined areas so others will know that you are not trapped inside.

If You Are Trapped

- Don't panic. Your ability to think clearly could save your life.
- If a telephone is available call your local emergency number or local fire department and state your exact location.
- Never open a closed door without feeling the door first with the back of your hand. If the door is hot, try another exit. If no other exit exists, seal the vents and cracks around the door with anything available.
- If you are having difficulties breathing, remain close to the floor and ventilate the room by opening or even breaking a window.
- If your clothes catch on fire, stop, drop and roll. Do not run. This only feeds the fire with more oxygen, making it burn faster.
- If a co-worker catches on fire, smother the flames by grabbing a jacket, blanket or rug and wrapping it around him or her.

Safety principles and recommended control measures

By applying the following five principles you will be well on the way to making sure that you are working safely with flammable substances.

Ventilation

Is there plenty of fresh air where flammable liquids or gases are stored and used? Good ventilation will mean that any vapours given off from a spill, leak or release from any process, will be rapidly dispersed.

Ignition

Have all the obvious ignition sources removed from the storage and handling areas. Ignition sources can be very varied and they include sparks from electrical equipment or welding and cutting tools, hot surfaces, open flames from heating equipment, smoking materials, static electricity etc.

Hazardous areas (zoning):

The extent of safety measures required to avoid ignition sources depends on the area in which the operation takes place. As far as the likely presence of ignitable gas/air or vapour/air mixtures is concerned, the following zones can be defined:

Zone 0: Areas in which an explosive atmosphere is continually present or present for long periods of time.

Zone 1: Areas in which an explosive atmosphere is likely to occur during normal operation. These conditions can prevail in the immediate vicinity of Zone 0.

Zone 2: Areas in which an explosive atmosphere is unlikely to occur during normal operation and, if it occurs, will only exist for a short time. These conditions can, among others, prevail in areas surrounding Zones 0 and 1.

Recommended measures: According to the classified zones part or all of the electrical equipment used may have to be flame or explosion-proof standard. Sound electrical safety is to be maintained (i.e. adequate earthing, overload protection, equipment and wiring in good repair). Hot surfaces and mechanically generated sparks should be avoided in such hazardous areas. Auxiliary equipment such as petrol or gas-driven fork-lift trucks, electrical dryers, shrink wrapping equipment with open ignition sources and battery charging stations must not be used in hazardous areas defined as zone 0 to 2. Non-routine activities such as maintenance work and plant clean-outs, which can produce ignition sources (e.g. welding, drilling, etc.) must be authorised by means of written work permits (see Tool 6).

In case that an explosive atmosphere consisting of solid matter (i.e. dust or powder) can occur, the following measures should be considered: Preventive measures (inerting and exclusion of ignition sour-

ces) and protective measures (explosion-pressure shock-proof construction, explosion suppression system and explosion-relief venting). Remember that for these measures special advice must be sought.

Containment

Are your flammable substances kept in suitable containers? If you have a spill will it be contained and prevented from spreading to other parts of the working area? Use of lidded containers and spillage catchment trays, for example, can help to prevent spillages spreading. Keep absorbent material handy.

Exchange (Substitution)

Can you exchange a flammable substance for a less flammable one? Can you eliminate flammable substances from the process altogether? You may be able to think of other ways of carrying out the job more safely.

Separation

Are flammable substances stored and used well away from other processes and general storage areas? Can they be separated by a physical barrier, wall or partition? Separating your hazards in this manner will contribute to a safer workplace (refer to Tool 7 "Safe Storage of Hazardous Chemicals").

Think about the flammable substances you have at the workplace and apply these principles wherever possible. Tell workers, and others who need to know, about the hazards and how they should control them.

Specific flammable materials

The following section deals with specific types of flammable substances.

Flammable liquids

Flammable liquids can give off large volumes of flammable vapours at room temperature. These vapours, when mixed with air, can ignite violently. Spilled flammable liquids can, if not contained, flow a long way to an ignition source and then flash back to the source of the leak. Spills on clothing can represent a serious risk of injury if ignited. To help control these risks:

- Store flammable liquids in a separate storage area, or in a purpose-made bin or cupboard.
- Dispense and use them in a safe place where there is good ventilation and no source of ignition.
- Keep containers closed when not in use. If possible, use safety containers, which have self-closing lids.
- Dispense liquids over a tray and keep some non-flammable absorbent material handy to mop up spills.
- Dispose of contaminated materials safely or call in disposal experts.

Flammable dusts

Finely divided flammable dusts dispersed in the workplace atmosphere can, if ignited, explode violently and cause a lot of damage. If you handle flammable dusts you need to remember the following:

- Keep plant dust-tight.
- Keep the working area dust-free by regular cleaning and vacuuming spillages as they occur.

Flammable solids

Some types of plastic foam, packaging materials, polyester wadding and textiles will ignite easily and burn fiercely, giving off a lot of dense black smoke. Remember:

- Do not store these materials close to heaters or electrical equipment, which could run hot and act as a local ignition source.
- Make sure that gangways and exits from storage and working areas are kept clear of packaging materials, finished products containing flammable solids etc. In the event of fire, gangways and exits could become obscured by smoke, so the easier they are to find, the better.

Flammable gases

Gases in cylinders are often stored at very high pressures so their uncontrolled release can be physically dangerous. A small amount of released gas can fill a large area with a potentially explosive mixture. This is particularly true of liquefied gases such as liquified petroleum gas (LPG). The following points need to be considered:

- Stored cylinders need to be suitably restrained and their valves protected from impact damage.
- Gas cylinders may need special valves, fittings and hoses.
- Always check the manufacturers' or suppliers' instructions and fit the correct equipment.
- Protect hoses from potential causes of damage that could cut, scuff or weaken them. Examine them regularly and replace them if they show signs of damage or wear that could give rise to a leak.

Oxygen

Although oxygen is necessary for life and is an essential ingredient in controlled burning (such as in a gas fire or during welding and cutting) its misuse can lead to serious consequences. Materials that ordinarily will only burn slowly will burn very vigorously in an oxygen-enriched atmosphere. Others, such as greases and oils may burst into flames in this kind of atmosphere. As well as the

precautions outlined above for flammable gases, the following points should be remembered:

- Never use oxygen instead of compressed air
- Never use oxygen to sweeten the air in a working area or confined space
- Never use grease or oil on equipment containing oxygen

Reactive chemicals

Some products contain chemicals, such as organic peroxides, which can explode if they are not stored and handled correctly (refer to Tool 7 "Safe Storage of Hazardous Chemicals"). Other substances can react vigorously with incompatible materials or contaminants. For example, oxidising chemicals can cause flammable materials to ignite and some substances, such as sodium, react violently with water and can ignite. The following points need to be considered:

- Storage and process temperatures may need to be carefully controlled to prevent dangerous decomposition or reaction.
- Check labels and safety data sheets for physical properties and incompatibility with other materials.

Summary

Whenever you work with flammable substances, there is the potential for something to go wrong. You need to think about possible problems and make sure everyone knows what to do in an emergency. Instructing staff in emergency procedures is an important part of their job training, and should be ongoing. Examples of things to think about are:

- Make sure workers know enough to prevent the mixing of incompatible chemicals.
- Lay down the procedures to be followed if there is a leak or spill of flammable material and make sure people know and understand them.

- If special first-aid facilities or equipment are required, then staff needs to be trained in their use.

A fire could occur any time and is a potential threat to life and property. To be safe in your workplace, you must learn the classes of fire, individual risks of different materials (e.g. electrical equipment) and substances (e.g. flammables), and how to prevent them. Make sure your company has an Emergency Response Plan so you and your co-workers know how to react if you're involved in a fire. Familiarise yourself with where the fire extinguishers are located in your building and how to identify the appropriate extinguisher for each class of fire. Remember the safety tips provided so you know how to react if a fire should occur. There's no second chance when it comes to fire.

Important terms to know

- **Autoignition temperature** means the minimum temperature required to cause self-sustained combustion, independent of any other source of heat.
- **Boiling point** means the temperature at which a liquid boils at a fixed pressure, especially under standard atmospheric conditions (liquid and vapour phases are in equilibrium with each other at a specified pressure).
- **Flashpoint** means the lowest temperature at which a liquid gives off enough vapour to form an ignitable mixture with air and burn when a source of ignition (sparks, open flames, cigarettes, etc.) is present.
- **Ignition temperature** means the minimum temperature to which a fuel must be heated in order to initiate or cause self sustained combustion independent of another heat source.
- **Lower flammable limit (LFL)** means the lowest concentration of a material that will propagate a flame. The LFL is usually expressed as a per-

cent by volume of the material in air (or other oxidant).

- **Dangerous substances** (in terms of fire & explosion) include: petrol; liquefied petroleum gas (LPG); paints; varnishes; solvents; and dusts which when mixed with air could cause an explosive atmosphere, for example, dusts from milling and sanding operations. Dangerous substances can be found, in varying quantities, in most workplaces.
- **Explosive atmosphere** is an accumulation of gas, mist, dust or vapour, mixed with air, which has the potential to catch fire or explode. An explosive atmosphere does not always result in an explosion, but if it caught fire the flames would quickly travel through it and if this happened in a confined space (e.g. in plant or equipment) the rapid spread of the flames or rise in pressure could also cause an explosion.



Extremely Flammable, Highly Flammable and Flammable

A Flammable Liquid is one with a flash point of less than 55 °C, a Highly Flammable Liquid (letter F) is one with a flash point of less than 21 °C (a Highly Flammable solid is one which is spontaneously combustible in air at ambient temperature or one which readily ignites after brief contact with a flame or one which evolves highly flammable gases in contact with water or moist air) and an Extremely Flammable Liquid (letter F+) is one with a flash point less than 0 °C and a boiling point of 35 °C or less.

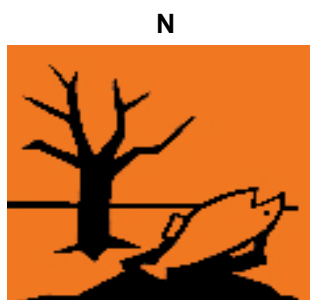
References

- Fire and explosion – How safe is your workplace? A short guide to the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) – For small and medium sized businesses; published by the Health and Safety Executive, UK; INDG370 - Reprinted 04/2004
- Further information on HSE's Safety Policy Directorate website for information on flammable substances, and explosive atmospheres <http://www.hse.gov.uk/fireandexplosion/index.htm>

Tool 9 – Hazardous substances that can cause harm to the environment and basic recommendations for disposal

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



In the next few paragraphs, some general control measures for these chemicals can be found. These general recommendations are based on the ILO Toolkit.

1. Recommendations for control of emissions into the environment as waste chemicals

In some countries local authorities or environment control authorities 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 recyclable by distilling, incineration, or used as fuel (co-processing), e.g. in cement production. 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 pit.
- 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) (see **Tool 7**).
- 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 in case of splashes.

2. 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, especially 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 so 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), 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: a) settling ponds, to remove suspended solids, b) interceptors to collect oil, and immiscible organic fluids from water, c) aeration ponds, to oxidise the liquid waste, and precipitate sludge, prior to release into the waste system, d) 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 of 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 company 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, and an impermeable barrier (e.g. concrete), with collection of rainwater run-off, and secure storage of products, and wastes.

Control of chemicals that poison organisms in sewage treatment works

Some chemicals are extremely 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.

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 emergency plans to deal with spills and fires.
- Dispose of sludge and waste solvents as special waste.
- Do not dump waste except in a specified pit.
- 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 enter sludge pits or any other confined space without making sure that the air is fit to breathe. 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.

3. 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 and 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 exists in a wide 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, corrosive properties of the dust and its potential to harm the environment, there is a range of air cleaner devices available: cyclone, electrostatic precipitator, wet scrubber, and fabric bag filter.

All of these require electric 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 as 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 special 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.

Websites on hazardous waste disposal:

Hazardous waste Directive (HWD, Council Directive 91/689/EC)

- The aim of the HWD is to provide a precise and uniform European-wide definition of hazardous waste and to ensure the correct management of such waste. In Annex III of the HWD there are 14 hazardous properties (H1-H14).

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML>

Hazardous waste: Interpretation of the definition and classification of hazardous waste

Simple and clear guide to help you in finding out if waste is hazardous or not

http://http://www.environment-agency.gov.uk/subjects/waste/1019330/1217981/1384307/?lang=_eg=

European waste list (EWL):

The European waste catalogue 2002 details a series of steps for identifying wastes in the catalogue. The catalogue consists of 20 chapters that are related to the process that generated the waste or to specific waste types. Chapters are divided in subchapters and in the subchapters are a list of unique six digits codes for each waste.

<http://ec.europa.eu/environment/impel/wastelst.htm>

How to apply the EWL and options of disposal:

A guide to help you find the best options of disposal

<http://www.um.baden-wuerttemberg.de/servlet/is/3105/english/Part%20C.pdf?command=downloadContent&filename=english/Part%20C.pdf>

Abbreviations used in this Chemical Management Guide

APR	Air purifying respirator
ANSI	American National Standards Institute
BAuA	Federal Institute for Occupational Safety and Health (Dortmund, Germany), Bundesanstalt für Arbeitsschutz und Arbeitsmedizin
BMZ	Federal Ministry for Economic Co-operation and Development (Bonn, Germany), Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung
CAS	Chemical abstract service registry number
CE	The CE mark, a stylized "CE" (for Conformité Européenne) placed on products to signify conformance with European Union regulations
CEN	Comite Europeen de Normalisation
CHS	Convention Project Chemical Safety (Bonn, Germany), GTZ Konventionsvorhaben Chemikaliensicherheit
DIN	Deutsche Institut für Normung
e.g.	For example
EN	European technical Standatrs, issued by CEN
EMS	Environmental Management System(s)
etc.	and so on/and others
EU	European Union
EurepGAP	Euro Retailer Procedure Working Group (Good Agricultural practice)
g/kg/t	grams/kilograms/tons
GCPF	Global Crop Protection Federation
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GTZ	German Agency for Technical Co-operation (Eschborn), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH
HSE	Health and Safety Executive (UK)
ICSC	International Chemical Safety Cards
IDLH	Inmediately dangerous to life and health
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/m ³	Millilitre/litre/cubic meter
m/s	Metres per second
MSDS	Material Safety Data Sheets
OEL	Occupational Exposure Limit
NPO	Non Product Output
PAPR	powered air purifying respirator
PCB	Polychlorinated biphenyls
PDS	Pesticide Data Sheet
PPE	Personal Protection Equipment
ppm	Parts per million
PVC	Polyvinyl chloride

Abbreviations used in this Chemical Management Guide

RPE	Respiratory Protection Equipment
R-Phrases	Risk-Phrases
SAR	Supplied-air respirator
S-Phrases	Safety-Phrases
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
\$US	United States Dollars
%	Percent

Abbreviations used in 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	Occupational Health and Safety Assessment 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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