

MSDS for TRICHLOROETHYLENE

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1 - PRODUCT IDENTIFICATION

PRODUCT NAME: TRICHLOROETHYLENE
 FORMULA: C₂HCL₃
 FORMULA WT: 131.40
 CAS NO.: 79-01-6
 NIOSH/RTECS NO.: KX4550000
 COMMON SYNONYMS: TRICHLOROETHENE; ETHINYL TRICHLORIDE; ACETYLENE TRICHLORIDE;
 TCE
 PRODUCT CODES: 5376, 9458, 9454, 9455, 9464, 9473
 EFFECTIVE: 01/22/87
 REVISION #03

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 3 SEVERE (CANCER CAUSING)
 FLAMMABILITY - 1 SLIGHT
 REACTIVITY - 1 SLIGHT
 CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES

PRECAUTIONARY LABEL STATEMENTS

WARNING

HARMFUL IF SWALLOWED OR INHALED
 CAUSES IRRITATION

NOTE: THIS MATERIAL OR ITS VAPORS IN CONTACT WITH FLAMES OR HOT GLOWING SURFACES MAY FORM CORROSIVE ACID FUMES.

NOTE: REPORTED AS CAUSING CANCER IN LABORATORY ANIMALS. EXERCISE DUE CARE. AVOID CONTACT WITH EYES, SKIN, CLOTHING. DO NOT BREATHE VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA(TM) STORAGE COLOR CODE: BLUE (HEALTH)

2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
TRICHLOROETHYLENE	90-100	79-01-6

3 - PHYSICAL DATA

BOILING POINT: 87 C (189 F) VAPOR PRESSURE(MM HG): 58

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MELTING POINT: -73 C (-99 F) VAPOR DENSITY(AIR=1): 4.53
 SPECIFIC GRAVITY: 1.47 EVAPORATION RATE: N/A
 (H₂O=1) (BUTYL ACETATE=1)

SOLUBILITY(H₂O): SLIGHT (0.1 TO 1 %) % VOLATILES BY VOLUME: 100

APPEARANCE & ODOR: COLORLESS LIQUID WITH CHLOROFORM ODOR.

 4 - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP N/A NFPA 704M RATING: 2-1-0

FLAMMABLE LIMITS: UPPER - 10.5 % LOWER - 8.0 %

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS

GIVES OFF FLAMMABLE VAPORS. VAPORS MAY FORM EXPLOSIVE MIXTURE WITH AIR. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE.

TOXIC GASES PRODUCED

HYDROGEN CHLORIDE, PHOSGENE, CHLORINE, CARBON MONOXIDE, CARBON DIOXIDE

 5 - HEALTH HAZARD DATA

SOME EXPERIMENTS WITH TEST ANIMALS INDICATED THAT THIS SUBSTANCE MAY BE ANTICIPATED TO BE A CARCINOGEN.

THRESHOLD LIMIT VALUE (TLV/TWA): 270 MG/M3 (50 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 1080 MG/M3 (200 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): MG/M3 (100 PPM)

TOXICITY: LD50 (ORAL-RAT) (MG/KG) - 7193
 LD50 (IPR-MOUSE) (MG/KG) - 3000
 LD50 (IV-MOUSE) (MG/KG) - 34

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

INHALATION OF VAPORS MAY CAUSE HEADACHE, NAUSEA, VOMITING, DIZZINESS,

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DROWSINESS, IRRITATION OF RESPIRATORY TRACT, AND LOSS OF CONSCIOUSNESS. INHALATION OF VAPORS MAY CAUSE PULMONARY EDEMA. CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION. PROLONGED EXPOSURE MAY CAUSE DERMATITIS. INGESTION MAY CAUSE NAUSEA, VOMITING, HEADACHES, DIZZINESS, GASTROINTESTINAL IRRITATION, CENTRAL NERVOUS SYSTEM DEPRESSION AND HEARING LOSS. CHRONIC EFFECTS OF OVEREXPOSURE MAY INCLUDE DAMAGE TO KIDNEYS, LIVER, LUNGS, BLOOD, OR CENTRAL NERVOUS SYSTEM.

TARGET ORGANS

RESPIRATORY SYSTEM, HEART, LIVER, KIDNEYS, CENTRAL NERVOUS SYSTEM

EYE/SKIN PROTECTION: SAFETY GOGGLES AND FACE SHIELD, UNIFORM,
PROTECTIVE SUIT, NEOPRENE GLOVES ARE RECOMMENDED.

9 - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: BLUE (HEALTH)

SPECIAL PRECAUTIONS

KEEP CONTAINER TIGHTLY CLOSED. STORE IN SECURE POISON AREA.

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

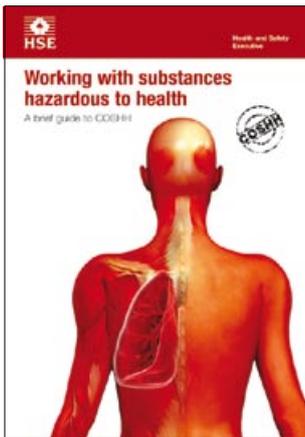
PROPER SHIPPING NAME	TRICHLOROETHYLENE (AIR ONLY)
HAZARD CLASS	ORM-A
UN/NA	UN1710
LABELS	NONE
REPORTABLE QUANTITY	1000 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	TRICHLOROETHYLENE
HAZARD CLASS	6.1
UN/NA	UN1710
LABELS	HARMFUL - STOW AWAY FROM FOOD STUFFS

Working with substances hazardous to health

A brief guide to COSHH



This is a web-friendly version of leaflet INDG136(rev5), revised 10/12

Introduction

This leaflet describes how to control hazardous substances at work, so they do not cause ill health. It will help you understand what you need to do to comply with the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended) which apply to the way you work with these substances.

This leaflet provides measures that you, as an employer, may need to do to protect your employees from hazardous substances at work. It will also be useful to employees and their safety representatives.

Why do I need to read this leaflet?

Every year, thousands of workers are made ill by hazardous substances, contracting lung disease such as asthma, cancer and skin disease such as dermatitis. These diseases cost many millions of pounds each year to:

- industry, to replace the trained worker;
- society, in disability allowances and medicines; and
- individuals, who may lose their jobs.

You, as the employer, are responsible for taking effective measures to control exposure and protect health. These measures can also improve production or cut waste.

Myth 'Of course it's safe – we've always done it this way.'

Reality Some diseases take years to develop. If exposure is high because the task has always been done that way, maybe it's time for a change.

Looking after your business

Your aim in running your business is to make a profit. You know what you do, and how you are doing it. You know what 'processes' and 'tasks' are involved. You know the short cuts. Ensuring your workers remain healthy may also lead to healthy profits.

Which substances are harmful?

- Dusty or fume-laden air can cause lung diseases, eg in welders, quarry workers or woodworkers.
- Metalworking fluids can grow bacteria and fungi which cause dermatitis and asthma.
- Flowers, bulbs, fruit and vegetables can cause dermatitis.
- Wet working, eg catering and cleaning, can cause dermatitis.
- Prolonged contact with wet cement in construction can lead to chemical burns and/or dermatitis.
- Benzene in crude oil can cause leukaemia.

Many other products or substances used at work can be harmful, such as paint, ink, glue, lubricant, detergent and beauty products.

Myth 'It's natural so it can't be harmful.'

Reality Natural materials can be harmful. For example, henna can cause dermatitis and asthma, wood dust can cause asthma, stone or concrete dust can cause lung disease such as silicosis, and citrus oils can cause skin problems.

Ill health caused by these substances used at work is preventable. Many substances can harm health but, used properly, they almost never do.

Find out the dangers in your business – ask your supplier, your trade association, and check for your industry on HSE's website: www.hse.gov.uk.

Substances can also have other dangerous properties. They may be flammable, for example solvent-based products may give off flammable vapour. Clouds of dust from everyday materials, such as wood dust or flour, can explode if ignited. This leaflet does not deal with flammability or explosion hazards (see 'Find out more').

Look at each substance

Which substances are involved? In what way are they harmful? You can find out by:

- checking information that came with the product, eg a safety data sheet;
- asking the supplier, sales representative and your trade association;
- looking in the trade press for health and safety information;
- checking on the Internet, eg HSE's website pages for your trade.

Think about the task

If the substance is harmful, how might workers be exposed? By:

- breathing in gases, fumes, mist or dust?
- contact with the skin?
- swallowing?
- contact with the eyes?
- skin puncture?

Bear these in mind when you look at the tasks.

Exposure by breathing in

Once breathed in, some substances can attack the nose, throat or lungs while others get into the body through the lungs and harm other parts of the body, eg the liver.

Exposure by skin contact

Some substances damage skin, while others pass through it and damage other parts of the body. Skin gets contaminated:

- by direct contact with the substance, eg if you touch it or dip your hands in it;
- by splashing;
- by substances landing on the skin, eg airborne dust;
- by contact with contaminated surfaces – this includes contact with contamination inside protective gloves.

Exposure by swallowing

People transfer chemicals from their hands to their mouths by eating, smoking etc without washing first.

Exposure to the eyes

Some vapours, gases and dusts are irritating to eyes. Caustic fluid splashes can damage eyesight permanently.

Myth 'I don't work with harmful substances.'

Reality Most businesses use substances that can be hazardous to health – even something as simple as flour can act as a substance hazardous to health.

Exposure by skin puncture

Risks from skin puncture such as butchery or needlestick injuries are rare, but can involve infections or very harmful substances, eg drugs.

Safety data sheets

Products you use may be 'dangerous for supply'. If so, they will have a label that has one or more hazard symbols. Some examples are given here.

These products include common substances in everyday use such as paint, bleach, solvent or fillers. When a product is 'dangerous for supply', by law, the supplier must provide you with a safety data sheet. Note: medicines, pesticides and cosmetic products have different legislation and don't have a safety data sheet. Ask the supplier how the product can be used safely.

Safety data sheets can be hard to understand, with little information on measures for control. However, to find out about health risks and emergency situations, concentrate on:

- Sections 2 and 16 of the sheet, which tell you what the dangers are;
- Sections 4-8, which tell you about emergencies, storage and handling.

Since 2009, new international symbols have been gradually replacing the European symbols. Some of them are similar to the European symbols, but there is no single word describing the hazard. Read the hazard statement on the packaging and the safety data sheet from the supplier.

European symbols



New International symbols



Hazard checklist

- Does any product you use have a danger label?
- Does your process produce gas, fume, dust, mist or vapour?
- Is the substance harmful to breathe in?
- Can the substance harm your skin?
- Is it likely that harm could arise because of the way you use or produce it?
- What are you going to do about it?
 - Use something else?
 - Use it in another, safer way?
 - Control it to stop harm being caused?

Myth 'What do you expect – it's a dirty job!'

Reality Why does your job need to be dirty? Think about changing the way you work to produce cleaner processes.

Assessing risk

Risk assessment is not just a paper exercise. It's about taking sensible steps to prevent ill health. You need to know how workers are exposed, and to how much, before you can decide if you need to do anything to reduce their exposure. The COSHH Regulations require employers to assess the risk to their employees, and to prevent or adequately control those risks. Sometimes, it's easy to judge the amount of exposure to substances and decide what you can do about it.

When the task involves very small amounts of material, even if these are harmful, when there is little chance of it escaping, the risk is low. But the risk in a different task – such as cleaning up and disposal – will be higher because the harmful substance may be breathed in or get onto the skin.

When the task involves larger amounts of material, with obvious leaks, exposure is higher and so is the risk. Whether the substance is harmful or not, your need to control it is obvious. Decide what measures you need to take, and when.

If you have five or more employees, you must record your assessment but, even if you have fewer than five, it makes sense to write down what steps you have taken to identify the risks. And the really important part is making a list of the actions you are taking to control the risks to health. You can look at examples of risk assessments for different industries on www.hse.gov.uk/risk/casestudies.

HSE has developed a free internet tool for identifying good control practice: www.coshh-essentials.org.uk. It covers a wide range of processes and activities and also produces advice for products that have safety data sheets.

However, there may be no 'good practice' advice available for your process. Where this is small-scale with obvious control measures, you can do the assessment yourself. In other cases, or where you are not sure, ask your supplier, trade association or other reliable information sources. You may need professional advice such as from an occupational hygienist – see 'Getting help'.

What are exposure control measures?

Control measures are always a mixture of equipment and ways of working to reduce exposure. The right combination is crucial. No measures, however practical, can work unless they are used properly.

So any 'standard operating procedure' should combine the right equipment with the right way of working. This means instructing, training and supervising the workers doing the tasks.

You need control measures that work and continue to work – all day, every day.

Examples of control measures

Substance, process	Control equipment	Way of working	Managing
<ul style="list-style-type: none"> ■ Cleaning with solvent on rag. 	<ul style="list-style-type: none"> ■ Use a rag holder. ■ Provide a small bin with a lid for used rags. 	<ul style="list-style-type: none"> ■ Avoid skin contact. ■ Reduce solvent vapour from used rags. 	<ul style="list-style-type: none"> ■ Check controls are used. ■ Safe disposal.
<ul style="list-style-type: none"> ■ Dust and sparks from abrasive wheel. 	<ul style="list-style-type: none"> ■ Put an enclosure around the wheel and extract the air to a safe place. 	<ul style="list-style-type: none"> ■ Check the airflow indicator. ■ Make sure the extraction works. 	<ul style="list-style-type: none"> ■ Maintain controls. ■ Test controls as required by law.
<ul style="list-style-type: none"> ■ Fume from cutting demolition scrap. 	<ul style="list-style-type: none"> ■ Ventilated welding helmet, gloves. ■ Washing facilities. 	<ul style="list-style-type: none"> ■ Work outdoors upwind of the fume wherever possible. ■ Allow the fume to clear before removing helmet. 	<ul style="list-style-type: none"> ■ Check if there is any lead paint on the scrap being cut. ■ Carry out health checks.
<ul style="list-style-type: none"> ■ Cutting-fluid mist from a lathe. ■ Swarf. 	<ul style="list-style-type: none"> ■ Put an enclosure around the lathe and extract the air to a safe place. ■ Protective gloves. 	<ul style="list-style-type: none"> ■ Use skin-care products. ■ Make sure the extraction works. ■ Allow time for the mist to clear from the enclosure before opening it. 	<ul style="list-style-type: none"> ■ Train workers. ■ Check and maintain fluid quality. ■ Test controls as required by law. ■ Carry out health checks.
<ul style="list-style-type: none"> ■ Dust from disc cutter on stone worktop. 	<ul style="list-style-type: none"> ■ Use an enclosure to extract air to a safe place. ■ High-efficiency vacuum cleaner. 	<ul style="list-style-type: none"> ■ Cut and polish worktops inside an enclosure. ■ Vacuum up dust. 	<ul style="list-style-type: none"> ■ Test and maintain controls. ■ Carry out health checks.

Myth 'They wouldn't sell it to us if it wasn't safe.'

Reality Just because something is available to buy, does not mean it is safe – you can buy cyanide for industrial use.

Choosing control measures

In order of priority:

- 1 Eliminate the use of a harmful product or substance and use a safer one.
- 2 Use a safer form of the product, eg paste rather than powder.
- 3 Change the process to emit less of the substance.
- 4 Enclose the process so that the product does not escape.
- 5 Extract emissions of the substance near the source.
- 6 Have as few workers in harm's way as possible.
- 7 Provide personal protective equipment (PPE) such as gloves, coveralls and a respirator. PPE must fit the wearer.

If your control measures include 5, 6 and 7, make sure they all work together.

Control equipment

Control equipment comes in many forms. It includes ventilation to extract dust, mist and fume; glove boxes and fume cupboards; spray booths and refuges (clean rooms in dirty work areas). It also includes using water to reduce dust, and systems for disinfecting cooling water.

For control equipment, your supplier should provide a 'user manual'. If you don't have one, ask for it. And if this is impossible, you may need professional help to write one. The user manual should set out schedules for checks, maintenance and parts replacement. For example it should include:

Myth 'I've given them all masks – problem solved!'

Reality This won't solve it. Control the source of exposure and then they might not need masks.

- a description of the system;
- the daily checks the worker or supervisor needs to carry out, eg the ventilation is turned on, the airflow indicator gives the right reading;
- the weekly or monthly checks the supervisor or owner needs to carry out, eg of equipment wear and tear, and that short cuts are not creating dangers;
- details of any thorough examination and test;
- signs of wear and control failure;
- a list of replaceable parts;
- a description of how operators should use the system so it works effectively.

Remedy defects in good time. It is pointless making checks if you take no action when something is wrong. And you are not managing health and safety properly if the 'thorough examination and test' produces a long list of 'actions needed'.

Keep simple records of your checks and actions, eg in a logbook, and keep these records for at least five years.

Staying in control: Checking and maintaining

Once you've got control, you need to keep it. As the employer, you must make sure that the control measures (equipment and the way of working) keep working properly.

You should name someone to be in charge of checking and maintaining control measures. It could be you, or someone you appoint, as long as they know what they need to do, and are able to do it. That is, they are 'competent' to:

- check that the process isn't emitting uncontrolled contaminants;
- check that the control equipment continues to work as it was designed;
- check that workers follow the right way of working.

Two of the most common control measures where maintenance is critical are local exhaust ventilation (LEV) and personal protective equipment (PPE).

Local exhaust ventilation (LEV)

If you use local exhaust ventilation to control exposure, it needs regular checking and thorough examination and testing at least once every 14 months or at more frequent intervals if you are using it with one of the processes listed in Schedule 4 of COSHH.

Many people, eg engineers or insurance companies can carry out thorough examination and testing of LEV. Whoever does the work must be competent – see 'Getting help'.

Personal protective equipment (PPE)

Personal protective equipment is often used as part of control measures. This also needs checking and maintenance because, if it fails, it no longer provides protection and exposes the wearer to danger. The users need to know exactly what they are doing, and so do the supervisors.

PPE suppliers and trade associations can tell you about training in how to use it properly. See 'Getting help' and 'Further information'.

Checklist for good control practice

- Do you design and run your processes to keep the spread of contaminants as low as possible?
- Do you think about all routes of exposure – breathing in, on skin or swallowing?
- Do you choose control measures according to the amount of substance, how it gets into the body and how much harm it will cause?
- Do you make sure that measures are effective, easy to use, and work properly?
- Do you also need to issue personal protective equipment (PPE)?
- Do you check regularly that measures continue to work, and keep simple records?
- Do you tell workers about the dangers and how to use control measures properly?
- Do you avoid increasing the overall health and safety risks when making changes?

Skills and experience

Competence

Ensure that whoever designs, installs, maintains and tests your control measures is competent – they have the necessary skills, knowledge and experience. You can assess the competence of equipment and service providers with questions such as:

- Have you done this sort of work before?
- What are your qualifications?
- Do you belong to a professional organisation?
- Can I speak to previous clients?

Ideally, you want someone who knows your industry, has a successful track record, and gives good value for money.

Worker involvement

Involve your workers in developing control measures to make sure they are suitable for the way they carry out the work. Encourage them to suggest improvements, and to report anything they think might be going wrong.

Training, instruction and information

Explain to your workers, and anyone else who needs to know, what the dangers are. It is poor practice just to hand them a page of written information.

- Show workers how to use control measures properly, and how to check that they are working.
- Carry out practice drills for cleaning up spills safely – do this before any spillages happen.
- If workers need to use respirators, they also need face fitting and training.
- If they need to use protective gloves, they need to know how to put them on and take them off without contaminating their skin. See 'Find out more'.

Keeping workers healthy

Monitoring exposure

Monitoring normally means air sampling but it may also involve taking biological samples, eg breath or urine. Monitoring normally makes reference to 'Workplace Exposure Limits' (WELs) published by HSE. These limits should not be exceeded (see EH40 in 'Find out more').

It is wasteful to try monitoring before you have put any control measures in place (see COSHH essentials sheet G409 www.hse.gov.uk/pubns/guidance/g409.pdf on air monitoring).

Health checks

If your trade press, HSE, or other information, shows there is a problem with health in your trade, such as asthma or dermatitis, your employees may need special health checks. The most common checks are for respiratory disease such as asthma and skin disease. See 'Find out more'.

REACH

REACH is a European Union regulation concerning the **R**egistration, **E**valuation, **A**uthorisation and restriction of **C**hemicals. It came into force on 1 June 2007 and replaces a number of European Directives and Regulations with a single system.

REACH will operate alongside COSHH and is designed so that better information on the hazards of chemicals and how to use them safely will be passed down the supply chain by chemical manufacturers and importers through improved safety data sheets.

Further information can be found on HSE's website: www.hse.gov.uk/reach/ and on the European Chemical Agency's website: www.echa.europa.eu/home_en.asp.

Getting help

What and who?	Trade association	HSE	Consultants/ service suppliers	Local health and safety groups
Good control	✓	✓	✓	✓
Testing LEV	✓	✓	✓	
Training	✓	✓	✓	✓
Monitoring		✓	✓	
Health checks		✓	✓	

This is not an inclusive list, but some useful sources of information and help are:

■ **The Occupational Safety and Health Consultants Register (OSHCR)**

www.hse.gov.uk/oshcr/index.htm

OSHCR is a register of consultants who can offer general advice to UK businesses to help them manage health and safety risks.

■ **British Occupational Hygiene Society (BOHS)** 5/6 Melbourne Business Court, Millennium Way, Pride Park, Derby, DE24 8LZ. Tel: 01332 298101 www.bohs.org.

BOHS is the professional body for occupational hygienists, who understand how workplace hazards affect worker health and systems to control risks to health from work. The website has a list of consultants.

■ **Health & Safety Laboratory (HSL)** Business Development Group, Health & Safety Laboratory, Harpur Hill, Buxton, Derbyshire SK17 9JN. Tel: 01298 218000 www.hsl.gov.uk.

HSL's services include specialist advice and consultancy, risk assessment, and workplace monitoring (including biological monitoring).

■ **Institution of Occupational Safety and Health (IOSH)** The Grange, Highfield Drive, Wigston, Leicestershire LE18 1NN. Tel: 0116 2573100 www.iosh.co.uk.

IOSH is the association for health and safety professionals. The website allows you to search for consultants.

■ **United Kingdom Accreditation Service (UKAS)** 21-47 High Street, Feltham, Middlesex TW13 4UN. Tel: 02089 178400 www.ukas.com.

The UKAS website has a search function to find accredited testing and inspection service providers.

■ **Trade associations** Health and safety information is often produced by trade associations and published in the trade press.

■ **Occupational health professionals (doctors or nurses)** Look in Yellow Pages or other trade indexes for occupational health under 'Health and Safety Consultants' or 'Health Authorities and Services', or visit www.nhsplus.nhs.uk.

■ **Safety Groups UK (SGUK)** Edgbaston Park, 353 Bristol Road, Edgbaston, Birmingham B5 7ST Tel: 0121 248 2011 www.safetygroupsuk.org.uk

Find out more

HSE COSHH website: www.hse.gov.uk/coshh/index.htm

A short guide to the Personal Protective Equipment at Work Regulations 1992
Leaflet INDG174(rev1) HSE Books 2005 www.hse.gov.uk/pubns/indg174.pdf

Clearing the air: A simple guide to buying and using local exhaust ventilation (LEV)
Leaflet INDG408 HSE Books 2008 www.hse.gov.uk/pubns/indg408.pdf

EH40/2005 Workplace exposure limits: Containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended) Environmental Hygiene Guidance Note EH40 (Second edition)
HSE Books 2011 ISBN 978 0 7176 6446 7
www.hse.gov.uk/pubns/books/eh40.htm

Fire and explosion: A brief guide to DSEAR in the workplace Leaflet INDG370(rev1)
HSE Books 2012 www.hse.gov.uk/pubns/indg370.pdf

Preventing contact dermatitis at work Leaflet INDG233(rev1) HSE Books 2007
www.hse.gov.uk/pubns/indg233.pdf

Read the label: How to find out if chemicals are dangerous Leaflet INDG352(rev1)
HSE Books 2010 www.hse.gov.uk/pubns/indg352.pdf

Respiratory sensitisers and COSHH: Breathe freely – An employers' leaflet on preventing occupational asthma Leaflet INDG95(rev2) HSE Books 1995
www.hse.gov.uk/pubns/indg95.pdf

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

This leaflet can be found at www.hse.gov.uk/pubns/indg136.htm

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Control approach 3

Vapour degreasing bath

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Containment



This guidance sheet is aimed at employers to help them comply with the requirements of

the Control of Substances Hazardous to Health Regulations 2002 (COSHH) by controlling exposure to chemicals and protecting workers' health.

The sheet is part of the HSE guidance pack *COSHH essentials: easy steps to control chemicals*. It can be used where the guide recommends control approach 3 (containment) as the suitable approach for your chemical(s) and task(s).

This sheet provides good practice advice on using vapour degreasing baths with medium or large quantities of liquids. It describes the key points you need to follow to reduce exposure to an adequate level.

It is important that all the points are followed.

Some chemicals can also be flammable or corrosive. Where they are, your controls must be suitable for those hazards too. Look at the safety data sheet for more information.

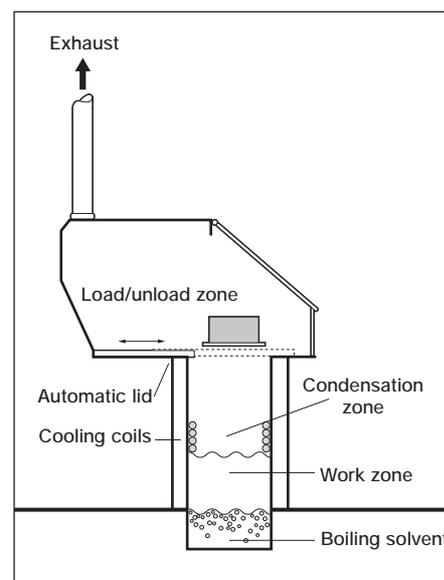
Depending on the scale of work, releases into the atmosphere may be regulated within the pollution prevention and control (PPC) framework. You should consult your local authority or the Environment Agency. In Scotland, consult the Scottish Environment Protection Agency (SEPA). They will advise you if PPC legislation applies to your company, and about air cleaning and discharging emissions into the air. Otherwise, minimise emissions into the air.

Access

- ✓ Control staff entry to the work area.
- ✓ The work area and equipment should be clearly labelled.

Design and equipment

- ✓ Design the equipment to fully enclose both the bath and the loading zone.
- ✓ The freeboard height should be at least 75% of the width of the open area of the bath.
- ✓ Set the thermostat correctly and balance the heating and cooling systems so as not to overload the cooling coils.
- ✓ Provide an extraction purge to remove any excess vapour from the load/unload zone.
- ✓ Provide an internal lid to reduce vapour release into the load/unload zone.
- ✓ Consider the need for a mechanical hoist to reduce manual handling and reduce operator exposure during loading/unloading.
- ✓ Ensure employees are trained on how to safely clean and maintain the bath.
- ✓ Ensure the bath has a bottom drain to remove solvent for cleaning.
- ✓ Design the closed system to allow easy maintenance.
- ✓ Keep the process equipment under negative pressure to prevent leaks.
- ✓ Discharge extracted air to a safe place away from doors, windows and air inlets.



Maintenance

- ✓ Ensure all equipment used in the task is maintained as advised by the supplier/installer, in effective and efficient working order and good repair.
- ✓ Adopt a 'permit to work' system for maintenance work.
- ✓ Follow any special procedures that are needed before the system is opened or entered, eg purging and washing.

Examination and testing

- ✓ Get information from the supplier on all parameters needed to safely operate the system.
- ✓ Visually check equipment at least once a week for signs of damage.

- ✓ Ensure the ventilation equipment is examined and tested against its performance standard. This is generally at least every 14 months (see HSE publication HSG54).
- ✓ Keep records of all examinations and tests for at least five years.

Cleaning and housekeeping

- ✓ Thoroughly clean work equipment and the working area daily. Clean other equipment and the workroom regularly - once a week is recommended.
- ✓ Deal with spills immediately. For liquids, contain or absorb spillages using granules or mats.
- ✓ Store containers in a safe place (see CGS 101).
- ✓ Dispose of empty containers safely.
- ✓ Put lids on containers immediately after use.

Personal protective equipment (PPE)

- ✓ Chemicals in **hazard group S** can damage the skin and eyes, or enter the body through the skin and cause harm. See CGS S100 and S101 for more specific advice. Check the safety data sheets to see what personal protective equipment is necessary.
- ✓ Ask your safety clothing supplier to help you select suitable protective equipment.
- ✓ Respiratory protective equipment (RPE) should not normally be necessary for routine operations. It may be necessary for some cleaning and maintenance activities, eg cleaning up spills.
- ✓ Ensure PPE is kept in a clean condition and replaced when necessary.

Training

- ✓ Give your workers information on the harmful nature of the chemicals.
- ✓ Provide them with training on: operating the process; following maintenance procedures; when and how to use PPE; and how to detect and deal with leaks.

Supervision

- ✓ Have a system to check that all control measures are in place and being followed.

Further information

- Safety data sheets
- *Maintenance, examination and testing of local exhaust ventilation* HSG54 (second edition) HSE Books 1998 ISBN 0 7176 1485 9
- *Health and safety at degreasing operations: sources of guidance* EIS22 HSE Books 1998
- *Maintenance and cleaning of solvent degreasing tanks* EIS20 HSE Books 1998
- *Surface cleaning: solvent update including the reclassification of trichloroethylene* EIS34 HSE Books 2002
- Control guidance sheets 101, S100 and S101

Employee checklist for making the best use of the controls

- Make sure the cooling coil and ventilation systems are switched on and are working.
- Make sure lids are shut except during loading/unloading.
- Do not overload or remove loads too quickly as this results in excessive vapour emissions.
- Look for signs of leaks, wear or damage of any equipment used. If you find any problems, tell your supervisor. Do not carry on working if you think there is a problem.
- Do not enter the bath for cleaning or maintenance without taking the precautions described in the HSE information sheet EIS20. People have died doing this job incorrectly.
- Wash your hands before and after eating, drinking or using the lavatory.
- Do not use solvents to clean your skin.
- Clear up spills immediately. For liquids, contain or absorb with granules or mats. Dispose of spills safely.
- Use, maintain and store any PPE provided in accordance with instructions.



COSHH essentials:
easy steps to control chemicals
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Immersion and cold cleaning of engineering components

HSE information sheet

Engineering Information Sheet No 21 (rev1)

This guidance is aimed at employers, managers and workers who carry out or specify cleaning and degreasing work in various industries.

Introduction

Cleaning and degreasing metal and other parts by dipping, soaking or spraying them with liquid cleaners is common. It is often referred to as 'immersion' or 'cold' cleaning (although the cleaning liquids are sometimes warmed). Many other components have to be degreased or cleaned in situ on plant or equipment.

This leaflet outlines the main health and safety hazards and risks. It includes the legal requirements applying to this work, which aim to minimise the risks to health and risks from fire and explosion.

Further general information is available in *Working safely with solvents: A guide to safe working practices*.¹

Is cleaning necessary?

This is the first question to ask. Changing processes or operation can avoid components becoming soiled or can reduce the level of soiling, making subsequent cleaning easier. Cleaning may not be critical or needed, saving money.

If cleaning is necessary then you should next consider the use of less hazardous alternatives.

Alternatives

A wide variety of hydrocarbon solvents and water-based formulations are now being used for the cleaning processes, which are less hazardous than those previously used.

Aqueous cleaning

Water-based formulations using detergent-type substances can be used. These may be alkaline or acid and therefore corrosive to skin and eyes. Working solutions and, more particularly, concentrates, may contain ingredients harmful to health if breathed or ingested, for example as dust or spray. Some organic solvents may be used in water-based mixtures.

In all cases a COSHH assessment should be made and appropriate precautions taken to avoid risks to health. Certain flammable solvents can also be used mixed into aqueous formulations. These should present no fire risk when in an aqueous working solution, but you should check the safety data sheet (see below).

Wipes

Pre-moistened water- or solvent-based wipes are a real alternative to traditional solvent and rag cleaning, reducing the risks and the costs. If you find yourself using large quantities then other degreasing methods might be appropriate.

What the law says

Risk assessment

Risk assessments are required by the Control of Substances Hazardous to Health Regulations (COSHH)² and the Management of Health and Safety at Work Regulations. Employers should use the information from suppliers, and especially the Safety Data Sheet (SDS) or extended SDS (eSDS) to help them carry out these risk assessments.

The inherent hazards of the chemicals used should be linked by the assessment to risks from an employer's particular operations. The assessment should determine the appropriate precautions. In addition, if the flammability or the method of use of the solvent presents a fire or explosion hazard, an assessment of the risk should be carried out in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).

Information from suppliers

Suppliers of dangerous substances are required to provide a SDS, or an eSDS for REACH-registered substances. This should contain information to enable the recipient to take necessary measures relating to the protection of health and safety at work and the environment (www.hse.gov.uk/reach/resources/reachsdgs.pdf).

Employers should use this information to control the risks identified in the risk assessment process (www.hse.gov.uk/reach/supplyuseduties.htm).

There are other requirements on suppliers under the Supply of Machinery (Safety) Regulations 2008 and section 6 of the Health and Safety at Work etc Act 1974. See www.hse.gov.uk/work-equipment-machinery/supplier.htm.

Confined spaces

In any enclosed or confined space, such as the inside of a tank, even a non-toxic solvent may have anaesthetic or asphyxiating effects if it is used in sufficient quantities. Breathing apparatus and other precautions may be required to prevent serious injury or even death. The Confined Spaces Regulations will apply to such work.³

Solvents user

Chlorinated solvents

Trichloroethylene, perchloroethylene and methylene chloride (dichloromethane or DCM) are available and widely used for vapour degreasing operations.^{4,5} DCM is now banned as a paint stripper unless in industrial installations with certain other conditions. It can still be used for degreasing as long as it is not stripping paint, varnish or lacquer.

These solvents are all volatile and as such suppliers do not normally recommend them for cold or in situ cleaning. Control measures would be required to prevent operators breathing the solvent vapours if it were necessary to use them.

Other organic chemical solvents

A wide variety of other organic chemical solvent cleaners are available, including petroleum distillates, terpenes and alcohols. A number of products based on bromine compounds are also now being marketed.

In selecting a product, users have to take into account not only how effectively it cleans but also any health, fire and environmental risks it may present in the

way they propose to use it. For example, n-Propyl Bromide (nPB) is classified as highly flammable, as well as being on the 'candidate list' of the European Chemicals Agency as a chemical that might go on their Substance of Very High Concern list which would then require authorisation for specified uses.

Health hazards from the use of solvents

Some of the products available are highly toxic, but many are of low toxicity. Suppliers should advise on hazards and any precautions which may be needed. In some cases good natural ventilation may be adequate to minimise the risks from solvent vapours but in other cases, local exhaust ventilation will be needed. In some circumstances respiratory protective equipment (RPE) may also be necessary. The COSHH assessment should inform the precautions needed.

Inhalation exposure to organic solvent vapour or liquids may be harmful to health. The severity of ill-health effects depends on:

- the substance;
- its concentration (in air);
- the length and frequency of exposure.

In addition to risks from inhalation, solvents can affect the skin as well as pass through unbroken skin leading to ill-health effects in other parts of the body.

There are three main areas of concern for workers' health:

- Situations which **are immediately dangerous to life** such as unconsciousness or asphyxiation, sometimes resulting in death, are usually the result of bad working practices associated with entry into or leaning over confined spaces, usually larger open topped tanks. The majority of serious incidents have occurred while:
 - degreasers are being maintained;
 - tanks are being cleaned out;
 - solvent is being replaced or topped up;
 - emergency rescues are being attempted.
- Short-term (**acute**) effects on health such as dermatitis caused by de-fatting of the skin, narcotic effects (dizziness, disorientation), nausea, headaches, fatigue and lethargy. These are usually caused by skin contact to neat solvents or breathing in high concentrations of solvent vapour in air. Severe cases of inhalation can result in death.
- Long-term (**chronic**) effects on health, such as liver diseases, nervous system damage and dermatitis, can be caused by regular exposure to solvents during use, maintenance and cleaning. Trichloroethylene is classified as carcinogenic;

nPB is classified as may damage fertility or may damage the unborn child; and perchloroethylene and dichloromethane are classified as suspected carcinogens.

Since all of the products are designed for cleaning and degreasing they will present some possibility of skin irritation or dermatitis. Some solvents are also able to penetrate intact skin and enter the bloodstream. This may not be a problem for intermittent or short-term skin exposures but may cause problems for prolonged skin exposure.

Control measures

Handling and application methods which avoid skin exposure should be considered first and may still require the use of suitable protective equipment such as chemical protective gloves, and sometimes overalls, to protect against residual risks. Care should be taken in selecting gloves and other protective clothing as different solvents affect the materials from which they are made in different ways. Some solvents may pass through some glove materials in a very short time. Use the SDS (or eSDS) and/or your supplier of personal protective equipment (PPE) for advice.

Where provided in an eSDS an exposure scenario describes the operating conditions and risk management measures that have been identified by the supplier as necessary to use the chemical safely. REACH requires you to follow the advice on the risk management measures or if you chose to use different risk management measures to those described then you should be able to justify why your measures offer an equivalent (or better) level of protection for human health (and the environment) for a particular job.

Chemical splashes to the eyes can be very dangerous, including serious and possibly lasting effects. Prolonged exposure to solvent vapours may also cause eye irritation. Some eye protection will be advisable for most operations. Chemical-resistant goggles or a face shield will be required where there is a significant risk of splashing with a chemical which may be harmful to the eyes.

Fire and explosion risks

Most of the hydrocarbon solvents likely to be used are flammable or combustible to some extent. Flashpoint gives an indication of flammability of a solvent but the method of use is also important in minimising the creation of flammable vapours during the work. In addition, it is important to eliminate possible sources of ignition in the vicinity.

Solvents for cold and in situ cleaning should be chosen with as high a flashpoint as is reasonably practicable. Most of the proprietary formulations available have flashpoints around 45 °C or above. Heating of the solvent and spraying or splashing during use will significantly increase the risk.^{6,7}

If lower-flashpoint solvents need to be used for immersion cleaning they should be used in purpose-designed plant incorporating specific precautions to contain solvent vapours. If lower-flashpoint solvents are used for cold or in situ cleaning, measures to minimise flammable solvent/air mixtures and to eliminate sources of ignition will be essential.

Guidance on fire safety can be found on HSE's dangerous substances and explosive atmospheres website (www.hse.gov.uk/fireandexplosion/dsear.htm). Detailed guidance on the use of flammable liquids is available in *The safe use and handling of flammable liquids*.⁶

Cleaning methods

Immersion cleaning

The cleaning vessel can range from a suitable open container to a large sophisticated plant with handling equipment for components, means of agitating or spraying solvent or the provision of ultrasonics. To avoid fire risks the supplier's guidance should be followed. Ultrasonics, for example, generate heat.

Where cleaning is carried out relatively routinely, properly engineered and installed equipment should be used, even if that is simple in design. If there are genuine ad hoc, short cleaning jobs then a suitable open container might be used in a way that minimises risks of solvent spillage and vapour release. The solvent should not be left in the open container after use.

If solvents are warmed to assist cleaning the maximum permissible operating temperature should be at least 15 °C below the flashpoint of the solvent used. Reliable, properly maintained thermostats and safety cut-outs will be needed to prevent overheating. Uncontrolled heating of flammable solvents should be avoided.

Measures appropriate to the plant and solvent will be required to control flammable vapours. Sources of ignition should be excluded from the area.

High-pressure spraying of flammable or combustible solvents can increase the risk of ignition and should only be carried out in an enclosure. Some high-flashpoint solvents sprayed under high pressure are

much more readily ignitable than they are in bulk. The risk of ignition in these circumstances may be hardly different from what would arise with low-flashpoint material. Static may be a source of ignition for some solvents. Suppliers should be able to advise on an appropriate standard of enclosure, possibly including vapour recovery and suitably protected electrical equipment.

Precautions should be taken to avoid spillage when transferring solvent from storage to the cleaning plant. Piped systems significantly reduce the risk. Closed containers and drum pumps are useful precautions. Open containers should not be used for transporting solvents.

Appropriate and adequate maintenance of any cleaning plant will be necessary to ensure continued solvent and vapour containment and recovery. For more information on vapour degreasing and recovery see HSE information sheet *Safe use of solvent degreasing plant*.⁷

In situ cleaning

In situ cleaning can be an effective way of cleaning a specific area with less cleaning solution use than might otherwise be needed. Pre-moistened wipes provide a real alternative and are available in water-based and solvent-based forms. If your degreasing or cleaning can be done in this way then the risks and the costs can be reduced. If you are using considerable quantities of wipes a closed system will result in lower exposures to any solvent and is likely to be more cost effective.

In general, the use of highly flammable solvents is not recommended for in situ cleaning. If, exceptionally, such materials have to be used, stringent precautions will be necessary to prevent a flammable mixture forming and remove or control all sources of ignition.

Solvents should be decanted into suitable sealed containers for transporting around the workplace and use. Open containers should not be used. Specially designed, non-spill swab pails are available to dispense flammable solvent safely. Their use is strongly recommended and would be essential in a confined space.

Flammable or combustible materials sprayed from an aerosol (or other high-pressure spray device) may also ignite readily whatever their flashpoints. Aerosol propellants are usually flammable, butane or propane for example. If aerosols or sprays are used, stringent precautions will be required to prevent a flammable vapour/air mixture forming and to ensure that there are no sources of ignition in the vicinity. The use of aerosols containing low-flash solvents

may be particularly attractive to those needing rapid drying of cleaned parts such as electrical switchgear. Flammable materials must not be sprayed onto any ignition source including hot or electrically 'live' equipment.

Rags or swabs that have flammable solvent on them can ignite spontaneously and any such use should be avoided where reasonably practicable. If used, then they should be removed promptly from workrooms and disposed of in fire-resistant bins. Suppliers may recommend soaking them in water before disposal. See the SDS or eSDS for details.

Assisted drying

If forced drying is required, special care needs to be taken to avoid flammable solvent/air mixtures and sources of ignition: pre-moistened wipes minimise the amount of cleaner used and so the drying time.

Storage of solvents

Bulk supplies of flammable solvents should be stored in a safe place in the open air or in a fire-resisting store as described in *The storage of flammable liquids in containers*.⁸

References and further reading

- 1 *Working with solvents: A guide to safe working practices* Leaflet INDG273(rev1) HSE Books 2013 www.hse.gov.uk/pubns/indg273.htm
- 2 *Working with substances hazardous to health: A brief guide to COSHH* Leaflet INDG136(rev5) HSE Books 2012 www.hse.gov.uk/pubns/indg136.htm
- 3 *Safe work in confined spaces. Confined Spaces Regulations 1997. Approved Code of Practice, Regulations and guidance* L101 (Third edition) HSE Books 2014 ISBN 978 0 7176 6622 5 www.hse.gov.uk/pubns/books/l101.htm
- 4 *Surface Cleaning and Preparation: Choosing the best option* GG354 Envirowise www.wrap.org.uk/sites/files/wrap/GG354.pdf www.envirowise.gov.uk
- 5 *Degreasing with solvents (low volatility, small scale work)* COSHH Essentials Sheet SR23 HSE 2007 www.hse.gov.uk/pubns/guidance/sr23.pdf
- 6 *The safe use and handling of flammable liquids* HSG140 (Second edition) HSE Books 2014 ISBN 978 0 7176 6609 6 www.hse.gov.uk/pubns/books/hsg140.htm

7 *Solvent vapour degreasing plant: Use, maintenance and cleaning* Engineering Information Sheet EIS47 HSE 2015
www.hse.gov.uk/pubns/eis47.pdf

8 *Storage of flammable liquids in containers* HSG51 (Third edition) HSE Books 2014
ISBN 978 0 7176 6608 9
www.hse.gov.uk/pubns/books/hsg51.htm

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

This leaflet is available at:
www.hse.gov.uk/pubns/eis21.pdf.

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Safe use of solvent degreasing plant

Engineering Information Sheet No 40

Introduction

This information sheet summarises the main precautions required when carrying out solvent degreasing. It is intended to assist companies using organic solvents (including trichloroethylene) as well as those introducing a 'drop-in' replacement, or converting solvent degreasing plants (degreasers) which previously used trichloroethylene. It should be read in conjunction with HSE's Engineering Information Sheet EIS20(rev1) *Maintenance and cleaning of solvent degreasing plant*.

Most emphasis has been put on open-topped, manually operated degreasing tanks because these have the greatest potential for causing over-exposure. The reclassification of trichloroethylene as a category 2 carcinogen under the Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP3)) and consequent requirements under the Control of Substances Hazardous to Health Regulations (COSHH) and the Solvent Emissions Directive (SED) are discussed in HSE's Engineering Information Sheet EIS34 *Surface cleaning: Solvent update including the reclassification of trichloroethylene*.

Various organic solvents are used in degreasing. The most commonly used are chlorinated solvents such as trichloroethylene, dichloromethane (methylene chloride) and perchloroethylene. These substances may be harmful to health if inhaled. The ill-health effects from inhalation would depend on the substance in use and the concentration and length of exposure. At high concentrations all organic solvents exert a strong narcotic effect and can be fatal. Skin exposure can cause irritation and dermatitis.

COSHH Regulations

The Control of Substances Hazardous to Health Regulations (COSHH) 2002 require exposure to substances hazardous to health to be prevented or, where this is not reasonably practicable, adequately controlled.

Category 1 and 2 carcinogens are subject to specific requirements under COSHH. Trichloroethylene users need to consider:

- (a) substitution, using an alternative solvent or cleaning process; or, if this is not reasonably practicable,
- (b) enclosing the degreasing process as far as is reasonably practicable.

The capital expenditure for a fully enclosed degreasing plant may be recovered from reduced solvent usage. Lower solvent consumption may also lead to the process falling outside the requirements of the SED.

For a properly designed, installed, operated and maintained traditional, open-topped degreaser, experience has shown that 8-hour time-weighted operator exposure levels to trichloroethylene can routinely be maintained well below 20 ppm. Exposures can be even lower with fully enclosed and automated plants.

HSE experience shows that exposures are not always adequately controlled. This is mainly due to poor design, installation and maintenance of the plant and poor working practices.

Equipment suppliers should provide comprehensive installation, operating and maintenance instructions which should be followed by users. Clear summaries of operating and maintenance procedures should be kept readily available for easy reference by plant operators.

Suppliers of solvents and other chemical formulations used for cleaning and degreasing should provide material safety data sheets and any other information necessary to enable customers to use their products safely.

Environmental legislation

The Solvent Emissions Directive has far-reaching implications for surface cleaning. This is outside the scope of this information sheet. Advice should be sought from the Environment Agency (EA), Scottish Environmental Protection Agency (SEPA), the Local Authority Environmental Health Department, the Department for Environment, Food and Rural Affairs (DEFRA) or Envirowise.

When assessing your options you should consider the requirements under both COSHH and the SED. You need to ensure that your process satisfies the requirements for both.

Is cleaning necessary?

This is the first question to ask. Some businesses have already found that by changing their process or operation they can avoid components becoming soiled, or they can reduce the level of soil. This makes

subsequent cleaning easier. Some companies have discovered that cleaning was not critical or necessary for their application. In many of these cases the changes have saved money.

If cleaning cannot be avoided, employers should review all the technical options and decide which method or technology is best for their particular operation. This review should take account not only of the ability of the cleaning technique to remove the dirt or soil, but also the health, safety and environmental implications of the alternatives and the respective costs.

There are many different methods of surface cleaning such as mechanical surface preparation (eg sanding, blasting, dry-ice bombardment); organic solvent cleaning; aqueous cleaning; semi-aqueous cleaning; biological cleaning; conversion coating and combined cleaning and coating. These are discussed in detail with their advantages and disadvantages in *Surface cleaning and preparation: Choosing the best option* GG354 (see page 6).

Even if you decide that solvent degreasing is still the best method for your application, you should examine your plant and process and consider how well the vapour is controlled.

Making the change

Most degreasers in use in the UK today were originally designed to use trichloroethylene, or at least used design criteria based on the properties of trichloroethylene. As a result, switching to an alternative solvent will mean that some adjustment to, or modification of, the plant will be necessary, since, strictly speaking, none of the alternatives are truly 'drop-in' replacements. If nothing else, boiling points are likely to differ, and so safety devices would need to be reset to take account of this.

The use of alternative solvents should be assessed taking into consideration all information. It will not be sufficient for users to simply change the solvent if the degreaser tank is in a poor state of repair and working practices are poor. Using a substitute in a badly maintained plant and/or continuing to follow poor working practices may even increase the risks by exposing workers to high levels of a different hazardous substance. The different solvents are not necessarily immediately interchangeable. If changing from trichloroethylene to either perchloroethylene or methylene chloride or any other organic solvent, then existing plant may require modifications. For example, thermostats will need re-setting if changing from trichloroethylene to perchloroethylene while changing to methylene chloride also requires a reduction in heat input.

Employers considering using a different organic solvent in their existing trichloroethylene degreaser should in

the first instance consult with the supplier(s) of the equipment and the solvent. The suppliers should be able to advise whether a particular installation meets current or any future emission limits or standards and, if not, what modifications are necessary, recommended and practicable. Upgrading certain plant features, especially on older conventional open-topped degreasers, can have a noticeable impact on operator exposure. For example, fitting a motorised lid, retrofitting enclosures with suitable exhaust ventilation, increasing the plant freeboard zone, using a mechanical hoist to load and unload the plant, installing additional cooling coils or refrigerated cooling coils etc can all help to reduce emissions. Again, the equipment supplier should be consulted before any changes are made.

A new COSHH assessment should be carried out where any significant changes are made to the plant, or its operation. Where an employer employs five or more employees, a record should be kept of the significant findings of the assessment as soon as is practicable after the assessment has been made. Employees should be involved in the changeover, both in terms of information and training.

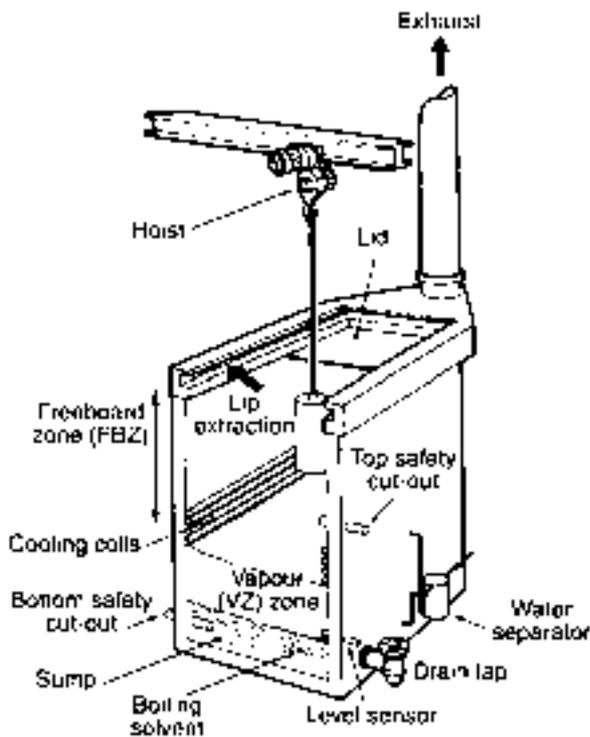
Plant and operational good practices

Failure to maintain and operate a degreaser properly can cause higher exposures than necessary. This information sheet explains what constitutes good practice in the use of solvent degreasers. Guidance is also given in HSE's *COSHH essentials*, Control guidance sheet 227 'Vapour degreasing bath engineering control' (see page 6). A schematic diagram showing the basic features of a widely used design of a conventional open-topped degreaser is given on page 3.

Plant and operational good practices which can minimise the operator exposure to solvents include:

Containment. Solvent degreasing should be carried out in an enclosed system where reasonably practicable. If this is not reasonably practicable, the process should be enclosed as far as possible. This may be achieved by the retrofitting of an enclosure to an open-topped degreaser which ensures that both the tank and the load/unload zone are fully enclosed. It is essential that any retrofitted enclosure is designed, installed and operated correctly and, most importantly, fitted with a suitable extraction system to provide adequate ventilation. Guidance is given in *COSHH essentials*, Control guidance sheet 321 'Vapour degreasing bath - Containment' (see page 6).

Retrofitting of an enclosure on a conventional open-topped degreaser can significantly reduce both operator exposure and vapour emissions into the workplace if designed, installed and operated correctly.



Plant location. Air turbulence in the plant area can cause serious solvent losses. The features that create air currents, and thus disturb the vapour in degreasing units, include: doors, windows, heating and ventilation systems, and busy passages. Degreasers should be located away from any draughts and should be positioned in a no-smoking area. They should be isolated from naked flames, hot surfaces and welding operations. All solvent degreasers emit solvent vapour. In a large workroom the vapour may be diluted and dispersed and cause low exposure. But in a small workroom the same emission rate may cause very significant exposure (there is less dilution, and people have to work nearer the source).

Cooling water supply. Anything which increases the movement of vapour from the vapour zone (VZ) into the freeboard zone (FBZ) will increase emissions and exposure to solvent vapour. Factors such as poor cooling and excessive heating can contribute significantly. The water-cooled condensing system is the primary means of containing solvent vapour within the degreasing plant. The correct flow of water through the system and the temperature of the water are of particular importance. If the outlet temperature is too high for the solvent in use, solvent vapours will not be effectively condensed and may escape from the top of the tank. If the outlet temperature is too low and below the dew point, water vapour will condense on the cooling coils and contaminate the solvent. The heating and cooling systems should be balanced in order to avoid overloading the cooling coils. If water is allowed to remain in the degreaser it can degrade the solvent and lead to corrosion problems.

The water outlet temperature will be influenced by the inlet temperature, which may vary throughout the year,

and by the work throughput of the plant. The cooling coils should be kept clean to ensure continuing efficient heat transfer.

The adequacy of the cooling coils should be checked considering the solvent in use. In some cases additional cooling coils will be necessary and/or refrigerated cooling coils may be recommended.

Lids. Lids on a conventional open-topped degreaser should be designed to fit within the FBZ, below the rim extraction vents. Unsuitable lids such as those which are fitted above the rim ventilation slot, those causing vapour drag-out when lifted, or which are made of unsuitable material should be replaced.

Using lids is important, particularly when the plant is starting up, closing down or idling. Segmented lids are useful on long degreasing units, since they allow partial opening for degreasing smaller items. Sectional lids or roller shutters, where fitted, should only be opened as far as is needed for loading or unloading. Failure to use covers during work breaks will cause unnecessary evaporation of solvent.

Lids which can be retrofitted to a conventional plant should preferably be of a roller or slide design, rather than lift-out panels, as horizontal movement on roller and sliding shutters is less likely to disturb the vapour in the plant.

Water separator. Water can enter a degreaser in a variety of ways. If allowed to remain, it can cause the solvent to degrade and can lead to corrosion. Water separators are normally fitted for the removal of excess water. For water separation to function correctly, it is vital that the gutters below the cooling coils do not overflow when the plant is running. Dirt and debris can build up in the solvent pipework and cause partial blockage, especially along the horizontal runs to the separator. If it is noticed that the gutters are tending to overflow, the pipework should be cleaned.

Support frames. Provision should be made for support frames within the condensation zone to support jig-mounted components. This enables the lifting device to be removed and the lid closed over the work while degreasing is in progress. Frames also help to prevent damage to vulnerable parts of the plant such as the cooling coils.

Freeboard zone. Above the cooling coils is what is known as the freeboard zone (FBZ). There is always some movement of vapour from the vapour zone (VZ) into the FBZ and from the FBZ into the workroom owing to turbulent air diffusion. The rim ventilation is there to control the movement from the FBZ into the workroom but it does not stop it.

The freeboard ratio is defined as the freeboard height divided by the width of the open area of the tank. The

higher this ratio, the less the chance of solvent leaving the plant and entering into the workplace atmosphere. A freeboard ratio of at least 0.75:1 and preferably 1:1 is recommended. A freeboard ratio of less than 0.75:1 is likely to lead to unnecessarily high operator exposure.

Rim ventilation (Lip extraction). Leakage of vapour-laden air from the FBZ into the work area is minimised by lip extraction applied at the top of the tank usually down both the long sides but sometimes on all four sides. The lip extraction is a secondary, but nevertheless essential, control measure to prevent operator exposure and the escape of solvent vapour into the workroom. It is important to remember that the ventilation will control, rather than eliminate, vapour emissions. An extraction rate of 640-915 m³/hr per m² of bath surface working area is recommended. For any degreaser with a specific rim vent design, extract fan specification and ductwork configuration, there will be a specific rim vent velocity. The degreaser supplier should provide the relevant figure.

Other extraction ventilation systems. Exhaust ventilation should be provided to remove solvent vapours from the load/unload zone of both multiple door degreasers and retrofitted enclosures on conventional open-topped degreasers. Exhaust ventilation should also be provided to remove vapours from the sludge door when this is opened, or from a pit in which a degreaser may be located.

Setting of safety devices. Safety devices such as sensors controlling sump level, sump temperature, top-safety cut-out and bottom safety cut-out should be set correctly for the solvent in use. These should be checked regularly. Top safety cut-out is a temperature sensor fitted within the FBZ just above the cooling coils. Its function is to cut off the heat source to the degreaser if the hot vapour level rises too high, for example because the cooling water supply has not been turned on or is inadequate or fails. Bottom safety cut-out is a safety device which is set to limit the temperature of the solvent to prevent overheating and the risk of fire when the solvent becomes heavily contaminated with oil and grease. Some degreasers are additionally fitted with a low level cut-out device which is intended to prevent fire or damage to the plant. Where this is fitted, reliance should not be placed totally on it, and visual checks should still be made on the solvent level.

Solvent level. Maintaining the correct solvent level will help avoid solvent acidity, which can lead to corrosion of the plant, causing leaks or solvent decomposition giving rise to chemical reactions. In addition, if the solvent level falls too low on a heavily contaminated plant, there may be a risk that oils will ignite with further noxious fume emissions.

Solvent condition. Decomposition of the solvent can lead to acid conditions in a degreaser. This can lead to

corrosion of the degreaser and possible solvent leaks. If aluminum or other light metal alloys are being cleaned, in extreme cases a rapid chemical reaction can occur, releasing hydrogen chloride. Warning of acid condition is sometimes given by the appearance of green corrosion deposits on the lower turns of the condensing coil. Decomposition can best be prevented by avoiding cross contamination of solvents, by preventing overheating, by keeping solvent levels topped up with fresh solvent and by regular cleaning out, particularly if light metal alloys are processed.

Correct stacking of hollow components. Hollow components or components with partial enclosed volumes (eg open tubing) require careful stacking or rotational jigs to facilitate draining; otherwise these will not drain properly and will still contain liquid when removed from the degreaser.

Drying time in the FBZ. Components should be allowed to hang dry in the FBZ of the degreaser until all residual solvent has evaporated (known as the dwell time). If there is no hoist or rest within the FBZ and the operator has to hold the basket manually, then dwell time is likely to be too short. A hook or fixture to facilitate this will be helpful and should be used.

Loading/unloading the plant at the correct speed. Loading work too quickly can create a piston effect, pushing solvent out of the degreaser, while withdrawing work too quickly can create excessive 'drag out'. The need for a mechanical hoist to reduce manual handling and to reduce operator exposure during loading/unloading should be considered. Where a hoist is used for loading and unloading, a maximum operating speed of three metres/minute in the vertical plane is recommended.

Workload. Loads should not exceed 50% of the open horizontal area at the plant. Consideration should be given to large components or baskets. Large area components or baskets may cause a pumping action, pushing vapour-laden air out of the FBZ. Large, vertically dimensioned articles may also cause bridging of the VZ and FBZ. Large components or baskets suspended in the FBZ and VZ at the same time may draw high concentrations of vapour into the FBZ.

Correct transfer of work between compartments in the plant. This should be done slowly and preferably below the vapour level. The work should be turned in the FBZ to minimise solvent drag-out.

Topping-up procedures. Fixed pipework should be connected to the sump for topping up with fresh solvent. This avoids operator exposure and possible spillages. If fresh solvent needs to be added, this should be done when the plant is cold, and the solvent should be piped in at a low level within the tank, with the cooling water system and rim ventilation operational. Poor practices such as pouring solvent into

the degreaser from a drum or bucket, particularly when the plant is hot, leads to very high exposures.

Leaks. Solvent leaks can occur from the sump door, pump parts or pipework joints. Corrosion may also result in solvent leaks from the plant. They may be noticed as slight, visible staining. These should not be ignored on the basis that the staining is slight. The amount of solvent lost may be high, as it evaporates, leaving only the oil and grease as evidence. Leaks should be repaired promptly. Checks for leaks should be done when plants are started up from cold because they are often easier to see. To minimise the likelihood of leaks from sump doors, new gaskets should be used each time a door is opened and replaced, unless the existing gasket is in perfect condition.

Avoid spraying above the vapour layer. Where a manual spray lance is used, the parts being sprayed should remain within the vapour zone below the cooling coils. The use of a lance may cause a lot of turbulence and vapour emission.

Clean-out procedures. These are of particular concern since fatal accidents have occurred to people entering degreasers without adequate precautions. Plant should be cleaned regularly to avoid the need for personnel to enter it. Exhaust ventilation should be fitted or made available to the clean-out hatch in the sump. In addition, adequate and suitable respiratory protection must be worn.

Where anyone has to enter degreasers or pits for cleaning, this must be done after an appropriate period of cooling and with the ventilation of the plant switched on, under a formal permit-to-work procedure. Self-contained or air-fed breathing apparatus and other precautions appropriate to work in confined spaces should be used, as detailed in HSE's Engineering Information Sheet EIS20(rev1) *Maintenance and cleaning of solvent degreasing tanks* (see page 6).

Maintenance of the plant. Whatever solvent you use, it is fundamental to the protection of the health of workers that you maintain your plant in an efficient state, in efficient working order and in good repair, and follow good working practices. The whole ventilation system, including the rim ventilation and any other control measures such as safety devices, should be subjected to thorough examination and testing at least once every 14 months by a competent person and records of each examination should be kept for five years. For such tests to be meaningful, it is essential that the design criteria for the particular plant are known.

Solvent management

It is important to have correct procedures for the management of solvent use in the workplace. This should form part of a solvent management plan which

should include: good waste management practices; information on solvent consumption and waste production; correct segregation and labelling of wastes and raw materials; solvent recovery; storage and disposal of waste; policy for dealing with spillages and fugitive emissions etc.

Measurement of emission and exposure

Monitoring of employee exposure to substances hazardous to health is required in circumstances described in regulation 10 of COSHH. Air sampling can form part of such monitoring. For a substance which is assigned an occupational exposure limit (OEL), monitoring is normally required unless the initial assessment shows that the level of exposure is unlikely to exceed the limit. OELs are published in HSE's *EH40 Occupational exposure limits* (ISBN 0 7176 2083 2).

To obtain the best indication of operator exposure and hence compliance with the numerical value, it will be necessary to sample over a full shift or perhaps a shorter, but representative, period from which full shift exposure can be extrapolated. An exposure monitoring regime should consider both short-term and long-term operator exposure to solvents.

This can be done by one of a choice of sampling devices worn on the lapel in the breathing zone. Some have a pump which draws air through a sample tube at a known rate. Others are diffusive samplers which need no pump. With both types, the collected samples are analysed in a laboratory to obtain a concentration value for the substance under test. Companies which do not have such facilities can use independent occupational hygiene consultants or may be able to obtain assistance from the suppliers of the solvent. *The directory of occupational hygiene consultants* is available from the British Institute of Occupational Hygienists (BIOH) (see page 6).

There are also samplers which do not require laboratory back-up because they give a direct reading. One type uses the diffusion principle combined with a coloured stain indicator. Though not as accurate as the more sophisticated methods described above, they can give a good indication of the level of exposure. In the above methods samplers are worn by operators in their breathing zones.

An alternative method of monitoring which may be used is to take measurements at suitable known locations. This can be done using detector tubes. A known amount of air is drawn through a detector tube by means of a set number of strokes of a simple hand-operated pump. The length of the coloured stain produced indicates the concentration of the solvent under test.

Detector tubes can be used for 'spot' measurement of emissions from the process at different points in the

work cycle and in the operator's breathing zone, particularly during the highest emission phase of the work cycle. The highest breathing zone concentration probably occurs when work is taken out of the tank. These are not time-weighted values so there can be difficulties in relating the results to the OEL, but if used properly by trained and competent personnel, detector tubes can give a good indication of vapour-in-air levels and emission patterns.

When carrying out a survey, the movement of air immediately above the plant, especially near the sides, should first be investigated using 'smoke tubes'. These generate a visible smoke to show the pattern of air movement and can also be used to check the rim ventilation. The information they give should be used in deciding where to use the detector tubes.

Measurements should be made at about 5 cm (2") above the middle of the top of the tank and at the locations where tests indicate there might be an escape of solvent vapour.

Detector tubes are typically accurate to +/- 10-15%. They can sometimes suffer from cross-sensitivity. This should be borne in mind when considering results. In cases of doubt, or if measured levels indicate that operator exposure is approaching the occupational exposure limit, a more sophisticated sampling method, as described earlier, may be needed.

Frequency of sampling

Sampling should be carried out:

- (a) when a COSHH assessment is first done and at any significant review of the assessment. Although air sampling is not always required for COSHH assessments it will normally be needed at a solvent degreaser because operating practices can vary and are important in controlling exposure;
- (b) when a degreaser is first installed and after significant repairs or modifications to any of the engineering controls, including the rim ventilation system, or the cooling system. This is to ensure that the controls are operating correctly;
- (c) after major maintenance, including any changes to the hardware;
- (d) if there are any significant changes to operators' working methods or if the type of job being done at the degreaser is changed, ie work throughput or type, or changes to operating practices;
- (e) if the type of solvent being used is changed;
- (f) if problems are suspected, eg if there is any noticeable increase in smell of solvent or complaints from employees about health effects;
- (g) to demonstrate to operators the effects of good and bad working practices.

Further reading

COSHH essentials: Easy steps to control chemicals. Control of Substances Hazardous to Health Regulations HSG193 HSE Books 1999 ISBN 0 7176 2421 8

Maintenance and cleaning of solvent degreasing plant EIS20(rev1) HSE Books 2002

Monitoring strategies for toxic substances HSG173 HSE Books 1997 ISBN 0 7176 1411 5

Seven steps to successful substitution of hazardous substances HSG110 HSE Books 1994 ISBN 0 7176 0695 3

n-Propyl bromide: Hazard assessment document EH75/3 HSE Books 2002 ISBN 0 7176 2350 5

n-Propyl bromide, Chemical Hazard Alert Notice CHAN No26 (Revised) (see HSE website)

The directory of occupational hygiene consultants BIOH Tel 01332 298087 (free)

Surface cleaning and preparation: Choosing the best option GG354 (replacing Vapour degreasing GG15) and *Help in choosing cost-effective options for surface cleaning and preparation* EN354 2003 Envirowise, Tel 0800 585794

Metal and precision cleaning and Cleaning electronics assemblies National Physical Laboratory Tel: 020 8977 3222 (free)

Surface cleaning suppliers list Engineering Employers' Federation (EEF) Tel: 020 7222 7777 (free)

Additional useful publications can be found in EIS20(rev1).

While every effort has been made to ensure the accuracy of the references listed in this publication, their future availability cannot be guaranteed.

Further information

HSE priced and free publications are available by mail order from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA Tel: 01787 881165 Fax: 01787 313995 Website: www.hsebooks.co.uk (HSE priced publications are also available from bookshops and free leaflets can be downloaded from HSE's website: www.hse.gov.uk)

For information about health and safety ring HSE's Infoline Tel: 08701 545500 Fax: 02920 859260 e-mail: hseinformationservices@natbrit.com or write to HSE Information Services, Caerphilly Business Park, Caerphilly CF83 3GG.

This leaflet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

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