BEST
PRACTICE
GUIDELINES

Guide to Managing Solvent Exposure

European Solvents Industry

2

Hydrocarbon &
Oxygenated Solvents
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INTRODUCTION

This document is one of a series of 'Best Practice Guidelines' published by the European Solvents Industry Group (ESIG). It aims to assist solvent users, particularly Small and Medium Size Enterprises (SMEs), in using both hydrocarbon and oxygenated solvents safely. This guide is aimed at managing solvent exposure in relation to the inhalation of vapour, and does not cover other health, safety and environmental impact. However, it is standard industry practice to minimise skin and eye contact, and to ensure the safe and enviromentally sound use of solvents. The approach described is based on a recent UK Health and Safety Executive initiative [1], although some changes have been introduced to adapt the scheme specifically for solvents. The approach represents a basic but effective way of defining the measures required to control exposure during solvent use via a simple risk assessment procedure. Specialist knowledge is not required to use the approach. Users should confirm that conclusions meet specific national regulatory requirements.

The overall risk assessment and control process is shown in Figure 1. The shaded area indicates the risk assessment procedure. The role of measuring solvent vapour concentrations, which was the subject of a previous ESIG Best Practice Guideline [2] is also shown.

HEALTH EFFECTS OF SOLVENTS

Exposure to solvents can occur via contact of the liquid with the skin or eyes, or inhalation of vapour or mist. Skin contact can lead to absorption through the skin: or with repeated or prolonged exposure can increase the potential for defatting, which may result in dermatitis.
Inhalation of solvent vapour can cause respiratory tract irritation, effects on the nervous system, such as dizziness and headaches, whilst very high exposures may cause unconsciousness and even death. However, the selection and use of appropriate controls allows solvents to be used safely and with confidence.

[1] COSHH Essentials (1999) UK Health & Safety Executive
[2] ESIG Measuring Solvent Vapour Concentrations in the Work Environment (1998)

HAZARD, EXPOSURE & RISK
THE BASIS OF THE APPROACH

- HAZARD is the potential of a substance to cause an adverse health effect. The most common EXPOSURE routes for solvents are inhalation of vapour and skin contact with liquids.

- RISK is the chance of an adverse effect occurring under the actual conditions of use and is therefore a function of both HAZARD and EXPOSURE i.e.:

  RISK = function [(HAZARD) x (EXPOSURE)]

- Consequently the RISK can be controlled by reducing the HAZARD (e.g. by the use of a less hazardous solvent) or the EXPOSURE, or both.

The technical approach described here is based on three elements:

- Commonly used solvents are divided into three groups. Grouping is based fundamentally on their recognised health hazards, relating to the inhalation of vapour. However, final judgement has been made using the expertise of industry toxicologists.

- The potential for exposure to vapour can be estimated from how readily the solvent forms a vapour, and the amount which is used. However, even if the solvent does not readily form a vapour, it may still present a risk to health if it is harmful at low concentrations in air or may be absorbed through the skin in harmful amounts.

- Based on the potential risk, one of four control approaches is identified which are used to identify the specific measures required to control solvent vapour to appropriate levels (i.e. within the OELs). These approaches also include measures for the prevention of both skin and eye contact.

Additional measures may be required if:

- Measurements or observations suggest that relevant Occupational Exposure Limits (OELs) may be exceeded.

- The workforce is experiencing adverse effects such as eye or respiratory tract irritation, headaches or other symptoms described in the product Safety Data Sheet.

THE RISK ASSESSMENT & CONTROL PROCEDURE

1. Identify which group the solvent is assigned to using Table 1. (Note the procedure for mixtures detailed and also any flammability risk phrases, e.g. R10, or skin and eye risk phrases, e.g. R21, in order that appropriate action may be taken.)

2. Determine the amount of solvent used for the process:

SMALL	grams or millilitres (i.e. up to 1000 mL [1 litre])
MEDIUM	kilograms or litres (i.e. > 1 to 10^3 litres)
LARGE	tonnes or cubic metres (i.e. > 10^3 litres)

3. Determine how readily the solvent forms a vapour under the conditions of use by referring to Appendix 2. (The volatility of a solvent is a measure of how readily a solvent forms a vapour and so relates to the potential for exposure by inhalation, not to its hazard. The assignment of a volatility category, as described in Appendix 2, is simply a means of ensuring that the correct control approach is identified to manage exposure.)

4. Use Table 2 to decide which control approach is appropriate. A summary of the measures is shown in Figure 2.

5. With reference to Tables 3 and 4, identify the specific control measures required. These become more stringent from Control Approach 1 to 4 and include equipment/ventilation design, maintenance, testing, the use of protective equipment, training and supervision. Controls should be selected to protect against inhalation and, where necessary, skin and eye contact.

FIGURE 1: RISK ASSESSMENT AND CONTROL PROCESS

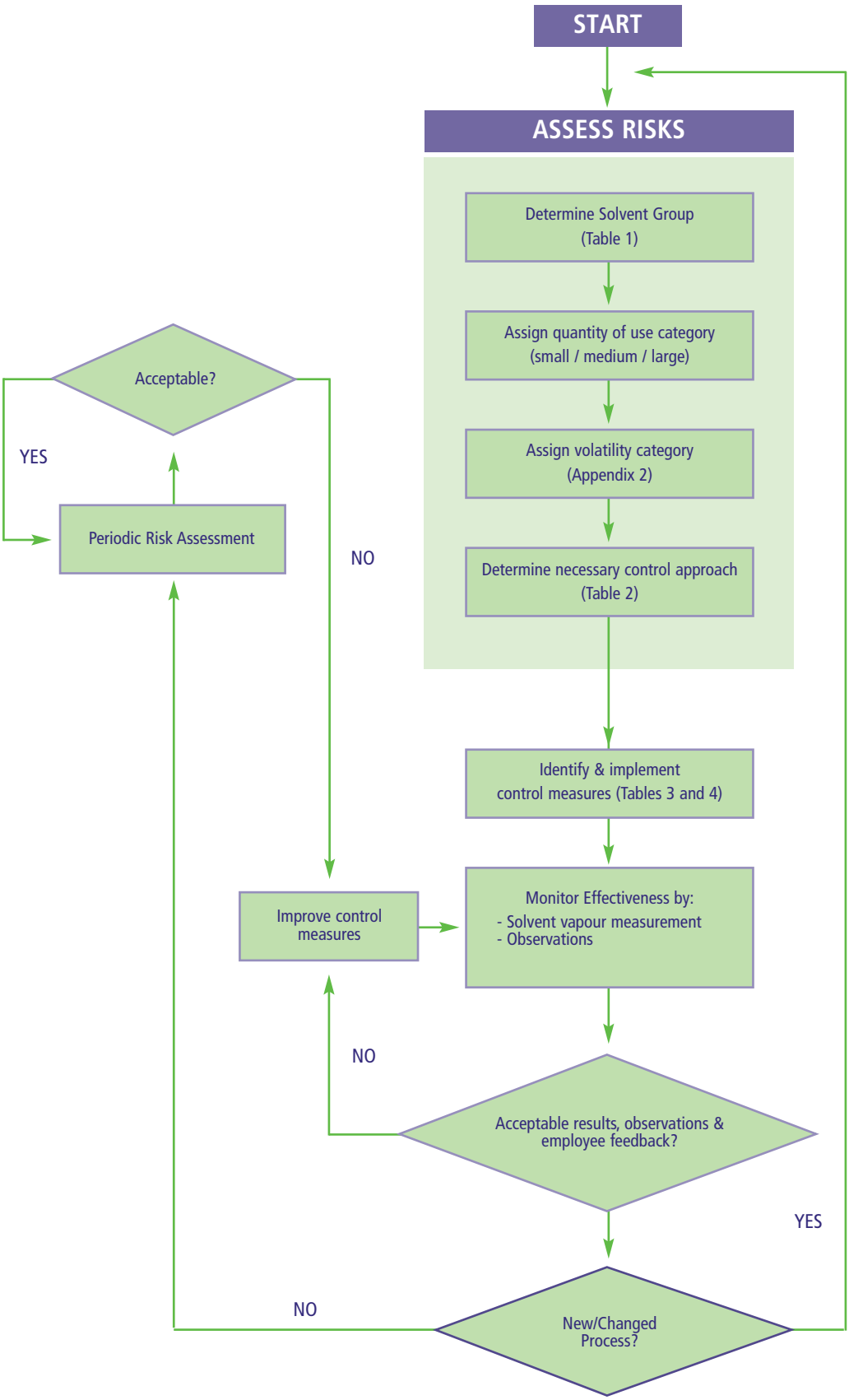

FIGURE 2: SUMMARY OF CONTROL APPROACHES

CONTROL APPROACH	TYPE	Level of Control	DESCRIPTION
1	General Ventilation	BASIC	Good general ventilation and working practices
2	Engineering Control		Local exhaust ventilation or other engineering control
3	Containment		Contained / enclosed systems
4	Special Measures	STRINGENT	Expert advice required

GROUPING OF SOLVENTS

In order to allocate solvents to one of the three groups (A to C), reference has been made to the Risk (R) phrases allocated to a solvent in relation to inhalation of its vapour. This approach used in conjunction with the expertise of industry toxicologists, allows for other considerations not covered by the formal classification. (The R phrases are assigned to substances, including solvents, based on the Classification, Packaging and Labelling of Dangerous Substances legislation, originally described in the EEC Directive 67/548/EEC, and are reviewed at regular intervals.) Table 1 lists the groups of solvents, with their boiling points and CAS Numbers [3]. All commonly used solvents are included, but the list is not exhaustive. For those solvents that are not in the list, further guidance is given below on how to assign a solvent to a particular group. The R phrases relevant to health, safety and environmental hazards of solvents are listed in Appendix 1, with examples for specific solvents.

Notes

1. The Hydrocarbon Classifications are based on the HSPA [4] Generic Product Groups. All classifications relate to the 25th ATP [5].
2. For solvents that are not listed in the above tables, the following process for grouping (based upon exposure by inhalation) can be used. You should refer to the safety data sheet, section 15 for the R phrase, and you should also take into account any other risk phrases that may require special attention (e.g. R21, harmful in contact with skin). Sections 7 and 8 of the safety data sheet have information on handling, storage and personal protection.

   Group A - no Risk Phrases associated with inhalation of solvent vapour, or R67
   Group B - R20 and/or R37
   Group C - R23, R39, R40, R48, R60, R61, R62, R63
3. Where boiling point ranges are indicated it is suggested that the initial boiling point is used in determining how readily a solvent forms a vapour (see Appendix 2).

[3] The CAS Number is the Chemical Abstract Service Number - a number assigned to a chemical that identifies it world-wide. CAS numbers have not been included for the majority of hydrocarbons, since these can have more than one number assigned depending on the supplier.

[4] HSPA is the Hydrocarbon Solvents Producers Association.

[5] ATP is the Adaptation to Technical Progress which relates to the classification of chemicals.

TABLE 1: SOLVENT GROUPS FOR HYDROCARBON & OXYGENATED SOLVENTS BASED ON INHALATION HAZARD

GROUP A

FAMILY	SOLVENT	CAS Number	Boiling Point °C
Alcohols	Ethanol / Industrial Methylated Spirits (IMS) / Denatured Ethanol	64-17-5	78
	n-Propanol*	71-23-8	97
	Iso-Propanol	67-63-0	82
	Hexanol	111-27-3	157
	Diacetone Alcohol (Tech)	123-42-2	168
Esters	Iso-Butyl Acetate	110-19-0	118
	Methyl Acetate	79-20-9	58
	Ethyl Acetate	141-78-6	77
	n-Propyl Acetate	109-60-4	102
	Iso-Propyl Acetate	108-21-4	89
	n-Butyl Acetate	123-86-4	127
	Amyl Acetate	628-63-7	149
	Iso-Amyl Acetate	123-92-2	142
Glycol Ethers/Esters	Diethylene Glycol Mono Butyl Ether	112-34-5	226
	Diethylene Glycol Mono Butyl Ether Acetate	124-17-4	242
	Propylene Glycol Mono Methyl Ether	107-98-2	120
	Propylene Glycol Mono Ethyl Ether	1569-02-4	133
	Dipropylene Glycol Mono Methyl Ether	34590-94-8	184 - 197
	Dipropylene Glycol Mono Ethyl Ether	30025-38-8	188 - 201
	Propylene Glycol Mono Methyl Ether Acetate	108-65-6	146
	Propylene Glycol Mono Ethyl Ether Acetate	54839-24-6	159
	Diethylene Glycol Mono Ethyl Ether	111-90-0	195 - 202
	Diethylene Glycol Mono Ethyl Ether Acetate	112-15-2	214
Ketones	Acetone	67-64-1	56
	Methyl Ethyl Ketone	78-93-3	80
Ethers	Diethyl Ether	60-29-7	35
Hydrocarbons	Isoparaffinic solvents 150-190		150 - 190
	Isoparaffinic solvents 180-220		180 - 220
	n-and isopentanes (excl. cyclopentane)		24 - 35
	Isohexane		55 - 63
	Aliphatic solvents 60-95 low n-hexane		60 - 95
	Cyclohexane	110-82-7	81
	Dearomatised heptane fraction		94 - 100
	Aliphatic dearomatised 80-110		80 - 110
	Aliphatic dearomatised 100-140		100 - 140
	Aliphatic dearomatised 135-165		135 - 165
	Dearomatised Mineral Spirits 150-200		150 - 200
	Dearomatised Mineral Spirit 175-220		175 - 220
	Aliphatic dearomatised 200-250		200 - 250

* n- propanol has been assigned the risk phrase R41 (risk of serious damage to eyes). Therefore, the appropriate protective equipment must be used (safety data sheet, section 8)

TABLE 1: continued SOLVENT GROUPS FOR HYDROCARBON & OXYGENATED SOLVENTS BASED ON INHALATION HAZARD

GROUP B

FAMILY	SOLVENT	CAS Number	Boiling Point °C
Alcohols	Tert-Butanol	75-65-0	83
	Cyclohexanol	108-93-0	161
	Iso-Butanol	78-83-1	108
	Sec-Butanol	78-92-2	100
	n-Butanol	71-36-3	118
	Amyl Alcohol	71-41-0	137
	Iso-Amyl Alcohol	123-51-3	133
Glycol Ethers/Esters	Ethylene Glycol Mono Butyl Ether	111-76-2	171
	Ethylene Glycol Mono Butyl Ether Acetate	112-07-2	194
Ketones	Methyl Iso-Butyl Ketone	108-10-1	117
	Methyl Amyl Ketone	110-43-0	151
	Methyl Iso-Amyl Ketone	110-12-3	145
	Cyclohexanone	108-94-1	157
Ethers	Tetrahydrofuran	109-99-9	66
Hydrocarbons	Toluene	108-88-3	110
	Solvent Xylene	130-20-7	137 - 142
	Aromatic solvents 160-185		160 - 185
	Aromatic solvents 180-215		180 - 215
	Mineral Spirits 150-200		150 - 200
	Mineral Spirits 175-220		175 - 220
	Heavy Mineral Spirits 200-260		200 - 260

GROUP C

FAMILY	SOLVENT	CAS Number	Boiling Point °C
Alcohols	Methanol	67-56-1	65
Glycol Ethers/Esters	Ethylene Glycol Mono Methyl Ether*	109-86-4	123
	Ethylene Glycol Mono Ethyl Ether*	110-80-5	143
	Ethylene Glycol Mono Methyl Ether Acetate*	110-49-6	143
	Ethylene Glycol Mono Ethyl Ether Acetate*	111-15-9	156
	Diethylene Glycol Mono Methyl Ether	111-77-3	194
Ketones	Methyl n-Butyl Ketone (Hexan-2-one)	591-78-6	125
	Isophorone	78-59-1	215
Hydrocarbons	Technical Hexane		65 - 70

* European suppliers of these specific four substances have pursued a voluntary policy for several years, of limiting supply only to non-consumer applications, and for use in industrial processes where no practicable substitutes have been found and where procedures to protect employee health can be ensured. The industry believes that these glycol ethers, can be used safely when they are handled in accordance with the manufacturer's information and guidance, and with good manufacturing and defined safe handling practices.

TABLE 2: DEFINITION OF CONTROL APPROACH

HAZARD GROUP A			
Quantity Used	CONTROL APPROACHES		
	Low Volatility	Medium Volatility	High Volatility
Small	1	1	1
Medium	1	1	2
Large	1	1	2

HAZARD GROUP B			
Quantity Used	CONTROL APPROACHES		
	Low Volatility	Medium Volatility	High Volatility
Small	1	1	1
Medium	1	2	2
Large	1	2	3

HAZARD GROUP C			
Quantity Used	CONTROL APPROACHES		
	Low Volatility	Medium Volatility	High Volatility
Small	1	2	2
Medium	2	3	3
Large	2	4	4

Prior to selecting control measures, you should first assess whether there is a problem with your current measures for managing solvent exposure, e.g. by monitoring airborne solvent concentrations and/or observing adverse effects experienced by the workforce.

The following hierarchy should be considered when selecting control measures:

- The use of an alternative solvent or lower operating temperatures. However, care should be taken in the choice of an alternative solvent to ensure that the substitute does not introduce new and/or greater overall health, safety or environmental risks.
- Use appropriate equipment design and operation to minimise vapour release and solvent spillage and the possibility of skin or eye contact.
- Remove solvent vapours by either general or local exhaust ventilation, to a safe point away from occupied working areas.
- Keep the number of people exposed to solvent vapours to a minimum.
- Use of personal protective equipment (PPE), e.g. gloves, respirators.

Many activities will be close to the boundary between 2 control approaches. In this situation there is clearly some flexibility in the selection of the specific control measures. For example, practical considerations and common industry practice, which has been shown by experience to be safe, may impact the final decision.

In general, special control measures (Control Approach 4) are unlikely to be necessary for the vast majority of commercial solvent applications. However, where special measures are indicated, more detailed advice than can be provided in this guide is required. This may involve the employment of a qualified occupational hygienist to undertake a more detailed risk assessment. Every aspect of the operation should be considered in detail in order to identify opportunities for exposure and appropriate control measures. Solvent substitution may have to be considered in these cases.

Mixtures of Solvents

Where mixtures containing the individual solvents described in Table 1 are employed, it is recommended that the following procedure is used:

- Allocate each solvent to the appropriate group
- Sum the volumes of solvent in each group to obtain the total volume of solvent corresponding to each of the groups A to C
- Assign a volatility class to each of these groups using the class of the most volatile constituent
- Determine the appropriate control approach for each group
- Select the most protective approach for use with the overall solvent mixture

(Case study 9, presented towards the end of this guide demonstrates how this procedure is applied within a worked example.)

TABLE 3: SELECTION OF SPECIFIC CONTROL MEASURES

CONTROL MEASURES	CONTROL APPROACH			
ACCESS	1	2	3	4
Consider restricting access to those who need to be there	✔			SEEK EXPERT ADVICE
Restrict access to authorised staff only		✔		
Control staff entry to work area; label work area and equipment			✔	
DESIGN AND EQUIPMENT				
Natural ventilation from open windows and doors may be adequate; more extensive applications may require mechanical ventilation (such as a wall mounted extractor fan or a ducted system). (Ensure emissions to environment comply with any national requirements.)	✔			
Apply local exhaust ventilation (LEV) as close to the vapour source as possible		✔		
Enclose the source of vapour as much as possible to help stop it spreading			✔	
Ensure sufficient uncontaminated make-up air is provided	✔	✔	✔	
Ensure, where possible, that vapours are drawn away from the worker by the ventilation system		✔		
Site the work away from doors and windows to prevent draughts interfering with the LEV system efficiency		✔		
Handle solvent in closed system; limited breaching allowed, e.g. to take samples (in safe specified manner)			✔	
Discharge extracted air away from doors, windows and air inlets to prevent vapour being drawn back into the workroom		✔	✔	
Provide an easy way of checking the LEV is working, e.g. pressure gauge or "tell-tale"		✔	✔	
Where possible, keep system under negative pressure to stop leaks			✔	
MAINTENANCE				
Maintain mechanical ventilation systems as advised by suppliers	✔	✔	✔	
Ensure all containment equipment is maintained as advised by the supplier			✔	
Adopt a "permit-to-work" system for maintenance work			✔	

TABLE 3 continued | SELECTION OF SPECIFIC CONTROL MEASURES

CONTROL MEASURES	CONTROL APPROACH			
EXAMINATION AND TESTING	1	2	3	4
Visually check ventilation/containment equipment at least weekly (e.g. using smoke) to ensure that it is working and has not been damaged	✔	✔	✔	SEEK EXPERT ADVICE
Obtain information on the design performance of the LEV for comparison with future test results		✔	✔	
Get ventilation systems checked periodically against the performance specification and keep records of the tests	✔	✔	✔	
Conduct periodic air monitoring to assess potential for exposure	✔	✔	✔	
CLEANING AND HOUSEKEEPING				
Clean up solvent spills immediately	✔	✔	✔	
Replace lids on solvent containers immediately after use	✔	✔	✔	
Store containers in a safe place and dispose of empty containers safely	✔	✔	✔	
Clean all work equipment and the work area regularly	✔	✔	✔	
PERSONAL PROTECTIVE EQUIPMENT (PPE)				
Solvents with Risk Phrases indicating potential damage to skin and eyes. If potential skin/eye contact cannot be prevented by other means, consult the Safety Data Sheet for advice on appropriate PPE	✔	✔	✔	
Keep PPE clean and replace at recommended intervals or when inspection indicates defects	✔	✔	✔	
Respiratory protective equipment (RPE) may be needed for some tasks, e.g. when containment is broken, cleaning up spills, etc. (There are two types, those that filter the air using a cartridge which removes the solvents as it passes through and those that provide fresh air. For cartridge designs, these have a limited life and should be changed regularly and stored in appropriate containers.)		✔	✔	
TRAINING				
Give workers information on the hazards of solvents	✔	✔	✔	
Provide training on handling solvents safely, the proper use of equipment and what to do if something goes wrong	✔	✔	✔	
SUPERVISION				
Check that control measures are in place and being followed	✔	✔	✔	

TABLE 4: EXAMPLES OF EQUIPMENT/VENTILATION DESIGN FOR COMMON ACTIVITIES INVOLVING SOLVENTS

	Operation	Indicated Control Approach	Suggested Equipment/ Ventilation	Case Study Link (p17-19)
I	Bench work involving small to medium quantities of Group A Solvents Group B Solvents Group C Solvents	 1 1 - 2 2 - 3	 Natural ventilation with possible use of extraction fan installed over bench. Use of extract enclosure or fume cupboard.	 Yes (2)
II	Use of solvent based trim paints in domestic situations (Group A and B)	1	Employ natural ventilation by opening doors and windows to dilute solvent vapours.	Yes (5)
III	Use of solvent based adhesives in floor laying; Group A Solvents Group B Solvents	 1 1 - 2	 Employ natural ventilation by opening doors and windows. Supplement by use of fans/air movers.	 Yes (1)
IV	Printing - small scale batch process (e.g. screen printing) Group A and B solvents	1 - 2	Ensure good general ventilation. Local extraction over machines where possible.	Yes (3, 7)
V	Printing - large scale continuous Group A and B solvent	2	Local exhaust ventilation over machines.	No
VI	IBC filling and emptying; Group A and B Solvents Group C Solvents	 2 - 3 3 - 4	 Vent displaced air to storage tank or high level discharge. Contain filling operation to maximum extent possible by extracted enclosure.	 No
VII	Drum filling; Group A and B Solvents Group C Solvents	 2 3	 Employ local exhaust ventilation as near to top of drum as possible. Contain filling operation to maximum extent possible by extracted enclosure.	 No
VIII	Manufacturing solvent containing products using medium quantities of solvents Group A and B Solvents	2	Use local exhaust ventilation (LEV) and supply fresh air to replace extracted air.	No
IX	Spray painting (medium scale) Group A and B Solvents	1 - 2	Provide extraction booth large enough to contain all equipment.	Yes (9)
X	Vapour degreasing bath Group A and B Solvents	2 - 3	Provide bath with rim/exhaust ventilation. Contain activity to greatest extent possible and provide extraction in drying zone.	Yes (4)
XI	Seed extraction with Group C Solvents (i.e. technical hexane)	4	Design plant to minimise solvent emissions and provide ventilated enclosures for sample taking.	Yes (6)

CASE STUDIES

1. Activity	Floor laying (at 25°C)	
Product	Adhesive containing toluene	Group B
Amount of Solvent used	2 litres	Medium Volume
Volatility	Bp 110°C	Medium Vapour
	CONTROL APPROACH	2

Control approach 2 is probably not practicable. Could substitute with an adhesive based on an aliphatic solvent, e.g. aliphatic dearomatised solvent 100 - 140 (Group A) which would indicate control approach 1, i.e. General Ventilation (see Operation III, Table 4).

2. Activity	Degreasing car parts in a solvent wash bath at 25°C	
Product	Dearomatised mineral spirit 175-220	Group A
Amount of Solvent used	10 - 200 litres	Medium Volume
Volatility	b.pt. 175°C	Low Vapour
	CONTROL APPROACH	1

General ventilation (see Operation I, Table 4). Protect skin with appropriate gloves.

3. Activity	Washing down of lithographic printing presses	
Product	Iso-Propanol	Group A
Amount of Solvent used	0.5 litres	Small Volume
Volatility	b.pt. 82°C	Medium Vapour
	CONTROL APPROACH	1

General ventilation (see Operation IV, Table 4). Use appropriate eye protection.

4. Activity	Vapour cleaning of metal parts	
Product	Isoparaffinic Solvent 180-220	Group A
Amount of Solvent used	500 litres	Med-Large Volume
Volatility	b.pt. 180°C	High Vapour (due to type of process)
	CONTROL APPROACH	2

Table 2 indicates Control Approach 2 for both Medium and Large volume. However, this activity is normally conducted in purpose designed closed equipment, incorporating flammability control, which offers Control Approach 3 (see Operation X, Table 4).

5. Activity	Brush application of indoor gloss paint	
Product	Mineral spirits 150-200 (white spirit)	Group B
Amount of Solvent used	0.4 litres (1 litre of Paint)	Small Volume
Volatility	b.pt. 150°C	Medium Vapour
	CONTROL APPROACH	1

General ventilation (see Operation II, Table 4).

6. Activity	Extraction of seeds	
Product	e.g. Technical Hexane	Group C
Amount of Solvent used	1 tonne	Large Volume
Volatility	b.pt. 65-70°C	High Vapour (due to type of process)
Special Control	CONTROL APPROACH	4

Seek expert advice (see Operation XI, Table 4).

7. Activity	Screen printing cleaning (e.g. 0.8m^2 screen size)	
Product	Cyclohexanone	Group B
Amount of Solvent used	800 millilitres	Small Volume
Volatility	b.pt. 157°C	Low Vapour
	CONTROL APPROACH	1

Ensure good general ventilation, local extraction over machines where possible (see Operation IV, Table 4).

8. Activity	Glass & surface cleaning in industrial setting	
Product	Ethylene glycol mono butyl ether (8% in water)	Group B
Amount of Solvent used	40 millilitres (0.5 litres of product)	Small Volume
Volatility	b.pt. 171°C	Low Vapour
	CONTROL APPROACH	1

Ensure good general ventilation.

9. Activity	Medium scale spraying with nitro-cellulose lacquer at 25°C	
Product	10% Methyl ethyl ketone, b.pt. 80°C 20% Methyl isobutyl ketone, b.pt. 117°C 5% Iso-propanol, b.pt. 82°C 5% Amyl alcohol, b.pt. 137°C 60% Toluene, b.pt. 110°C	
Amount of Solvent used	2 litres @ 25°C	
Volatility	for all constituents	
As this is a complex solvent system, we need to split each component into the relevant groups, volumes and volatilities, then assess the control approach appropriate to each group of solvents. Finally, we select the approach providing the highest overall level of control. The volumes of each group of solvents with the same hazard and volatility groupings are summed for this assessment.		
Product	(a) MEK and Iso-propanol (15% of total Solvent Volume)	Group A
Amount of Solvent used	15% of 2 litres = 300millilitres	Small Volume
Volatility	Medium	Medium Vapour
	CONTROL APPROACH	1
Product	(b) Toluene, MIBK and Amyl Alcohol (85% of total Solvent Volume)	Group B
Amount of Solvent used	85% of 2 litres = 1.7 litres	Medium Volume
Volatility	Medium	Medium Vapour
	CONTROL APPROACH	2
Select Control Approach 2. Extraction booth/enclosure (see Operation IX, Table 4). Use appropriate skin and eye protection.		

Worked Example of Case Study 9	
Determine Solvent Group: (Ref: Table 1)	(i) Methyl ethyl ketone (10%) + Iso-propanol (5%) = Group A (15% of total solvent mixture) (ii) Methyl isobutyl ketone (20%) + Amyl alcohol (5%) + Toluene (60%) = Group B (85% of total solvent mixture)
Assign Quantity of Use Category: (Ref: text p.4)	(i) 15% of 2 litres = 0.3 L (300 mL) = SMALL volume. (ii) 85% of 2 litres = 1.7 L (1700 mL) = MEDIUM volume.
Assign Volatility Category: (Ref: Appendix 2)	Group A (Methyl ethyl ketone = b.pt. 80°C; Iso-propanol = b.pt. 82°C at 25°C are MEDIUM VOLATILITY.) Group B (Methyl isobutyl ketone = b.pt. 117°C, Amyl alcohol = b.pt. 137°C, Toluene = b.pt. 110°C at 25°C are MEDIUM VOLATILITY.)
Determine Necessary Control Approach: (Ref: Table 2)	Group A - small volume & medium volatility 1 Group B - medium volume & medium volatility 2
	nb: Adopt the highest level of control recommended, therefore adopt Control Approach 2.

KEY MESSAGES

- This is a SIMPLE approach which does NOT require specialist knowledge to use.
- Practical effective guidance is provided on the measures required to control inhalation of solvent vapour.
- It is standard industry practice to minimise skin and eye contact. (Refer to safety data sheet section 8.)
- By selecting an appropriate combination of solvent and control measures, safe working conditions can be achieved for the majority of applications.
- If Control Approach 4 is indicated, specialist advice may be required to assist in the design of any engineering controls and to confirm the risk assessment.
- Once the appropriate control measures have been selected, make sure that the installer of any equipment is clear of your objectives and tests the modified process over the whole range of situations to ensure that your objectives are achieved.
- Engineering controls require regular maintenance and testing to ensure they continue to function effectively.
- Solvent vapour measurements should be undertaken to determine that the control measures are working correctly. Record and keep the results for future reference. 'A Guide to Measuring Solvent Vapour Concentrations in the Work Environment' is available from ESIG.
- Should any 'odd' or 'unexpected' results be obtained, conduct an investigation immediately to determine the reason. Record and keep the measurements and explanations.
- Help and advice is available from your solvent supplier who should be consulted if there is any query relating to the procedure outlined in the Guidance.

Appendix 1: RISK PHRASES THAT CAN RELATE TO SOLVENTS

In the regulations, chemicals have been assigned risk phrases. The following risk phrases can be relevant to hydrocarbon and oxygenated solvents, however, only some of the risk phrases detailed below apply to a specific solvent (examples are shown).

Inhalation

R20	Harmful by inhalation
R23	Toxic by inhalation
R37	Irritating to the respiratory system
R67	Exposure may cause dizziness and drowsiness

Others (health)

R22	Harmful if swallowed
R25	Toxic if swallowed
R39	Danger of very serious irreversible effects
R40	Possible risk of irreversible effects
R48	Danger of serious damage to health by prolonged exposure
R60	May impair fertility
R61	May cause harm to unborn child
R62	Possible risk of impaired fertility
R63	Possible risk of harm to the unborn child
R65	Harmful: may cause lung damage if swallowed

Skin and Eye Contact

R21	Harmful in contact with skin
R24	Toxic in contact with skin
R36	Irritating to eyes
R38	Irritating to the skin
R41	Risk of serious damage to eyes
R66	Repeat exposure may cause skin dryness and cracking

Safety

R10	Flammable
R11	Highly flammable
R12	Extremely flammable
R19	May form explosive peroxides

Environment

R50	Very toxic to aquatic organisms
R51	Toxic to aquatic organisms
R52	Harmful to aquatic organisms
R53	May cause long term adverse effects in the aquatic environment

Examples:

Ethanol	R11
Methyl Ethyl Ketone	R11, R36, R66, R67
n-Butyl Acetate	R10, R66, R67
Propylene Glycol Mono Methyl Ether Acetate	R10, R36
Xylene	R10, R20/21, R38
Aliphatic Dearomatised 80/110	R11, R38, R51/53, R65, R67
Mineral Spirits 175-220	R65, R66

(As can be seen from the above examples, some solvents are allocated combination Risk Phrases, based upon those listed above.)

Appendix 2: DETERMINATION OF HOW READILY A SOLVENT FORMS A VAPOUR

The volatility of a solvent is a measure of how readily a solvent forms a vapour and so relates to the potential for exposure by inhalation, not to its hazard. The assignments for volatility given in this appendix represent a means of ensuring that the correct control approaches can be put in place to manage exposure.

- Solvents with boiling points below 50°C can be regarded as high volatility.
- Solvents with boiling points from 50°C to 150°C can be regarded as medium volatility.
- Solvents with boiling points over 150°C can be regarded as low volatility

The operating temperature will effect the volatility of the solvent.

Therefore;

- If using a medium volatility solvent (i.e. one with a boiling point from 50°C to 150°C) at operating temperatures within 30°C of its boiling point, treat as high volatility.
- If using a low volatility solvent (i.e. one with a boiling point above 150°C) at operating temperatures within 30°C of its boiling point, treat as high volatility. If operating within 130°C to 30°C of its boiling point, treat as medium volatility.

e.g.
Dearomatised Mineral Spirits 150-200°C

- If operating at 30°C, then medium volatility (since 30°C is within 130°C of the b.pt.)
- If operating at 120°C, then high volatility (since 120°C is within 30°C of the b.pt.)

Similarly,
Ethylene Glycol Mono Butyl Ether (b.pt. 171°C)

- If operating at 20°C, then low volatility (since 20°C is not within 130°C of the b.pt.)
- If operating at 50°C, then medium volatility (since 50°C is within 130°C of the b.pt.)

Appendix 3: GLOSSARY

ATP	Adaptation to Technical Progress
b.pt.	Boiling Point
CAS No.	Chemical Abstracts Service Number
ESIG	European Solvents Industry Group
HSPA	Hydrocarbon Solvents Producers Association
IBC	Intermediate Bulk Containers
LEV	Local Exhaust Ventilation
OEL	Occupational Exposure Limits
OSPA	Oxygenated Solvents Producers Association
PPE	Personal Protective Equipment
RPE	Respiratory Protective Equipment
SDS	Safety Data Sheet

European Solvents Industry

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