Occupational Exposure Monitoring

at

FM Extrusions, Worsley

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FTOM 24648

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GEMINI ADHESIVES LIMITED

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EXECUTIVE SUMMARY

As part of their ongoing commitment to comply with Health and Safety legislation, Gemini Adhesives Limited (Gemini) commissioned RPS Health, Safety and Environment to carry out a monitoring study at the FM Extrusions Factory in Worsley, Manchester. The study was undertaken by Martin Johnson of RPS Health, Safety and Environment on the 12th March 2013.

A strategy of personal sampling was undertaken in accordance with guidance published by the Health and Safety Executive to assess occupational exposure to a number of hazardous substances. Monitoring was conducted during two separate exercises that simulated the fitting of capping and coving strips for commercial flooring; first using Grabfast Gold as a contact adhesive and then using a competitor branded adhesive. The specified hazardous substances were measured using a sampling technique in accordance with the methodology described in the HSE's in MDHS 96: *Volatile Organic Compounds in Air*.

This survey will enable Gemini to comply with the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as Amended), in particular Regulations 7 and 10. The results will also assist Gemini to carry out and/or review risk assessments in the above areas as required by Regulation 6 of the COSHH Regulations.

Findings
The calculated exposure results for the hazardous substances tested during the Grabfast Gold simulation were all significantly lower than the associated occupational exposure limits. With the exception of toluene, this was also the case for the substances sampled during the second test (using the branded adhesive). Without taking into consideration the protection afforded by the use of a half-mask respirator used during the second test, the exposure result for toluene was almost twice the long term exposure limit. However, provided the respiratory protective equipment is used and maintained correctly, there is little risk to worker health whilst using the branded contact adhesive.

It can be concluded that on the basis of the simulated occupational exposure monitoring undertaken in the proposed rest room at the FM Extrusions Factory in Worsley, Manchester and taking into consideration observations made during the survey, it is evident there is little cause for concern with regard to operator health.

Recommendations
On the basis of the occupational exposure monitoring undertaken in the proposed rest room at the FM Extrusions Factory in Worsley, Manchester on the 12th March 2013 and taking into consideration the control measures in place and working practices, a number of general recommendations have been made to help reduce exposure to volatile organic compounds when using the two contact adhesives tested in this survey.

1.0 INTRODUCTION

At the request of Mr A. Douglas of Gemini, RPS Health, Safety and Environment carried out workplace air monitoring at the FM Extrusions Factory in Worsley, Manchester. The aim of the survey was to assess occupational exposure to a number of hazardous substances, during an exercise that simulated the fitting of capping and coving strips for commercial flooring with specified contact adhesives.

The data produced by the survey is intended to assist Gemini in completing the risk assessments required under Regulation 6 of the COSHH Regulations 2002 as amended.

Simulated sampling was undertaken in a small room (proposed rest room) in one corner of the factory. According to Gemini personnel this potentially represents the worst case exposure scenario for workers might be subject to, whilst laying sheeting within a typical commercial/public property. This report and the sampling conducted refer to prevailing conditions at the time of the survey and care needs to be taken when extrapolating the findings to estimate potential exposures under other conditions.

1.1 Scope of Works

The scope of works was based upon the RPS Health, Safety and Environment proposal to Gemini, with the site work being agreed by Martin Johnson of RPS Health, Safety and Environment and Mr A. Douglas of Gemini.

The occupational exposure investigations undertaken during the survey consisted of personal monitoring techniques only, for the substances and areas listed in 1.2 below.

1.2 Breakdown of Sampling and Analysis

Personnel	Analyte(s)	No. of Samplers Deployed	Sample Type Taken
Tony M^{c}Ghee (Floor Layer) – Adhering Capping and Coving Strips to the wall using Gemini Grabfast Gold sprayed contact adhesive	Isobutane Dichloromethane Propane	1	Personal
Tony M^{c}Ghee (Floor Layer) – Adhering Capping and Coving Strips to the wall using a competitor hand applied contact adhesive	Acetone Butanone n-Hexane Toluene (methylbenzene) Xylene (isomers of dimethylbenzene)	1	Personal

2.0 METHODOLOGY

2.1 General

A strategy of personal sampling was undertaken in accordance with guidance published by the Health and Safety Executive. Personal samples were located within the breathing zone, no more than 30 cm from the nose and mouth area. All samples taken were analysed in the RPS Laboratories Ltd UKAS accredited laboratory in Manchester. Where appropriate, personal exposures have been time weighted with regard to the specified reference periods quoted in Environmental Hygiene Guidance Note EH40/05 in accordance with the method quoted therein.

Hazardous Substance	Method Reference	Capture Media/Sampling Head
Volatile Organic Compounds (VOCs) inc.: Acetone Isobutane Butanone Dichloromethane n-Hexane Propane Toluene Xylene	MDHS 96 with subsequent solvent desorption and analyses by gas chromatography-flame ionisation detection	Solid sorbent tube capture using SKC type 226-09 (CSC activated carbon) with GF filtration

2.2 Sampling for Volatile Organic Compounds (VOCs)

Sampling for VOCs was undertaken in accordance with prescribed procedures published in the HSE's published monitoring method MDHS 96 – *Volatile organic compounds in air*. Samples were captured onto SKC 226-09 activated carbon sorbent tubes with GF filtration. The sample trains were calibrated at the start and end of sampling to determine the volume of air sampled, using a traceable Bios Drycal Defender dry flow meter. Workplace air was drawn through the sorbent tubes at controlled flow rates using battery powered sample pumps. All samples were carefully recovered, stored appropriately and made ready for transport to the laboratory for subsequent solvent desorption, and analyses by Gas Chromatography – Flame Ionisation Detection. Analyses for Acetone, Butanone, Dichloromethane, n-Hexane, Toluene and Xylene were carried out following RPS Laboratories' accredited procedure O8. Analyses for the two alkanes were conducted using an in-house developed procedure G8.

3.0 OBSERVATIONS

General
Gemini manufactures and supplies a range of sprayable contact adhesives for bonding capping and coving strips for commercial flooring. The Adhesives are intended for use by commercial flooring companies working on large private and public buildings. This survey was carried out to assess exposure to the various VOCs contained within two protection covering contact adhesives used by flooring contractors. One was a competitor brand hand applied adhesive and the other was Gemini's own sprayable Grabfast Gold. According to Gemini, floor laying personnel tend to work 8 hour shift with a ½ hour break. Although a number of operatives can work on a particular job at any one time (depending on the size of the building), individual contractors tend to work alone in specific areas/rooms of a building.

For logistical reasons monitoring was conducted during a simulated exercise in a factory selected by Gemini in Worsley (FM Extrusions). A single contractor was employed by Gemini to fit floor/wall coving and capping in a small corner room (approximately 2.5m x 4m), intended to be converted into a rest room. The internal room has no ventilation or extraction and according to Gemini personnel potentially represents the worst case exposure scenario for flooring contractors.

The coving and capping simulated exercise was carried out twice in the same room, first using the Grabfast Gold contact adhesive and then using the competitors. Gemini was advised to use the adhesives in this order to ensure the less volatile components of the slower drying branded adhesive did not interfere with the second simulation exercise, and to reduce the worker's exposure period.

The plastic concave coving provides a stable backing at the wall/floor joint over which PVC flooring can be laid. The capping provides a fixing point on the wall for the flooring. Contact adhesives are used in coving and capping because they provide an effective technique for bonding the plastic sheeting to uneven surfaces. Floor covering is installed normally using a water-based adhesive.

3.1 Simulation Exercise Using Grabfast Gold

The following observations were made during the survey in relation to worker exposure to the main hazardous solvents contained in Grabfast Gold:

The operative first cleared the floor of debris using a combination of a long handled brush, a dust pan and brush and a vacuum cleaner. He used an infrared heater for a short period to heat the room to a reasonable temperature – Grabfast works optimally at 18^{o}C. The Grabfast Gold self contained maintenance free 17kg canister spray gun system was made ready. This was done outside the room, in the main factory.

The operative then coated the entire room, only spraying the required area of floor and wall where the coving and capping was to be bonded. The operative did this using a long sweeping action whilst on his hands and knees. On occasion his face was less then 0.25m from the nozzle head of the spray gun. The spray period within the room was approximately 4 minutes duration over which time the door into the factory was left open. The operative left the room immediately when the spray application was completed, which is typical procedure according to the operative.

The operative then set up his equipment and sprayed one side of the capping/coving profiles out in the main factory, where the effects of dilution ventilation would be greater. Again this is a typical procedural response in order to reduce exposure. The spraying of the

stripping took only 2 to 3 minutes to complete. After a short drying period, the operative carried the prepared capping/coving profiles into the room and bonded it to the walls and floor. He hand pressed the strips into place and mitred the corners whilst on his hand and knees. His head was close to the coated surfaces at all times.

During the Grabfast simulation the operative wore standard knitted gloves but did not wear any form of respiratory protective equipment. According to Gemini the flooring contractors would perhaps replicate between 6 to 8 times the amounts of work completed in this simulation during a typical working day.

3.2 Simulation Exercise Using a Competitor Brand Adhesive

The following observations were made during the survey in relation to worker exposure to the main hazardous solvents contained in the competitor brand adhesive:

The 5L containers of branded adhesive and coating brushes were made ready outside the room, in the main factory. The operative opened the first 5L container to mix, and began hand coating the floor and wall areas where the coving and capping was to be bonded. The operative did this using a long sweeping motion whilst on his hands and knees. His face was always close to the contact surface. The operative worked in the room until all surfaces were coated and this took 3 to 4 times longer than the application of the Grabfast. The door into the factory was left open and the operative left the room immediately all the surfaces were coated.

The operative then laid out on the floor of the main factory all the capping/coving profiles and began to hand coat the adhesive on the contact surface side. Again this took considerably longer to complete than the spray coating application with Grabfast Gold. The operative's head was generally close to the contact surfaces while he was undertaking this task. After a certain length of drying time, the operative carried the prepared capping/coving profiles into the room and bonded them to the walls and floor. He hand pressed the strips into place and mitred the corners whilst on his hand and knees. His head was close to the coated surfaces at all times.

During this simulation the operative wore standard knitted gloves and a soft moulded rubber Safir R300 half mask respirator, fitted with a class A1/P2 R326 organic vapours/dust cartridge (EN141 2000). According to the operative he only wears respiratory protective equipment (RPE) if he can detect a strong odour in the area he his working. During this simulation exercise a relatively strong toluene type odour could be detected in both areas where the adhesive was being used, both during the application and drying stages.

4.0 HYGIENE STANDARDS

The Health and Safety Executive (HSE) publish a list of Occupational Exposure Limits (OELs) in their publication EH40, which form part of the requirements of the Control of Substances Hazardous to Health Regulations 2002 (COSHH) as amended by the Control of Substances Hazardous to Health (Amendment) Regulations 2004.

Workplace Exposure Limits (WELs) are OELs set under COSHH, in order to help protect the health of workers. WELs are concentrations of hazardous substances in air, averaged over a specified period of time referred to as a time-weighted average (TWA). Two time periods are used: long term (8-hour TWA) and short term (15 minutes). Long-term exposure limits are intended to control the health effects associated with prolonged or accumulated exposure. Short-term exposure limits (STELs) are set to prevent acute health effects even from brief exposure.

WELs are derived by the following criteria:

1. The WEL value would be set at a level at which no adverse effects on human health would be expected to occur based on the known and/or predicted effects of the substance. However, if such a level cannot be identified with reasonable confidence, or if this level is not reasonably achievable, then:

2. The WEL value would be based at a level corresponding to what is considered to represent good control, taking into account the severity of the likely health hazards and the costs and efficacy of control solutions. Wherever possible, the WEL would not be set at a level at which there is evidence of adverse effects on human health.

Adequate control of exposure will require employers to:

a) Apply the eight principles of good practice for the control of substances hazardous to health;

b) Ensure that the WEL is not exceeded; and

c) Ensure that exposure to substances that can cause occupational asthma, cancer, or damage to genes that can be passed from one generation to another, is reduced as low as is reasonably practicable.

The absence of a substance from the list of WELs does not indicate that it is safe. For these substances, exposure should be controlled to a level to which nearly all the working population could be exposed, day after day, without adverse effects on health. As part of the risk assessment required under Regulation 6 of COSHH, employers should determine their own working practices and in-house standards for control. Further advice can be found in the following HSE sources:

Monitoring strategies for toxic substances (HSG 173);

COSHH Essentials: Easy steps to control chemicals. Control of Substances Hazardous to Health Regulations. HSG 193 (Second Edition), 2003 – an internet access version is also available at www.coshh-essentials.org.uk; and

The limits relevant to this survey are as follows:

Substance	Type of Limit	8-hr TWA Limit ($mg.m^{-3}$)	15-minute STEL ($mg.m^{-3}$)	Notation	R&S Phases
Acetone	WEL	1210	3620		-
Butane (all isomers)	WEL	1450	1810	Carc, (only applies if Butane contains more than 0.1% of buta-1,3-diene)	-
Butan-2-one	WEL	600	899	BMGV, Sk	-
Dichloromethane	WEL	350	1060	BMGV, Sk	-
n-Hexane	WEL	72	-	-	-
Propane (all isomers)	PEL	1800	-	-	-
Toluene	WEL	191	384	Sk	-
Xylene (all isomers)	WEL	220	441	BMGV, Sk	-

Key:

8-hr TWA	8-hour Time Weighted Average
WEL	Workplace Exposure Limit
$mg.m^{-3}$	Milligrammes per cubic metre
STEL	Short Term Exposure Limit
PEL	Permissible Exposure Limit set by OSHA
BMGV	The is a biological monitoring guidance value(s).
Sk	Can be absorbed through the skin. May lead to systemic toxicity.

5.0 RESULTS

5.1 Summary Table of Personal Monitoring Results

Personnel	Hazardous Substance	Airborne Concentration ($mg.m^{-3}$)	8-Hour TWA Concentration ($mg.m^{-3}$) Ψ	8-Hour TWA OEL ($mg.m^{-3}$)
Tony M^{c}Ghee (Floor Layer) – Adhering Capping and Coving Strips to the wall using Gemini Grabfast Gold sprayed contact adhesive	Dichloromethane	224	210	1210
	Isobutane	24.3	118	1450
	Propane (all isomers)	126	22.8	600
Tony M^{c}Ghee (Floor Layer) – Adhering Capping and Coving Strips to the wall using a competitor hand applied contact adhesive	Acetone	57.4	53.9	350
	Butanone	8.1	7.6	72
	n-Hexane	< 0.36	< 0.33	1800
	Toluene	398	373	191
	Xylene (all isomers)	< 0.36	< 0.33	220

Notes:
Ψ = Calculated 8-hr TWA based on the assumption that the simulated laying of plastic sheeting was repeated over an 8 hour period with a ½ break.
$mg.m^{-3}$ = Milligrammes per cubic metre.
TWA = Time Weighted Average.
OEL = Occupational Exposure Limit.

Full tabulated results can be found in the appendices to this report.

6.0 DISCUSSION AND CONCLUSIONS

On the basis of the simulated occupational exposure monitoring undertaken in the proposed rest room at the FM Extrusions Factory in Worsley, Manchester on the 12th March 2013 and taking into consideration observations made during the survey, it is evident there is little cause for concern with regard to operator health.

6.1 Occupational Exposure to Hazardous Substances contained in the Grabfast Gold Adhesive

The calculated 8-hr TWA results for the personal sample taken for Tony M^{c}Ghee were 210mg.m^{-3}, 118mg.m^{-3} and 22.8mg.m^{-3} respectively for Dichloromethane, Isobutane and Propane. Based on these results, which are all substantially below their associated long term WEL, it can be demonstrated there is little risk to the health of workers through the inhalation of these volatile organic compounds.

6.2 Occupational Exposure to Hazardous Substances contained in the Competitor Branded Adhesive

The calculated 8-hr TWA results for the personal sample taken for Tony M^{c}Ghee were as follows:

Acetone = 53.9 mg.m^{-3}
Butanone = 7.6 mg.m^{-3}
n-Hexane = <0.33 mg.m^{-3}
Toluene = 373 mg.m^{-3}
Xylene = < 0.33 mg.m^{-3}

Toluene was the only substance with an exposure result greater than its associated 8-hr TWA occupational exposure limit. It was twice the long term exposure limit value of 191 mg.m^{-3} and nearly breached the STEL of 384 mg.m^{-3}. However the operative, when using the adhesive, wore RPE fitted with the correct filter type (with a suitable assigned protection factor). This will have provided him with sufficient protection provided the equipment was well maintained and fitted correctly. It must be noted that a number of factors influence whether RPE provides appropriate protection to a particular hazardous substance, and some general recommendations have been made regarding this in section 7.0 below.

The calculated 8-hr TWA results for the Acetone, Butanone, n-Hexane and Xylene for were all significantly below the respective WELs, which demonstrates there is little risk to the health of workers through the inhalation of these volatile organic compounds.

7.0 RECOMMENDATIONS

On the basis of the simulated occupational exposure monitoring undertaken in the proposed rest room at the FM Extrusions Factory in Worsley, Manchester on the 12th March 2013 and taking into consideration the control measures in place and working practices, some general recommendations have been made with respect to exposure control:

- In real work situations during the fitting capping and coving for flooring (irrespective of the adhesive being used) the area(s) should be ventilated as much as possible, to help dilute the concentrations of the volatile organic compounds in the workplace air;
- In the absence of any other control measures it is recommended that RPE should always be worn when working with the branded adhesive. The A1 vapour filter fitted to the operative's mask has a high enough assigned protection factor that it should provide an appropriate level of protection against the inhalation of Toluene, at the concentration found during this survey. However, the effectiveness of any RPE is strongly influenced by how it is used and maintained;
- It is recommended any operative who chooses to or is required to wear RPE (as a result of a COSSH risk assessment for example) whilst fitting capping and coving, should be trained in the selection, wearing, storage and maintenance of that RPE. The training should include as a minimum the reasons why RPE is required, information about the different types of RPE available, how RPE should be stored and disposed of and most importantly, how the selected RPE should be correctly used and maintained.

APPENDIX 1

Occupational Exposure Monitoring Record Forms

OCCUPATIONAL EXPOSURE MONITORING RECORD FORM

Job No	FTOM 24648	**Client**	Gemini Adhesives Limited
Date	12th March 2013	**Site**	FM Extrusions, Worsely
Site Staff	Martin Johnson	**Sheet**	1 of 2

Sample No	Operator Name/ Sample Location	Analyte	Average Sampling Rate (ml/min)	Sample Durat'n (Min)	Sample Volume (l)	Amount Detected (µg)	Conc'n ($mg.m^{-3}$)	8 Hr TWA ($mg.m^{-3}$)
20003596	Tony M^{c}Ghee (Floor Layer) – Adhering Capping and Coving Strips to the wall using Gemini Grabfast Gold sprayed contact adhesive	Dichloromethane	56.84	29	1.65	369	224	210
		Isobutane				40	24.3	118
		Propane (all isomers)				207	126	22.8

Key:

conc'n = concentration
TWA = Time Weighted Average
$mg\ m^{-3}$ = milligrammes per cubic metre
µg = micrograms

OCCUPATIONAL EXPOSURE MONITORING RECORD FORM

Job No	FTOM 24648	**Client**	Gemini Adhesives Limited
Date	12th March 2013	**Site**	FM Extrusions, Worsely
Site Staff	Martin Johnson	**Sheet**	2 of 2

Sample No	Operator Name/ Sample Location	Analyte	Average Sampling Rate (ml/min)	Sample Durat'n (Min)	Sample Volume (l)	Amount Detected (µg)	Conc'n ($mg.m^{-3}$)	8 Hr TWA ($mg.m^{-3}$)
20003597	Tony M^{c}Ghee (Floor Layer) – laying wall protection sheeting (cove and cap) using a competitor hand applied contact adhesive	Acetone	105.67	54	5.71	328	57.4	53.9
		Butanone				46	8.1	7.6
		n-Hexane				< 2	< 0.36	< 0.33
		Toluene				2270	398	373
		Xylene (all isomers)				< 2	< 0.36	< 0.33

Key:

conc'n = concentration
TWA = Time Weighted Average
mg m^{-3} = milligrammes per cubic metre
µg = micrograms

APPENDIX 2

Legislation

LEGISLATION

Health and Safety at Work Etc Act (1974)

Employers' and Employees' responsibilities for health and safety are laid down by the Health and Safety at Work Etc Act (1974). This Act seeks to protect all persons at work whether employers, employees or members of the general public affected by the work activities.

The Control of Substances Hazardous to Health (COSHH) Regulations (Fifth Edition) 2002 (as Amended)

The COSHH Regulations lay down requirements that may be described in summary:

Undertake an assessment, which evaluates the risk to health created by the use of hazardous substances in the workplace and documents the necessary precautions to be taken to ensure that the risk is adequately controlled.

Under the revised regulations the following information shall be considered within the assessment:

- Control measures required to control exposure and the effect of these measures.
- The hazardous properties and health hazards of the substance.
- Level, type and duration of exposure.
- Circumstances of work including the quantities used.
- Relevant Workplace Exposure Limits (WELs).
- Maintenance activities.
- Results of health surveillance and exposure monitoring.
- Additive or synergistic effects of exposure to substances simultaneously.
- Approved classification of any biological agent.

(Regulation 6)

Preventing or Reducing Exposure

Exposure to substances hazardous to health must be prevented or adequately controlled. To secure prevention, consideration should be given to substituting with a less hazardous substance or less hazardous form of the substance. Adequate control shall also be achieved by means other than personal protection. Preference should be given to controlling exposure at source, providing suitable processes and systems of work and limiting the number of personnel and duration of those potentially exposed. Suitable general ventilation should be provided.

For substances deemed to be a carcinogen under COSHH the following hierarchy of control must be adopted: A carcinogen is defined as a substances assigned Category 1 or 2 under Chemical (Hazards, Information and Packaging) Regulations (CHIP3) 2002.

Hierarchy of Control

- Totally enclose the process and handling systems unless this is not reasonably practical.
- Prohibit eating, drinking and smoking in areas contaminated by carcinogens.
- Clean of floors, walls and other surfaces at suitable intervals.
- Designate areas contaminated by carcinogens.
- Storing, handling and disposing of carcinogens safely.

(Regulation 7)

Every employer shall ensure that, where control measures are provided to control exposure such control measures should be properly used or applied. Similarly, the COSHH Regulations place a duty upon employees to look after and report defects on, and make full and proper use of, any control measure provided.
(Regulation 8)

Where engineering controls such as local exhaust ventilation are used to control exposure to hazardous substances, a documented systematic approach to the maintenance, examination and testing should be carried out to ensure that they continue to provide effective and efficient control. Specified controls are required to be checked on a routine basis as detailed within the regulations.
(Regulation 9)

The Workplace Exposure Limits for the quantities of substances within the atmosphere are defined by the Health and Safety Commission and published by the Health and Safety Executive in document EH40/2005.

The majority of assessments may be carried out simply by examination of the hazard data sheets available on the substances used and employing appropriate control measures. However, not all substances may be assessed as easily. Monitoring for the levels of hazardous substances in the atmosphere should be carried out where requisite; for example:

- demonstrate that an WEL is not exceeded;
- show that control measures are adequately reducing exposure below the standards
- where substances are listed in Schedule 5 of the COSHH Regulations.

(Regulation 10)

Health surveillance should be carried out where appropriate, egg where adverse changes can be detected early, or where results can assist in the evaluation of the effectiveness of control measures employed. Health surveillance may involve simple skin checks, lung function tests or more extensive blood and urine tests. Results of health surveillance should be documented and kept for forty years.
(Regulation 11)

Information, instruction and training should be provided to all employees involved in the handling of substances hazardous to health.
(Regulation 12)

- Information regarding the nature of the hazards and the risks.
- Instruction on how to work safely with hazardous substances.
- Training on how to fully comply with the Regulations, make use of the control measures provided etc.

Arrangements to deal with accident, incidents, and emergencies (without prejudice to management regulations)

- Procedures (including First Aid and Safety Drills) prepared
- Information on emergency arrangements including
  1. Details of work hazards/identification arrangements
  2. Specific hazards likely to arise
- Establish suitable warning and communication systems to enable an appropriate response

(Regulation 13)

The COSHH Amendments Regulations 2004, which came into force on 17 January 2005, reinforce the existing requirements under the COSHH Regulations to follow good practice in controlling exposure to substances hazardous to health. The Regulations were clarified and consolidated by the introduction of eight principles, which apply regardless of whether a substance has been assigned an OEL:

i. Design and operate processes and activities to minimise emission, release and spread of substances hazardous to health.

ii. Take into account all relevant routes of exposure-inhalation, skin absorption and ingestion when developing control measures.

iii. Control exposure by measures that are proportionate to the health risk.

iv. Choose the most effective and reliable control options that minimise the escape and spread of substances hazardous to health.

v. Where adequate control of exposure cannot be achieved by other means, provide, in combination with other control measures, suitable protective equipment.

vi. Check and review regularly all elements of control measures for their continuing effectiveness.

vii. Inform and train all employees on the hazards and risks from the substances with which they work and the use of control measures developed to minimise the risks.

viii. Ensure that the introduction of control measures does not increase the overall risk to health and safety.

APPENDIX 3

Health Effects

HEALTH EFFECTS

Acetone

Acetone is a colourless, volatile, flammable liquid with a pungent odour. The solvent is used as an industrial solvent in resins, lacquers, oils, fats etc.

From a health point of view, acetone is one of the least hazardous industrial solvents, but is a very flammable and explosive substance (explosive limits: 2.6%-12.8% in air). Acetone is highly volatile and may be inhaled in large quantities when it is present in high concentrations. It may be absorbed into the blood through the lungs and diffused throughout the body. Limited skin absorption also occurs with acetone.

Typical symptoms observed after acetone exposure are: narcosis, slight skin irritation and pronounced mucous membrane irritation. Cases of chronic poisoning resulting from prolonged exposure to low concentrations of acetone are rare; however in cases of repeated exposure to low concentrations, headaches, drowsiness, vertigo, irritation of the throat and coughing have been reported.

2 Butanone (Methyl Ethyl Ketone)

The principal health effect is that of irritation of the eyes and respiratory tract. There is little available evidence on systemic toxicity (affecting organs in the body remote from the point of entry). Repeated exposure to the skin may cause dermatitis. The principal routes of entry are inhalation and skin absorption.

Dichloromethane (Methylene Chloride)

Dichloromethane is mildly irritating to skin on repeated contact. Problems may be accentuated if the chemical is being 'sealed' to skin by shoes or tight clothing. The risk is highest with paint remover formulations that form a "skin" or film.

Inhalation of dichloromethane in concentrations, sufficient to produce 5% carboxyhaemoglobin, impaired human performance under difficult or demanding task conditions. Apparently, carbon monoxide, the main metabolite of dichloromethane, was responsible for observed performance decrements.

After a 3-hour exposure to 800 ppm dichloromethane, significant deficits in psychomotor tasks (e.g. simple and choice reaction times, reduced tapping speed and impaired co-ordination and steadiness) developed in human volunteers. Levels of 10,000-25,000 ppm of dichloromethane produced coma in humans within a short period of time.

Blood carboxyhaemoglobin levels should not exceed 5% in workers exposed to methylene chloride. This carboxyhaemoglobin level approximates the concentration obtained following a workday exposure to 100 ppm dichloromethane in resting non-smokers.

Phosgene poisoning has been reported to occur in several cases where dichloromethane was used in the presence of an open fire.

Toluene

Toluene is a clear, colourless, noncorrosive liquid with a sweet, pungent, benzene-like odour.

Toluene may be encountered in the manufacture of benzene. It is also used as a solvent for paints and coatings, or as a component of automobile and aviation fuels.

Toluene may cause irritation of the eyes, respiratory tract, and skin. Repeated or prolonged contact with liquid may cause removal of natural lipids from the skin, resulting in dry, fissured dermatitis. The liquid splashed in the eyes may cause irritation and reversible damage.

Acute exposure to toluene predominantly results in central nervous system depression. Symptoms and signs include headache, dizziness, fatigue, muscular weakness, drowsiness, inco-ordination with staggering gait, skin paresthesias, collapse and coma.

Animal tests have suggested that it may cause hearing and eyesight damage but this is inconclusive. Animal tests have also suggested that high exposure levels may affect the unborn child, but again the evidence is not conclusive.

Xylene
Xylene is harmful via inhalation, ingestion and skin absorption/contact. Xylene vapour may cause irritation of the eyes, nose and throat. Repeated or prolonged skin contact may cause drying and defatting of the skin which may lead to dermatitis. Liquid xylene is irritating to the eyes and mucous membranes and aspiration of a few millilitres may cause chemical pneumonitis, pulmonary oedema and haemorrhage. Repeated exposure of the eyes to high concentrations of xylene vapour may cause reversible eye damage.

Acute exposure to xylene vapour may cause central nervous system depression and minor reversible effects upon liver and kidneys. At high concentrations xylene vapour may cause dizziness, staggering, drowsiness and unconsciousness. Also at very high concentrations, breathing xylene vapours may cause pulmonary oedema (water on the lung), anorexia, nausea, vomiting and abdominal pain.

Volatile Organic Compounds (VOC)
VOCs are released from virtually any process that employs substances containing organic solvents. VOCs are given off by the evaporation of solvents in a wide range of commercially available products such as paints, coatings, paint removers, paint thinners, adhesives, caulking, carpets, photocopiers, acoustic ceiling tiles, air fresheners, cleaning agents, organic solvents, fabric softeners and tobacco smoke.

Most hydrocarbons are non-toxic or have a low toxicity, although benzene and n-hexane are atypical. Hydrocarbons from C_4 upward exhibit increasing irritancy to the upper respiratory tract and increasing depression of the central nervous system. Above C_{14} the volatility of the substances is too low to generate significant vapour exposures. Unsaturated cycloparaffins are more toxic than their saturated counterparts and aromatic hydrocarbons are the most toxic of the group.

The acute effects of occupational exposure to VOCs include dizziness and fatigue, concentration and memory difficulties, headaches, impairment of physical and neurological functions due to CNS depression and mood or behavioural changes. These symptoms are usually transient and usually subside following cessation of exposure. There is little information known on the existence of chronic, and possibly irreversible, effects resulting from repeated exposure to low levels of solvents over a working lifetime.

The health effects caused by exposure to n-hexane and benzene are distinctly different from general mixed hydrocarbon exposures. Benzene is a recognised human carcinogen and n-hexane is implicated in peripheral neuropathy.