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Occupational hygiene assessment during foam spraying operations

Insulfoam Solutions

C/- Third Ecology Pty Ltd

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Occupational hygiene assessment during foam blowing operations

This report has been checked and released for transmittal to Insulfoam Solutions.

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Executive Summary

Insulfoam Solutions engaged Alert Solutions to assess the occupational exposure to airborne chemicals and noise during the various facets of the urethane foam spraying operations using Sealaction components by Insulfoam Solutions. The survey was conducted on January 9, 2007 over the course of foam spraying in a basement work area at RMIT in Melbourne.

The results indicate that in the immediate area of the operator during the spraying isocyanate exposures can exceed the recommended exposure standard. Also noise levels exceeding recommended exposure limits can be experienced in the rear of the truck while the main compressor operates, as well as while using the air saw for trimming excess foam.

The current personal protective equipment used by personnel has been assessed in light of these results. Recommendations with regard to ongoing operational considerations to continue to minimise potential atmospheric contaminant and noise exposure during urethane foam applications are discussed in more detail in the report.

1 Introduction

Alert Solutions was commissioned by Insulfoam Solutions to conduct an occupational hygiene assessment of relevant aspects of the application of Sealection 500 Spray Foam Insulation. During foam spraying by Insulfoam Solutions in a basement laboratory area at The Royal Melbourne Institute of Technology (RMIT) campus in Franklin Street, North Melbourne the concentration of potential airborne contaminants and noise exposure associated with the process were evaluated. The survey was conducted on January 9, 2007.

The survey was conducted during foam application activities considered by Insulfoam Solutions personnel to be representative of typical anticipated Sealaction 500 Spray Foam Insulation application processes when the process is commercially operating. It should be noted that the truck containing the foam component chemical storage and preparation currently has a metal panel wall between the storage area and the compressor which is planned to be lined with insulation. Therefore the current noise measurements made in the truck are likely to be attenuated, to some degree at least, when this insulation is installed and therefore reduce potential operator noise exposure in this area.

Isocyanate, general volatile organic compounds (VOC) and noise monitoring was conducted in various localities and areas of the 500 Spray Foam Insulation storage, mixing and application operation. All samples were taken during typical representative operations associated with each of the process stages on the day of the assessment.

2 Process description

Sealaction 500 Spray Foam Insulation is an alternative product to current insulation materials such as fibreglass batts with energy and noise insulating properties. The insulating urethane foam material is created by mixing two proprietary products, denoted Sealaction A and Sealaction B, at a temperature of around 55 degrees. Typically components A and B are delivered from storage drums via individual hose lines to an applicator gun where they are mixed in a 1:1 ratio as they are sprayed to the site being insulated. The reaction causes an expansion of the mixture and the final foam is formed in less than 2 seconds. The Material Safety Data Sheets (MSDS) for the two Sealaction components show that Component A of the urethane foam system (Demilec A 500) is a mixture of polymeric diphenylmethane diisocyanate (polymeric MDI) and 4,4-diphenylmethane diisocyanate (4,4 MDI) and is classified as a hazardous substance. It is not a dangerous good. Component B of the urethane foam system (Demilec B 500) is a non hazardous polyol blend that is also not a dangerous good.

Insulfoam Solutions operates their urethane foam spraying operations from the enclosed rear of a truck. This contains bunded, constrained two each of 200 litre containers of the A and B components of the urethane foam system on either wall of the truck, and a heating system and hose storage rack for delivery of the components to the applicator. There is also a compressor for the supply of fresh breathing air to the foam spraying operator. As mentioned previously the truck also contains a main compressor to power the various facets of the process, currently separated from the rear area of the truck by a metal skin wall.

During the assessed application process the spray operator was observed to wear disposable overalls and full face supplied air breathing apparatus, which Insulfoam Solutions personnel indicated will be the level of protection used by spray operators.

Following spraying, excess urethane foam can be trimmed from application sites using techniques including air saws.

3 Occupational exposure limits

Atmospheric Contaminants

The National Occupational Health and Safety Commission *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* sets out exposure standards for airborne contaminants. These represent airborne concentrations of individual chemical substances which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers. The exposure standards do not represent "no-effect" levels that guarantee protection for every worker. Given the nature of biological variation and the range of individual susceptibility, it is inevitable that a very small proportion of workers who are exposed at concentrations around or below the exposure standard may suffer mild or transitory discomfort. An even smaller number may exhibit symptoms of illness.

Exposure standards apply to long-term exposure to a substance over an 8-hour workday, for a five-day working week, over an entire (40 year) working life. Where workers have a working day longer than 8 hours the TWA exposure standard may need to be reduced by a suitable factor to ensure adequate worker protection.

The Exposure Standards are applicable to airborne concentrations of single pure substances and are set at levels that will protect ***most*** people; however, because of the variability in susceptibility between individuals, there may be a small proportion of workers who may suffer mild and transitory discomfort at concentrations around, or below, the exposure standard. An even smaller number may exhibit symptoms of illness. Exposure Standards determine whether a *potential* exists for over exposure, and hence, adverse health effects. Any concentration which exceeds one-half the exposure standard (a level normally used as an "action-level") may be cause for concern, therefore, and warrants action being taken to reduce the exposure of any employee working in that area.

Component A of the urethane foam system (Demilec A 500) contains MDI, which as noted in the MSDS is a hazardous substance. Potential exposure to isocyanates including MDI should be minimised as they are reported to produce an asthma like allergic response often associated with a sensitisation and antibody response. This can lead to sensitised persons having adverse reactions to concentrations well below accepted occupational exposure standards. Studies of the ocular and dermal irritation potential of MDI indicate only minimal to average effects.

Table 1 below shows the exposure standards for MDI and VOC including the Time-Weighted Average (TWA) and Short-Term Exposure Limits (STEL) where appropriate, based on the epidemiological data.

Table 1 Exposure Standard

Compound	Exposure Standards (mg/m^3)	
	TWA* (8 hr average)	STEL# (15 mins)
Isocyanates (including MDI)	0.02 (5ppb)	0.07 (18ppb)
VOC (as n-hexane)	72 (20 ppm)	-

Notes:

* TWA - 8 hour time weighted average exposure limit

\# STEL – Short term 15 minute exposure limit

Noise

The Victorian Noise Regulations 2004 defines the exposure standard as:

a. The 8 hour equivalent continuous sound pressure level of 85 dB(A) measured in A-weighted decibels referenced to 20 micropascals; and

b. The linear (unweighted) peak hold sound pressure level reading of 140 dB(C) measured in decibels referenced to 20 micropascals determined by sound measuring equipment with a P time weighting function.

Exposure to noise must be measured at the employee's ear position. In determining if persons are at risk of excessive noise exposure the effect of any hearing protection device must not be taken into account.

This noise exposure level at equivalent ear position has been used as the criteria for Australian Standard 1269-2005, consisting of 5 sections, called *Occupational Noise Management*. The recommended exposure level is based on the equal energy principle, and is related to the fact that noise damage is cumulative and assumes that the work duration is approximately 40 hours per week or 160 hours per month. An employee's exposure of 85 dB(A) over an 8-hour day will result in an effective noise exposure of 1 "*pascal squared hour*" Pa^2h (which previously was referred to as a noise dose of 100%).

An effective noise exposure of 1 Pa^2h, can be reached by shorter exposures to louder sounds or conversely longer exposures to quieter sounds based on the 3 dB halving principle.

Table 2 Allowable average noise level (L_{Aeq}) for different shift durations[1]

Average Noise Level (L_{eq} dB(A))	Duration of shift (hours)
82	12
83	10
85	8
88	4
91	2
94	1
97	0.5
100	0.25

[1] For employees working a shift duration of 10 hours or longer, AS 1269 recommends that the measured Leq over the shift period is normalised to an 8-hour equivalent level and the normalised exposure level is adjusted to allow for the reduced recovery time between shifts. It is assumed Insulfoam Solutions personnel will work nominal 8-hour shifts and therefore this adjustment has not been made.

4 Methodology

The sampling protocol was designed to monitor real time atmospheric contaminant concentrations of MDI and VOC and noise levels at the various main parts of the urethane foam application process.

Isocyanate concentrations were measured using a GMD systems 'Autostep Plus' with type TDI/MDI/HDI paper tape. The Autostep Plus has an analytical range of 0 to 500 ppb with a sensitivity of 0.01 ppb.

Real-time assessment of Volatile Organic Compounds (VOC) was conducted through the use of a Rae Systems Minirae 2000 Portable monitor. This instrument provides an indication of the total airborne concentration of VOC's and is useful in providing an indication of the *potential* for exposure. Although it cannot differentiate between the different organic species, comparison of the exposure standard of n-hexane (20 ppm) with the measured VOC concentration is a conservative approach in assessing any potential significant VOC exposures.

Noise measurements were taken in accordance with AS 1269 Section 2. As specified in the standard, at each measuring position sound pressure level readings were taken using a Brüel & Kjær Type 1 Sound Level Meter, model 2238, integrated over a relevant time period to a representative L_{eq} dB(A) for the task or area. This measurement represents the equivalent continuous sound pressure level over the observation period, at each location, measured in A-weighted decibels and referenced to 20 micropascals. C-weighted peak noise levels and the dB(A) range were also measured.

5 Findings / Results

Table 3. Foam spray monitoring results, RMIT January 9, 2006

Location / Task	MDI (ppb)	VOC (ppm)	L_{eq} dB(A)	dB(C) Peak
1 metre from exterior of truck, driver side while main compressor running	-	-	73	100
Approx 10 metres from exterior of truck, driver side while main compressor running	-	-	67	96
Approx 10 metres from exterior of truck, doorway side to rear of truck, door open with compressor running	-	-	72	95
Inside rear of truck, centre of work area	ND	0 – 0.1	88	108
Inside rear of truck, on top of Sealaction A drum beside extraction nozzle	0 – 1	0 – 0.1	-	-
In RMIT basement room urethane foam being sprayed, background prior to spraying	ND	ND	56	80
In RMIT basement room while urethane foam being sprayed, at spray operator shoulder	20 – 27	1 – 2	80	106
In RMIT basement room while urethane foam being sprayed, approx 10 metres from spraying	2 – 3	0.4 – 0.7	77	94
In RMIT basement room beside air saw compressor	-	-	87	103
In RMIT basement room beside air saw, at operator ear	-	-	92	112
Immediately beside surface of urethane foam approx 24 hours after spraying	ND	ND	-	-
8 Hr Time Weighted Average Exposure Standard	5	20	85	140 *

Notes:

ND – Not Detected

Sampled at height equivalent to operator/bystander breathing/hearing zone

* - peak noise measured as instantaneous sound pressure level

6 Discussion & Conclusions

Atmospheric Contaminants

Chemicals may enter the body by inhalation, ingestion or absorption through the skin. Once inside the body the chemicals act on particular organs depending on their individual toxicity. In respect of people spraying urethane foam the major route of exposure is by inhalation of dusts and fumes.

For a health risk to arise from the inhalation of a substance it must first be present in the atmosphere above a certain threshold concentration. Whether or not this occurs depends on several factors, including the physical arrangement of facilities such as ventilation, and the proximity of the workers to the contaminant.

When considering the hazards associated with any workplace, it is essential to understand the relationship between 'hazard', 'exposure' and 'risk'. '*Hazard'* is the potential for an agent or process to do harm. *'Risk'* is the likelihood that an agent will produce injury or disease under specified conditions. Health effects can only occur if a worker is actually exposed to the hazard. The risk of injury or disease usually increases with the duration and frequency of *exposure* to the agent, and the intensity/concentration and toxicity of the agent.

The monitoring observations and results during the current survey of the Insulfoam Solutions foam spraying activities raise the following discussion points.

The MSDS indicate the hazardous substance contained in the urethane foam components is MDI. The air monitoring results for isocyanates indicates that under the assessment conditions the exposure standard for isocyanate is exceeded in the immediate vicinity of the operator applying the foam as it reacts. Isocyanates are not readily filtered out of the atmosphere, and therefore the recommendation is that supplied air respiratory protection is used in situations where isocyanate exposure can occur. This respiratory protection protocol is used by the operator spraying the urethane foam, along with the use of protective eye wear, disposable chemical overalls and gloves. These protective strategies appear to be appropriate for the foam spraying operation.

Other assessed areas including the truck and areas remote from the spraying activity show MDI and VOC concentrations either below respective exposure limits or below the method detection limit. Therefore under these conditions there should be minimal, if any, potential for excessive atmospheric exposure to these chemicals and hence no requirement for respiratory protection.

Noise

From the sound pressure measurements taken during this survey it is evident that currently in the rear of the truck while the main compressor operates and around the air compressor for the air saw and while operating the air saw noise levels exceed the relevant permissible exposure standard of 85 dB(A) for an 8-hour shift. Therefore persons in these areas or conducting these tasks are at risk of excessive noise exposure.

Peak noise readings taken during the sound pressure level measurements showed that the peak criteria limit of 140 dB(C) was not exceeded during the sound pressure level measurements as a result of any operations or activities.

Noise Control

It is the responsibility of the employer to ensure that each employee's exposure to noise is controlled to minimise risk to health and safety. This can be achieved through the following measures.

1. **Engineering Controls**: Any engineering procedure that reduces the sound level either at the source of the noise or in its transmission but does not include the use of a hearing protection device.

2. **Administrative Controls:** Systems of work that substantially reduce the exposure of employees to noise including reduction in exposure time but does not include engineering controls and hearing protection devices.

3. **Hearing Protection Devices:** A device or pair of devices worn by, or inserted in the ears of, a person to reduce noise exposure.

It is important to understand that the exposure to noise of any employee should be controlled so that it does not exceed the exposure standard by:

a. Implementation of engineering controls to the extent that is practicable; and

b. If engineering controls do not reduce the exposure of employees to the exposure standard, by implementation of administrative controls to the extent practicable; and

c. If engineering and administrative controls do not reduce employees' exposure to noise to the exposure standard, by providing and maintaining hearing protection devices to employees which will ensure the employees' exposure to noise, taking into account the effect of the device, does not exceed the exposure standard.

With respect to hearing protectors, there may be some merit in considering a number of alternatives to enable employees to suit their individual needs and they should normally be regarded as an interim measure while control of noise exposure is being achieved by other means.

Hearing Protection

If proper thought is not given to the selection of hearing protectors then they will not be worn when needed. The comfort of the hearing protector is an important consideration in the maximisation of the wear time of the protective device.

The main recommended method for selecting appropriate attenuation for a hearing protector in the Occupational Noise Management Standard AS 1269 – 2005 is called the Classification process. This process is based on the L_{Aeq} 8h for which the hearing protector must provide adequate attenuation. For each hearing protector classification, there is a range of SLC_{80} ratings that are considered to be adequate. Table 4 summarises the requirements of the Classification process.

Table 4 Hearing Protection Classification

Hearing protector classification	$L_{Aeq\ 8h}$ for which the classification group is applicable (in dB(A))	SLC_{80} range
1	Less than 90	10 to 13
2	90 to less than 95	14 to 17
3	95 to less than 100	18 to 21
4	100 to less than 105	22 to 25
5	105 to less than 110	26 or greater

All hearing protection devices will only provide maximum protection if they are correctly fitted and maintained in good condition. The performance of worn or damaged hearing protectors deteriorates rapidly. Earmuff cushions should be replaced as soon as they begin to harden (this can happen in one month) and in any event at least once a year. Clip-on or helmet mounted devices must not be left with the cushions compressed against the edge of the helmet as this reduces their effectiveness in only a few minutes.

Currently hearing protection is not used by Insulfoam Solution personnel during any of the activities involved in the spraying of urethane foam. The results indicate that hearing protection use should be considered by personnel conducting work for extended periods in the rear of the truck while the compressor is going, as well as while the air saw is used to trim overspray. The highest noise level measured of 92 dB(A) using the air saw would result in the operator being exposed to their permissible daily noise dose in approximately 1.5 hours of this task, assuming no other significant noise exposure during that shift period. As shown in the hearing protection classification table hearing protectors of classification 2 or better should ensure that the dB(A) level experienced by the wearer would be within the 85 dB(A)-criterion level during all the measured operations.

7 Recommendations

Based on the results of the current survey, the following recommendations are suggested for consideration by Insulfoam Solutions if they are not already in place:

1. For the operator spraying the urethane foam, the use of supplied air respiratory protection incorporating eye protection, disposable protective overalls and gloves should continue to prevent exposure to MDI and overspray. If other activities not assessed during this survey were to expose persons to atmospheric MDI, this level of personal protective equipment should be used.

2. Operators working in the rear of the truck while the main compressor is operating, as well as using the air saw to remove excess foam should be provided with appropriate hearing protectors for use if these activities are to be conducted for extended periods in the workday.

3. It is essential that personnel be trained in the proper use of personal protective devices where they may be needed. Workplace Protective Equipment training and procedures should be developed to reinforce the importance of respiratory and hearing protection use.

4. Consideration should be made to isolating areas foam is being sprayed in for the duration of the activity to minimise the risk of chemical, noise or safety hazard exposures to unprotected personnel.

5. Should operating conditions alter such that potential exposures of personnel to operational chemicals and / or noise levels change, the occupational environment should be re-assessed.

6. MSDS documentation for particularly the hazardous substance (Demilec A 500) used as part of the urethane foam process should be carried in the truck for reference if required, consistent with the requirements of the Victorian Hazardous Substances legislation.

7. The results of this assessment should be made available to interested parties as appropriate.

8 References

National Occupational Health and Safety Commission *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* 1995.

Occupational Health and Safety (Hazardous Substances) Regulations 1999.

Occupational Health and Safety (Noise) Regulations 2004.

Australian Standard 1269 - 2005: *Occupational Noise Management*.

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