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Environment, Health & Safety PU IH Report

Subject:

Industrial Hygiene Study

Customer:

Dunlop Protective Footwear

Raalte, The Netherlands

Report Reference:

0291-001

Author(s):

████████████████████

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INDUSTRIAL HYGIENE STUDY REPORT

Reference	0291-001	Form	IH-CoE-Form [REDACTED]
Survey date(s)	20-June-2024	Report date	15-August-2024

CUSTOMER		PROJECT MANAGER	
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Function	
Signature	

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GLOSSARY OF TERMS

CAS	Chemical Abstract Service
DNEL	Derived No Effect Level
EAME	Europe/Africa/Middle East
EHS	Environment, Health and Safety
IH	Industrial Hygiene
ISO	International Organisation for Standardization
MDI	Methylene Diphenyl Isocyanate
MDHS	Method for the Determination of Hazardous Substances
mg/m ³	milligrams per cubic meter
NA	Not available
ND	None Detected
OEL	Occupational Exposure Limit
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PU	Polyurethanes
REACH	Registration, Evaluation, Authorization and Restriction of Chemical substances
RPE	Respiratory Protective Equipment
RNCO	Total Organic Isocyanates
STEL	Short Term Exposure Limit
TIP	Total Inhalable Particulates
TWA	Time-Weighted Average
VOC	Volatile Organic Compound

1 EXECUTIVE SUMMARY

An Industrial Hygiene (IH) study was carried out at Dunlop, Raalte, The Netherlands on the 20th of June 2024. The study was requested by the PU elastomers team and the customer themselves to evaluate the exposure risks during production of protective footwear.

The study was carried out by the PU EAME industrial hygiene group, working independently from commercial departments within Huntsman.

1.1 Study objectives

Following study objectives have been agreed :

- Airborne exposure assessment to airborne Methylene Diphenyl Isocyanate (MDI) and NCO at the workplace.
- Airborne exposure assessment to Volatile Organic Compounds (VOCs) at the workplace.
- Airborne exposure assessment to 1-Hydroxypyridine-2-thione zinc salt (zinc omadine) at the workplace.

1.2 Conclusions

Based on the results of the samples taken at the time of the survey and the operational conditions present at that time, following conclusions have been deducted:

- Airborne exposure to MDI is well under control, no isocyanates were detected at the workplace and the detection limit of the samples were well below the Dutch OEL
- Airborne exposure to VOC is under control but improvements can be made at the ink station.
- The sampling method used to assess zinc omadine could only sample all dust, not just zinc omadine and thus was not ideal, but exposure seems to be under control.

2 POTENTIAL HEALTH RISKS

2.1 MDI (CAS 101-68-8)

<p>Hazard pictograms</p>	 
<p>Health impact</p>	<ul style="list-style-type: none"> • H315 : Causes skin irritation Skin corrosion / irritation - category 2 • H317 : May cause an allergic skin reaction Skin sensitization - category 1 • H319 : Causes serious eye irritation Serious eye damage / eye irritation - category 2 • H332 : Harmful if inhaled Acute toxicity : inhalation - category 4 • H334 : May cause allergy or asthma symptoms or breathing difficulties if inhaled Respiratory sensitization - category 1 • H335 : May cause respiratory irritation Specific target organ toxicity : inhalation (respiratory tract) - category 3 • H351 : Suspected of causing cancer Carcinogenicity - category 2 • H373 : May cause damage to organs through prolonged or repeated exposure Specific Target Organ Toxicity Repeated Exposure - category 2 Affected organ: respiratory system
<p>Occupational Exposure Limits (OEL)¹</p>	<ul style="list-style-type: none"> • The 8-hour Time Weighted Average (TWA) is 0.05 mg/m³ • The 15-minutes Short Term (STEL) is 0.05 mg/m³
<p>REACH Derived No Effect Level (DNEL)_{workers} – Local effects [irritation]- Acute</p>	<ul style="list-style-type: none"> • The DNEL is 0.1 mg/m³
<p>REACH Derived No Effect Level (DNEL)_{workers} – Local effects [irritation]- Long-term</p>	<ul style="list-style-type: none"> • The DNEL is 0.05 mg/m³
<p>REACH Derived No Effect Level (DNEL)_{workers} – Systemic effects [sensitisation]</p>	<ul style="list-style-type: none"> • No DNEL for respiratory sensitisation is calculated as there is no validated method. Human experience shows clearly that if the exposure concentrations of MDI are kept below 0.05 mg/m³, generally no new cases of MDI asthma are observed.

¹ Dutch legislation references the German limit for MDI so that was used: Grenswaarden gezondheidsschadelijke stoffen 2017 (Limit values of health-damaging substances 2017)(Dutch)(crn) - Product Safety [p 66]

2.2 Iso-propanol (CAS 67-63-0)

Hazard pictograms	 
Health impact	<ul style="list-style-type: none"> • H225 Highly flammable liquid and vapour Flammable liquids – category 2 • H319 Causes serious eye irritation Serious eye damage / eye irritation - category 2 • H336 May cause drowsiness or dizziness Specific target organ toxicity after single exposure – category 3
OEL⁷	<ul style="list-style-type: none"> • The 8-hour Time Weighted Average (TWA) is 492 mg/m³²

^{2 2} TLV 2024 (ACGIH)

2.3 1-Hydroxypyridine-2-thione zinc salt (CAS 13463-41-7)

Labelling according Regulation (EC) No 1272/2008

Pictogram



Signal Word

Danger

Hazard Statements

H301 Toxic if swallowed.
 H318 Causes serious eye damage.
 H330 Fatal if inhaled.
 H360D May damage the unborn child.
 H372 Causes damage to organs through prolonged or repeated exposure.
 H410 Very toxic to aquatic life with long lasting effects.

Precautionary Statements

P202 Do not handle until all safety precautions have been read and understood.
 P260 Do not breathe dust.
 P273 Avoid release to the environment.
 P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
 P304 + P340 + P310 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/ doctor.
 P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Supplemental Hazard Statements

none

Restricted to professional users.

2.4 1,2,4-Trimethylbenzene (CAS 95-63-6)

Labelling according Regulation (EC) No 1272/2008

Pictogram



Signal Word

Danger

Hazard Statements

H226 Flammable liquid and vapor.
 H304 May be fatal if swallowed and enters airways.
 H315 Causes skin irritation.
 H319 Causes serious eye irritation.
 H332 Harmful if inhaled.
 H335 May cause respiratory irritation.
 H411 Toxic to aquatic life with long lasting effects.

Precautionary Statements

P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
 P273 Avoid release to the environment.
 P301 + P310 IF SWALLOWED: Immediately call a POISON CENTER/ doctor.
 P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
 P304 + P340 + P312 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
 P331 Do NOT induce vomiting.

Supplemental Hazard Statements

none

OEL⁷

- The 8-hour Time Weighted Average (TWA) is 49 mg/m³

³ TLV 2024 (ACGIH)

3 MONITORING STRATEGY

3.1 Introduction

The production of protective footwear is performed on multiple semi-automated production machines. Each machine consists of multiple shoe moulds that are positioned in a circle. The machine will turn regularly with the almost finished shoe as the final product. The process starts with the operator putting the inside liner of the shoe over the inside mould of the shoe. This is then enclosed with a secondary mould and an MDI-based system is injected into the mould at about 60 degrees Celsius. After a full circle on the machine the boot is removed from the machine and set aside to be transported to the finishing line where the excess plastic is removed from the boots, and they are treated with finishing ink.

3.2 Airborne exposure assessment to airborne RNCO, MDI, TIP and VOCs at the workplace

3.2.1 Methodology

The quantitative analytical determination of airborne VOCs and TIP concentrations at the workplaces are carried out according to NIOSH traceable methods and NIOSH 0500 respectively. The VOC samples were taken using activated charcoal tubes SKC 226-10 and analysed using Gas Chromatograph with Flame Ionisation Detection instrumentation. The analysis for the sample is performed by the Laboratory for occupational hygiene and toxicology of the Catholic University of Leuven (KUL).. The analysis for both sampling methods is performed by the Laboratory for Occupational Hygiene and Toxicology of the Katholieke Universiteit of Leuven (KUL).

The sampling of airborne RNCO and MDI concentrations is performed using ASSET™ EZ4-NCO sampler and samples are submitted for analysis to the laboratory “Institutet För Kemisk Analys Norden” (IFKAN) according to method ISO17734-1.

More details regarding these methods are listed in the appendix.

3.2.2 Sampling strategy

The overview of the sampling plan is listed in the table below:

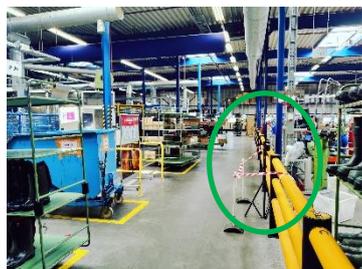
	RNCO	MDI	VOC	TIP
Personal monitoring	One working shift, where all operators work along the production line, are monitored during normal production activities : <ul style="list-style-type: none"> • Three operators working at the shoe manufacturing machines were monitored (PU 2, 4 and 6) • Two operators working at the finishing line • One operator working at the “kitchen” • One operator at the finishing inks 			
Analytical background monitoring				



Panel PU 4



Panel PU 5



Walkway between PU
5&6

3.2.3 Evaluation of the results

General

It must be noted that the results reflect the concentration at the time of the survey taking into account the operational conditions during the sampling period (climatic conditions, air flows in production hall, etc.).

Results reported are calculated based on the sample duration / volume and target compounds detected in / on the sample medium.

Since sensitising substances (MDI) are possibly present in workplace atmosphere, exposure risks should be minimised as low as reasonably practical. Where and when deemed needed, risk reduction measures recommendations will be given in section 4.3.

Two exposure assessments are carried out:

1. Based on “Grenswaarden gezondheidsschadelijke stoffen 2017 (Limit values of health-damaging substances 2017)”
2. Based on the Threshold Limit Values (TLV) 2024 published by ACGIH.

The results of MDI are obtained by summing the results of all individual relevant diisocyanates (2,4'-MDI and 4,4'-MDI).

The results are compared to the Occupational Exposure Limit or TLV according to the table below:

Assessment	Exposure limit (mg/m ³)	Exposure limit (EL)	Compound
Dutch OEL	0.05	OEL-TWA 8hrs/DNEL	MDI
TLV ACGIH	594	OEL-TWA 8hrs	Acetone
	492		Isopropanol(IsoP)
	238		Diacetone alcohol)
	25		Cumene
	49		Mesitylene
	49		1,2,3-trimethylbenzene
	49		1,2,4-trimethylbenzene
	49		1-methoxy-2-propanol acetate

All VOCs were compared to the TLV not the Dutch OEL due to unavailability of the “ Grenswaarden gezondheidsschadelijke stoffen” document.

Personal samples

The non-sampled period is considered as a period where the same exposure levels are occurring. However, it must be noted that activities with higher exposure risks could have taken place in the non-sampled period. Therefore, it is advised to carry out a chemical risk assessment to identify additional critical activities while handling isocyanates or other chemicals not assessed during this survey.

At the start of the sampling operators are given a “task sheet” on which they are requested to complete which activities are carried out during which time periods and which PPE is used. This might be useful for later reference in case high personal results have been detected.

Strictly speaking, only the results from personal samples are taken into account for verification compliance with local exposure limits.

Background samples

The background concentration results give an overview of the workplace air quality at different locations. These results do not represent personal exposure unless an operator would stand at the same location for 8 hours. Background samples are taken at head height at positions and at areas where workers would be or would pass the process and they are not to be confused with samples trying to identify potential emission source.

Although the relevant exposure limits are strictly speaking only relevant for result obtained via personal sampling, the background samples are assessed similarly as the personal exposure samples.

4 RESULTS AND DISCUSSION

4.1 Exposure assessment to airborne MDI, VOCs and Zinc Omadine at the workplace

4.1.1 Personal Results

Sample Reference Number	Sample Period	Person - Task	Results (mg/m ³) ⁴	Compound	Evaluation [Result/EL-TWA] (%) ⁵
LT/24/0291001001	06:00 – 13:20	Operator – PU 4	<0.00008 ND	MDI	<0.16 ND
LT/24/0291001002			2.0	IsoP(VOC)	0.41
LT/24/0291001003	06:12 – 13:12	Operator PU 2	<0.00008 ND	MDI	<0.16 ND
LT/24/0291001004			1.3	IsoP(VOC)	0.26
LT/24/0291001005	06:11 – 13:30	Operator PU 6	<0.00008 ND	MDI	<0.16 ND
LT/24/0291001006			1.5	IsoP(VOC)	0.30
LT/24/0291001007	06:15 – 10:45	Operator - Finishing	1.2	IsoP(VOC)	
LT/24/0291001008	07:57 – 13:44	Operator - Finishing	Traces	VOC	/
LT/24/0291001009	06:00 – 13:20	Operator – Kitchen	Traces	VOC	/
LT/24/0291001010 ⁶			0.21	TIP (ZO)	/

⁴ ND = None Detected; *All VOC samples contain trace amounts of a large number of different VOCs such as Toluene, xylenes, n-hexane, etc. commonly found in solvents and paints(See chapter 5.4)*

⁵ *The most stringent exposure limit of section 3.2.3 has been used for evaluation of the results; (Result) / (8-hour exposure limit (chapter 3.2.3))*

⁶ *See discussion*

Sample Reference Number	Sample Period	Person - Task	Results (mg/m ³) ⁷	Compound	Evaluation [Result/EL-TWA] (%) ⁸
LT/24/0291001020 ⁹	13:44 – 14:18	Operator – Finishing inks	3.0	acetone	0.51
			17.5	Diacetone alcohol	7.35
			1.6	1-Methoxy-2-propanol-acetate	/
			1.1	Cumene	4.4
			3.6	n-propylbenzene	/
			8.8	3-ethyltoluene	/
			3.4	4-ethyltoluene	/
			4.1	mesitylene	8.37
			3.8	2-ethyltoluene	/
			10.5	1,2,4-tri-Methylbenzeen	21.43
			1.4	1,2,3-tri-Methylbenzeen	2.86

⁷ ND = None Detected; All VOC samples contain trace amounts of a large number of different VOCs (Toluene, xylenes, n-hexane, etc. commonly found in solvents and paint(see chapter 5.4))

⁸ The most stringent exposure limit of section 3.2.3 has been used for evaluation of the results

⁹ Not all found chemical have an Occupational Exposure Limit

4.1.2 Analytical background results

Sample Reference Number	Sample Period	Sample Location	Results (mg/m ³) ¹⁰	Compound	Evaluation [Result/EL-TWA] (%)
LT/24/0291001011	06:56 – 12:12	PU 4 panel	<0.00011 ND	MDI	<0.22 ND
LT/24/0291001012			Traces	VOC	/
LT/24/0291001013	06:59 – 12:15	PU 5 panels	<0.00011 ND	MDI	<0.22 ND
LT/24/0291001014			2.3	IsoP (VOC)	0.47
LT/24/0291001015	07:45 – 11:00	Walkway between PU 5 & 6 (below ventilation ducts)	1.3	IsoP (VOC)	0.26

¹⁰ ND = None Detected; All VOC samples contain trace amounts of a large number of different VOCs (Toluene, xylenes, n-hexane, etc. commonly found in solvents and paints(see chapter 5.4)

4.2 Observations

It was observed that operators do not wear the recommended Personal Protection Equipment(PPE):

REACH compliance

The standard general RMM for processes or tasks using MDI based products < 40°C and PMDI based products < 45°C or when no aerosols are being generated:

- *E11 DM: Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) and*
- *E3: Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop and*
- *PPE14: Use suitable eye protection and gloves and*
- *EI 19: Ensure operatives are trained to minimize exposures and*
- *PPE27: Wear suitable coveralls to prevent exposure to the skin.*

Operators who come into close contact with Isocyanates or freshly made Isocyanate-based products should follow above recommendation.

4.3 Discussion of the results

4.3.1 Isocyanates, VOC TIP personal airborne results

- No isocyanates were detected from 3 personal samples taken. Detection limits were well below the relevant exposure limit.
- One personal TIP sample was taken as a stand-in for 1-Hydroxypyridine-2-thione zinc salt (zinc omadine). Note that this sample tested for ALL dusts, not just for zinc omadine.

There is no legally binding limit available for this chemical, but the SDS does mention an unofficial Occupational Exposure Limit (OEL) of 0.35 mg/m³ over an 8-hour period. The result was below this with 0.21 mg/m³. If we assume all dust sampled was zinc amadine this would result in an exposure of 60% of the OEL. It's difficult to draw any conclusions from this one sample since it sampled all dusts present, but improved local ventilation or giving the option to the operator to wear a dust mask during critical phases could be an option.

- The personal VOC sample from the Operator at the ink station showed medium levels of exposure to a whole list of different VOCs. None of these chemicals separately were close to the OEL, but since most of the found chemicals are similar, with similar effects, the overall exposure is not negligible. Improved local ventilation at this workstation could be an option.

All the other personal samples showed a low amount of Isopropanol and trace amounts of a whole range of VOCs (see chapter 5.4 for examples).

4.3.2 Isocyanates and VOC background results

- No isocyanates and only trace amounts of VOC were detected from the 2 background samples taken. All results were well below the relevant exposure limits. Trace amounts of VOCs seem to be present in all areas of the factory floor. This could be caused by the ventilation system that is reusing air from the factory without a VOC filter. Making changes to this ventilation system or improving general ventilation could lessen this issue.

5 APPENDIX

5.1 Method summary isocyanates

ISO 17734-1:2013 : *“Determination of organonitrogen compounds in air using liquid chromatography and mass spectrometry – Isocyanates using dibutylamine derivatives”*

Sampling	Analysis
<p>Medium : DBA coated denuder tube followed by DBA coated 13 mm Type A/E Glass Fibre filter</p> <p>Sampler : Solvent free sampler</p> <p>Pump : SKC Universal TX pump</p> <p>Flow rate : 0.200 ml/min (filter)</p> <p>Pump Calibration : Bios flow meter</p> <p>Sampled air volume : up to 400 l</p> <p>Blank : 1 field blank per set of samples</p>	<p>Analytical instrument : LC-MS/MS</p> <p>Flow : 0.05 ml/min</p> <p>Gradient : water / acetonitrile / 0.05% formic acid</p> <p>Autosampler : 2 µl injection volume</p> <p>Column : Supelco, Ascentis Express C18 2.7µ 1mmx50.0mm</p> <p>MS/MS : Triple quadrupole working in the electrospray mode monitoring positive ions, MRM quantifications</p>

Validation

Method Detection Limit : 0.0002 µg/m³ (for MDI and TDI in a 15 l air sample)

Method Quantification Limit : 0.07 µg/m³ (for MDI and TDI in a 15 l air sample)

Precision : RSD < 5%

Overall expanded uncertainty : 32 %

References

ISO 17734-1:2013 : *“Determination of organonitrogen compounds in air using liquid chromatography and mass spectrometry – Isocyanates using dibutylamine derivatives”*

EN 1076:2009 : *“Workplace exposure – Procedure for measuring gases and vapours using pumped samplers – Requirements and test methods”*

EN 482:2006 : *“Workplace atmospheres – General requirements for the performance of procedures for the measurement of chemical agents”*

5.2 Method summary NIOSH 0500

PARTICULATES NOT OTHERWISE REGULATED, TOTAL 0500

DEFINITION: total aerosol mass CAS: NONE RTECS: NONE

METHOD: 0500, Issue 2		EVALUATION: FULL	Issue 1: 15 February 1984 Issue 2: 15 August 1994
OSHA: 15 mg/m ³ NIOSH: no REL ACGIH: 10 mg/m ³ , total dust less than 1% quartz		PROPERTIES: contains no asbestos and quartz less than 1%	
SYNONYMS: nuisance dusts; particulates not otherwise classified			
SAMPLING		MEASUREMENT	
SAMPLER: FILTER (tared 37-mm, 5-µm PVC filter)		TECHNIQUE:	GRAVIMETRIC (FILTER WEIGHT)
FLOW RATE: 1 to 2 L/min		ANALYTE:	airborne particulate material
VOL-MIN: 7 L @ 15 mg/m ³ -MAX: 133 L @ 15 mg/m ³		BALANCE:	0.001 mg sensitivity; use same balance before and after sample collection
SHIPMENT: routine		CALIBRATION:	National Institute of Standards and Technology Class S-1.1 weights or ASTM Class 1 weights
SAMPLE STABILITY: indefinitely		RANGE:	0.1 to 2 mg per sample
BLANKS: 2 to 10 field blanks per set		ESTIMATED LOD:	0.03 mg per sample
BULK SAMPLE: none required		PRECISION (\bar{S}_r):	0.026 [2]
ACCURACY			
RANGE STUDIED:	8 to 28 mg/m ³		
BIAS:	0.01%		
OVERALL PRECISION (\bar{S}_r):	0.056 [1]		
ACCURACY:	±11.04%		
APPLICABILITY: The working range is 1 to 20 mg/m ³ for a 100-L air sample. This method is nonspecific and determines the total dust concentration to which a worker is exposed. It may be applied, e.g., to gravimetric determination of fibrous glass [3] in addition to the other ACGIH particulates not otherwise regulated [4].			
INTERFERENCES: Organic and volatile particulate matter may be removed by dry ashing [3].			
OTHER METHODS: This method is similar to the criteria document method for fibrous glass [3] and Method 5000 for carbon black. This method replaces Method 5349 [5]. Impingers and direct-reading instruments may be used to collect total dust samples, but these have limitations for personal sampling.			

5.3 Method summary VOC

Annex 1 : List of compounds (with CAS-number) determined in VOC-analysis

Hydrocarbons :	Halogenated compounds :	Miscellaneous :
<u>n-pentane [109-66-0] *</u>	<u>methylene chloride [75-09-2] * **</u>	<u>tetrahydrofuran [109-99-9] *</u>
<u>2-methylbutane [78-78-4]</u>	<u>chloroform [67-66-3] *</u>	<u>2-methyltetrahydrofuran [96-47-9]</u>
<u>2,3-dimethylbutane [79-29-8]</u>	<u>tetrachloromethane [56-23-5] *</u>	<u>1,4-dioxane [123-91-1] *</u>
<u>2-methylpentane [107-83-5] *</u>	<u>1,1-dichloroethane [75-34-3]</u>	<u>acetonitrile [75-05-8] *</u>
<u>3-methylpentane [96-14-0] *</u>	<u>1,2-dichloroethane [107-06-2] *</u>	<u>acrylonitrile [107-13-1] *</u>
<u>cyclopentane [287-92-3]</u>	<u>trans-1,2-dichloroethene [156-60-5]</u>	<u>gamma-butyrolactone [96-48-0]</u>
<u>methylcyclopentane [96-37-7] *</u>	<u>cis-1,2-dichloroethene [156-59-2]</u>	<u>linalool [78-70-6]</u>
<u>n-hexane [110-54-3] *</u>	<u>1,1,1-trichloroethane [71-55-6] *</u>	
<u>cyclohexane [110-82-7] *</u>	<u>1,1,2-trichloroethane [79-00-5]</u>	Ketones :
<u>1-hexene [592-41-6]</u>	<u>1,1,2,2-tetrachloroethane [79-34-5]</u>	<u>acetone [67-64-1] *</u>
<u>cyclohexene [110-83-8]</u>	<u>pentachloroethane [76-01-7]</u>	<u>methyl ethyl ketone [78-93-3] *</u>
<u>n-heptane [142-82-5] *</u>	<u>trichloroethylene [79-01-6] *</u>	<u>methyl-n-butyl ketone [591-78-6]</u>
<u>2,2,3-tri-methylbutane [464-06-2]</u>	<u>tetrachloroethylene [127-18-4] *</u>	<u>methyl-iso-butyl ketone [108-10-1] *</u>
<u>2,2-dimethylpentane [590-35-2]</u>	<u>iso-propylchloride [75-29-6]</u>	<u>methyl-iso-amyl ketone [110-12-3]</u>
<u>2,3-dimethylpentane [565-59-3]</u>	<u>1,2,3-trichloropropane [96-18-4]</u>	<u>ethyl-n-pentyl ketone [106-68-3]</u>
<u>2,4-dimethylpentane [108-08-7]</u>		<u>di-n-propyl ketone [123-19-3]</u>
<u>2-methylhexane [591-76-4]</u>	<u>mono-chlorobenzene [108-90-7] *</u>	<u>di-iso-propyl ketone [565-80-0]</u>
<u>3-methylhexane [589-34-4]</u>	<u>benzylchloride [100-44-7]</u>	<u>di-iso-butyl ketone [108-83-8]</u>
<u>methylcyclohexane [108-87-2] *</u>	<u>benzylidenechloride [98-87-3]</u>	<u>cyclohexanone [108-94-1] *</u>
<u>n-octane [111-65-9] *</u>	<u>p-dichlorobenzene [106-46-7] *</u>	<u>isophorone [78-59-1]</u>
<u>iso-octane [540-84-1] *</u>	<u>o-dichlorobenzene [95-50-1]</u>	<u>mesityloxide [141-79-7]</u>
<u>2,3,4-tri-methylpentane [565-75-3]</u>	<u>m-dichlorobenzene [54-173-1]</u>	<u>diacetone alcohol [123-42-2] *</u>
<u>2,3-di-methylhexane [584-94-1]</u>	<u>1,2,3-trichlorobenzene [87-61-6]</u>	<u>acetophenone [98-86-2]</u>
<u>3,4-di-methylhexane [583-48-2]</u>		<u>1-methyl-2-pyrrolidone [872-50-4]</u>
<u>2,5-di-methylhexane [592-13-2]</u>	<u>1,2-dibromoethane [106-93-4]</u>	<u>cyclopentanone [120-92-3]</u>
<u>2,2,5-tri-methylhexane [3522-94-9]</u>	<u>1-bromo-3-chloropropane [109-70-6]</u>	<u>2-methylcyclohexanone [583-60-8]</u>
<u>2-methylheptane [592-27-8]</u>	<u>2-bromoethylbenzene [103-63-9]</u>	<u>3-methylcyclohexanone [591-24-2]</u>
<u>3-methylheptane [589-81-1]</u>	<u>1-bromo-4-fluorobenzene (460-00-4)</u>	<u>4-methylcyclohexanone [589-92-4]</u>
<u>4-methylheptane [589-53-7]</u>	<u>methyl iodide [74-88-4]</u>	
<u>n-nonane [111-84-2] *</u>		
<u>4-methylnonane [17301-94-9]</u>	Alcohols :	Esters :
<u>n-decane [124-18-5] *</u>	<u>ethanol [64-17-5] *</u>	<u>methyl formate [107-31-3]</u>
<u>n-undecane [1120-21-4] *</u>	<u>n-propanol [71-23-8]</u>	<u>ethylformate [109-94-4]</u>
<u>n-dodecane [112-40-3] *</u>	<u>iso-propanol [67-63-0] *</u>	<u>n-propyl formate [110-74-7]</u>
<u>n-tridecane [629-50-5]</u>	<u>1-butanol [71-36-3] *</u>	<u>methyl acetate [79-20-9] *</u>
<u>n-tetradecane [629-59-4]</u>	<u>2-butanol [78-92-2] *</u>	<u>ethyl acetate [141-78-6] *</u>
<u>n-pentadecane [629-62-9]</u>	<u>iso-butanol [78-83-1] *</u>	<u>vinyl acetate [108-05-4]</u>
<u>n-hexadecane [544-76-3]</u>	<u>tert-butanol [75-65-0] *</u>	<u>n-propyl acetate [109-60-4] *</u>
<u>limonene [5989-27-5] *</u>	<u>3-pentanol [584-02-1]</u>	<u>iso-propyl acetate [108-21-4] *</u>
<u>cis-decalin [493-01-6]</u>	<u>iso-amyl alcohol [123-51-3]</u>	<u>n-butyl acetate [123-86-4] *</u>
<u>trans-decalin [493-02-7]</u>	<u>tert-amyl alcohol [75-85-4]</u>	
	<u>cyclohexanol [108-93-0] *</u>	<u>iso-butyl acetate [110-19-0] *</u>
Glycol ethers and derivatives :	<u>methyl-iso-butylcarbinol [108-11-2]</u>	<u>tert-butyl acetate [540-88-5]</u>
<u>ethylene glycol monomethyl ether (2-methoxyethanol) [109-86-4] * ***</u>	<u>benzylalcohol [100-51-6] *</u>	<u>n-amyl acetate [628-63-7] *</u>
<u>ethylene glycol monoethyl ether (2-ethoxyethanol) [110-80-5] * ***</u>	<u>allylalcohol [107-18-6]</u>	<u>iso-amyl acetate [123-92-2]</u>
<u>ethylene glycol mono-iso-propyl ether (iso-propoxyethanol) [109-59-1]</u>		<u>benzyl acetate [140-11-4]</u>
<u>ethylene glycol monopropyl ether (2-propoxyethanol) [2807-30-9]</u>	Ethers :	<u>ethyl propionate [105-37-3]</u>
<u>ethylene glycol monobutyl ether (2-butoxyethanol) [111-76-2] * ***</u>	<u>diethylether [60-29-7] *</u>	<u>n-propyl propionate [106-36-5]</u>
<u>ethylene glycol dimethyl ether (dimethylglycol) [110-71-4]</u>	<u>di-iso-propylether [108-20-3]</u>	<u>methylbutyrate [623-42-7]</u>
<u>ethylene glycol diethyl ether (diethylglycol) [629-14-1]</u>	<u>tert-butylmethyl ether [1634-04-4] *</u>	<u>ethyl butyrate [105-54-4]</u>
<u>ethylene glycol monomethyl ether acetate (methyl glycol acetate) [110-49-6] *</u>	<u>dibutylether [142-96-1]</u>	<u>methyl acrylate [96-33-3]</u>
<u>ethylene glycol monoethyl ether acetate (ethyl glycol acetate) [111-15-9] *</u>		<u>ethyl acrylate [140-88-5]</u>
<u>ethylene glycol monobutyl ether acetate (butyl glycol acetate) [112-07-2] *</u>		<u>butyl acrylate [141-32-2]</u>
<u>ethylene glycol acetate [542-59-6]</u>		<u>methyl methacrylate [80-62-6] *</u>
<u>ethylene glycol diacetate [111-55-7]</u>		<u>ethyl methacrylate [97-63-2]</u>
<u>diethylene glycol diethyl ether (diethyl diglycol) [112-36-7]</u>		<u>butyl methacrylate [97-88-1]</u>
<u>propylene glycol monomethyl ether (1-methoxy-2-propanol) [107-98-2] *</u>		<u>iso-butyl methacrylate [97-86-9]</u>
<u>propylene glycol monoethyl ether (1-ethoxy-2-propanol) [1569-02-4]</u>		<u>dimethyl succinate [106-65-0]</u>
<u>propylene glycol monomethyl ether acetate (1-methoxy-2-propanol acetate) [108-65-6] *</u>		<u>dimethyl glutarate [1119-40-0]</u>
<u>propylene glycol monoethyl ether acetate (1-ethoxy-2-propanol acetate) [98516-30-4]</u>		<u>dimethyl adipate [627-93-0]</u>
<u>ethylene glycol monohexylether (hexylcellosolve) [112-25-4]</u>		

5.4 Examples lab results VOC samples

- Sample LT/24/0291001012

Identiteit: 7/24. staal 012 - 1° s.	
Het luchtmonster bevat geen producten in concentraties hoger dan de op de keerzijde vermelde rapporteringsgrenzen.	
Er werden sporen aangetroffen van de volgende stoffen:	
Pr #	Productnaam
107	iso-Propanol
39	Ethylbenzeen
40	m-Xyleen
41	p-Xyleen
46	o-Xyleen
89	2-Methylhexaan
19	3-Methylhexaan
23	n-Heptaan
188	4-Methylnonaan
en een reeks niet geïdentificeerde producten	

en een reeks niet geïdentificeerde producten

- Sample LT/24/0291001008

Identiteit: 5/24. staal 008 - 1° s.	
Het luchtmonster bevat geen producten in concentraties hoger dan de op de keerzijde vermelde rapporteringsgrenzen.	
Er werden sporen aangetroffen van de volgende stoffen:	
Pr #	Productnaam
107	iso-Propanol
31	Tolueen
38	n-Butylacetaat
144	Methoxy-2-propanol-acetaat
39	Ethylbenzeen
40	m-Xyleen
41	p-Xyleen
46	o-Xyleen
149	1-Ethoxy-2-propanol-acetaat
89	2-Methylhexaan
18	2,3-di-Methylpentaan
19	3-Methylhexaan
23	n-Heptaan
26	Methylcyclohexaan
48	n-Nonaan
62	n-Decaan
188	4-Methylnonaan
en een reeks niet geïdentificeerde producten	

5.5 Correct selection and use of gloves

Nitrile gloves must be used for dermal protection against isocyanates and especially latex gloves must not be used.

Allergic reactions associated with the use of latex gloves are relatively common, with reports of sensitization of up to 30% of health care workers. In the special case where it is necessary for an Associate to wear latex gloves, it is recommended that the following management steps be taken:

- Gloves should only be used if there is a clear need to do so.
- Staff should be made aware of the problems of glove allergy, especially latex sensitization.
- Powdered gloves (especially corn-starch) should be avoided.
- Associates with a significant history of allergy should be provided with alternatives, following consultation with your EHS Department or Safety Section.

If Nitrile gloves are not compatible for other chemicals (where a breakthrough of the chemical is likely or the protection degree is unknown), latex gloves can be worn over the Nitrile gloves to prevent latex allergenic reactions.

However, the information about the right selection of the gloves must be retrieved by the supplier, delivering him the information regarding the chemical compounds involved during these activities.

5.6 Correct selection and use for eye protection

Eye protection should be worn at all times when handling isocyanates and should be adequate to prevent the possibility of any isocyanate entering the eye. Care should be taken to ensure that eye protection is not handled with contaminated gloves. A full face shield should be worn if there is the possibility of splashing.

5.7 CONFIDENTIALITY

Regarding this service, the IH CoE group agrees to treat all information, except as noted below, obtained from the client and generated by the laboratory as confidential and to not disclose it to third parties, including governmental authorities, unless required to do so by applicable law.

The IH CoE group will immediately inform the client in writing of any request by third parties for disclosure of such information. Notwithstanding the above, if underlying data connected to the service is used to conduct further investigations for publication purposes, this information will be disclosed. However, the IH CoE group will maintain confidentiality with respect to information identifying the client, unless otherwise approved in writing by the client.

5.8 Websites

Useful information regarding isocyanates and their applications can be found on the following websites:

www.polyurethanes.org and www.diisocyanates.org

NOTICE

The information and recommendations in this report ("information") are based upon conditions and practices observed and data made available at the time of this survey. The methods used to generate data are believed to be up to date and the most appropriate for use under the operational and environmental parameters existing at the time of the survey. Information is presented in good faith and believed to be correct as of this date. Huntsman Polyurethanes however makes no representation as to the completeness or accuracy of the information, and you should make your own determinations as to its suitability and fitness for purpose to your particular operation. In no event will Huntsman Polyurethanes be responsible for any damages of any nature (herein included without limitation, any consequential loss, pure economic loss, loss of profits and loss of business) resulting from the use of, reliance upon, or the misuse of any information for any purpose.

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