Investigation report into exposure to solvent vapours in Sir James Black Centre Level 1 Laboratories

Written by Ian Scragg, Head of Safety Services on 22 April 2013.

Version: Final for submission to the University H&S sub-committee and subsequent report to a University Court Committee (ie HR Committee).

Background

On 28 Feb 2013 it was discovered that two Vacuubrand pumps on the east end bays in the north laboratory Sir James Black Centre (SJB) level 1 had been disconnected and moved elsewhere. The exhaust line had not been blanked off and was left open to the laboratory. The pumps were disconnected in 2006 because they were no longer required.

On 1 March 2013 it was discovered a Vacuubrand pump on the south laboratory had also been disconnected, and not blanked off. This pump was disconnected toward the end of 2011.

It appears likely that pumps were also removed for repair by the Workshop without the open ends being blanked off.

Tests with diethyl ether revealed that solvent vapour leaked into the laboratory from the open ends of disconnected lines.

The system was installed in 2005 during completion of SJB. The system was procured by College of Life Sciences (CLS), as an independent contract to the construction contract for SJB. This was done to enable the users more input into the specification and functionality of the system. The installer was one the largest and most respected installer of vacuum systems in Europe. The installer liaised with the Design Team, Main Contractor and Estates and Buildings. Training was given on the system to CLS staff by the supplier when it was installed. Records of training, system plans, commissioning data, inspection and maintenance records are not available.

There have been reports of “smells” in the north laboratory for several years and staff report having to leave the laboratory on occasions. An accident report was sent in 2008 to Head of Safety Services reporting a chemical leaking into the laboratory when a fume cupboard was being used (Appendix 1).

An e-mail was sent on 2 March 2011 to many staff stating “several chemists *(working in the south side lab)* have complained that the smells are causing severe headaches and vomiting sensations”.

The Health and Safety Executive was informed of this dangerous occurrence (Appendix 2).

Statements by staff are given in Appendix 3.

A list of solvents used in the labs and brief details of daily activities are given in Appendix 4. Details of current and previous staff who have worked in SJB level 1 will be lodged with this report.

The Institution of Occupational Medicine was commissioned on the 8 March 2013 to carry out measurements to estimate the possible level of exposure. A copy of their report is given in Appendix 5.

Recommendations

1. An inventory of installations shall be drawn up by CLS and E&B. This inventory will state which party is responsible for each item on the inventory.
2. The responsible party ie CLS or E&B will ensure these installations are fit for purpose, inspected & maintained according to the manufacturers' instructions, and in accord with relevant legislation.
3. Users should be fully trained in the use of such installations, including the reporting of faults. This training should be recorded and refresher training given at suitable intervals.
4. Head of Safety Services will introduce a formal system to ensure reported accidents/incidents have been resolved.
5. Head of Safety Services will meet with Vice-Principal, College Secretary and other CLS staff to review in detail how H&S is managed within CLS: specifically; culture, roles, responsibilities & reporting lines, and the provision of safe facilities, procedures & people.

Appendix 1

10109

UNIVERSITY SAFETY SERVICES
ACCIDENT AND INCIDENT REPORT FORM

For office use only
Ref No:
HSE No:
Received:

Section A: Which of the following best describes Accident/Incident

Accidental Injury ☐ | Fatality ☐ | Physical Violence ☐ | Property Loss/Damage ☐ | Verbal Abuse or threatening behaviour ☐
Ill Health ☐ | Near Miss ☑ | Other (specify) ☑ Smelly Reagent

Section B: Details of person involved in Accident/Incident

Full Name (including title): DR NAJAF ALWAHARK
Date of Birth: 26 . 10 . 62
Home/Term Address: 73 Ancrum Rd Dundee
Staff ☑ | Student PG ☐ | Student UG ☐ | Contractor ☐
Member of public ☐ | Other (specify)
Post Code: DD2 2HT | Tel: 807309
Occupation: CHEMIST | Male ☑ | Female ☐
Department/School: Life Sciences

Section C: Details of Accident/Incident

Time: 10:00 Am | Date: 1/12/08 | Location: 1L2-244

Brief description of Accident/Incident: NAJAF WAS CARRYING OUT A WORK UP PROCEDURE . THE FUME HOOD WHICH INVOLVED THE USE OF ETHANE THIOL WHICH HAS A PUNGENT ODOUR AND IS HARMFUL BY INHALATION. ALTHOUGH THE THIOL WAS CONTAINED IN THE HOOD IT WAS APPARENT THAT THE SMELL WAS COMING THROUGH THE DUCTING IN THE ROOF SPACE.

Section D: Illness or Injury Details

Nature of injury or illness (eg abrasion to right leg)

Did accident/incident prevent injured person carrying out normal work activity? Yes ☐ No ☐
If YES: Has injured person returned to normal duties? Yes ☐ No ☐
If YES, when did they return?

Details of First Aid given:

Treatment given by: | First Aider/Nurse/Doctor (delete as appropriate)

Further treatment required: GP ☐ | Hospital ☐ | Other ☐ Please specify

Section E: Accident/Incident Management

Line manager/Supervisor: BRIAN HERRICK | Signature: Brian V. Herrick
Position: LABS MANAGER | Ext: | Date and Time reported: 1/12/08 11:00Am.

Brief details of immediate action taken to prevent recurrence: TO BE INVESTIGATED BY ENGINEER.

Section F: Witness Details

Name: | Name:
Department/School: Ext: | Department/School: Ext:

Please send this form to Safety Services, 3 Cross Row as soon as possible
Serious accidents/incidents should be reported immediately by telephone to Safety Services (Ext 84104)

DATA PROTECTION ACT
Personal details entered in this form will be used for health and safety purposes. You have the right to ask for a copy of the form, and to request that inaccurate data is corrected. This information may be disclosed to the Health and Safety Executive to comply with Reporting of Injuries Diseases and Dangerous Occurrences Regulations 1995, and to the Secretary's Office for insurance purposes.

Safety Services Use

No further Action ☐ | Investigated by:
Investigation Required ☑ | Investigation completed:

Irene Blair & Terry Jonaway investigating. Engineer called

Appendix 2: HSE notification

HSE

Health and Safety Executive

F2508 - Report of a dangerous occurrence

Notification Number	0A48093C47

About you and your organisation

Notifier Name	Dr Ian Scragg

Organisation Name	Dundee University		
Address	Nethergate DUNDEE Angus DD14HN		
Job Title	Head of Safety Services		
Email	i.g.scragg@dundee.ac.uk		
Phone No	01382 384103	**Fax No**	

Where did the incident happen

The incident happened at the above address

The enforcing authority for the address where the incident happened is HSE

About the incident

Incident Date	01/01/2006	**Incident Time**	12:00
In which local authority did the incident occur? (Country, Geographical Area and Local Authority)			
Scotland, Scotland, Dundee			
In which department or where on the premises did the incident happen?			
Sir James Black Centre			
What type of work was being carried out (generally the main business activity of the site)?			
Main Industry			
Government administrative functions, Education, Health			
Main activity			
Sports, recreation education			
Sub activity			
Sports, recreation education			

About the type of dangerous occurrence

Dangerous occurrence	Accidental release or escape of substances liable to cause harm
Description	Two vacuum pumps disconnected from vacuum system without capping inlet and outlet. This led to solvent vapours being discharged into lab. Staff reports of severe headaches and nausea. IOM are coming on site tomorrow to assess potential levels of exposure.

Appendix 3
Staff members employed for several years.

Problems reported verbally to Laboratory Manager on several occasions. A long standing issue for which nothing was done. Problem identified on Thurs 28th Feb 2013 because a very smelly sulphury compound was used.

E-mail sent from Laboratory Manager to CLS H&S on 2 March 2011 stating several staff working in south side laboratory have reported severe headaches and vomiting sensations, and biologists working in JBC 1 north are frequently smelling smoke. E-mail copied to around 50 staff, including senior staff.

Appendix 4
Information collated by research staff.

Solvents commonly used in JBC 1 North Lab:
Methanol
Ethanol
Ethyl acetate
Hexane
Toluene
Tetrahydrofuran
Dichloromethane
Chloroform
Petroleum ether 40-60
Acetone
Diethyl ether
7M Ammonia methanol
Acetic acid
N,N'-Dimethyformamide
Dimethy sulfoxide
Acetonitrile
1,4-Dioxane

The list shows the most commonly used solvents. Red solvents have been used on a daily basis over the past year mainly for work up and chromatography. These activities involve the use of the vacuum lines for filtration (in fumehoods) and rotary evaporation. Apparently toluene and chloroform (marked in purple) were routinely used by Andrei Nikolaevs group for work up and chromatography. The other solvents are used on a less frequent basis, mainly in reactions.

Rotary evaporators are one of the most heavily used pieces of equipment in the lab. The rotary evaporators are used on and off all day (9am-5pm). We estimate over the past year each of the 4 rotary evaporators in the lab is used on average for 3-4 hours a day. The vacuum lines are also used for filtrations

carried out during reaction work up. This activity may be carried out once a day in each fumehood and the duration of this activity is no more than 5 minutes on average. The vacuum line is also used overnight by one of the chemists to remove trace solvents from solids and oils.

Appendix 5. IOM Report

Paper C

WORKING FOR A HEALTHY FUTURE

Services Report 606-01807
April 2013

MONITORING OF OCCUPATIONAL EXPOSURE TO HAZARDOUS SUBSTANCES WITHIN THE COLLEGE OF LIFE SCIENCES CHEMISTRY LABORATORIES FOR UNIVERSITY OF DUNDEE

Craig Lewis
Occupational Hygienist
IOM Consulting Ltd.

RESEARCH CONSULTING **SERVICES**
Multi-disciplinary specialists in Occupational and Environmental Health and Hygiene

www.iom-world.org

OUR IMPACT ON THE ENVIRONMENT

At IOM we seek to minimise our environmental impact. We produce thousands of reports every year and these consume a large quantity of paper. To minimise our impact on the environment, we prefer to only provide an electronic copy of reports, although we can provide a paper copy on request. If you have any additional requirements please let us know.

Paper C

WORKING FOR A HEALTHY FUTURE

REPORT TO CLIENT

Monitoring of Occupational Exposure to Hazardous Substances within the College of Life Sciences Chemistry Laboratories for University of Dundee

Report Issued:
18th April 2013

Report prepared for:

Ian Scragg
Head of Safety Services
University of Dundee
Nethergate
Dundee
DD1 4HN

Contract No: 606-01807

Report prepared by:

Craig Lewis
Occupational Hygienist
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CONTENTS

1 INTRODUCTION

IOM were requested by Ian Scragg, Head of Safety Services, University of Dundee to carry out an investigation of the potential exposure of staff to a range of volatile organic compounds. The request followed the discovery that modifications had been made to equipment within the Chemistry Laboratories which it was suspected could have resulted in the liberation of various chemicals into the work environment.

The main aim of the sampling survey was to establish what the potential exposure of staff to airborne chemicals could have been whilst using the Vacuubrand vacuum pumps and associated filtration equipment and vacuum lines.

In addition a request was made by a member of the University staff to determine the consequences of the sash height of the fume cupboards on the amount of vapour produced from the outlets of the equipment.

The survey was undertaken by Craig Lewis of IOM Consulting Ltd. with monitoring carried out on 24th March 2013.

On the day of the survey the samples were collected over representative periods when working activities were being undertaken as advised by University staff. It is therefore believed that the results are representative of these operating conditions.

The airborne samples were collected in accordance with the IOM's UKAS accreditation. The samples for toluene analysis were analysed in accordance with the IOM's UKAS accreditation. All other analysis was conducted in accordance with the IOMs quality assurance systems. Opinions and interpretations of the results expressed in this report are out with the remit of this accreditation.

This report describes the measurement methodology results and summarises the findings and results. In particular the report considers the potential exposure of staff to the organic compounds.

2 BACKGROUND

On 28 February 2013 it was discovered by the University of Dundee that two Vacuubrand pumps located in the east end bays of the north chemistry laboratory, level 1 of the JBC building had been disconnected and moved elsewhere. The exhaust line attached to the pumps had not been blanked off and had been left open to vent into the laboratory. It is understood that the pumps were disconnected in 2006 because they were no longer required.

On 1 March 2013 it was discovered that a Vacuubrand pump in the south laboratory had also been disconnected, this had also not been blanked off. It is reported that this pump was disconnected toward the end of 2011.

There have been reports of “smells” in the north laboratory over a period of time and staff had reported feeling unwell on several occasions.

Exploratory tests carried out by the laboratory staff with diethyl ether indicated that solvent vapour leaked into the laboratory from the open ends of the disconnected lines when the pumps were in use.

Ian Scragg requested IOM to meet with the staff involved to discuss what measurements and assessments could be carried out to determine what concentrations, if any, staff may have been exposed to over the period of time that the equipment had been used with the outlets open to the laboratory environment.

Following the initial meeting and subsequent provision of additional information relating to the use of the equipment and the chemicals a sampling programme was agreed.

3 SAMPLING SURVEY

3.1 Sampling Strategy

The following scenarios were discussed with the laboratory staff and agreed to be typical of the use of the equipment and the chemicals. These scenarios were therefore selected as providing results which would have been typical of the conditions described by the staff and under which potential exposure to the substances could have occurred.

Vacuubrand –

- The vacuum system is used during Buchner filtrations. The system can remain drawing vacuum for long periods of time dependant on the nature of the precipitate and the drying time required.

Rotary evaporators –

- The rotary evaporators were set up with the standard volume of solvent normally used during laboratory the procedures carried out.

The locations identified include three bays in the North Side Laboratory and four bays in the South Side Laboratory. Samples were also collected next to the vacuum pumps located in each laboratory located in the bench footwells.

It is acknowledged that not every chemical, or specific use of equipment, could be identified or replicated during the sampling survey. However, it is considered that the results provide a good indication of the concentrations of airborne substances which could have been present during the normal use of the most commonly used chemicals. A small number of situations were also assessed during the survey to represent conditions which could have been considered more of a 'worst case' scenario.

The equipment was used for periods of approximately three hours during which the various chemicals selected for test were processed.

The general conditions within the laboratory were left as standard, i.e. the fume cupboards were switched on at all times. The sash height of some of the cupboards where the pumps and filtration units would normally vent to was altered during the tests to simulate normal working practices.

The majority of the direct reading results were obtained from the North laboratory. This is where the majority of the complaints had come from and was also the area where the outlets had been disconnected for the longest period of time.

Only static samples were collected during the survey, this ensured that University personnel were not required to work with the equipment and in the laboratories over a long period of time when vapours could have been being introduced into the area. The use of static sampling equipment also enabled the collection of samples to assess the concentration of a number of chemicals at the same time.

It is understood that some staff will have been required to work at specific work stations/ benches for periods of time and the results from the static samples, located at these positions, will represent the airborne concentrations to which staff working at those positions would have been exposed.

It should however be noted that the results from static samples cannot be directly compared with workplace exposure limits. However, in this instance it is considered that the results do give a good indication of exposure and the exposure limits have therefore been used to inform the results.

The survey was carried out at the weekend when the laboratory was not in general use. This enabled the different scenarios to be set up without interference to, or from, others using the facilities.

A small number of University of Dundee staff were present during the sampling survey to operate the equipment and to discuss the use of the equipment, both in normal operations and any potential worst case scenarios.

3.2 Substances of Interest

Sampling was carried out during the use of rotary evaporators and vacuum pumps to measure the airborne concentrations of the following chemicals:

- Ethyl acetate
- Hexane
- Dichloromethane
- Toluene
- Chloroform
- Methanol

These chemicals have been identified as the most commonly used by staff, both in the recent past and by previous members of staff.

It is quite possible that other chemicals have been processed in the equipment over the year. However, those of an organic nature are likely to have passed through the equipment in a manner similar to those monitored during the tests. The results from the monitoring are therefore considered to give a good representation of the how vapours, in general, would have been generated from the equipment and entered into the laboratories.

3.3 Sample collection and analysis

3.3.1 Adsorbent Tubes

All sampling and analysis for the solvents used was carried out in accordance with MDHS 70.

These analytes were collected on SKC adsorbent tubes (226-01 and 226-10). Each adsorbent tube was activated by cutting the glass ends off, which permitted airflow through the adsorbent material. Each tube was connected to a low-flow adaptor which was in turn connected to a battery-operated personal sampling pump (Casella CEL Apex and/or SKC Aircheck).

The flow rates were set using a calibrated rotameter. The flow rate was set before sampling, and then checked during and also after the sampling period. After sampling, each tube was removed from the apparatus and the ends were sealed with plastic caps.

Samples were collected at static locations over a period of approximately three hours to enable an appropriate detection levels to be achieved. The samples were positioned approximately 1.5 – 2m from ground level (head height, within the breathing zone) where possible.

A minimum of one field blank was collected on each survey. Field blanks are prepared in the same clean area that all other samples are prepared and processed.

3.3.2 Direct Reading Instrument

In order to address the issue raised concerning the effect of the sash height measurements were taken using a direct reading instrument, a Tiger Phocheck. This was used to measure the concentrations of general volatile organic compounds (VOCs) at the outlets of the equipment with the fume cupboard sash heights in various positions.

The VOC meter was also used to check levels for the safety of the IOM operative and University staff during the sampling survey and at the end of the survey to demonstrate that any residual concentrations, which had been generated during the tests, had been reduced before the laboratory was put back into general use.

While the instrument can average the concentrations over known periods of time on this occasion it was used mainly to measure the peaks of the VOCs during specific activities or conditions.

The Phocheck was set to measure total volatile organic compounds (VOCs) not the specific individual chemicals which were being processed during the survey. This mode was selected as it was anticipated that the VOC peaks would be very transitory and in trying to measure all six chemicals data may have been lost.

4 DISCUSSION OF RESULTS

4.1 Airborne Concentrations

The results from the monitoring carried out, on 24th March 2013 in the north and south chemistry laboratories in the College of Life Sciences, to assess potential personal exposure are given in Tables 1 and 2, respectively.

4.1.1 Outlet Positions

The results show, not unexpectedly, that the highest concentrations of the chemicals were measured at the pump outlets and under the benches where the pumps are located. The highest concentration measured in the south laboratory was of ethyl acetate at the pump outlet in Bay 1. A small concentration of dichloromethane (DCM) was also detected at this location.

In the north laboratory the concentrations measured of all chemicals at the outlet tubing were higher than those measured in the south laboratory. The concentration of DCM and methanol reached the relevant WELs. These highest results were measured at the pump outlet under Bay 3. It is noted that although the concentrations of these substances were measured at concentrations close to the WELs they do not represent concentrations to which laboratory staff would have been exposed.

4.1.2 Bench Locations

The results from the samples located on the benches, i.e. those results which are more representative of personal exposure, were much lower than the concentrations measured at the outlets. This is indicative of the dilution effect that will be present in the laboratories where the number of air exchanges per hour will be in the order of 4 -10.

In the north laboratory measurable concentrations of all of the six chemicals in use were detected. However, the concentrations measured at the benches, where staff would work, were all low in comparison with the relevant WELs. Again the highest concentrations measured were of DCM and of methanol.

In the south laboratory the concentrations of the four chemicals which were used during the trial, as measured at work benches, were all very low, and well below the relevant WELs.

4.2 Direct Reading Results

4.2.1 General

The results of the measurements taken with the direct reading instrument are given in Tables 3 and 4 respectively. These readings were taken primarily to determine the effect of the sash height on the concentration of vapours at the outlets.

The method provides a single figure taken to represent the VOC mixture, although the instrument will be calibrated with an individual substance, in this instance to isobutylene. The instrument will detect volatile compounds but may also detect substances which would be classified as very volatile.

The results relate to total VOC concentrations and not to the individual substances which were being processed at the time of the sampling survey. They do however give a good indication of the likelihood of substances to have been present in the laboratory environment and how long the concentrations would be have been maintained at increased levels. The results can also be used to give comparison of total VOC concentrations during differing conditions, as with the sash heights.

It should be noted that the results provided in Tables 3 and 4 represent measurements of very transient peak concentrations, i.e. in the order of 20-30 seconds, and can therefore not be compared to the results from the adsorbent tube sample results, or to the WELs, which are based on a time weighted concentration averaged over an eight hour period.

4.2.2 North Laboratory

The highest concentrations measured were again at the outlet of the tubes from the equipment. The concentrations increased by approximately 25 – 30% when the fume cupboard sashes were in the fully closed position, as compared to the sashes at the normal working height. It is most probable that the sashes would normally have been operated at the normal height.

The concentrations during the use of four rotovacs ranged from 192 – 314 and would therefore be deemed to be significant, however, these concentrations were only maintained for very short durations and were taken directly from the open duct outlet.

Concentrations measured at the outlet were highest during the filtration of DCM and ethyl acetate, and were significantly higher than those measured during the use of the rotary evaporation equipment only.

4.2.3 South Laboratory

As discussed previously fewer measurements were taken in the South laboratory. The results show that a concentration of 1058 ppm was measured at the open pump outlet, whilst the pump was being used to filter ethyl acetate in Bay1.

4.2.4 Readings in the General Laboratory Environment

The VOC meter was used to check levels for the safety of the IOM operative and University staff during and after the survey. The readings were zero during an initial visit to the laboratories when the equipment was not being used, i.e. background levels. Readings of zero were also recorded at the outlets when the duct ends had been closed off in the correct manner.

Readings taken at points adjacent to the open duct in bay 3 at the operators' bench during the sampling survey showed steady concentrations of just above zero at 1-2ppm.

4.2.5 Specific Activities

Measurements made during the removal of waste from the vacuum pump showed concentrations of <5ppm, i.e. very low.

No other specific activities in relation to the use of the equipment or potential exposure were identified by the University staff.

5 EXPOSURES

The above section discusses the actual concentrations measured, however the actual exposure to which staff may have been exposed will be altered by the other factors, such as; the length of time spent in the laboratories; the position in which they worked; the frequency of the filtration processes; and the quantity and type of chemicals processed. Other factors such as the use of the fume cupboards and general ventilation within the laboratories will also have had an effect on the actual exposure of the staff.

The results obtained during this sampling survey are indicative of the conditions set at the time of the survey. While it is likely that conditions would have been different at other times, the consultation with the staff prior to the survey has helped identify the conditions which were most common and most likely to have occurred. The results are therefore considered to be a good representation of conditions within the laboratories.

The samples in the laboratory were collected over a three hour period when the equipment was being used intensively. Although this situation could have occurred in the past there are also times when it is known that the equipment would not have been used. The static samples were located at the bench positions for the duration of the survey. Although it is reported that some staff would have spent long periods at the benches, others would have duties which would have taken them out of the laboratory environment for at least some periods of the day. The results from the static samples would therefore be an overestimate for such personnel.

When compared with the relevant workplace exposure limits the results indicate that if staff were working in similar conditions for a full shift that their exposures, to the substances monitored, would have been well below the relevant exposure limits.

6 CONCLUSION

Airborne monitoring was carried out in the north and south laboratories of the Life Sciences College at the University of Dundee on 24th March 2013. The purpose of the sampling was to try and ascertain the airborne concentrations of various volatile organic compounds which may have entered the laboratory environments following modifications to the vacuum and filtration equipment.

Measurements were made over a period of approximately three hours, during which various chemicals were processed through the equipment, in a manner which was thought by the University staff to simulate the manner in which the equipment would have been used over a period of time. As far as possible the activities and conditions give a representation of the average concentrations to which laboratory staff may have been exposed, under the test conditions.

In addition real time measurements were taken with a direct reading instrument to measure the transitory higher concentrations associated with the areas close to the outlets of the vacuum and filtration equipment.

The results clearly demonstrate that volatile organic compounds are released into the laboratory environment when the equipment is used without the exhaust line outlets being coupled to the fume cupboard extraction.

However, the concentrations measured at the outlets, located under the work benches, reduced the further away from the outlets, reducing to very low concentrations at the work benches where staff would spend their time.

The results from the long term sampling, which can be compared with the relevant workplace exposure limits, indicate that the actual exposures of staff working in the laboratories would not have exceeded the WELs, and would have been less than about a twentieth of the WEL.

Report prepared by: **Authorised by:**

…… ……

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Table 1: Results of Air Monitoring for Ethyl Acetate, Hexane, Dichloromethane, Toluene, Chloroform and Methanol as measured in the North Laboratory on 24th March 2013

Sample No	Sample Description	Volume Sampled (Litres)	Ethyl Acetate	n-Hexane	Dichloromethane	Toluene	Chloroform	Methanol
			ppm	ppm	ppm	ppm	ppm	ppm
North Laboratory								
CLS 01	1st bay adjacent to L2-240 A&B fume cupboards	25.923	0.08	0.07	2.34	0.01	0.12	-
CLS 13	1st bay adjacent to L2-240 A&B fume cupboards	27.135	-	-	-	-	-	1.24
CLS 02	4th bay under bench at open pump tubing	23.790	0.69	0.04	42.68	0.03	0.48	-
CLS 14	4th bay under bench at open pump tubing	22.425	-	-	-	-	-	16.10
CLS 03	2nd bay adjacent to L2-240 C&D fume cupboards	26.200	0.10	0.01	4.24	0.01	0.05	-
CLS 15	2nd bay adjacent to L2-240 C&D fume cupboards	27.600	-	-	-	-	-	4.42
CLS 04	3rd bay under bench at open pump tubing	26.532	15.28	1.28	103.73	0.56	4.15	-
CLS 16	3rd bay under bench at open pump tubing	28.050	-	-	-	-	-	185.84
CLS 05	3rd bay on bench	24.822	0.06	0.01	2.64	<0.01	0.04	
CLS 17	3rd bay on bench	22.589	-	-	-	-	-	0.94
Workplace Exposure Limit (8hr TWA)			**200**	**20**	**100**	**50**	**2**	**200**

Table 2: Results of Air Monitoring for Ethyl Acetate, Hexane, Dichloromethane, Toluene, Chloroform and Methanol as measured in the South Laboratory on 24th March 2013

Sample No	Sample Description	Volume Sampled (Litres)	Ethyl Acetate	n-Hexane	Dichloromethane	Toluene	Chloroform	Methanol
			ppm	ppm	ppm	ppm	ppm	ppm
South Laboratory								
CLS 06	1st bay under bench at open pump outlet adjacent to L2-221 M&N	33.366	4.71	<0.01	0.32	<0.01	<0.01	-
CLS 18	1st bay under bench at open pump outlet adjacent to L2-221 M&N	29.382	-	-	-	-	-	<0.01
CLS 07	2nd bay general on bench adjacent to L2-221 M&N	31.000	<0.01	<0.01	<0.01	<0.01	<0.01	-
CLS 19	2nd bay general on bench adjacent to L2-221 M&N	31.579	-	-	-	-	-	<0.01
CLS 08	2nd bay general on bench adjacent to L2-221 K&L	32.103	0.01	<0.01	0.02	<0.01	<0.01	-
CLS 20	2nd bay general on bench adjacent to L2-221 K&L	30.914	-	-	-	-	-	<0.01
CLS 09	4th bay general on bench adjacent to L2-221 G&H	30.500	<0.01	0.01	0.03	<0.01	<0.01	-
CLS 21	4th bay general on bench adjacent to L2-221 G&H	30.907	-	-	-	-	-	<0.01
CLS 10	6th bay general on bench adjacent to L2-221 C&D	31.571	<0.01	<0.01	0.02	<0.01	0.01	-
CLS 22	6th bay general on bench adjacent to L2-221 C&D	31.491	-	-	-	-	-	<0.01
CLS 11	7th bay general on bench adjacent to L2-221 A&B	31.668	<0.01	<0.01	0.01	<0.01	<0.01	-
CLS 23	7th bay general on bench adjacent to L2-221 A&B	29.795	-	-	-	-	-	<0.01
Workplace Exposure Limit (8hr TWA)			**200**	**20**	**100**	**50**	**2**	**200**

Table 3: Results from Direct Reading Instrument – North Laboratory

Location/ Sampling Activity	Activity/ Condition	Peak Conc. (VOCs) (ppm)	Comment
North Laboratory	Four rotovacs running with hexane, ethyl acetate, chloroform, methanol and DCM.		
1. Outlet in Bay 3	Fume cupboard sashes at normal sash height.	192	In open duct
2. Outlet in Bay 5	Fume cupboard sashes at normal sash height.	228	In open duct
3. Outlet in Bay 3	Fume cupboard sashes fully closed	238	In open duct
4. Outlet in Bay 5	Fume cupboard sashes fully closed	313	In open duct
5. Outlet in Bay 3	1 sash fully open, with vent from equipment leading into this fume cupboard	216	In open duct
6. Outlet in Bay 5	1 sash fully open, with vent from equipment leading into this fume cupboard	314	In open duct
7. At seat adjacent to open duct in Bay 3	Rotovacs operating	-	
8. Outlet in Bay 3	Ethyl acetate filtration	875	In open duct
9. Outlet in Bay 5	Ethyl acetate filtration	820	In open duct
10. Outlet in Bay 3	DCM filtration	1157	In open duct
11. Outlet in Bay 5	DCM filtration	763	In open duct
12. Bay 5 – technicians work bench in corner	Background	0	Above open duct location
13. Outlet in Bay 3	Rotovacs operating	120	
14. Outlet in Bay 5	Rotovacs operating	25 - 164	
15. Bay 3	Head height at bench	1.2	
16. Bay 3	Ethyl acetate filtration	2.2	adjacent to open outlet
17. Bay 3	Vacuum pump waste removal, flask removed and emptied	3	
18. Bay 3	At bench height	0.0	Outlet sealed
19. Bay 3	At sealed outlet	0.2	
20. Bay 3	At sealed outlet	0.0	Outlet tightened
21. Bay 5	At sealed outlet	0.0	
22. Bay 3	At bench height	0.0	

Table 4: Results from Direct Reading Instrument – South Laboratory

Location/ Sampling Activity	Activity/ Condition	Peak Conc. (VOCs) (ppm)	Comment
South Laboratory	Seven evaporators running in Bays 2-6 using: hexane, ethyl acetate, methanol and DCM		
1. Bay 1	Open pump line under bench	0	
2. Bay 1	Pump being used to filter ethyl acetate in Bay 1 , fume cupboard L2-221-N	1058	In open duct
3. Bay 1	Pump being used to filter ethyl acetate in Bay 3 , fume cupboard L2-221-J	3	In open duct
4. Bay 1	Filtration of ethyl acetate	0	Outlet sealed
5. Bay 2	Inside waste bin	1	

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