REC
Resource & Environmental Consultants Ltd

UKAS TESTING 2082

MONITORING OF EMISSIONS FROM THE LEV STACKS, HUNTINGDON SITE

12 & 13 SEPTEMBER, 2012

Prepared for Xaarjet Ltd

REC Report 71454p1r0

Issued: 10 October, 2012

REC Air Quality

GREEN ACHIEVER

SAFEcontractor APPROVED

Prepared for:

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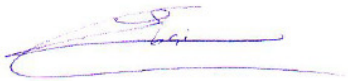
Issued : 10 October, 2012
Reference : 71454p1r0



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Paul Furmston, Director

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EXECUTIVE SUMMARY

Resource & Environmental Consultants (REC) Ltd was commissioned by Xaar Ltd to monitor emissions of pollutants released from the Local Exhaust Ventilation (LEV) stacks at their site in Huntingdon.

In accordance with the requirements of their site permit, B22/11 issued by Huntingdonshire DC, monitoring has been undertaken for the following pollutants:-

- Total Volatile Organic Compounds (VOCs) expressed as Carbon (C)
- Target VOCs, including isopropyl alcohol and acetone

The following results were obtained from the emission monitoring survey and are compared with the current permit limit:-

Target VOC Data

Species	Accreditation Status	Emission Concentration (mg/Nm^3)	Permit Limit (mg/Nm^3)
LEV 1 Acetone	B	<1.8	None set
LEV 1 Isopropyl alcohol	B	12.1	None set
LEV 2 Acetone	B	<1.7	None set
LEV 2 Isopropyl alcohol	B	<1.7	None set
LEV 9 Acetone	B	4.1	None set
LEV 9 Isopropyl alcohol	B	4.6	None set
LEV 13 Acetone	B	12.3	None set
LEV 13 Isopropyl alcohol	B	11.1	None set
LEV 14 Acetone	B	12.6	None set
LEV 14 Isopropyl alcohol	B	<1.6	None set
LEV 15 Acetone	B	<1.6	None set
LEV 15 Isopropyl alcohol	B	<1.6	None set
LEV 16 Acetone	B	12.4	None set
LEV 16 Isopropyl alcohol	B	3.3	None set

NOTE 1: All data are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for moisture and oxygen content unless otherwise stated.
NOTE: UKAS Status:- (A) REC Ltd accredited for sampling and analysis. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd.

Total VOC Data

Species	Accreditation Status	Emission Concentration (mg/Nm^3)	Permit Limit (mg/Nm^3)
LEV 1 Total VOCs (as C)	A	28.7	75
LEV 2 Total VOCs (as C)	A	15.6	75
LEV 9 Total VOCs (as C)	A	6.8	75
LEV 13 Total VOCs (as C)	A	6.3	75
LEV 14 Total VOCs (as C)	A	4.8	75
LEV 15 Total VOCs (as C)	A	1.8	75
LEV 16 Total VOCs (as C)	A	26.0	75

NOTE 1: All data are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for moisture and oxygen content unless otherwise stated.
NOTE: UKAS Status:- (A) REC Ltd accredited for sampling and analysis.

1. INTRODUCTION

1.1 Background

Xaarjet Ltd commissioned REC Ltd to conduct an emission monitoring survey on various LEV stacks at their site in Huntingdon.

Xaarjet Ltd produces printheads at their plan in Huntingdon. Acetone and Isopropyl alcohol are used to clean units used in this process.

1.2 Scope of the Survey

An emission monitoring survey was required to determine the release concentrations of various pollutants from the LEV system. Concentrations of the following pollutants were quantified during the survey:

- Total Volatile Organic Compounds (VOCs) expressed as Carbon (C).
- Acetone
- Isopropyl alcohol

Ancillary measurements of stack dimensions, temperature and velocity were also made to allow pollutant emission rates to be calculated.

Sampling for Total VOCs from each LEV was carried out on a continuous basis with measured concentrations being data-logged at over each sampling period.

Acetone and Isopropyl alcohol concentrations were sampled onto a single adsorption tube from each LEV with concentrations time weighted over the sampling period.

All results were to be reported at 273K, 101.3kPa, wet gas, without correction for oxygen content.

1.3 Sampling Personnel

Monitoring was conducted by the following REC Ltd permanent staff:-

- Paul Jones - Team Leader, MM02 021, MCERTS Level 2, TE1-4
- Michelle Edwards - Assistant, MM05 659, MCERTS Level 2, TE1&2

2. METHODOLOGY

2.1 Species & Techniques

The following table shows the reference methods used for the emission monitoring survey:

Species	UKAS Status	Method	Uncertainty (±%)	Limit of Detection
Total VOCs (as C)	A	In house method MM0002 based on BS EN 12619 or BS EN 13526	10	1 mg/m^3
Acetone	B	In house method MM0011 based on BS EN 13649	30	0.1 mg/m^3
Isopropyl alcohol	B	In house method MM0011 based on BS EN 13649	30	0.1 mg/m^3

NOTE: UKAS Status:- (A) REC Ltd accredited for sampling and analysis. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd.

2.2 Sampling & Analytical Methodology

Total VOCs

To determine the concentration of VOCs in emissions, Bernath 3006 portable flame ionisation detector (FID) was employed. The analyser consists of a sintered filter, to remove particulate matter, a heated sampling line and heated FID block. This equipment satisfies the requirements of BS ENs 13526 and 12619 and in-house method MM0002 was followed.

The instrument is calibrated over a number of ranges against a traceable propane (C_3H_8) standard prior to and on completion of each test.

VOCs are detected by the FID with the output being proportional to the number of carbon atoms present in the sample. The readout displays a VOC figure expressed in ppm as carbon which is converted to mg/Nm^3 as carbon.

Target VOCs

Sampling for target VOCs was carried out using charcoal adsorption tubes using methodology as per BS EN 13649 (in house method MM0011). The tubes were connected to low flow sampling pumps fitted with a stroke meter to determine the volume sampled. The pump stroke rate was determined quarterly against a UKAS calibrated bubble flowmeter.

The tubes were chemically desorbed and analysed by a high resolution GC/MS operating in the target mode to identify and quantify the compounds of interest against prepared standards. From the mass of each target VOC detected on the tube in microgram (µg/tube) and volume sampled, an emission concentration was calculated.

Stack Temperature and Velocity

To determine the stack temperature, a calibrated thermocouple and digital indicator were employed. The exhaust gas velocity was investigated using a pitot static probe (to MM0004) and digital manometer.

2.3 Laboratory Analysis

An approved UKAS accredited sub-contractor, SAL Ltd, undertook the sample analysis for Acetone and Isopropyl alcohol.

A copy of their Certificate of Analysis is enclosed in Appendix 1.

3. SAMPLING AND OPERATIONAL DETAILS

3.1 Process Description

The operations at Xaarjet Ltd are authorised under a Part B permit issued by the Local Authority under the Environmental Permitting Regulations, 2010.

The process is therefore under Huntingdonshire District Council (DC) regulation and must demonstrate compliance with the emission limits stipulated in the site permit reference B22/11.

Xaarjet Ltd produce high quality inkjet printer heads for use in OEM Printers at their facility in Huntingdon. This is a continuous process where the fumes are extracted through an LEV system.

The main aim of these tests was to measure VOC concentrations from LEV sources to assess fugitive releases under the Solvent Emissions Directive.

3.2 Sampling Positions

On each LEV system access was provided by means of an approximately 1" diameter sampling point. The sampling points provided were less than 4 x hydraulic diameters from any flow disturbance both upstream and downstream from the sampling plane.

The sampling points do not satisfy the requirements of BS EN 13284/ EA Guidance M1 regards their positioning but provided reasonable access for the sampling equipment and were in the most practicable sampling locations.

Diagrams detailing the sampling positions and taken from Site Worksheets are provided in Appendix 2.

3.3 Uncertainty

All standard methods were fully complied with, consequently the standard uncertainties apply. The sample plane does not meet the requirements stated in Environment Agency Technical Guidance Note M1.

REC has calculated uncertainty budgets for all of the pollutants listed in the Method Details Table in Section 2.1 above in accordance with calculations and methodology supplied by the Source Testing Association (STA). These uncertainties are quoted in the Tables section of this report.

3.4 Emission Monitoring Survey Details

The emission monitoring survey was carried out on the LEV systems over the period 12 - 13 September, 2012. The table overleaf summarises the actual sampling periods.

SAMPLING PERIODS

Stack Ref	Parameters	Sample Time (& Date)
LEV 1	Total VOCs Acetone & Isopropyl alcohol	12:53 – 13:52 (12/09/12)
LEV 2	Total VOCs Acetone & Isopropyl alcohol	11:48 – 12:48 (12/09/12)
LEV 9	Total VOCs Acetone & Isopropyl alcohol	09:54 – 10:54 (13/09/12)
LEV 13	Total VOCs Acetone & Isopropyl alcohol	11:25 – 12:25 (13/09/12)
LEV 14	Total VOCs Acetone & Isopropyl alcohol	09:19 – 10:19 (13/09/12)
LEV 15	Total VOCs Acetone & Isopropyl alcohol	08:41 – 09:41 (13/09/12)
LEV 16	Total VOCs Acetone & Isopropyl alcohol	13:34 – 14:34 (12/09/12)

4. RESULTS AND DISCUSSION

4.1 Initial Velocity and Temperature Traverse

An initial pitot-static pressure and temperature traverse was carried out. From these data stack velocity, expressed in metres per second (m/s), and volumetric flowrates expressed in cubic metre per hour (m^3/hr) have been calculated.

The results are reported at actual stack conditions and the volumetric flowrate is further expressed at the standard reference conditions of 273K, 101.3kPa i.e. standard temperature and pressure (STP). The results are summarised in Table 1.

4.2 Total VOC Emission Data

The results of the VOC monitoring tests are summarised in Table 2 and Figures 1 to 7. The table presents the averages of concentrations measured throughout each of the sample periods.

Concentrations are expressed in mg/m^3 as carbon (C) at the standard reference conditions of 273K, 101.3kPa without correction for water vapour content.

4.3 Target VOCs

The results of the VOC monitoring using adsorption tubes are summarised in Table 3 (Acetone emissions) and Table 4 (Isopropyl alcohol emissions).

From the mass of each target VOC detected on the tube in microgram (µg) and volume samples in litres an emission concentration was calculated.

Concentrations are expressed in mg/m^3 at the standard reference conditions of 273K, 101.3kPa without correction for water vapour content.

====== End of Report Text ======

FIGURES

Fig 1: Total VOC Emission Data, Xaarjet Ltd, LEV 1, (12/09/12)

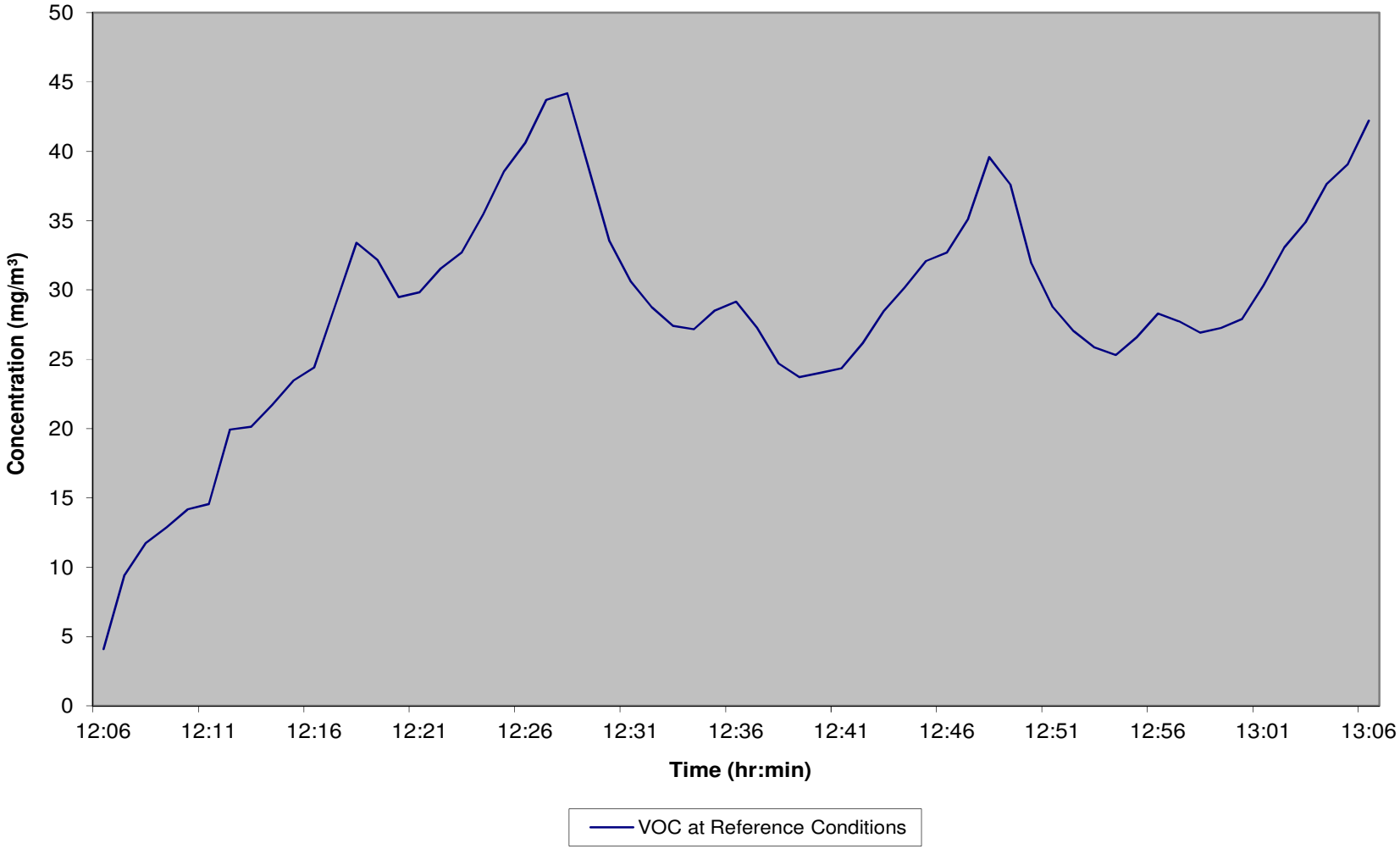


Fig 2: Total VOC Emission Data, Xaarjet Ltd, LEV 2, (12/09/12)

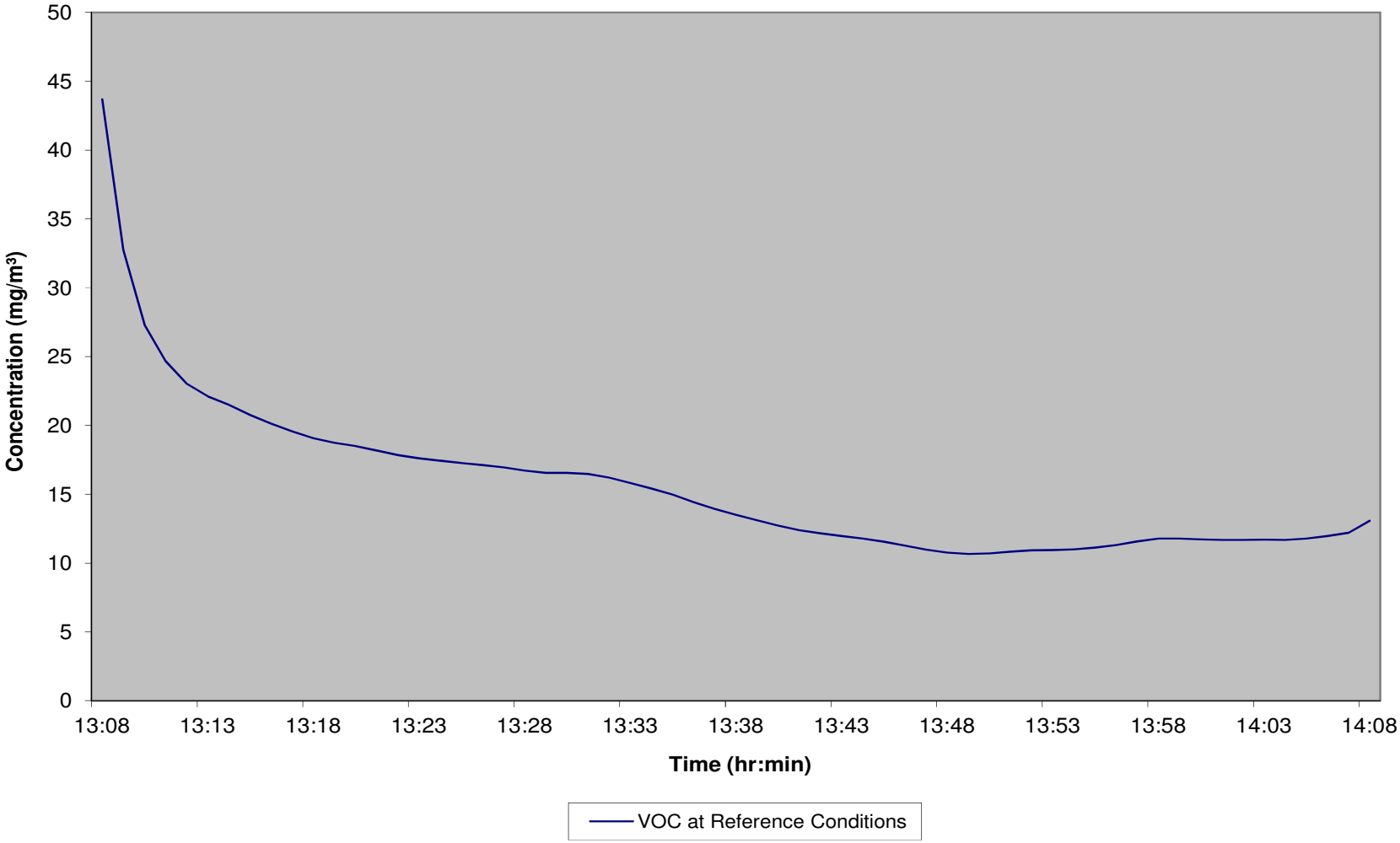


Fig 3: Total VOC Emission Data, Xaarjet Ltd, LEV 9, (13/09/12)

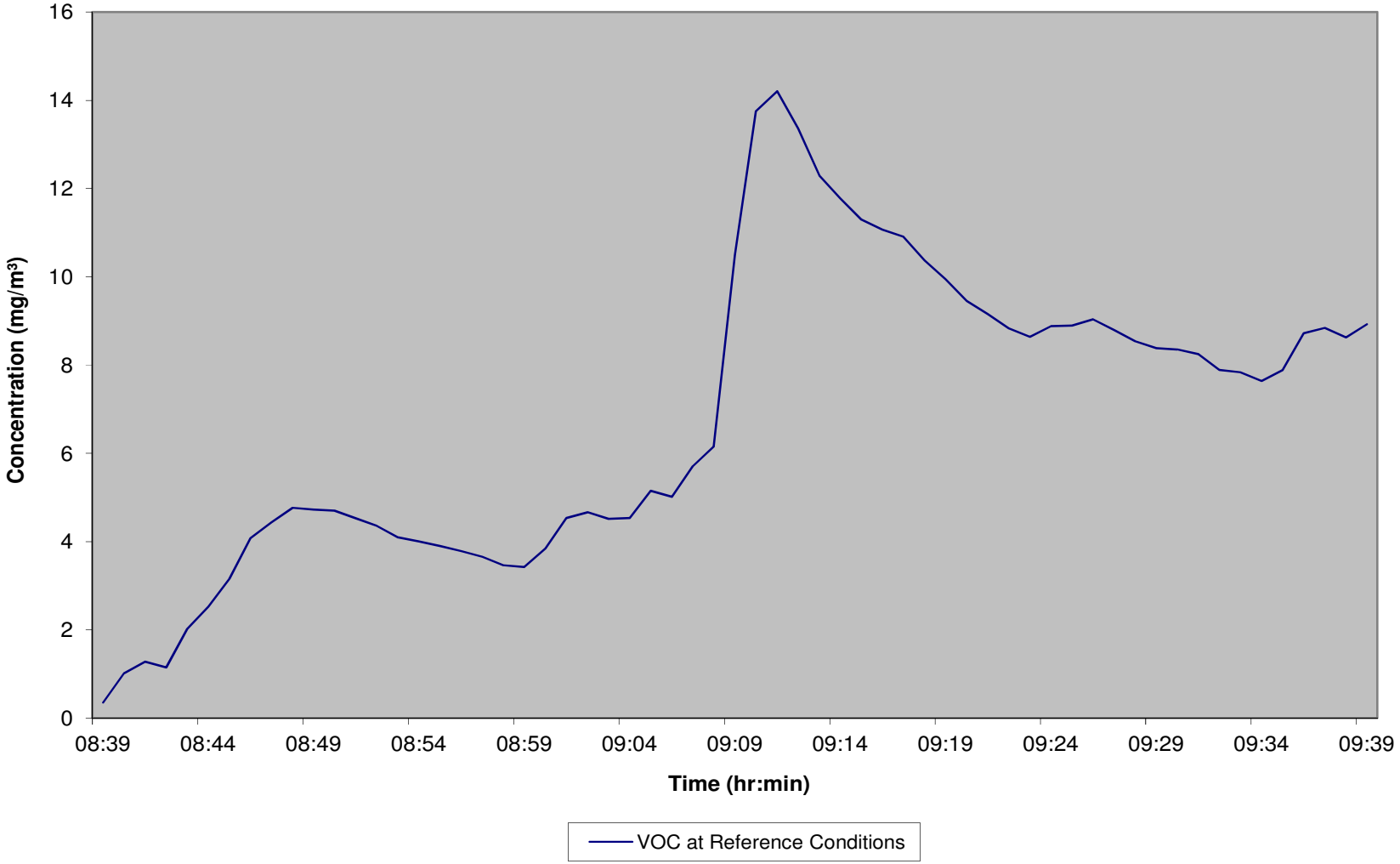


Fig 4: Total VOC Emission Data, Xaarjet Ltd, LEV 13, (13/09/12)

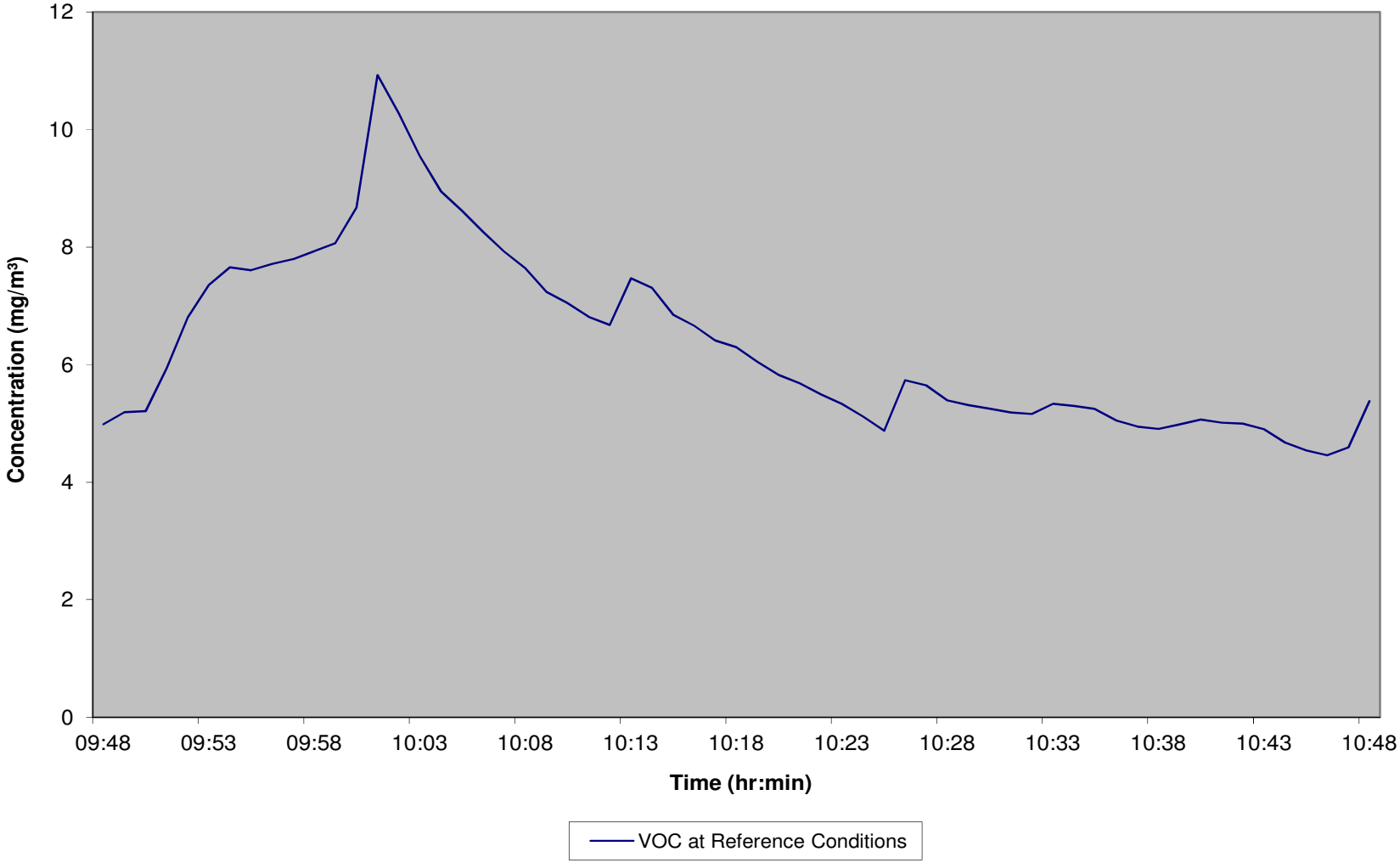


Fig 5: Total VOC Emission Data, Xaarjet Ltd, LEV 14, (13/09/12)

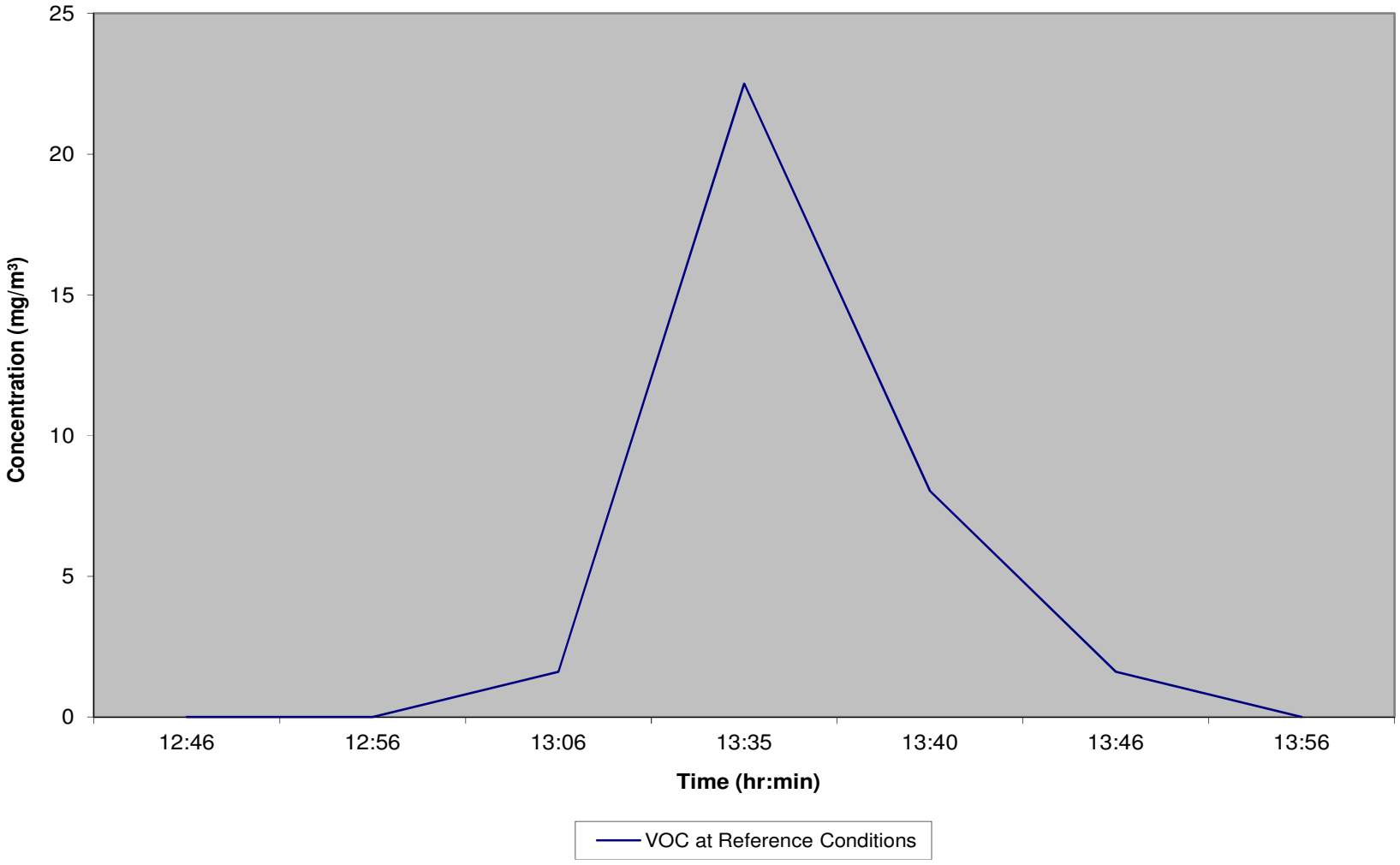


Fig 6: Total VOC Emission Data, Xaarjet Ltd, LEV 15, (13/09/12)

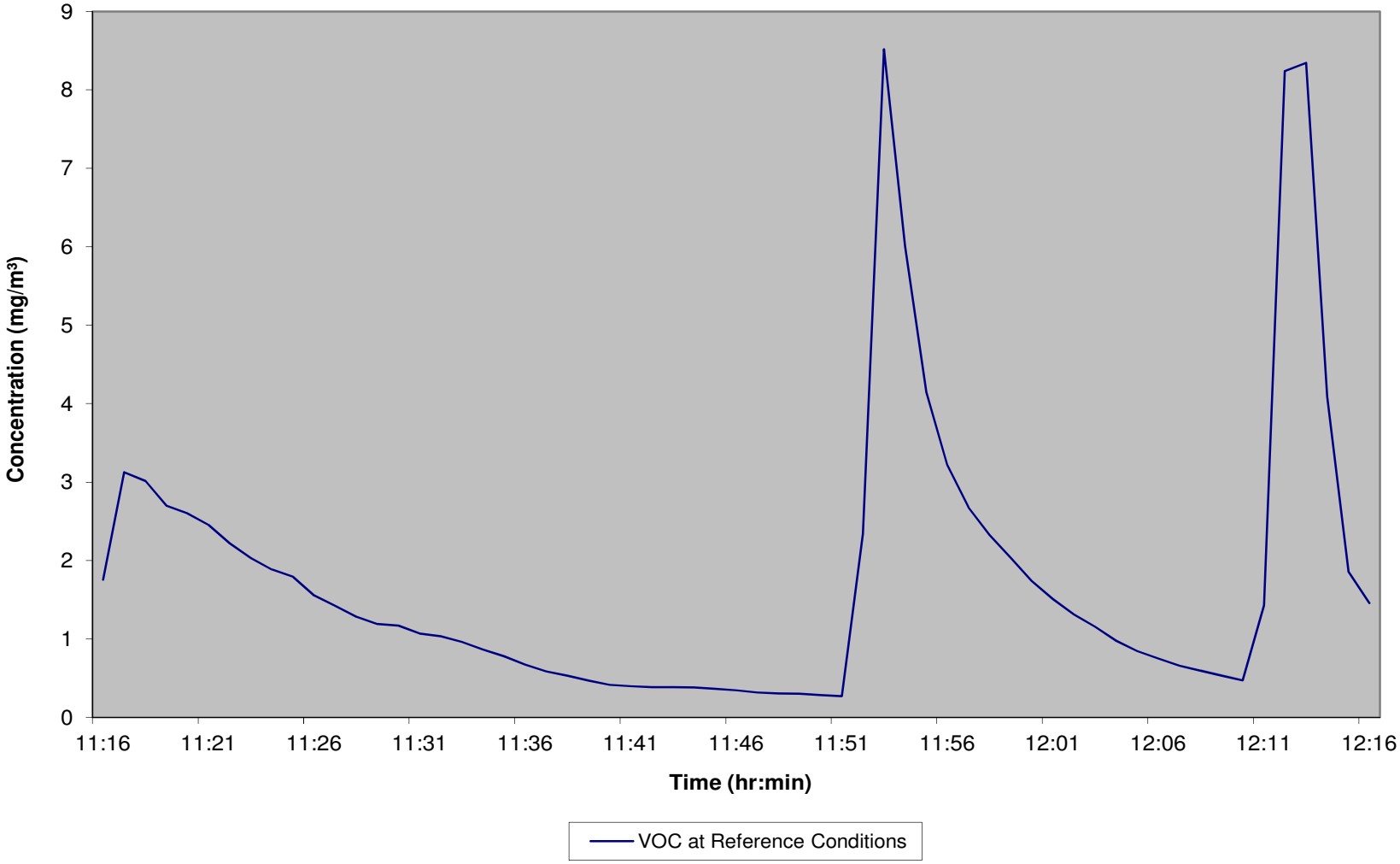
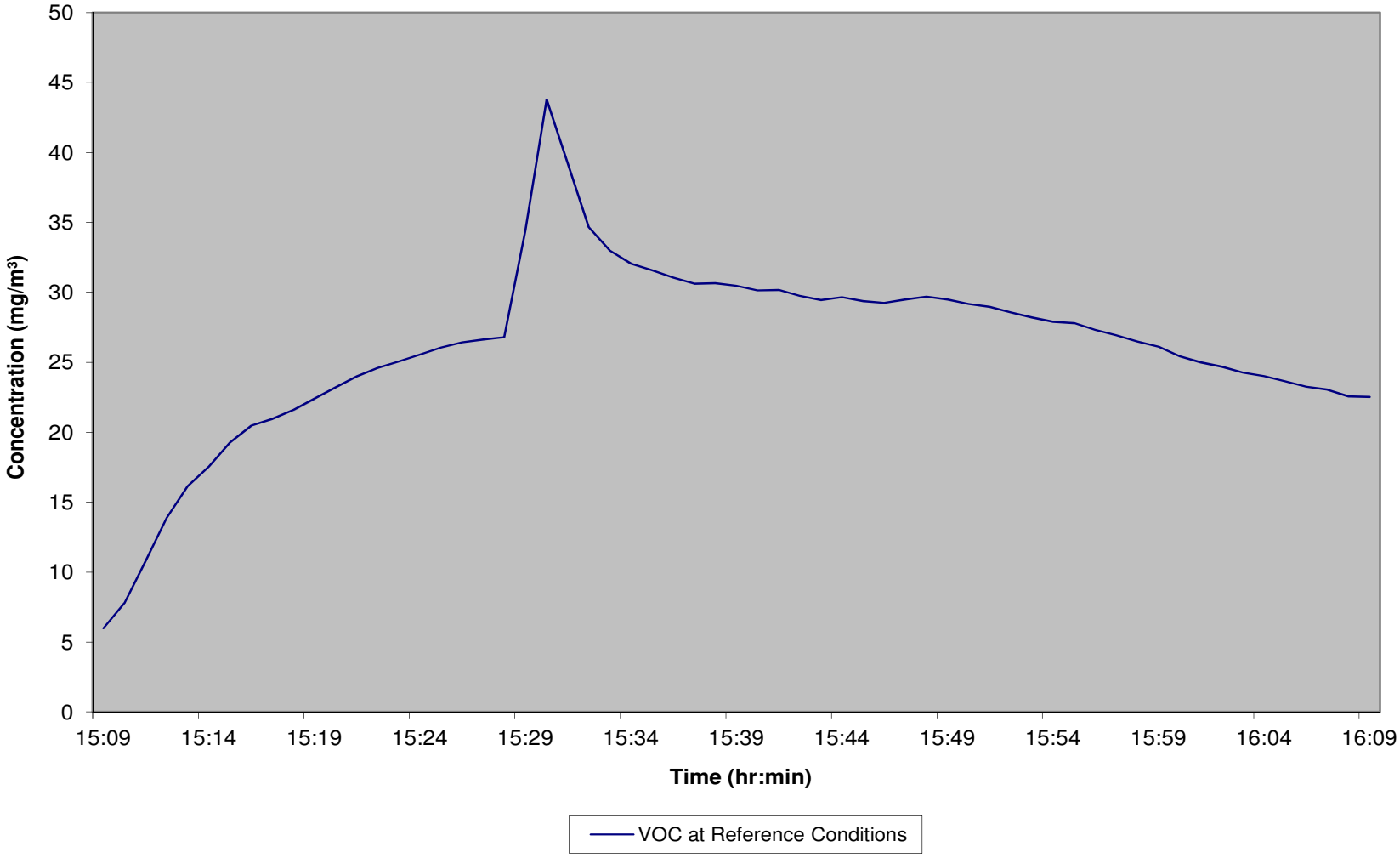


Fig 7: Total VOC Emission Data, Xaarjet Ltd, LEV 16, (12/09/12)



TABLES

TABLE 1

FLOW DATA

Stack Ref.	Stack Temp	Av Pitot ΔP	Duct Diam	X-Sect. Area	Velocity (actual)	Volume Flow (m^3/hr)	
	(^{0}C)	(Pa)	(cm)	(m^2)	(m/s)	(actual)	(@ ntp)
LEV 1	15	85	39	0.119	11.8	5,068	4,800
LEV 2	15	30	30	0.071	7.0	1,780	1,689
LEV 9	18	12	31	0.075	4.4	1,208	1,134
LEV 13	26	55	60	0.283	9.7	9,847	8,988
LEV 14	24	85	45	0.159	12.0	6,847	6,298
LEV 15	23	8	24	0.045	3.7	596	550
LEV 16	27	17	22	0.038	5.4	736	670

TABLE 2

TOTAL VOC EMISSION DATA SUMMARY

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 1	17.8	28.7
Uncertainty (±)		2.8

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 2	9.7	15.6
Uncertainty (±)		2.7

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 9	4.2	6.8
Uncertainty (±)		2.7

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 13	4.0	6.3
Uncertainty (±)		2.7

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 14	3.0	4.8
Uncertainty (±)		3.4

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 15	1.1	1.8
Uncertainty (±)		2.7

Stack Ref	Total VOCs	
	ppm (as C_3H_8)	mg/m^3 as C
LEV 16	16.2	26.0
Uncertainty (±)		2.7

TABLE 3

ACETONE EMISSION DATA SUMMARY

Sampling Data	LEV 2	LEV 1	LEV 16	LEV 15	LEV 14	LEV 9	LEV 13
Start Time	11:48	12:53	13:34	08:41	09:19	09:54	11:25
End Time	12:48	13:53	14:34	09:41	10:19	10:54	12:25
Counter Start	248607	257871	439619	267431	450018	277642	460024
Counter End	257839	267380	449798	277520	459988	288078	470807
Calibration Factor	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Volume Sampled (litres)	6.185	6.371	6.820	6.760	6.680	6.992	7.225
Ambient Temp (^{o}C)	17	17	17	18.6	18.6	18.6	18.6
Ambient Press (kPa)	100.8	100.8	100.8	101.3	101.3	101.3	101.3
Volume Sampled, 273K, 101.3kPa (litres)	5.794	5.968	6.388	6.328	6.254	6.546	6.764
Analytical Data	**32541/1**	**32541/2**	**32541/3**	**32541/5**	**32541/6**	**32541/7**	**32541/8**
Mass Acetone on tube front section (µg)	<10	<10	69	<10	69	17	73
Mass Acetone on tube rear section (µg)	<10	<10	<10	<10	<10	<10	<10
Mass on Back-up Section (%)	NA	NA	0	NA	0	0	0
Emission Concentration Data	**LEV 2**	**LEV 1**	**LEV 16**	**LEV 15**	**LEV 14**	**LEV 9**	**LEV 13**
Acetone (mg/m^3)	<1.7	<1.8	12.4	<1.6	12.6	4.1	12.3
Uncertainty (± mg/m^3)	1.0	1.0	3.7	0.9	3.8	1.2	3.7

TABLE 4

ISOPROPANOL EMISSION DATA SUMMARY

Sampling Data	**LEV 2**	**LEV 1**	**LEV 16**	**LEV 15**	**LEV 14**	**LEV 9**	**LEV 13**
Start Time	11:48	12:53	13:34	08:41	09:19	09:54	11:25
End Time	12:48	13:53	14:34	09:41	10:19	10:54	12:25
Counter Start	248607	257871	439619	267431	450018	277642	460024
Counter End	257839	267380	449798	277520	459988	288078	470807
Calibration Factor	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Volume Sampled (litres)	6.185	6.371	6.820	6.760	6.680	6.992	7.225
Ambient Temp (^{o}C)	17	17	17	18.6	18.6	18.6	18.6
Ambient Press (kPa)	100.8	100.8	100.8	101.3	101.3	101.3	101.3
Volume Sampled, 273K, 101.3kPa (litres)	5.794	5.968	6.388	6.328	6.254	6.546	6.764
Analytical Data	**32541/1**	**32541/2**	**32541/3**	**32541/5**	**32541/6**	**32541/7**	**32541/8**
Mass IPA on tube front section (µg)	<10	62	11	<10	<10	20	65
Mass IPA on tube rear section (µg)	<10	<10	<10	<10	<10	<10	<10
Mass on Back-up Section (%)	NA	0	0	NA	NA	0	0
Emission Concentration Data	**LEV 2**	**LEV 1**	**LEV 16**	**LEV 15**	**LEV 14**	**LEV 9**	**LEV 13**
Isopropanol (mg/m^3)	<1.7	12.1	3.3	<1.6	<1.6	4.6	11.1
Uncertainty (± mg/m^3)	1.0	3.6	1.0	0.9	0.9	1.4	3.3

APPENDIX 1

Certificate of Analysis

Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
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M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2404

Report Number: 296619-1

Date of Report: 27-Sep-2012

Customer: Resource Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Salford
M50 2UE

Customer Contact: Ms Michelle Edwards

Customer Job Reference: 71454
Customer Site Reference: Date Collected: 12+13 September 2012
Date Job Received at SAL: 20-Sep-2012
Date Analysis Started: 24-Sep-2012
Date Analysis Completed: 26-Sep-2012

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

Tests covered by this certificate were conducted in accordance with SAL SOPs

UKAS TESTING
1549

Report checked
and authorised by :
Mary Drury
Project Manager

Issued by :
Mary Drury
Project Manager

Signature valid
Digitally signed by Mary Drury
Date: 2012.09.27 11:40:46 BST
Reason: Issue
Location: SAL

SAL Reference: 296619
Project Site: Date Collected: 12+13 September 2012
Customer Reference: 71454

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite A

				SAL Reference	**296619 001**	**296619 002**	**296619 003**	**296619 004**	**296619 005**
				Customer Sample Reference	**71454/1 FRONT**	**71454/2 FRONT**	**71454/3 FRONT**	**71454/4 FRONT**	**71454/5 FRONT**
				Test Sample	**AR**	**AR**	**AR**	**AR**	**AR**
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Acetone	GC/MS	10	µg	U	<10	<10	**69**	<10	<10
Propan-2-ol	GC/MS	10	µg	U	<10	**62**	**11**	<10	<10

SAL Reference: 296619
Project Site: Date Collected: 12+13 September 2012
Customer Reference: 71454

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite A

				SAL Reference	**296619 006**	**296619 007**	**296619 008**	**296619 009**	**296619 010**
				Customer Sample Reference	**71454/6 FRONT**	**71454/7 FRONT**	**71454/8 FRONT**	**71454/1 BACK**	**71454/2 BACK**
				Test Sample	**AR**	**AR**	**AR**	**AR**	**AR**
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Acetone	GC/MS	10	µg	U	**79**	**17**	**73**	<10	<10
Propan-2-ol	GC/MS	10	µg	U	<10	**20**	**65**	<10	<10

SAL Reference: 296619
Project Site: Date Collected: 12+13 September 2012
Customer Reference: 71454

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite A

				SAL Reference	**296619 011**	**296619 012**	**296619 013**	**296619 014**	**296619 015**
				Customer Sample Reference	**71454/3 BACK**	**71454/4 BACK**	**71454/5 BACK**	**71454/6 BACK**	**71454/7 BACK**
				Test Sample	**AR**	**AR**	**AR**	**AR**	**AR**
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Acetone	GC/MS	10	µg	U	<10	<10	<10	<10	<10
Propan-2-ol	GC/MS	10	µg	U	<10	<10	<10	<10	<10

SAL Reference: 296619
Project Site: Date Collected: 12+13 September 2012
Customer Reference: 71454

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Suite A

				SAL Reference	**296619 016**
				Customer Sample Reference	**71454/8 BACK**
				Test Sample	**AR**
Determinand	**Method**	**LOD**	**Units**	**Symbol**	
Acetone	GC/MS	10	µg	U	<10
Propan-2-ol	GC/MS	10	µg	U	<10

Index to symbols used in 296619-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

APPENDIX 2

Photographs of Sampling Locations

CLEAN ROOM 2

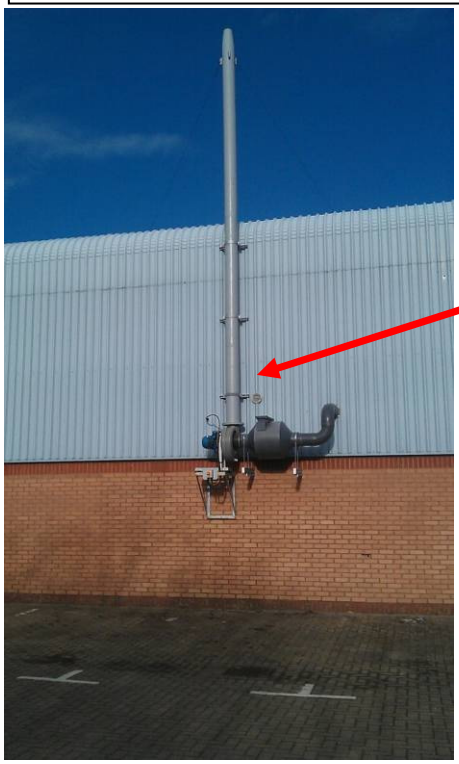
LEV 5	LEV 9	LEV 7	LEV 8
Laser chambers	**Room extract**	Plating line 1	Machining

LEV 11 – Laser chambers

LEV 13 – Room extract

LEV 10 – Machining

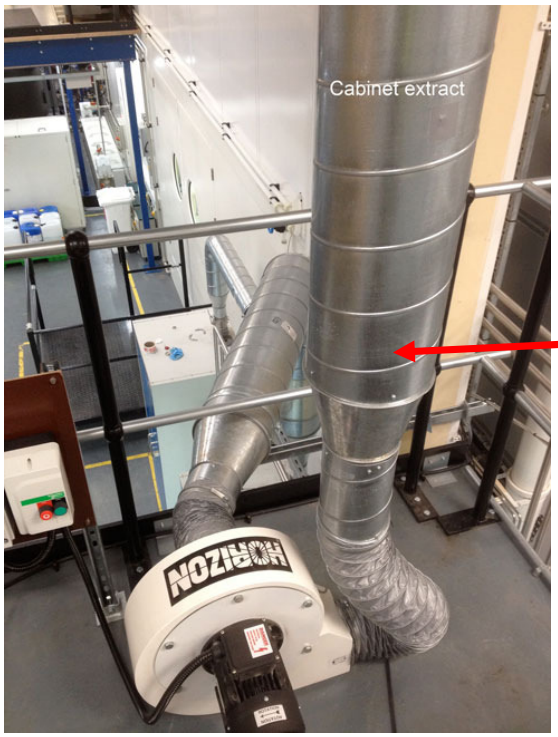
CLEAN ROOM 1



BACK END ASSEMBLY

LEV 14
Room extract

FLUSHING RIGS IPA STORAGE



LEV15
IPA cabinets

NEW PLATING LINE

LEV 6
Plating line 2

LASER GAS CABINETS CLEAN ROOM 3

LEV 12
Laser gas cabinets

APPENDIX 3

Calculations

Conversion Factors

ppm ® mg/Nm³ (at 273K, 101.3kPa: STP)

CO	x	1.25	
SO_2	x	2.86	
VOC's	x	1.61	(ppm as C_3H_8 to mg/Nm^3 as C)
NO_X	x	2.05	(ppm NO + NO_2 to mg/m^3 as NO_2)

Oxygen Correction to Reference Value

Concentration at (STP) -> Concentration at 273K, 101.3kPa, reference O_2 and Dry Gas, i.e.

Concentration X ((20.9-O_2 ref)/(20.9-O_2 measured)) = Concentration at ref Oxygen state.

Example Calculation

SO_2 concentration at STP	=	170.7 mg/Nm³
Oxygen percentage in gas stream	=	13.8%
Reference Oxygen	=	11%

SO_2 concentration at reference O_2 conditions	=	170.7 ((20.9-11)/(20.9-13.8))
	=	238 mg/Nm³ at 273K, 101.3kPa, 11% O_2 and Dry Gas

Moisture Correction (Wet to Dry)

Concentration of Gas Dry = Concentration of x 100/100-Bws Gas Wet

Concentration of Gas Wet = Concentration of x 100-Bws/100 Gas Dry

Where Bws = moisture content of gas stream in percent (Vol/Vol).

Example

VOC concentration	=	25 mg/Nm³ (Wet)
Moisture Content	=	27.1%
Concentration of VOC	=	25 (100/(100-27.1))

Carbon (C) to Trichloethylene (TCE)

ppm TCE = ppm C x 0.6715

TCE in mg/m^3 = TCE ppm x 5.864 (Mol Wt/22.4)