EMISSIONS MONITORING

@ XaarJet Limited
Huntingdon, Cambridgeshire

Prepared by D. Clough, J. Bello, A. Barwick & P. Awolesi

Prepared for:

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Report No. ESL/XL/EPA March 2012

1.0 INTRODUCTION

Environmental Science Limited (ESL) was commissioned by Xaar, 1 Hurricane Close, Ermine Business Park, Huntingdon, Cambs, PE29 6XX, to conduct a stack emission survey on 5th to 9th March 2012. The total number of stacks at Xaar has increased since the third clean room was completed last year.

ESL was requested to variously quantify VOC (total solvent), nickel sulphate, hydrochloric acid, sulphuric acid, hydrofluoric acid, nitric acid and lead concentrations being emitted from thirteen stacks at the above address. To this effect, David Clough (project leader), Joshua Bello, Patrick Awolesi and Alexander Barwick were present to take samples during the week of 5th March 2012.

2.0 METHODS

2.1 Gas sample collection/ analysis

Acid gases (plus sulphate) were drawn through SKC silica gel tubes using SKC™ 224-43EX pumps at a rate of 100 to 132 ml/m. Rates of flow were monitored via a Platon Flowbits 0-250 ml/m air rotameter, calibrated via a Bios Defender 510 traceable flow calibration standard unit with a range of 50 ml to 5 l/m. A traceable calibration certificate for this unit is given in Appendix A. Analysis was via Ion chromatography.

Lead samples were collected into high efficiency PFA impingers using high purity D.I. water. Isokinetic sampling was used to collect the samples along with four point extraction. Samples were taken post fan using SKC™ MCS Flite pumps with flow rate continuously monitored using a Cole-Parmer 0-20 l/m air rotameter. The rotameter was calibrated to a Bios Defender 510 traceable flow calibration standard unit, with a calibrated range of 50 ml to 5 l/min. A traceable calibration certificate for this unit is given in the appendix.

A TSI Velocicalc was used to collect the flow data via sophisticated running average software routines which ensure accuracy over the whole surface area sampled. The Velocicalc uses thermal anemometry, (hot wire). A traceable calibration certificate for this unit is given in the appendix Lead analysis was via ICP/MS.

VOC on-line readings were taken using a Thermo PT GC-FID with heated sample line, (170 degree C). Accuracy is within 2.5% of reading and the limit of detection is 0.1 ppm. The unit was calibrated each day using a 100ppm standard of propane. All VOC sample locations were at ambient temperature. A traceable calibration certificate is given in the appendix of this report.

All laboratory analysis conducted via UKAS validated methods under testing No. 0605.

The thirteen stack sampling locations were photographed and these are shown on the following pages:


LEV 6


LEV14


LEV 3
LEV 2
LEV 1
LEV 4
RHF


LEV 15
HORIZON


LEV 11
LEV 13
LEV 10

3.0 RESULTS

3.1 LEV 1

The results are given in table form below. All samples were taken on 9th March 2012. All VOC results have been calculated using reference conditions 273°C/ 101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average	Maximum reading
08.15 to 13.15 hrs.	<0.2	<0.2	<0.2

The VOC levels were at background levels for the five-hour sampling period.

3.2 LEV 2

The results are given in table form below. All samples were taken on 8th March 2012. All VOC results have been calculated using reference conditions 273°C/101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average (13.55-14.25 hrs)	Maximum reading (14.05 hrs)
09.25 to 14.25 hrs.	0.5	1.3	2.2

The on-line FID illustrated that the VOC levels were low over the five-hour sampling period.

3.3 LEV 3

The results are given in table form below. All samples were taken on 8th March 2012.

Sample No.	Sample duration (hrs.)	Hydrogen fluoride result
1	08.11 to 12.32 hrs.	<0.16 mg/m^3

The hydrogen fluoride level in the stack was below the detection limit for the test.

3.4 LEV 4

The results are given in table form below. All samples were taken on 8th March 2012.

Sample No.	Sample duration (hrs.)	Hydrogen fluoride result
1	12.52 to 14.25 hrs.	<0.40 mg/m^3

The hydrogen fluoride level in the stack was below the detection limit for the test.

3.5 LEV 5

The results are given in table form below. All samples were taken on 8th March 2012.

Sample No.	Sample duration (hrs.)	Hydrogen fluoride result
1	08.18 to 12.28 hrs.	<0.16 mg/m^3

The hydrogen fluoride level in the stack was below the detection limit for the test.

3.6 LEV 6

The results are given in table form below. All samples were taken on 7th March 2012.

No.	Sample duration (hrs.)	Results in mg/m^3				
		Nitric acid	Hydrochloric acid	Sulphuric acid	Hydrofluoric acid	Nickel sulphate
1	10.32-15.15	<0.06	<0.03	<0.06	<0.14	<0.09

Acid gas and nickel sulphate levels in the stack were below the detection limit for the test.

3.7 LEV 7

The results are given in table form below. All samples were taken on 5th March 2012.

Sample No.	Sample duration (hrs.)	Results in mg/m^3			
		Nitric acid	Hydrochloric acid	Sulphuric acid	Hydrofluoric acid
1	11.55 to 13.17	<0.19	<0.10	<0.19	<0.48
2	13.17 to 15.10	<0.14	<0.07	<0.14	<0.35
3	15.10 to 16.47	<0.16	<0.08	<0.16	<0.40

Acid gas levels in the stack were below the detection limit for the test.

3.8 LEV 8

The results are given in table form below. All samples were taken on 5th March 2012.

Sample No.	Sample duration	Lead results
1	11.37 to 12.38 hrs.	0.0002 mg/m^3
2	12.43 to 14.24 hrs.	0.0003 mg/m^3
3	15.09 to 16.45 hrs.	0.0011 mg/m^3

Lead levels were observed to be at trace concentrations for all three runs.

3.9 LEV 9

The results are given in table form below. All samples were taken on 5th March 2012. All VOC results have been calculated using reference conditions 273°C/101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average (11.24-11.54 hrs)	Maximum reading (10.56 hrs)
10.49 to 15.49 hrs.	18.5	30.8	49.7

The on-line FID illustrated that the VOC levels were higher than for the previous survey conducted in 2011.

3.10 LEV 11

The acid gas results are given in table form below. Taken on 7th March 2012.

Sample No.	Sample duration (hrs)	Results in mg/m^3			
		Nitric acid	Hydrochloric acid	Sulphuric acid	Hydrofluoric acid
1	11.30 to 13.30	<0.08	<0.04	<0.08	<0.20

Acid gas levels in the stack were less than levels for all four acids tested.

The VOC results are given in table form below. Taken on 7th March 2012. All VOC results have been calculated using reference conditions 273°C/101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average (09.30-10.00 hrs)	Maximum reading (09.30 hrs)
07.50 to 12.50 hrs.	0.2	0.7	1.3

The on-line FID illustrated that the VOC levels were low over the five-hour sampling period.

3.11 LEV 13

The results are given in table form below. All samples were taken on 7th March 2012. VOC results have been calculated using reference conditions 273°C/101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average (14.55-15.25 hrs)	Maximum reading (15.00 hrs)
12.50 to 17.50 hrs.	0.3	0.5	0.6

The on-line FID illustrated that the VOC levels were low over the five-hour sampling period.

3.12 LEV 14

The results are given in table form below. All samples were taken on 6th March 2012. All VOC results have been calculated using reference conditions 273°C/101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average (15.15-15.45 hrs)	Maximum reading (15.45 hrs)
13.45 to 18.45 hrs.	1.1	2.6	3.5

The on-line FID illustrated that the VOC levels were low over the five-hour sampling period.

3.13 LEV 15

The results are given in table form below. All samples were taken on 6th March 2012. All VOC results have been calculated using reference conditions 273°C/101.3 KPa.

Sampling period	VOC (as C) results in mg/m^3		
	5 hr. average	Peak 30 min average (11.20-11.50 hrs)	Maximum reading (11.23 hrs)
08.06 to 13.06 hrs.	4.8	7.0	16.6

The on-line FID illustrated that the VOC levels were low over the five-hour sampling period.

4.0 CONCLUSIONS

4.1 The results show that, at the time of sampling, the thirteen extract stacks were emitting low, or less than concentrations for the gases monitored and were therefore well controlled.

APPENDIX

CERTIFICATE OF CALIBRATION AND TESTING

TSI Instruments Ltd, Stirling Road, Cressex Business Park
High Wycombe Bucks HP12 3ST England
Tel: (Int +44) (UK 0) 1494 459200 Fax: (Int +44) (UK 0) 1494 459700 http://www.tsiinc.co.uk

Environment Condition		
Temperature	24.4	°C
Relative Humidity	46.84	%RH
Barometric Pressure	998.6	hPa

Model	966
Serial Number	P11390036

☒ As Left ☐ As Found
☒ In Tolerance ☐ Out of Tolerance

– Calibration Verification Results –

Temperature Verification — System T-200 — *Unit: °C*

#	Standard	Measured	Allowable Range	#	Standard	Measured	Allowable Range
1	0.0	0.0	-0.3~0.3	2	60.0	59.9	59.7~60.3

Velocity Verification — System V-351 — *Unit: m/s*

#	Standard	Measured	Allowable Range	#	Standard	Measured	Allowable Range
1	0.00	0.00	-0.02~0.02	7	3.29	3.27	3.19~3.39
2	0.18	0.18	0.17~0.20	8	5.06	5.07	4.91~5.21
3	0.33	0.33	0.32~0.35	9	7.47	7.47	7.24~7.69
4	0.51	0.51	0.49~0.53	10	12.64	12.77	12.26~13.02
5	0.81	0.81	0.79~0.84	11	22.86	22.94	22.17~23.55
6	1.66	1.69	1.61~1.71	12	40.55	40.67	39.33~41.76

Humidity Verification — System H-200 — *Unit: %RH*

#	Standard	Measured	Allowable Range	#	Standard	Measured	Allowable Range
1	10.0	9.1	7.8~12.2	4	70.0	69.3	67.8~72.2
2	30.0	28.3	27.8~32.2	5	90.0	88.9	87.8~92.2
3	50.0	49.2	47.8~52.2				

TSI does hereby certify that the above described instrument conforms to the original manufacturer's specification (not applicable to As Found data) and has been calibrated using standards whose accuracies are traceable to members of the European co-operation for Accreditation (EA) (for example: UKAS, SWEDAC, DAkkS) or has been verified with respect to instrumentation whose accuracy is traceable to some member of EA, or is derived from accepted values of physical constants. TSI's calibration system is registered to ISO-9001:2008 and meets the requirements of ISO 10012:2003.

Measurement Variable	System ID
Pressure	E006001
DC Voltage	E006012
Pressure	E006059
Temperature	E006020
Temperature	E006007
Humidity	E006018
Temperature	E006006

Measurement Variable	System ID
Pressure	E006000
Temperature	E006021
Velocity	E006017
DC Volts	E006008
Temperature	E006127
DC Volts	E006125

P. McBAIN

11 OCT 2011

DOC ID: CERT_GEN_ACC

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ELECTRONIC CALIBRATOR UKAS TRACEABLE CALIBRATION CERTIFICATE

CERTIFIED TRUE COPY
SIGN:
DATE: 14th Sept 2011

Model	717-510MA
Serial Number	111156
SKC Reference Number	96184

The above unit has been calibrated at the SKC European Service Centre against UKAS traceable measuring equipment, which in turn has been calibrated by UKAS accredited laboratories.

The reference and test instruments were connected in turn to a stable flow source.

Indicated Average Volumetric Flow of Reference Instrument ml/min	Indicated Average Volumetric Flow of Test Instrument ml/min	Difference Volumetric Flow ml/min	Percentage %
499.36	498.45	0.91	0.18
1,001.58	1,002.18	0.60	0.06
2,000.46	2,003.36	2.90	0.15
4,006.22	4,003.21	3.00	0.07
5,000.89	4,998.18	2.70	0.05

For SKC Limited

27/04/11
Date

Re-certification is due one year from the date of this certificate.

Registered in England No: 1658380
Registered Office as above

Solvent usage at Xaar Huntingdon manufacturing site

The two solvent used in manufacturing for surface cleaning are IPA and Acetone and the ratio of usage is 16.74:1 (IPA:Acetone). The specific gravity of the two substances are 0.78 (IPA) and 0.79 (Acetone) given the ratio of usage the figure used for tonnage calculations of solvent collections is 0.78.

IPA booked from stores : 39,960 Litres [31,168.8 Kg]

Acetone booked from stores: 2, 387.5 Litres [1,886.125 Kg]

Solvent collections : 35,870 Litres [33,054.925 Kg]

Fugitive = (1 – (Collection / Total booked)) * 100 %= 15.3%

FUGITIVE VALUE 15.3% **PERMIT LEVEL 20%**

Results from Monitoring

LEV	Location	Checking for - SOLVENTS	Checking Required	75mg /m^3 avge	Pk	Max
14	Back end assy	Room extraction solvents 2011 readings	√	1.1 (0.6)	2.6 (1.8)	3.5
16	Validation Lab.	Room extraction – solvents (Future install)	X			
11	C.R. 3 Laser Stack	Possible exhaust from laser chambers clean room 3 – Fluorine, Hydrogen Chloride	√			
13	C.R. 3 room exhaust	Room extraction – solvents 2011 readings	√	0.3 (0.3)	0.5 (2.6)	0.6
10	C.R. 3 room exhaust	Room extraction from machining area –PZT water vapour from machining	√			
5	C.R. 2 room exhaust	Possible exhaust from laser chambers clean room 3 – Fluorine	√			
7	C.R. 2 plating line 1	Extraction from plating line 1 – full range of acids	√			
9	C.R. 2 room exhaust	Room extraction – solvents 2011 readings	√	18.5 (8.3)	30.8 (14.9)	49.7
8	C.R. 2 area exhaust	Room extraction from machining area –PZT water vapour from machining	√			
6	C.R. 2 Plating line 2	Extraction from plating line 2 – full range of acids	√			
1	C.R. 1 room exhaust	Room extraction - solvents	√	0.2	0.2	0.2
3	C.R. 1 laser exhaust	Possible exhaust from laser chambers clean room	√			
2	C.R. 1 room	Room extraction - solvents	√	0.5	1.3	2.2

	exhaust					
4	C.R. 1 gas exhaust	Emergency extraction for clean-room 1 laser gas cabinets - fluorine.	X			
12	Bay 3 / 4 roof	Emergency extraction for clean-room 3 laser gas cabinets – fluorine and hydrogen chloride.	X			
15	Bay 2 rear wall	Flammable cabinets for IPA used for IPA flushing rigs	√	4.8	7	16.6
				25.4	42.4	72.7

Condition clause 6 : Regular external monitoring of odours and visual checks from stacks have shown no emissions or odours external to the buildings.

Condition Clause 17 : The average solvent readings during emission testing from ALL stacks was an hourly emission level average 25.4 mg /m^3 the permit level gives 75 mg/m^3 with a peak average from ALL stacks of 42.4 mg /m^3 permissible level 1.5 times permit level – 112.5 mg /m^3.

The peak emissions from all stacks was shown to be below the permissible level.

Note: LEV 9 shows significant increases over 2011 readings and although remaining within the permit level an investigation to be carried out (CAR_40995.42125 dated 26/03/2012)

Although not part of the permit the acid emissions are shown below for completeness. The results show that the acid emissions are well controlled with only trace levels from all plating line stacks.

LEV	Location	Checking for - ACIDS	Checking Required	F_2	HNO_3	H_2SO_4	HCL
14	Back end assy	Room extraction solvents	√				
16	Validation Lab.	Room extraction – solvents (Future install)	X				
11	C.R. 3 Laser Stack	Possible exhaust from laser chambers clean room 3 – Fluorine, Hydrogen Chloride	√				
13	C.R. 3 room exhaust	Room extraction - solvents	√				
10	C.R. 3 room exhaust	Room extraction from machining area –PZT water vapour from machining	√				
5	C.R. 2 room exhaust	Possible exhaust from laser chambers clean room 3 – Fluorine	√	0.16			
7	C.R. 2 plating line 1	Extraction from plating line 1 – full range of acids	√	0.00	0.19	0.19	0.08
9	C.R. 2 room exhaust	Room extraction - solvents	√				
8	C.R. 2 area exhaust	Room extraction from machining area –PZT water vapour from machining	√				
6	C.R. 2 Plating line 2	Extraction from plating line 2 – full range of acids	√	0.14	0.06	0.06	0.03

1	C.R. 1 room exhaust	Room extraction - solvents	√				
3	C.R. 1 laser exhaust	Possible exhaust from laser chambers clean room	√	0.16			
2	C.R. 1 room exhaust	Room extraction - solvents	√				
4	C.R. 1 gas exhaust	Emergency extraction for clean-room 1 laser gas cabinets - fluorine.	X	0.40			
12	Bay 3 / 4 roof	Emergency extraction for clean-room 3 laser gas cabinets – fluorine and hydrogen chloride.	X				
15	Bay 2 rear wall	Flammable cabinets for IPA used for IPA flushing rigs	√				
				0.86	0.25	0.25	0.11