EMISSIONS MONITORING SURVEY

Prepared for:

Linx Printing Technologies Ltd.
Burrell Road
St Ives
Huntingdon
Cambridgeshire
PE27 3LA

Permit Number	**: PG6/44(04)**
Variation Number	**: 2004**
Installation	**: Manufacturing Main Vent**
Visit Details	**: Annual Compliance – 2013**
Job Number	**: P1869**
Report Number	**: R001**
Report Issue Date	**: 15th November 2013**
Survey Dates	**: 5th November 2013**

Prepared by:

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Report Issue:		**FINAL**	
Report Prepared by:		**Report Reviewed & Approved by** MCERTS Level Two Technical Endorsements TE1, TE2, TE3 & TE4	
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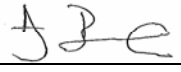
		MCERTS No:	MM 03 235
		Signature:	
Date:	14/11/13	***Date:***	15/11/13

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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2499

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MCERTS requirements mean that comparison of results with emissions limit values is not permitted within this report.

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PART 1 - EXECUTIVE SUMMARY

1 Monitoring Objectives

Environmental Compliance Ltd (ECL) was commissioned by **Linx Printing Technologies Ltd** to undertake an emission monitoring survey at their **Ink Manufacturing site in St Ives**. This report presents the findings of the study.

The monitoring at this installation was carried out in accordance with our quotation reference **PC/P1869/Q001**, for compliance check monitoring of emissions to air. The substances requested for monitoring at each emissions point are listed below:

Substances to be monitored	Emission Point Identification
	Ink Manufacture – Main Vent
Particulates	• U
Total Organic Carbon (TVOC)	• U

• Denotes the substances to be monitored.

U **Denotes UKAS accreditation is held for monitoring that substance, but does not mean that it has been claimed which will depend on whether the testing could be completed in accordance with the Standard Reference Method.**

Special Requirements: *"Test TVOC for full 8 hours"*

1.1 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Units	Uncertainty %	Reference Conditions 273 K, 101.3 kPa	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method	Tick if non-conforming test (see Sections 2 & 5)	Operating Status
Ink Manufacture – Main Vent	Particulates [$]	20	0.64	mg/m^3	27	& Wet Gas	05/11/13	08:05 – 10:05	BS EN 13284-1	UKAS / MCERTS	✔	Normal
	Particulates [$]	20	0.20	mg/m^3	100	& Wet Gas	05/11/13	10:30 – 12:30	BS EN 13284-1	UKAS / MCERTS	✔	
	TVOC as Carbon	150	84.24	mg/m^3	2	& Wet Gas	05/11/13	08:02 – 16:02	BS EN 12619:2013	UKAS / MCERTS		

Notes

The uncertainty figure presented in Table 1.1 for TVOC is the “measurement uncertainty” figure, which does not take into account the variability of the measured sample values.
The “uncertainty of measurement results” figure, which does include this contribution, is also presented in the appendices of the report.

Notes

Emission Limit Value	The emission limit value is that stated in the permit and will be expressed as a concentration or a mass emission.
Periodic Monitoring Result	The result given is expressed in the same terms and units as the emission limit value.
Uncertainty	The uncertainty associated with the quoted result is at the 95% confidence interval. The Uncertainty results **DO NOT** take into account the effect of the sample location limitations.
Reference Conditions	All results are expressed at 273 K and 101.3kPa. The oxygen and moisture corrections are stated.
Monitoring Method Reference	The method stated is in accordance with the Environment Agency Technical Guidance Note M2, or other method approved by the Environment Agency.
Accreditation for use of Method	**The details indicate the accreditation for the use of the complete monitoring method, e.g. MCERTs, UKAS. If use of the method is not accredited " NA" is stated.**
Operating Status	The details indicate the feedstock and the loading rate of the plant during monitoring.
[$]	Chemical Analysis on sample reagents was performed by an External Laboratory as detailed in Section 4
NU	UKAS Accreditation Held but UKAS Accreditation cannot be claimed for the test as sampling did not comply with the Standard Reference Method (SRM), see section 2 & 5
NA	**Method is NOT UKAS Accredited.**

1.2 Operating Information

Emission Point Reference	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results					
							Parameter	Date	Time	CEMS Results	Periodic Monitoring Results	Units
Main Vent	Batch	08:00 – 16:30	n/a	n/a	None	Normal	…	…	…	n/a	…	…

Notes:

Process Type	State whether the process is a continuous or batch process.
Process Duration	If a batch process, state the duration, frequency and details of the portion of the batch sampled. If continuous state "NA"
Fuel	If applicable, state the fuel type If not applicable state "NA"
Feedstock	State the feedstock type
Abatement	State the type and whether operational during monitoring. If not applicable state "NA"
Load	State the normal load, throughput or rating of the plant
CEMS Data	Enter this data for each CEM installed if it is has been provided by operator otherwise state “NP” (NOT PROVIDED)

2 Monitoring Deviations

The objective of the survey was to measure the concentrations of pollutants from the processes / locations as detailed in Section 1. This survey meets the requirements of the site's **PPC Permit Number: PG6/44(04)** where UKAS and MCERTS accreditation has and could be claimed for the testing in the monitoring results table.

There were no modifications to the sampling procedures (TPDs) listed in section 4.

There were no substance deviations from the original and agreed emissions monitoring schedule.

Non-conforming tests are as follows:-

Particulate samples were made from centre point only, whereas BS EN 13284 stipulates 5 sample points for a duct with this diameter (500mm). This deviation was made for safety reasons, as there are no internally threaded sample ports available so securing the probe at all the sample points was not possible**. This non-conformity does not alter the accreditation status of the tests.**

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of these non-conformities or sample location limitations.

Homogeneity tests have/ have not been completed and are not applicable to this location as the duct area is <1m^2.

PART 2 – SUPPORTING INFORMATION

3 SAMPLING STAFF DETAILS

Site Sampling Team

Names of Site Team	Dates on Site	MCERTS No.	LEVEL	Technical Endorsements
Andy Barnes	05/11/13	MM 03 235	2	TE1, TE2, TE3, TE4

Report Reviewer

Name	MCERTS No.	LEVEL	Technical Endorsements
Andy Barnes	MM 03 235	2	TE1, TE2, TE3, TE4

Technical Endorsement Key:-

TE1 – **Isokinetic** Particulates, Temperature & Velocity Profiles, Oxygen.
TE2 – **Isokinetic** Extractive Pollutants:- Metals, Dioxin & Furans, PAHs, PCBs, HCl, HF.
TE3 – **Non-Isokinetic** Extractive Pollutants:- Speciated VOCs, HF, HCl, Cyanide.
TE4 – **Continuous Analysers** (Combustion Gases):- TVOC, CO, NOx, SO2.

4 SAMPLING PROTOCOLS / METHODOLOGIES

Any required modifications to the Technical Procedure Documents (TPDs) specified below will be detailed in section 2 of this report.

TVOC as Carbon

Testing was carried out using an MCERTS Certified Signal 3030PM FID and heated gas sample line, with reference to the manufacturer's operation handbook, **BS EN 12619:2013** and in-house technical procedure **ECL/TPD/032**.

The analyser was calibrated on site using certified propane span gases, (made up in synthetic air) which are traceable to ISO 17025 standard. (with uncertainty <2%).

Zero measurements were performed using synthetic air zero gas, with TVOC content less than 0.2 mg/m^3 (or purity greater than 99.998%).

The analyser was calibrated directly into the sample inlet and then checked through the entire sampling system (including sampling probe, heated filter and heated gas transport lines). Data was corrected by molecular weight to TVOCs as total carbon.

Data was recorded as minute averages over each test period. The data is presented in the Figures Section and the minute averaged data is detailed in the Tables Section**.**

Pressure, Temperature and Velocity

Testing was carried out using a sampling system in accordance with **BS EN 13284-1 & MID** and In-house technical procedure **ECL/TPD/022.**

Temperature was recorded using a thermocouple and digital temperature reader.

Velocity and pressure were recorded using an "L" type pitot and digital manometer, data being recorded in Pascals.

Particulates

Testing was carried out using a Manual Stack Sampling system in accordance with **BS EN 13284-1 & MID** and In-house technical procedure **ECL/TPD/027A**

Isokinetic particulate sampling is achieved when the velocity of gas entering the sampling nozzle is exactly equal to the velocity of the approaching gas stream within the stack.

A measured volume of sample gas is withdrawn from the stack isokinetically through a sampling nozzle and through 37mm pre-weighed and pre-blown GFA filter positioned in an unheated housing inserted into the stack.

Particulate matter is collected on the filter. Following testing the front half of the filter housing, probe (out-stack sampling only) and the sample nozzle are rinsed to remove any particulate matter which, may have impacted on the surfaces during testing. The dry residue of the Acetone used for rinses is <5mg/l. The filters and rinses are subsequently analysed to determine the amount of particulate matter captured.

The standard pre-sample conditioning temperature of the filters is 180^{o}C and the standard post-sample conditioning temperature is 160^{o}C. (Any modifications to this are noted in section 2 of this report). Apparent weights are corrected, if required, based on the weights of three control filters and evaporating basins which are weighed (pre and post sampling) with each batch of filters & rinses.

Scientific Analysis Laboratories Ltd (SAL) who are situated in Manchester carried out the analysis of the samples. **SAL** are UKAS accredited for this analysis. In addition to the survey samples, appropriate field blanks are submitted as part of the technical procedure.

5 SAMPLE POINT DESCRIPTIONS

The homogeneity test is applicable to combustion processes. This includes but is not restricted to, those regulated under the Waste Incineration Directive (**WID**) and the Large Combustion Plant Directive (**LCPD**).

Homogeneity testing has not been completed at this location. The test is not usually required for stacks with sampling plane areas of <1m^2 (below 1.13m in diameter for circular ducts).

The sample location that was monitored is detailed below:-

Ink Manufacture – Main Vent

The sampling plane is in long straight vertical section of the emissions stack.

The diameter at the sample plane is 0.5m.

The flow characteristics meet the ***requirements*** of the standard.

2 x 2" ports are available and are located as per the requirements of BS EN 13284.

The equipment is set up at ground level, with probes raised to the sample plane (<5m) via temporary access.

Samples for Particulates are non-conforming tests, due to the fact that not all the designated sample points on the sample plane could be used. Whilst it was possible to safely reach both ports for the purposes of the pitot traverse, there was no safe way to support the probe in Port B for particulate sampling, and in port A, the probe was fixed at a single (centre) point in the duct. This non-conformity does not alter the accreditation status of the tests.

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of these non-conformities or sample location limitations.

EQUIPMENT IDs
(Pre site checklist from SSP)

Linx Printing Technologies Ltd
Permit No : PG6/44(04)
Variation No : 2004
Report Ref : P1869 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2013
Survey Dates : 5th November 2013
Report Issue Date. : 15th November 2013

PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

(Completed before departure to site and when on site in full)

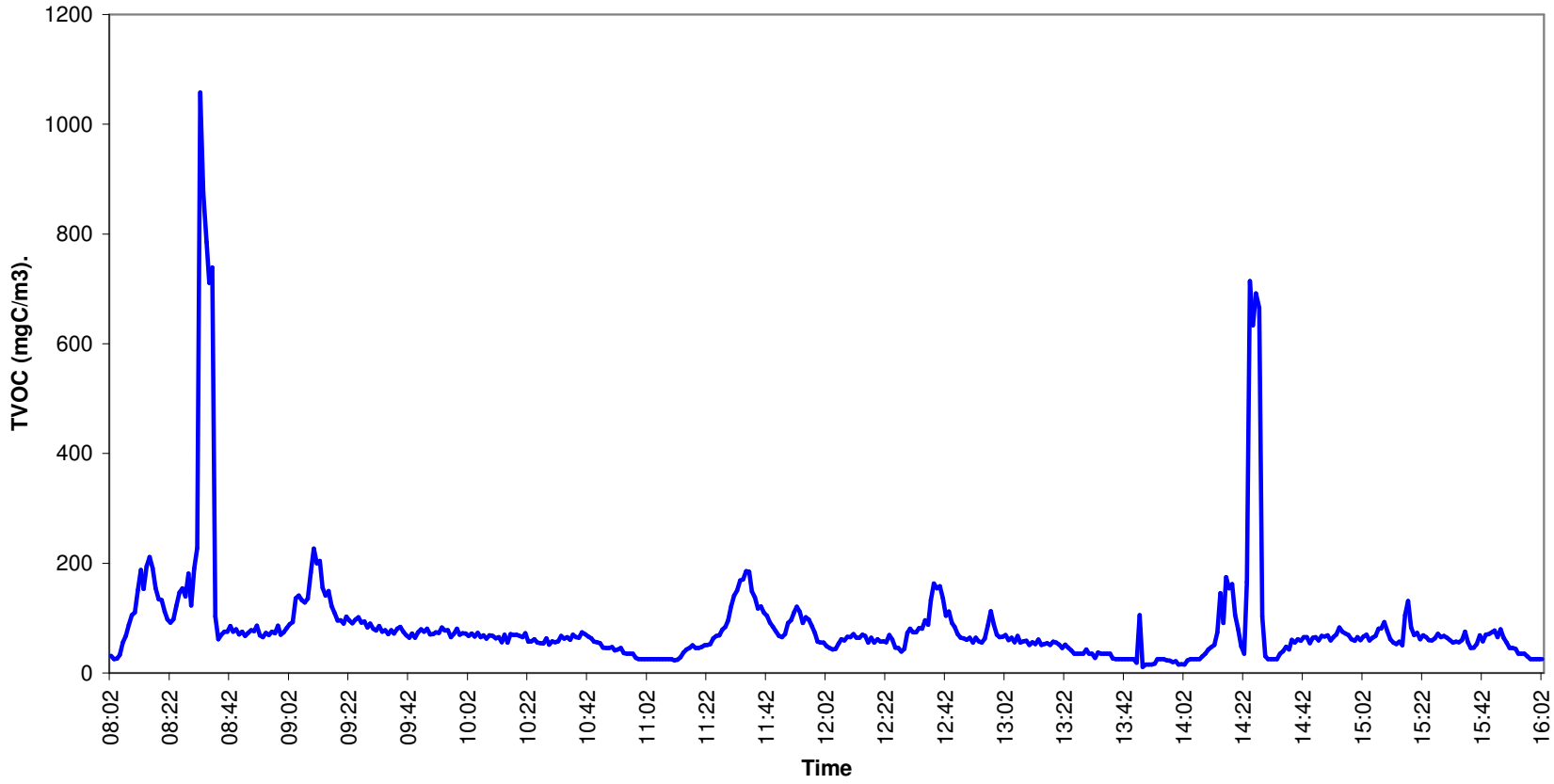
Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001								
MST Nozzle set									
MST "S" Type Pitot									
MST Probe									
MST Hot Box									
MST Impinger Arm									
Barometer		629							
Site Balance									
Site Check weights									
Horiba	E002								
Heated Probe / Filter									
Chiller									
Sonimix									
Heated Line									
FID	E003	304							
Heated Line		354	355						
Heated Probe / Filter		806							
Testo	E004								
FTIR	E005								
Heated Probe / Filter									
Heated Line									
Stackmite	E006	366							
"L" Type Pitot		487							
Digital Manometer		506							
Stack Thermocouple		464							
Thermocouple Reader		414							
Nozzle Set		801							
Workhorse Pumps	E007								
Low Flow Pumps									

Quantity of Ice Required / Used for Survey	ZERO	Bags (2kg bags)

FIGURES

Figure 1

**TVOC Data Recorded From Linx Printing, Main Vent - Manufacturing,
on 05/11/2013, Between 08:02 and 16:02.
Reference Conditions 273K, 101.3kPa & Wet Gas.**



TABLES

Linx Printing Technologies Ltd			Installation Name	: Manufacturing Main Vent
Permit No	: PG6/44(04)		Visit Details	: Annual Compliance – 2013
Variation No	: 2004		Survey Dates	: 5th November 2013
Report Ref	: P1869	: R001	Report Issue Date.	: 15th November 2013

Table 1

TOC Data Recorded from Manufacturing - Main Vent

Sample Period: 08:02 – 16:02 on the 5th November 2013

Volumetric Flowrate (Reference Conditions) = 0.84 **m^3/sec ***

	Average	Emission Rate
	mg/m^3	**Kg/hr**
TVOCs (as carbon)*	**84.24**	**0.255**

*** Reference Conditions (273K, 101.3 kPa & Wet Gas)**

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Table 2 – Particulates

Data Recorded from Manufacturing - Main Vent

Emission Parameter	Units	TPM 1	Blank
Stack Diameter	metres	0.50	…
			…
Area of Sample Plane	m^2	0.196	…
Moisture Content	%	0.10	…
Oxygen Content	%	20.90	…
Stack Temperature	°C	19	…
Gas Velocity (at Stack Conditions)	m/sec	4.70	…
Gas Velocity (Reference Conditions)	m/sec*	4.29	…
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.92	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.84	…
Sample Date	…	05/11/2013	…
Sample Period	…	08:05 - 10:05	…
Sample Volume (at Stack)	m^3	1.91	…
Sample Volume (reference Conditions)	m^3*	1.74	1.74
Isokinetic Sampling Rate	%	108.4	...
Sample Reference (ECL ID)	ECL/13/	5478 & 5479	5482 & 5483
Mass of Particulate Matter Collected	mg	1.12	0.35
Concentration of Particulate Matter	mg/m^3*	**0.64**	0.20
Emission Rate of Particulate Matter	g/hr	1.95	…
Expanded Uncertainty (% Relative)	%	27	…
Emission Limit Value (ELV)	mg/m^3*	20	…
Blank Concentration as Percentage of ELV	%	…	1.00

*Reference Conditions (273K, 101.3kPa, Wet Gas)

Linx Printing Technologies Ltd
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Table 3 – Particulates

Data Recorded from Manufacturing - Main Vent

Emission Parameter	Units	TPM 2	Blank
Stack Diameter	metres	0.50	…
			…
Area of Sample Plane	m^2	0.196	…
Moisture Content	%	0.11	…
Oxygen Content	%	20.90	…
Stack Temperature	°C	19	…
Gas Velocity (at Stack Conditions)	m/sec	4.70	…
Gas Velocity (Reference Conditions)	m/sec*	4.29	…
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.92	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.84	…
Sample Date	…	05/11/2013	…
Sample Period	…	10:30 - 12:30	…
Sample Volume (at Stack)	m^3	1.92	…
Sample Volume (reference Conditions)	m^3*	1.75	1.75
Isokinetic Sampling Rate	%	108.9	...
Sample Reference (ECL ID)	ECL/13/	5480 & 5481	5482 & 5483
Mass of Particulate Matter Collected	mg	0.35	0.35
Concentration of Particulate Matter	mg/m^3*	**0.20**	0.20
Emission Rate of Particulate Matter	g/hr	0.61	…
Expanded Uncertainty (% Relative)	%	>100%	…
Emission Limit Value (ELV)	mg/m^3*	20	…
Blank Concentration as Percentage of ELV	%	…	<1.00%

*Reference Conditions (273K, 101.3kPa, Wet Gas)

VELOCITY TRAVERSE PROFILES

Environmental Compliance Limited

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance – 2013**
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Report Ref	**: P1869 : R001**	**Report Issue Date.**	**: 15th November 2013**

Environmental Compliance Limited	Traverse Data Profoma	Date of Measurement	05/11/2013

Company	Linx Printing	Stack Diameter (mm)	500	Pitot tube coefficient	1.00
Site	St Ives	Port Length (mm)		Pitot ID	487
Location	Manufacturing	Duct Length (mm) A		Stack Thermocouple ID	464
Stack	Main Vent	Duct width (mm) B		Stack Thermocouple Reader ID	414
Job No	P1869	Barometric Pressure. (mb)	989	Manometer ID	506
Operators	AB	Static Pressure. (mm $H_2$0) (= Pa/9.81)	0.5	Barometer ID	629

	Distance to Point (mm)	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test ° From Reference	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test ° From Reference
	55	A1	19.0	7.0	10	B1	19.0	22.0	5
	250	A2	19.0	13.0	6				
	445	A3	19.0	20.0	5	B3	19.0	9.0	10
Total			57				38		
Max			19	20.0			19	22.0	
Min			19	7.0			19	9.0	
Average			19.0	13.3			19.00	15.50	

Average temp (K)	292

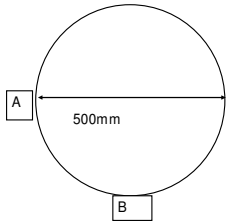
Suitability of Sampling Position	Actual Stack Conditons
Permitted highest:lowest flow pressure ratio =9:1	3.14:1
Average deviation of flow from axis <15°	OK
X-sectional area for stacks= πr^2	0.20 m^2
X-sectional area for ducts = L x B	0.000 m^2
Suitabilty of Position for Sampling	OK

Stack Moisture	0.1	%
Measured Oxygen	20.9	%
Measured Carbon Dioxide	0.0	%
Dry Gas Molecular Weight	28.836	g/g mole

Gas Velocity (as Measured)	4.81	m/sec
Gas Velocity (Reference Conditions)	4.39	m/sec*
Volumetric Flowrate (as Measured)	0.9435	m^3/sec
Volumetric Flowrate (Reference Conditions)	0.8612	m^3/sec*

*Reference Conditions: 273K, 101.3kPa, Wet Gas

Diagram/ Description of Cross Section of Stack/Duct



Access is via temporary platform

Plane is <5m above ground

All kit stays on ground, plenty of space.

Only probes raised via temporary access and tied to stack brace

Deviations from procedure/ non - conformities

Two ports are fitted, but not threaded.
It is possible to pitot traverse both ports safely, but for particulate sampling, for safety, the probe is tied in a single fixed position.

Compliance With Positional Requirements?

Height of sample ports from Platform	**1.0m**
Number of sample ports	**2**
Width of platform (port back to handrail)	**1.5m**

Nearest downstream disturbance	Exit	4m
Nearest upstream disturbance	Bend	2m
Disturbances are classed as bends, fans or diameter variations		

FIELD CALIBRATION AND SAMPLING DATA

Linx Printing Technologies Ltd
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TVOC - FIELD DATA SHEET

Client	Linx
Site	St Ives
Date	05/11/2013
Location	Manufacturing
Stack ID	Main Vent
Stack Temp °C	19
Ambient Temp	During Pre-test Calibration 12
Ambient Temp (sampling)	1= 12 2= 13 3= 14
Job No	P1869
Operators	AB

Barometric Pressure mb	989	
Barometer ID	ECL/ID/ 629	
Analyser ID	ECL/ID/ 304	
Sonimix/ MFC ID	ECL/ID/ n/a	
Heated Line/ Controller ID	ECL/ID/ 354 & 355	
Heated Line Set Temp °C	180	
Heated Line Length	10	m
Heated Filter ID	ECL/ID/ 806	
Heated Filter Set Temp °C	180	
Logger ID	217	

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)
Zero Gas (Synthetic Air)	Gas/ 1220	…	…
Hydrogen / Helium	Gas/ 1199	…	…
Propane (In Air)	Gas/ 1176	907.2 ppm	9.07 ppm

	Analyser Range	Span Gas value used
Propane	1000 ppm	907.2 ppm

Analyser Range should be not less than the expected peak emissions.

Span Gas Values should be **either** *approximately the half-hourly ELV* **OR** ***50%*** *to* ***90%*** *of the Selected Analyser Range.*

	Direct Calibration (Rear of Analyser)					
	Zero Cal		Span Gas Cal		Zero Check	
	Start Time	End Time	Start Time	End Time	Start Time	End Time
ZERO /SPAN/ ZERO	07:28	07:33	07:34	07:39	07:40	07:45

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

	PRE System Verification Check (Down Line)			
	Zero Check		Span Check	
	Start Time	End Time	Start Time	End Time
ZERO / SPAN	07:46	07:51	07:53	07:58

Response Time SYSTEM Span Gas Cal		
Start Time	90% Time	less than 200s (Y/N)
07:52	07:53	Y

	Start Time	End Time	Location	Production Details
Sample Period	08:00	16:03	Main Vent	Varied - Normal
Sample Period				
Sample Period				
Sample Period				
Sample Period				
Sample Period				

	POST System Verification Check (Down Line)			
	Zero Check		Span Check	
	Start Time	End Time	Start Time	End Time
ZERO / SPAN	16:05	16:10	16:10	16:16

Process Details / Comments

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		TVOC ppm
Analyser Range		1000
Repeatability at Zero		2
Span Gas Concentration Applied		907.2
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	917.2
	Zero	3.30
Difference (Zero)		3.2982
<2×Repeatability @ Zero?		YES
Pre Test	Zero	3.30
	Span	904.0
Difference (Zero)		0.0000
<2% Relative to Direct Span		YES
Difference (Span)		3.1900
<2% Relative to Direct Span		YES
Post Test	Zero	3.30
	Span	909.7
Difference (Zero)		0.0000
Zero Drift <2% of Applied Span?		YES
Difference (Span)		5.6485
Span Drift <2% of Applied Span?		YES
Zero and Span Drift <5% of Applied Span?		YES

Environmental Compliance Limited

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Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	05/11/2013

ECL/TPD/	27a	Time taken to change Ports?	Start Time	08:05	End Time	10:05	Duration (mins)	120

Client	Linx Printing	Stack Profile	Circular	Pitot ID	487	Stack Thermocouple ID	464	Impingers	n/a
Site	St Ives	Stack Area (m^2)	0.20	Manometer ID	506	Stack Temp Reader ID	414	SOL/	n/a
Location	Manufacturing	Barometric Pressure (mb)	989	Barometer ID	629	Meter Thermocouple ID	366	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H^20) (Pa/9.81)	0.5	DGM Yd	1.0277	Meter Temp Reader ID	366	End Weight (g)	1.40
Test No.	TPM 1	Pitot coefficient	1	Nozzle ID	801	Dry Gas Meter ID	366	Total weight (g)	1.40
Job No	P1869	Balance ID	n/a	Nozzle Size (mm)	8.14	Timer ID	366		
ECL Site Staff	AB	Console ID	366	Filter ID	883	Rotameter ID	366		

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

	Sample	Leak 1	Leak 2	Leak 3	Leak 4
Start Volume	1377844.0				
Final Volume	1379732.0				
Total Volume	1888.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	1607.41
	Actual Sample Volume	1741.97
1888.0	Isokinetic Percentage	108.37

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	20			20
Time Of Leak Check	08:00			10:08
Leak % of set rate	0.5			0.5

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.10
Measured CO_2 %		Ref O_2	11
Measured CO ppm		Dry Gas Molecular Weight	28.84

TPD/27A is carried out with an unheated sampling system only.

Traverse Point	A2	A2	A2	A2	A2	A2	A2	A2	Total
Time Interval (mins)	5	5	5	5	5	5	5	5	
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (Pa)	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.0
Velocity at Stack (m/s)	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	13.7	13.8	13.9	14.0	14.0	14.1	14.1	14.2	14.0
Meter (Tm)	7.00	9.00	11.00	12.00	13.00	14.00	15.00	16.00	12.1
Stack Temp (Ts)	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.0

Acetone SOL/	2345
DI Rinse SOL/	2341

Original Flowrate Settings	
Tm	40
Ts	19
% moisture	

Traverse Point	A2	A2	A2	A2	A2	A2	A2	A2	Total
Time Interval (mins)	5	5	5	5	5	5	5	5	
Time/Point (mins)	40 - 45	45 - 50	50 - 55	55 - 60	60 - 65	65 - 70	70 - 75	75 - 80	
ΔP (Pa)	13.00	13.00	13.00	13.00	13.00	13	13	13	13.0
Velocity at Stack (m/s)	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	14.3	14.4	14.5	14.6	14.7	14.8	14.8	14.9	14.6
Meter (Tm)	18.00	21.00	22.00	24.00	26.00	28	29	30	24.8
Stack Temp (Ts)	19.00	19.00	19.00	19.00	19.00	19	19	19	19.0

Traverse Point	A2	A2	A2	A2	A2	A2	A2	A2	Total
Time Interval (mins)	5	5	5	5	5	5	5	5	
Time/Point (mins)	80 - 85	85 - 90	90 - 95	95 - 100	100 - 105	105 - 110	110 - 115	115 - 120	
ΔP (Pa)	13	13	13	13	13	13	13	13	13.0
Velocity at Stack (m/s)	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	14.9	15.0	15.1	15.1	15.2	15.2	15.2	15.2	15.1
Meter (Tm)	31	33	34	35	36	36	37	37	34.9
Stack Temp (Ts)	19	19	19	19	19	19	19	19	19.0

Environmental Compliance Limited

Linx Printing Technologies Ltd		Installation Name	: Manufacturing Main Vent
Permit No	: PG6/44(04)	Visit Details	: Annual Compliance – 2013
Variation No	: 2004	Survey Dates	: 5th November 2013
Report Ref	: P1869 : R001	Report Issue Date.	: 15th November 2013

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	05/11/2013

ECL/TPD/	27a	Time taken to change Ports?	Start Time	10:30	End Time	12:30	Duration (mins)	120

Client	Linx Printing	Stack Profile	Circular	Pitot ID	487	Stack Thermocouple ID	464	Impingers	n/a
Site	St Ives	Stack Area (m^2)	0.20	Manometer ID	506	Stack Temp Reader ID	414	SOL/	n/a
Location	Manufacturing	Barometric Pressure (mb)	989	Barometer ID	629	Meter Thermocouple ID	366	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H^20) (Pa/9.81)	0.5	DGM Yd	1.0277	Meter Temp Reader ID	366	End Weight (g)	1.50
Test No.	TPM 2	Pitot coefficient	1	Nozzle ID	801	Dry Gas Meter ID	366	Total weight (g)	1.50
Job No	P1869	Balance ID	n/a	Nozzle Size (mm)	8.14	Timer ID	366		
ECL Site Staff	AB	Console ID	366	Filter ID	884	Rotameter ID	366		

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

	Sample	Leak 1	Leak 2	Leak 3	Leak 4
Start Volume	1379780.0				
Final Volume	1381760.0				
Total Volume	1980.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	1607.33
	Actual Sample Volume	1750.46
1980.0	Isokinetic Percentage	108.90

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	20			20
Time Of Leak Check	10:25			12:35
Leak % of set rate	0.5			0.5

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.11
Measured CO_2 %		Ref O_2	11
Measured CO ppm		Dry Gas Molecular Weight	28.84

TPD/27A is carried out with an unheated sampling system only.

Traverse Point	A2	A2	A2	A2	A2	A2	A2	A2	Total
Time Interval (mins)	5	5	5	5	5	5	5	5	
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (Pa)	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.0
Velocity at Stack (m/s)	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	14.8	14.8	14.9	15.0	15.0	15.0	15.0	15.1	14.9
Meter (Tm)	28.00	29.00	30.00	32.00	32.00	33.00	33.00	34.00	31.4
Stack Temp (Ts)	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.0

Acetone SOL/	2345
DI Rinse SOL/	2341

Original Flowrate Settings	
Tm	40
Ts	19
% moisture	

Traverse Point	A2	A2	A2	A2	A2	A2	A2	A2	Total
Time Interval (mins)	5	5	5	5	5	5	5	5	
Time/Point (mins)	40 - 45	45 - 50	50 - 55	55 - 60	60 - 65	65 - 70	70 - 75	75 - 80	
ΔP (Pa)	13.00	13.00	13.00	13.00	13.00	13	13	13	13.0
Velocity at Stack (m/s)	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	15.1	15.1	15.2	15.3	15.3	15.3	15.4	15.4	15.2
Meter (Tm)	34.00	35.00	37.00	38.00	39.00	39	40	40	37.8
Stack Temp (Ts)	19.00	19.00	19.00	19.00	19.00	19	19	19	19.0

Traverse Point	A2	A2	A2	A2	A2	A2	A2	A2	Total
Time Interval (mins)	5	5	5	5	5	5	5	5	
Time/Point (mins)	80 - 85	85 - 90	90 - 95	95 - 100	100 - 105	105 - 110	110 - 115	115 - 120	
ΔP (Pa)	13	13	13	13	13	13	13	13	13.0
Velocity at Stack (m/s)	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	15.4	15.4	15.4	15.4	15.5	15.5	15.5	15.5	15.4
Meter (Tm)	41	41	41	41	42	42	42	42	41.5
Stack Temp (Ts)	19	19	19	19	19	19	19	19	19.0

LABORATORY ANALYSIS RESULTS

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

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Report Number: 360093-1

Date of Report: 14-Nov-2013

Customer: Environmental Compliance Ltd
Unit G1
Main Avenue
Treforest Industrial Estate
Pontypridd
CF37 5BF

Customer Contact: Mr Andrew Barnes

Customer Job Reference: P1869
Customer Purchase Order: E2178
Date Job Received at SAL: 09-Nov-2013
Date Analysis Started: 11-Nov-2013
Date Analysis Completed: 14-Nov-2013

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING
1549

Report checked and authorised by :
Kayleigh McCann
Project Manager

Issued by :
Kayleigh McCann
Project Manager

Validity unknown
Digitally signed by Kayleigh McCann
Date: 2013.11.15 15:55:49 GMT
Reason: Issued
Location: SAL

Linx Printing Technologies Ltd
Permit No : PG6/44(04)
Variation No : 2004
Report Ref : P1869 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2013
Survey Dates : 5th November 2013
Report Issue Date. : 15th November 2013

SAL Reference: 360093
Customer Reference: P1869

Filter GFA 37mm Analysed as Filter GFA 37mm
Miscellaneous

					SAL Reference	360093 001	360093 003	360093 005	360093 007
					Customer Sample Reference	ECL/13/5478	ECL/13/5480	ECL/13/5482	ECL/13/5484
					Test Sample	AR	AR	AR	AR
					Date Sampled	05-NOV-2013	05-NOV-2013	05-NOV-2013	05-NOV-2013
Determinand	Method	LOD	Units	Symbol					
Particulates (Total)	Grav (5 Dec)	0.05	mg	U		0.62	<0.05	<0.05	<0.05

SAL Reference: 360093
Customer Reference: P1869

Wash(Acetone) Analysed as Wash(Acetone)
Miscellaneous

					SAL Reference	360093 002	360093 004	360093 006	360093 008
					Customer Sample Reference	ECL/13/5479	ECL/13/5481	ECL/13/5483	ECL/13/5485
					Test Sample	AR	AR	AR	AR
					Date Sampled	05-NOV-2013	05-NOV-2013	05-NOV-2013	05-NOV-2013
Determinand	Method	LOD	Units	Symbol					
Particulates (Total)	Grav	0.3	mg	U		0.5	<0.3	0.3	<0.3

Index to symbols used in 360093-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

UNCERTAINTY CALCULATIONS

Linx Printing Technologies Ltd		Installation Name	: Manufacturing Main Vent
Permit No	: PG6/44(04)	Visit Details	: Annual Compliance – 2013
Variation No	: 2004	Survey Dates	: 5th November 2013
Report Ref	: P1869 : R001	Report Issue Date.	: 15th November 2013

TVOC Measurement Uncertainty

Performance Characteristics	Standard Uncertainty	Distributiuon	Min Certified Ranges TVOC 0 - 15 mgC/m^3
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.40
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.35
Repeatability Standard Deviation (span)	u_r	Normal (Divisor = 1)	4.69
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	0.35
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.30
Interferents[1]	u_i	Rectangular (Divisor = √3)	4.39
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	14.58

Note:

$$when\ \left|(x_{i,max} - x_{i,adj})\right| = \left|(x_{i,min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement, dry gas
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m^3 / %Vol
7 Applies to TOC analyser (*Signal 3030 FID) only

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.035
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	4.69
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	2.75
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.052
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	14.58
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	15.57
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	31.14
Applied Span Concentration			1457.87
Measured Span Concentration, STP Dry Gas			1457.51
Expanded measurement uncertainty as % of Applied Span			2 %

* Signal 3030 FID

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance – 2013**
Variation No	**: 2004**	**Survey Dates**	**: 5th November 2013**
Report Ref	**: P1869 : R001**	**Report Issue Date.**	**: 15th November 2013**

TVOC Uncertainty of Measurement Results

Uncertainty Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range TVOC 0 - 15 mgC/m³
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.40
Span drift[2]	$u_{d,s}$			0.35
Losses / leakage in the sample system[4]	u_{loss}			0.35
Temperature dependant span drift[5]	u_t			0.30
Interferents[1]	u_i			4.39
Effect of Voltage Fluctuation[7]	u_v			1.80
Effect of Oxygen Synergism[7]	u_{syn}			

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})(x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below). $\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	TVOC 0 - 15 mgC/m³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.035
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.05
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

Uncertainty Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	TVOC 0 - 15 mgC/m³
Losses / leakage in the sample system	u_{loss}	05/11/13 08:02 - 12:02	0.348
Standard Error of Measured Value	u_{SE}	05/11/13 08:02 - 12:02	7.49

Effect on Uncertainty Caused by Oxygen

$$uCorr^{n}_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} =$$

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = \quad 1.0000$$

$$uf_{o_2} = \frac{uCorr^{n}_{o_2}}{f_{o_2}} x100 = \quad 0.00 \quad \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Uncertainty Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m³
Measured Concentration	05/11/13 08:02 - 12:02	99.00
Expanded Uncertainty as Percentage of Measured Concentration		15 %

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{syn}^2}$

Expanded uncertainty (at 95% confidence) $U_{exp} = 2 \times u_c$

1 Expressed as a percentage of the analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Where the uncertainty of Oxygen is taken as the standard error of the time averaged value used to correct to Reference Oxygen
7 Where the uncertainty of Moisture is taken as the standard error of the time averaged value used to correct to Dry Conditions
8 Where no uncertainty is presented above, the uncertainty is >100%

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance – 2013**
Variation No	**: 2004**	**Survey Dates**	**: 5th November 2013**
Report Ref	**: P1869 : R001**	**Report Issue Date.**	**: 15th November 2013**

Uncertainty Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range TVOC 0 - 15 mgC/m^3
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.40
Span drift[2]	$u_{d,s}$			0.35
Losses / leakage in the sample system[4]	u_{loss}			0.35
Temperature dependant span drift[5]	u_t			0.30
Interferents[1]	u_i			4.39
Effect of Voltage Fluctuation[7]	u_v			1.80
Effect of Oxygen Synergism[7]	u_{sym}			

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})(x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	TVOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.035
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.05
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

Uncertainty Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	TVOC 0 - 15 mgC/m^3
Losses / leakage in the sample system	u_{loss}	05/11/13 12:02 - 16:02	0.244
Standard Error of Measured Value	u_{SE}	05/11/13 12:02 - 16:02	5.43

Effect on Uncertainty Caused by Oxygen

$$uCorr^{n}_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} =$$

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = \quad 1.0000$$

$$uf_{O_2} = \frac{uCorr^{n}_{O_2}}{f_{O_2}} x100 = \quad 0.00 \quad \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Uncertainty Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m^3
Measured Concentration	05/11/13 12:02 - 16:02	69.33
Expanded Uncertainty as Percentage of Measured Concentration		16 %

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_t^2 + u_{loss}^2 + u_i^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{sym}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Where the uncertainty of Oxygen is taken as the standard error of the time averaged value used to correct to Reference Oxygen
7 Where the uncertainty of Moisture is taken as the standard error of the time averaged value used to correct to Dry Conditions
8 Where no uncertainty is presented above, the uncertainty is >100%

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance – 2013**
Variation No	**: 2004**	**Survey Dates**	**: 5th November 2013**
Report Ref	**: P1869 : R001**	**Report Issue Date.**	**: 15th November 2013**

Site: Linx Printing, St Ives
Location: Manufacturing , Stack ID: Main Vent

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	Solution mg	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
			TPM 1					
Particulates	0.62	0.50	1.12	0.14	0.27	0.0700	0.14	0.15

	TPM 1			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.89	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	1.03	...		...	...	
Meter Temperature (T_m)	297.07	k	uT_m	1.5	k	
Static Pressure of Stack P_{static}	0.50	mmH_2O	uP_{static}	0.25	mmH_2O	
Absolute Stack Pressure ρ_s	741.81	mmHg	up_s	0.8	mmHg	
Barometric Pressure ρ_b	741.99	mmHg	up_b	3.8	mmHg	
Average Differential Pressure (ΔP) + ρs	99.08	mmH_2O	$u\Delta H$	0.25	mmH_2O	
Oxygen content ($O_{2,m}$)	20.90	%by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.00	%by volume	
Moisture Content (H_2O)	0.0996	%by volume	uH_2O	0.09	%by volume	

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying th contributing factor e.g. i =uV_m, uT_m etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = 1.00$$

Uncertainty in correction factor to STP due to measured barometric pressure uncertainty component (upb), measured static pressure uncertainty component (uPstatic) & measured temperature of dry gas uncertainty component (uT_m)

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.932$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.49	0.49	0.0000477	0.0000119
up_b	0.49	0.48	0.000648	0.00243
uT_m	0.49	0.48	0.000852	0.00128
H_2O	0.49	0.49	0.00486	0.000425

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = 0.00259$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uVstd) & volume uncertainty component (uVm)

$$V_{std} = V_{measured} \times f_s = 1.7597$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	1.76	1.75	1.89	0.00490
Effect of uV_m	1.76	1.76	0.93	0.000932

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00928$$

Uncertainty of correction factor to reference oxygen due to measured oxygen uncertainty component (uf_{O2}) & Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.00$$

$$uCorr^n_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times Uncertainty\ of\ O_2\ Measurement = 1.00$$

$$uf_{o_2} = \frac{uCorr^n_{o_2}}{f_{o_2}} \times 100 = 0.00$$

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM), oxygen correction uncertainty component (uf_{Oxy}) and STP volume uncertainty component (uVstp)

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = 0.64$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	0.72	0.55	0.57	0.0864
uV_{stp}	0.64	0.63	0.36	0.00336

Measurement Uncertainty of Determinand (excluding correction for oxygen)

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
0.09	0.17	0.64	27.2%

Measurement Uncertainty of Determinand (including correction for oxygen)

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corrⁿ Factor	Overall Measurement Uncertainty inc O_2 Corrⁿ factor (*Ucombined*) %
Particulates	27.2	0.0	27.2

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance – 2013**
Variation No	**: 2004**	**Survey Dates**	**: 5th November 2013**
Report Ref	**: P1869 : R001**	**Report Issue Date.**	**: 15th November 2013**

Site: Linx Printing, St Ives
Location: Manufacturing , Stack ID: Main Vent

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	Solution mg	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
				TPM 2				
Particulates	0.0500	0.30	0.35	0.14	0.27	0.0700	0.14	0.15

	TPM 2			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.98	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	1.03	...		...	...	
Meter Temperature (T_m)	310.03	k	uT_m	1.5	k	
Static Pressure of Stack P_{static}	0.50	mmH_2O	uP_{static}	0.25	mmH_2O	
Absolute Stack Pressure ρ_s	741.81	mmHg	up_s	0.8	mmHg	
Barometric Pressure ρ_b	741.99	mmHg	up_b	3.8	mmHg	
Average Differential Pressure (ΔP) + ρs	99.08	mmH_2O	$u\Delta H$	0.25	mmH_2O	
Oxygen content ($O_{2,m}$)	20.90	%by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.00	%by volume	
Moisture Content (H_2O)	0.11	%by volume	uH_2O	0.09	%by volume	

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying th contributing factor e.g. i =uV_m, uT_m etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = 1.00$$

Uncertainty in correction factor to STP due to measured barometric pressure uncertainty component (upb), measured static pressure uncertainty component (uPstatic) & measured temperature of dry gas uncertainty component (uT_m)

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.893$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.47	0.47	0.0000466	0.0000117
up_b	0.48	0.47	0.000634	0.00238
uT_m	0.48	0.47	0.000815	0.00122
H_2O	0.48	0.47	0.00475	0.000413

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = 0.00240$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uVstd) & volume uncertainty component (uVm)

$$V_{std} = V_{measured} \times f_s = 1.7684$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	1.77	1.76	1.98	0.00476
Effect of uV_m	1.77	1.77	0.89	0.000893

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00945$$

Uncertainty of correction factor to reference oxygen due to measured oxygen uncertainty component (uf_{O2}) & Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.00$$

$$uCorr^n_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured}) x (20.9\% - O_{2,measured})} x\, Uncertainty\ of\ O_2\ Measurement = 1.00$$

$$uf_{o_2} = \frac{uCorr^n_{o_2}}{f_{o_2}} x100 = 0.00$$

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM), oxygen correction uncertainty component (uf_{Oxy}) and STP volume uncertainty component (uVstp)

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = 0.20$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	0.28	0.11	0.57	0.0860
uV_{stp}	0.20	0.20	0.11	0.00106

Measurement Uncertainty of Determinand (excluding correction for oxygen)

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
0.09	0.17	0.20	86.9%

Measurement Uncertainty of Determinand (including correction for oxygen)

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corrⁿ Factor	Overall Measurement Uncertainty inc O_2 Corrⁿ factor (*Ucombined*) %
Particulates	86.9	0.0	86.9