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 2012**
Job Number	**: P1583**
Report Number	**: R001**
Report Issue Date	**: 28th November 2012**
Survey Dates	**: 14th November 2012**

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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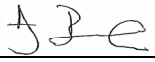
		Signature:	
Date:	27/11/12	***Date:***	28/11/12

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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2499

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Opinions and Interpretation expressed within this report are outside the scope of the UKAS accreditation.

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/P1583/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 (TOC)	• U

Special Requirements: *"Test TOC 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	5.84	mg/m^3	4	& Wet Gas	14/11/12	09:00 – 11:00	BS EN 13284-1	UKAS / MCERTS	✓	Normal – see notes in section 1.2
	Particulates $	20	0.57	mg/m^3	28	& Wet Gas	14/11/12	11:15 – 13:15	BS EN 13284-1	UKAS / MCERTS	✓	
	Particulates $	20	0.53	mg/m^3	30	& Wet Gas	14/11/12	13:25 – 15:25	BS EN 13284-1	UKAS / MCERTS	✓	
	TOCs as Carbon	150	138.1	mg/m^3	5	& Wet Gas	14/11/12	08:05 – 16:04	BS EN 13526	UKAS / MCERTS	✓	

Notes

The uncertainty figure presented in Table 1.1 for TOC 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.

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).

The following details regarding process operation were recorded by site personnel for inclusion in this report.

Main-line & mini-line operating from circa 08:00.

Significant powder additions took place during particulate test 1 (09:00 – 11:00).

An accidental spillage occurred (open bottle of solvent) near to one of the floor extraction points at 10:30 (shown by large spike in TOC concentration graph) – clean up was complete within 10 minutes.

Main-line was noted to have ceased production by 15:00, but the mini-line was still operating to the end of the sample period at 16:04.

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.**

TOC sampling was made on the 1000ppm range of the FID, this was to cover possible very high spikes of data as had been recorded historically. The span gas chosen was at 200ppm, (close to 1.5 x ELV), but this is not within the 50 – 90% of analyser range as stipulated in BS EN 13526. **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	14/11/2012	MM03 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):- TOCs, 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.

TOCs 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 13526** and in-house technical procedure **ECL/TPD/032**.

The analyser was calibrated on site using certified propane span gases which are traceable to ISO 17025 standard. (with uncertainty <2%). Zero measurements were performed using Nitrogen. The analyser was calibrated directly into the sample inlet and then checked through the entire sampling system (including sampling probe and heated gas transport lines). Data was corrected by molecular weight to TOCs 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**.**

The date of the last control gas mixture test on the FID was April 2012.

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 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).

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 : P1583 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance 2012
Survey Dates : 14th November 2012
Report Issue Date : 28th November 2012

PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

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

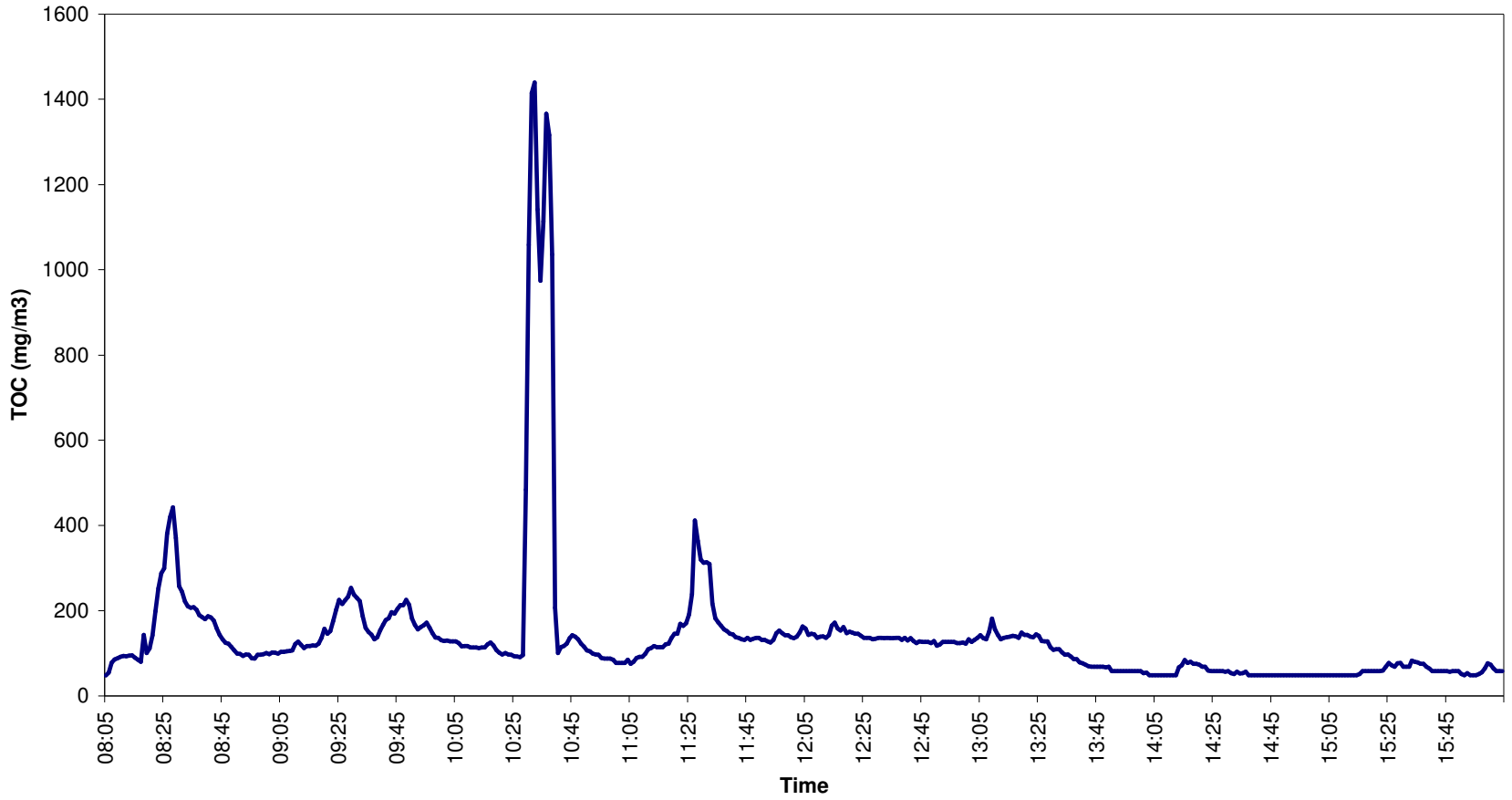
Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001								
MST Nozzle set									
MST "S" Type Pitot									
MST Probe									
MST Hot Box									
MST Impinger Arm									
Barometer		352							
Site Balance									
Site Check weights									
Horiba	E002								
Heated Probe									
Chiller									
Sonimix									
Heated Line									
FID	E003	516							
Heated Line		212	213						
Testo	E004								
FTIR	E005								
Heated Probe									
Heated Line									
Stackmite	E006	367							
"L" Type Pitot		489							
Digital Manometer		506							
Stack Thermocouple		464							
Thermocouple Reader		414							
Nozzle Set		800							
Workhorse Pumps	E007								
Low Flow Pumps									

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

FIGURES

Figure 1

TOC Emissions Data - Linx Printing - Main Vent.
Data Recorded on 14/11/12 - 08:05 to 16:04.
Data Presented at 273K, 101.3kPa & Wet Gas



TABLES

Linx Printing Technologies Ltd			Installation Name	: Manufacturing Main Vent
Permit No	: PG6/44(04)		Visit Details	: Annual Compliance 2012
Variation No	: 2004		Survey Dates	: 14th November 2012
Report Ref	: P1583	: R001	Report Issue Date	: 28th November 2012

Table 1

TOC Data Recorded from Manufacturing - Main Vent

Sample Period: 08:05 – 16:04 on the 14th November 2012

Volumetric Flowrate (Reference Conditions) = 0.79 **m^3/sec ***

	Average	Emission Rate
	mg/m^3	**Kg/hr**
TOCs (as carbon)*	**138.06**	**0.393**

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

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Table 2 – Particulates

Data Recorded from Production - Main Vent

Emission Parameter	Units	TPM 1	Blank
Stack Diameter	metres	0.50	…
			…
Area of Sample Plane	m^2	0.196	…
Moisture Content	%	0.12	…
Oxygen Content	%	20.90	…
Stack Temperature	°C	18	…
Gas Velocity (at Stack Conditions)	m/sec	4.24	…
Gas Velocity (Reference Conditions)	m/sec*	4.03	…
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.83	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.79	…
Sample Date	…	14/11/2012	…
Sample Period	…	09:00 - 11:00	…
Sample Volume (at Stack)	m^3	2.18	…
Sample Volume (reference Conditions)	m^3*	2.07	2.07
Isokinetic Sampling Rate	%	109.4	…
Sample Reference (ECL ID)	ECL/12/	6448 & 6449	6450 & 6451
Mass of Particulate Matter Collected	mg	12.10	0.15
Concentration of Particulate Matter	mg/m^3*	**5.84**	0.07
Emission Rate of Particulate Matter	g/hr	16.62	…
Expanded Uncertainty (% Relative)	%	4	…
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
Permit No : PG6/44(04)
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Installation Name : Manufacturing Main Vent
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Table 3 – Particulates

Data Recorded from Production - Main Vent

Emission Parameter	Units	TPM 2	Blank
Stack Diameter	metres	0.50	…
			…
Area of Sample Plane	m^2	0.196	…
Moisture Content	%	0.13	…
Oxygen Content	%	20.90	…
Stack Temperature	°C	18	…
Gas Velocity (at Stack Conditions)	m/sec	4.24	…
Gas Velocity (Reference Conditions)	m/sec*	4.03	…
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.83	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.79	…
Sample Date	…	14/11/2012	…
Sample Period	…	11:15 - 13:15	…
Sample Volume (at Stack)	m^3	2.03	…
Sample Volume (reference Conditions)	m^3*	1.93	1.93
Isokinetic Sampling Rate	%	101.8	…
Sample Reference (ECL ID)	ECL/12/	6452 & 6453	6450 & 6451
Mass of Particulate Matter Collected	mg	1.10	0.15
Concentration of Particulate Matter	mg/m^3*	**0.57**	0.08
Emission Rate of Particulate Matter	g/hr	1.62	…
Expanded Uncertainty (% Relative)	%	28	…
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 4 – Particulates

Data Recorded from Production - Main Vent

Emission Parameter	Units	TPM 3	Blank
Stack Diameter	metres	0.50	…
			…
Area of Sample Plane	m^2	0.196	…
Moisture Content	%	0.13	…
Oxygen Content	%	20.90	…
Stack Temperature	°C	18	…
Gas Velocity (at Stack Conditions)	m/sec	4.24	…
Gas Velocity (Reference Conditions)	m/sec*	4.03	…
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.83	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.79	…
Sample Date	…	14/11/2012	…
Sample Period	…	13:25 - 15:25	…
Sample Volume (at Stack)	m^3	2.01	…
Sample Volume (reference Conditions)	m^3*	1.90	1.90
Isokinetic Sampling Rate	%	100.5	…
Sample Reference (ECL ID)	ECL/12/	6454 & 6455	6450 & 6451
Mass of Particulate Matter Collected	mg	1.01	0.15
Concentration of Particulate Matter	mg/m^3*	**0.53**	0.08
Emission Rate of Particulate Matter	g/hr	1.51	…
Expanded Uncertainty (% Relative)	%	30	…
Emission Limit Value (ELV)	mg/m^3*	20	…
Blank Concentration as Percentage of ELV	%	…	<1.00%

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

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VELOCITY TRAVERSE PROFILE

Environmental Compliance Limited

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
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Variation No	**: 2004**	**Survey Dates**	**: 14th November 2012**
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Environmental Compliance Limited	Traverse Data Proforma	Date of Measurement	14/11/2012

Company	Linx Printing	Stack Diameter (mm)	500	Pitot tube coefficient	1.00
Site	St Ives	Port Length (mm)	0	Pitot ID	489
Location	Production	Duct Length (mm) A		Stack Thermocouple ID	464
Stack	Main Vent	Duct width (mm) B		Stack Thermocouple Reader ID	414
Job No	P1583	Barometric Pressure. (mb)	1025	Manometer ID	506
Operators	AB	Static Pressure. (mm $H_2$0) (= Pa/9.81)	0.5	Barometer ID	352

	Distance to Point (mm)	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test °From Reference	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test °From Reference
	55	A1	18.0	6.0	10	B1	18.0	22.0	6
	250	A2	18.0	11.0	8				
	445	A3	18.0	18.0	5	B3	18.0	8.0	8
Total			54				36		
Max			18	18.0			18	22.0	
Min			18	6.0			18	8.0	
Average			18.0	11.7			18.00	15.00	

Average temp (K)	291

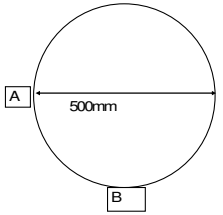
Suitability of Sampling Position	Actual Stack Conditons
Permitted highest:lowest flow pressure ratio =9:1	3.67:1
Average deviation of flow from axis <15°	OK
X-sectional area for stacks= πr^2	0.20 m^2
X-sectional area for ducts = L x B	0.000 m^2
Suitabilty of Position for Sampling	OK

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

Gas Velocity (as Measured)	4.49	m/sec
Gas Velocity (Reference Conditions)	4.26	m/sec*
Volumetric Flowrate (as Measured)	0.8807	m^3/sec
Volumetric Flowrate (Reference Conditions)	0.8360	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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FID CALIBRATION

			TOC ppm		
Analyser Range			1000		
Repeatability at Zero			10		
Span Gas Concentration Applied			199.9		
Zero Gas Concentration Applied			0		
Direct Cal		Zero	0.00		
		Span	200.34		
		Zero	3.03		
Difference (Zero)			3.028787879		
<2×Repeatability @ Zero?			YES		
Pre Test		Zero	3.03		
		Span	199.58		
Difference (Zero)			0		
<5% (2% for O_2) Relative to Direct Span			YES		If Red CONTACT QM
Difference (Span)			0.757196977		
<5% (2% for O_2) Relative to Direct Span			YES		If Red CONTACT QM
Post Test		Zero	0.00		
		Span	209.74		
Difference (Zero)			3.029		
<2% of Analyser Range			YES		If Red apply Drift
Difference (Span)			10.159		
<2% of Analyser Range			YES		If Red apply Drift
Drift <5% of Analyser Range?			YES		If Red CONTACT QM

Environmental Compliance Limited

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Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	14/11/2012

ECL/TPD/	27a	Time taken to change Ports	0	Start Time	09:00	End Time	11:00	Duration (mins)	120

Client	Linx Printing	Stack Profile	Circular	Pitot ID	489	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	Production	Barometric Pressure (mb)	1025	Barometer ID	352	Meter Thermocouple ID	367	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H_2O) (Pa/9.81)	0.5	DGM Yd	1.0202	Meter Temp Reader ID	367	End Weight (g)	2.00
Test No.	TPM 1	Pitot coefficient	1	Nozzle ID	800	Dry Gas Meter ID	367	Total weight (g)	2.00
Job No	P1583	Balance ID	n/a	Nozzle Size (mm)	9.12	Timer ID	367		
ECL Site Staff	AB	Console ID	367	Filter ID	799	Rotameter ID	367		

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	1268770.0				
Final Volume	1270935.0				
Total Volume	2165.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	1892.48
	Actual Sample Volume	2070.20
2165.0	Isokinetic Percentage	109.39

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	20			20
Time Of Leak Check	08:55			11:02
Leak % of set rate	0.5			0.5

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.12
Measured CO_2 %		Ref O_2	20.9
Measured CO ppm		Dry Gas Molecular Weight	28.84

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	16.3	16.3	16.3	16.5	16.6	16.7	16.8	16.9	16.5
Meter (Tm)	9	10	10	12	14	16	17	19	13.4
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	16.9	16.9	17.0	17.0	17.2	17.2	17.2	17.3	17.1
Meter (Tm)	20	20	21	22	24	25	25	26	22.9
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.3	17.4	17.4	17.4	17.5	17.5	17.5	17.5	17.4
Meter (Tm)	27	28	28	29	30	30	30	30	29.0
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Acetone SOL/	1994
DI Rinse SOL/	2000

Original Flowrate Settings	
Tm	30
Ts	18
% moisture	0.1

Environmental Compliance Limited

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance 2012**
Variation No	**: 2004**	**Survey Dates**	**: 14th November 2012**
Report Ref	**: P1583 : R001**	**Report Issue Date**	**: 28th November 2012**

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	14/11/2012

ECL/TPD/	27a	Time taken to change Ports	0	Start Time	11:15	End Time	13:15	Duration (mins)	120

Client	Linx Printing	Stack Profile	Circular	Pitot ID	489	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	Production	Barometric Pressure (mb)	1025	Barometer ID	352	Meter Thermocouple ID	367	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H^20) (Pa/9.81)	0.5	DGM Yd	1.0202	Meter Temp Reader ID	367	End Weight (g)	2.00
Test No.	TPM 2	Pitot coefficient	1	Nozzle ID	800	Dry Gas Meter ID	367	Total weight (g)	2.00
Job No	P1583	Balance ID	n/a	Nozzle Size (mm)	9.12	Timer ID	367		
ECL Site Staff	AB	Console ID	367	Filter ID	800	Rotameter ID	367		

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	1271000.0				
Final Volume	1273085.0				
Total Volume	2085.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	1892.34
	Actual Sample Volume	1925.65
2085.0	Isokinetic Percentage	101.76

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	20			20
Time Of Leak Check	11:10			13:20
Leak % of set rate	0.5			0.5

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.13
Measured CO_2 %		Ref O_2	20.9
Measured CO ppm		Dry Gas Molecular Weight	28.84

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.3	17.4	17.5	17.5	17.6	17.6	17.6	17.6	17.5
Meter (Tm)	26	28	30	30	31	31	32	32	30.0
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Acetone SOL/	1994
DI Rinse SOL/	2000

Original Flowrate Settings	
Tm	30
Ts	18
% moisture	0.1

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.6	17.6	17.6	17.7	17.7	17.7	17.7	17.7	17.7
Meter (Tm)	32	32	32	33	33	33	33	33	32.6
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
Meter (Tm)	33	34	34	34	34	34	34	34	33.9
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Environmental Compliance Limited

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance 2012**
Variation No	**: 2004**	**Survey Dates**	**: 14th November 2012**
Report Ref	**: P1583 : R001**	**Report Issue Date**	**: 28th November 2012**

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	14/11/2012

ECL/TPD/	27a	Time taken to change Ports	0	Start Time	13:25	End Time	15:25	Duration (mins)	120

Client	Linx Printing	Stack Profile	Circular	Pitot ID	489	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	Production	Barometric Pressure (mb)	1025	Barometer ID	352	Meter Thermocouple ID	367	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H^20) (Pa/9.81)	0.5	DGM Yd	1.0202	Meter Temp Reader ID	367	End Weight (g)	2.00
Test No.	TPM 3	Pitot coefficient	1	Nozzle ID	800	Dry Gas Meter ID	367	Total weight (g)	2.00
Job No	P1583	Balance ID	n/a	Nozzle Size (mm)	9.12	Timer ID	367		
ECL Site Staff	AB	Console ID	367	Filter ID	794	Rotameter ID	367		

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	1273100.0				
Final Volume	1275165.0				
Total Volume	2065.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	1892.31
	Actual Sample Volume	1902.25
2065.0	Isokinetic Percentage	100.52

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	20			20
Time Of Leak Check	13:22			15:30
Leak % of set rate	0.5			0.5

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.13
Measured CO_2 %		Ref O_2	20.9
Measured CO ppm		Dry Gas Molecular Weight	28.84

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.6	17.6	17.6	17.6	17.6	17.6	17.7	17.7	17.6
Meter (Tm)	31	31	31	32	32	32	33	33	31.9
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Acetone SOL/	1994
DI Rinse SOL/	2000

Original Flowrate Settings	
Tm	30
Ts	18
% moisture	0.1

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
Meter (Tm)	33	33	33	33	34	33	33	33	33.1
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	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)	11	11	11	11	11	11	11	11	11.0
Velocity at Stack (m/s)	4.24	4.24	4.24	4.24	4.24	4.24	4.24	4.24	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
Meter (Tm)	33	34	34	34	34	34	34	34	33.9
Stack Temp (Ts)	18	18	18	18	18	18	18	18	18.0

LABORATORY ANALYSIS RESULTS

Linx Printing Technologies Ltd
Permit No : PG6/44(04)
Variation No : 2004
Report Ref : P1583 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance 2012
Survey Dates : 14th November 2012
Report Issue Date : 28th November 2012

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: Supplement to 304813-1

Date of Report: 27-Nov-2012

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

Customer Contact: Mr Andrew Barnes

Customer Job Reference: P1583
Customer Purchase Order: E0815
Date Job Received at SAL: 20-Nov-2012
Date Analysis Started: 21-Nov-2012
Date Analysis Completed: 23-Nov-2012

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 :
Jennifer Wraith
Sales Support Manager

Issued by :
Kayleigh McCann
Project Manager

Validity unknown
Digitally signed by Kayleigh McCann
Date: 2012.11.28 10:47:10 GMT
Reason: Issued
Location: SAL

Linx Printing Technologies Ltd
Permit No : PG6/44(04)
Variation No : 2004
Report Ref : P1583 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance 2012
Survey Dates : 14th November 2012
Report Issue Date : 28th November 2012

SAL Reference: 304813
Customer Reference: P1583

Filter Quartz 37mm Analysed as Filter Quartz 37mm
Miscellaneous

				SAL Reference	**304813 001**	**304813 003**	**304813 005**	**304813 007**
				Customer Sample Reference	**ECL/12/6448**	**ECL/12/6450**	**ECL/12/6452**	**ECL/12/6454**
				Test Sample	**AR**	**AR**	**AR**	**AR**
Determinand	**Method**	**LOD**	**Units**	**Symbol**				
Particulates (Total)	Grav (5 Dec)	0.05	mg	U	**12**	<0.05	**1.0**	**0.91**

SAL Reference: 304813
Customer Reference: P1583

Wash(Acetone) Analysed as Wash(Acetone)
Miscellaneous

				SAL Reference	**304813 002**	**304813 004**	**304813 006**	**304813 008**
				Customer Sample Reference	**ECL/12/6449**	**ECL/12/6451**	**ECL/12/6453**	**ECL/12/6455**
				Test Sample	**AR**	**AR**	**AR**	**AR**
Determinand	**Method**	**LOD**	**Units**	**Symbol**				
Particulates (Total)	Grav	0.1	mg	U	<0.1	<0.1	<0.1	<0.1

Index to symbols used in Supplement to 304813-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

Notes

Supplement issued to amend the customer reference as requested by the customer.

UNCERTAINTY CALCULATIONS

Linx Printing Technologies Ltd
Permit No : PG6/44(04)
Variation No : 2004
Report Ref : P1583 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance 2012
Survey Dates : 14th November 2012
Report Issue Date : 28th November 2012

TOC Measurement Uncertainty

Signal 3030 FID Performance Characteristics	Standard Uncertainty	Distributiuon	Minimum Certified Range (R_i) *TOC 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)	7.56
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	0.01
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)	2.89
Effect of Voltage Fluctuation[7]	u_v	Rectangular (Divisor = √3)	1.80
Effect of Oxygen Synergism[7]	u_{syn}	Rectangular (Divisor = √3)	4.60

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

Signal 3030 FID Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.03
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	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	7.56
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.01
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.137
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	1.67
Effect of Voltage Fluctuation (See Note 7	u_v	$u(x_i) = \frac{u_v \times R_i}{\sqrt{3}} =$	0.16
Effect of Oxygen Synergism (See Note 7	u_{syn}	$u(x_i) = \frac{u_{syn} \times R_i}{\sqrt{3}} =$	0.40
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	7.77
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	15.53
Applied Span Concentration			321.27
Measured Span Concentration, STP Dry Gas			325.96
Expanded measurement uncertainty as % of Applied Span			4.8%

* Signal 3030 FID

Linx Printing Technologies Ltd
Permit No : PG6/44(04)
Variation No : 2004
Report Ref : P1583 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance 2012
Survey Dates : 14th November 2012
Report Issue Date : 28th November 2012

TOC Uncertainty of Measurements

Uncertainty Calculations Part 1

Signal 3030 FID Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	ım Certified Rar *TOC 0 - 15 mgC/m³
Lack of fit(1)	u_{lof}	Rectangular	$\sqrt{3}$	4.00E-01
Span drift(2)	$u_{d,s}$			3.54E-01
Losses / leakage in the sample system(4)	u_{loss}			6.32E-03
Temperature dependant span drift(5)	u_t			3.00E-01
Effect of Voltage Fluctuation(7)	u_v			1.80E+00

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), $\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$

Signal 3030 FID Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	*TOC 0 - 15 mgC/m³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	3.46E-02
Span drift	$u_{d,s}$			3.07E-02
Temperature dependant span drift	u_t			1.37E-01
Interferents	u_i			3.80E-01
Effect of Voltage Fluctuation (See Note)	u_v			1.56E-01

Uncertainty Calculations Part 2

Signal 3030 FID Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	*TOC 0 - 15 mgC/m³
Losses / leakage in the sample system	u_{loss}	14/11/12 08:05 - 16:04	8.73E-03
Standard Error of Measured Value	u_{SE}	14/11/12 08:05 - 16:04	7.40E+00

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

Signal 3030 FID Uncertainty	Date & Time	*TOC 0 - 15 mgC/m³
Measured Concentration	14/11/12 08:05 - 16:04	138.06
Expanded Uncertainty as Percentage of Measured Concentration		10.7%

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

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

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance 2012**
Variation No	**: 2004**	**Survey Dates**	**: 14th November 2012**
Report Ref	**: P1583 : R001**	**Report Issue Date**	**: 28th November 2012**

Site: Linx Printing, St Ives
Location: Production , 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	LAB Method Uncert (%) K=2 Solution mg	Standard Uncertainty Filter mg	Standard Uncertainty Solution mg	Combined Uncertainty mg
			TPM 1					
Particulates	12.00	0.10	12.10	0.14	0.27	0.0700	0.14	0.15

	TPM 1			Standard Uncertainty @ 95%	
Sampled Volume (V_m)	2.17	**m^3**	**uV_m**	0.001	**m^3**
Meter Correction Factor (Yd)	1.02	**...**		...	**...**
Meter Temperature (T_m)	294.90	**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	768.81	**mmHg**	**up_s**	0.8	**mmHg**
Barometric Pressure ρ_b	769.00	**mmHg**	**up_b**	3.8	**mmHg**
Average Differential Pressure (ΔH)	102.65	**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)	0.12	**%by volume**	**uH_2O**	0.07	**%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:

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

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

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.966$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.50	0.50	0.0000475	0.0000119
up_b	0.50	0.50	0.000646	0.00242
uT_m	0.50	0.50	0.000883	0.00133
H_2O	0.50	0.50	0.00502	0.000370

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00262$$

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

$$V_{std} = V_{measured} \times f_s = \quad 2.0917$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uf_s	2.10	2.09	2.16	0.00567
Effect of uV_m	2.09	2.09	0.97	0.000966

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0123$$

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)

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

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	...	...	...	...

$$uL = \frac{Conc \times \frac{2}{100}}{\sqrt{3}} = \quad \text{mg/Nm}^3 \quad 0.0668$$

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

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = \quad 5.78$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	5.86	5.71	0.48	0.0727
uO_2	...	...	...	...
uV_{stp}	5.82	5.75	2.77	0.0341

Combined Uncertainty

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

Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
0.10	**0.21**	**5.78**	**3.6%**

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance 2012**
Variation No	**: 2004**	**Survey Dates**	**: 14th November 2012**
Report Ref	**: P1583 : R001**	**Report Issue Date**	**: 28th November 2012**

Site: Linx Printing, St Ives
Location: Production , 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	1.00	0.10	1.10	0.14	0.27	0.0700	0.14	0.15

	TPM 2			Standard Uncertainty @ 95%	
Sampled Volume (V_m)	2.09	**m^3**	**uV_m**	0.001	**m^3**
Meter Correction Factor (Yd)	1.02	**...**		...	**...**
Meter Temperature (T_m)	305.32	**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	768.81	**mmHg**	**up_s**	0.8	**mmHg**
Barometric Pressure ρ_b	769.00	**mmHg**	**up_b**	3.8	**mmHg**
Average Differential Pressure (ΔH)	100.09	**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)	0.13	**%by volume**	**uH_2O**	0.08	**%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:

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

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

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.933$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.49	0.49	0.0000467	0.0000117
up_b	0.49	0.49	0.000634	0.00238
uT_m	0.49	0.49	0.000852	0.00128
H_2O	0.49	0.49	0.00493	0.000390

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00251$$

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

$$V_{std} = V_{measured} \times f_s = \quad 1.9454$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uf_s	1.95	1.94	2.08	0.00524
Effect of uV_m	1.95	1.94	0.93	0.000933

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0110$$

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)

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

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	...	...	...	...

$$uL = \frac{Conc \times \frac{2}{100}}{\sqrt{3}} = \quad \text{mg/Nm}^3 \quad 0.00653$$

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

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = \quad 0.57$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	0.64	0.49	0.51	0.0782
uO_2	...	...	...	...
uV_{stp}	0.57	0.56	0.29	0.00319

Combined Uncertainty

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

Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
0.08	**0.16**	**0.57**	**27.8%**

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: PG6/44(04)**	**Visit Details**	**: Annual Compliance 2012**
Variation No	**: 2004**	**Survey Dates**	**: 14th November 2012**
Report Ref	**: P1583 : R001**	**Report Issue Date**	**: 28th November 2012**

Site: Linx Printing, St Ives
Location: Production , 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	LAB Method Uncert (%) K=2 Solution mg	Standard Uncertainty Filter mg	Standard Uncertainty Solution mg	Combined Uncertainty mg
			TPM 3					
Particulates	0.91	0.10	1.01	0.14	0.27	0.0700	0.14	0.15

	TPM 3			Standard Uncertainty @ 95%	
Sampled Volume (V_m)	2.07	**m^3**	**uV_m**	0.001	**m^3**
Meter Correction Factor (Yd)	1.02	**...**		...	**...**
Meter Temperature (T_m)	306.11	**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	768.81	**mmHg**	**up_s**	0.8	**mmHg**
Barometric Pressure ρ_b	769.00	**mmHg**	**up_b**	3.8	**mmHg**
Average Differential Pressure (ΔH)	102.65	**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)	0.13	**%by volume**	**uH_2O**	0.08	**%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:

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

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

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.931$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.49	0.49	0.0000466	0.0000116
up_b	0.49	0.49	0.000634	0.00238
uT_m	0.49	0.49	0.000850	0.00127
H_2O	0.49	0.49	0.00493	0.000395

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00245$$

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

$$V_{std} = V_{measured} \times f_s = \quad 1.9223$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uf_s	1.93	1.92	2.07	0.00507
Effect of uV_m	1.92	1.92	0.93	0.000931

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0105$$

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)

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

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	...	...	...	...

$$uL = \frac{Conc \times \frac{2}{100}}{\sqrt{3}} = \quad \text{mg/Nm}^3 \quad 0.00607$$

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

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = \quad 0.53$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	0.60	0.45	0.52	0.0791
uO_2	...	...	...	...
uV_{stp}	0.53	0.52	0.27	0.00287

Combined Uncertainty

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

Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
0.08	**0.16**	**0.53**	**30.2%**