SOLVENT INVENTORY

Period: 1 November 2014 - 30 April 2015

Company: Linx Printing Technologies Ltd
Linx House
8 Stocks Bridge Way Compass Business Park
St Ives
Cambs PE27 5JL

Contact: Andy Mee

Product	Part No.	Quantity (Kg)	Solvent Content (%)	Quantity (Litres)	Density (Kg/L)	Weight of Solvent used (Kg)
Ethyl Lactate	BP800002	2365	100		1.034	2365
Ind. Meth. Spirits	BP800012		100		0.8	0
Acetone	BP800013	86900	100		0.791	86900
TSDA3	BP800035	26860	100		0.8	26860
Diethylketone	BP800045	450	100		0.8	450
Antiterra 204	BP800053		50		0.85	0
PGMMEA	BP800056	54	100		0.968	54
White dispersion PGMMEA	BP800097	0	15	0	2	0
White dispersion TSDA	BP800098	332	15	166	2	49.8
Ethyl Acetate	BP800100	0	100	0	0.901	0
Methyl Acetate	BP800106	1980	100		0.934	1980
MEK Black Ink	BP990001 (1010)	0	92	0	0.85	0
MEK Solvent	BP990025	450240	100		0.804	450240
MEK Ink Red	BP990026 (1018)	0	93		0.9	0
Black to Red Jet Ink	BP990037 (1270)	3	93		0.85	2.79
Solvent	BP990042 (1540)	0	100		0.8	0
MEK Ink Black/Blue	BP990049 (1290)	54.9	93	61	0.9	51.1
MEK Ink Black/Red	BP990050 (1280)	5.95	93	7	0.85	5.5
Ink Red Mastercote	BP990058 (6100)	4.3	76	5	0.86	3.268
Solvent Mastercote	BP990059 (6600)	16.8	95	21	0.8	15.96
Ink Clear UV Readable	BP990060 (1121)	0	80		0.9	0
Black Water Removable	BP990067 (1035)	0	75		0.9	0
Solvent Water Removable	BP990068 (1535)	0	100		0.8	0
Blue Ink Mastercote	BP990069 (6120)	50	75		0.86	37.5
Blue Ink Mastercote	BP990072 (6220)	2	57.6		0.9	1.152
Blue Solvent Mastercote	BP990073 (6650)	3.228	90.3	4	0.807	2.9
Washdown Mastercote	BP990075	0	10		0.95	0
MEK Ink Black Alk Rem	BP990077 (1070)	0	75		0.9	0
MEK Solvent Alk Rem	BP990079 (1560)	0	99		0.8	0
MEK Solvent Alk Rem	BP990080 (1590)	0	99		0.8	0
White Pigmented Ink	BP990083 (1059)	0	80		0.9	0
Videojet Elk Grove	BP990085 (1075)	436.05	70	513	0.85	305.2
Black UV Cure Ink	BP990088	0	50	0	0.95	0
MEK Black Pigmented	BP990090	0	88		0.9	0
TSDA-3/Methanol Blend	BP990096	1141	100		0.792	1141
Opaque Blue Pigmented	BP990097	0	77		0.967	0
Vinyl White Ink	BP990110	0	80		0.9	0
Vinyl Yellow Ink	BP990111	4860	80	5400	0.9	3888
Vinyl Black Ink	BP990113	0	88	0	0.9	0
Vinyl Blue Ink	BP990114	0	80	0	0.9	0
Opaque Blue Pigmented	BP990115	0	77		0.967	0
Vinyl White Ink	BP990123	0	80	0	0.9	0
Opaque Blue Pigmented	BP990125	0	77		0.967	0
Opaque Blue Pigmented	BP990126	0	77	0	0.967	0
White Pigmented Ink	BP990127	0	80	0	0.9	0
White Vinyl Pigmented	BP990128	0	80	0	0.9	0
Nazdar Navy Diaper Ink	BP990129	172	75	200	0.86	129
Nazdar Diaper Solvent	BP990130	83	95	100	0.83	78.9

Less Solvent returned for recycling (Kg)	Nil
Total Solvent used (Kg)	574561

EMISSIONS MONITORING SURVEY

Prepared for:

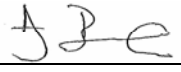
Linx Printing Technologies Ltd.
Burrell Road
St Ives
Huntingdon
Cambridgeshire
PE27 3LA

Permit Number	**: B04/94**
Variation Number	**: PPC10/08**
Installation	**: Manufacturing Main Vent**
Visit Details	**: Annual Compliance – 2014**
Job Number	**: P2208**
Report Number	**: R001**
Report Issue Date	**: 24th November 2014**
Survey Dates	**: 4th November 2014**

Prepared by:

Environmental Compliance Limited
Unit G1
Main Avenue
Treforest Industrial Estate
Pontypridd
CF37 5BF.

Tel: 01443 841760
Fax: 01443 841761

Report Issue:		**FINAL**	
Report Prepared by:		**Report Reviewed & Approved by** **MCERTS Level Two** **Technical Endorsements TE1, TE2, TE3 & TE4**	
Name:	Jon Litterick	***Name:***	Andy Barnes
		MCERTS No:	MM 03 235
		Signature:	
Date:	19/11/14	***Date:***	24/11/14

This report is not to be used for contractual or engineering purposes unless this approval sheet is signed where indicated by the approver and the report is designated "FINAL".

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2499

This report has been prepared by Environmental Compliance Limited (ECL) in their professional capacity as Environmental Consultants. The contents of the report reflect the conditions that prevailed and the information available or supplied at the time of its preparation. The report, and the information contained therein, is provided by ECL solely for use and reliance by the Client in performance of ECLs duties and liabilities under its contract with the Client. Until ECL has received payment in full as detailed in the quotation or contract the contents of this report remain the legal property of ECL. The contents of the report do not, in any way, purport to include any manner of legal advice or opinion.

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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.

TABLE OF CONTENTS

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/P2208/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	0.68	mg/m^3	21	& Wet Gas	04/11/14	09:10 – 11:10	BS EN 13284-1	UKAS / MCERTS	✔	Normal
	Particulates $	20	1.82	mg/m^3	8	& Wet Gas	04/11/14	11:15 – 13:15	BS EN 13284-1	UKAS / MCERTS	✔	
	TVOC as Carbon	150	109.4	mg/m^3	2	& Wet Gas	04/11/14	08:20 – 16:19	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: B04/94** 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	04/11/14	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/032A**.

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 Quartz 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 : B04/94
Variation No : PPC10/08
Report Ref : P2208 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2014
Survey Dates : 4th November 2014
Report Issue Date. : 24th November 2014

PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

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

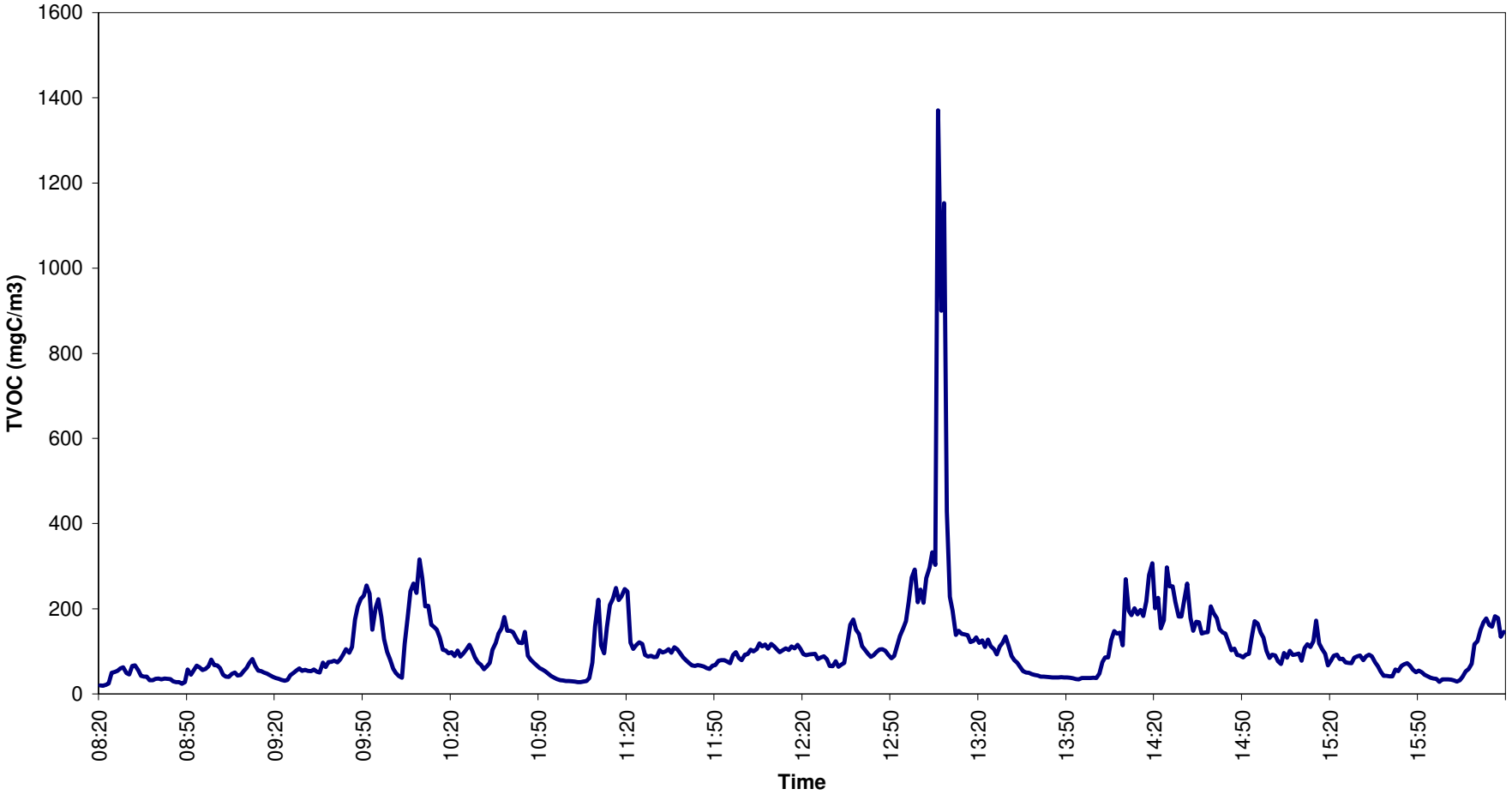
Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001								
MST Nozzle set									
MST "S" Type Pitot									
MST Probe									
MST Hot Box									
MST Impinger Arm									
Barometer		351							
Site Balance									
Site Check weights									
Horiba	E002								
Heated Probe / Filter									
Chiller									
Sonimix									
Heated Line									
FID	E003	516							
Heated Line		354	355						
Heated Probe / Filter		919							
Testo	E004								
FTIR	E005								
Heated Probe / Filter									
Heated Line									
Stackmite	E006	367							
"L" Type Pitot		489							
Digital Manometer		421							
Stack Thermocouple		464							
Thermocouple Reader		370							
Nozzle Set		802							
Workhorse Pumps	E007								
Low Flow Pumps									

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

FIGURES

Figure 1

TVOC Continuous Data Recorded From - Linx Printing - Main Vent, Manufacturing.
On 04/11/14, Between 08:20 & 16:19.
Data Presented at 273K, 101.3kPa & Wet Gas.



TABLES

Linx Printing Technologies Ltd			Installation Name	: Manufacturing Main Vent
Permit No	: B04/94		Visit Details	: Annual Compliance – 2014
Variation No	: PPC10/08		Survey Dates	: 4th November 2014
Report Ref	: P2208	: R001	Report Issue Date.	: 24th November 2014

Table 1

TVOC Data Recorded from Manufacturing - Main Vent

Sample Period: 08:20 – 16:19 on the 4th November 2014

Volumetric Flowrate (Reference Conditions) = 0.87 **m^3/sec ***

	Average	Emission Rate
	mg/m^3	**Kg/hr**
TVOCs (as carbon)*	**109.4**	**0.343**

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

Linx Printing Technologies Ltd
Permit No : B04/94
Variation No : PPC10/08
Report Ref : P2208 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2014
Survey Dates : 4th November 2014
Report Issue Date. : 24th November 2014

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	%	0.09	...
Oxygen Content	%	20.90	...
Stack Temperature	°C	20	...
Gas Velocity (at Stack Conditions)	m/sec	4.90	...
Gas Velocity (Reference Conditions)	m/sec*	4.44	...
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.96	...
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.87	...
Sample Date	...	04/11/2014	...
Sample Period	...	09:10 - 11:10	...
Sample Volume (at Stack)	m^3	2.41	...
Sample Volume (reference Conditions)	m^{3*}	2.18	2.18
Isokinetic Sampling Rate	%	100.7	...
Sample Reference (ECL ID)	ECL/14/	5150 & 5151	5154 & 5155
Mass of Particulate Matter Collected	mg	1.48	0.35
Concentration of Particulate Matter	mg/m^{3*}	**0.68**	0.16
Emission Rate of Particulate Matter	g/hr	2.13	...
Expanded Uncertainty (% Relative)	%	21	...
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 : B04/94
Variation No : PPC10/08
Report Ref : P2208 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2014
Survey Dates : 4th November 2014
Report Issue Date. : 24th November 2014

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	%	0.09	...
Oxygen Content	%	20.90	...
Stack Temperature	°C	20	...
Gas Velocity (at Stack Conditions)	m/sec	4.90	...
Gas Velocity (Reference Conditions)	m/sec*	4.44	...
Volumetric Flowrate (Stack Conditions)	m^3/sec	0.96	...
Volumetric Flowrate (Reference Conditions)	m^3/sec*	0.87	...
Sample Date	...	04/11/2014	...
Sample Period	...	11:15 - 13:15	...
Sample Volume (at Stack)	m^3	2.31	...
Sample Volume (reference Conditions)	m^{3*}	2.09	2.09
Isokinetic Sampling Rate	%	96.4	...
Sample Reference (ECL ID)	ECL/14/	5152 & 5153	5154 & 5155
Mass of Particulate Matter Collected	mg	3.80	0.35
Concentration of Particulate Matter	mg/m^{3*}	**1.82**	0.17
Emission Rate of Particulate Matter	g/hr	5.71	...
Expanded Uncertainty (% Relative)	%	8	...
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	**: B04/94**	**Visit Details**	**: Annual Compliance – 2014**
Variation No	**: PPC10/08**	**Survey Dates**	**: 4th November 2014**
Report Ref	**: P2208 : R001**	**Report Issue Date.**	**: 24th November 2014**

Environmental Compliance Limited	Traverse Data Profoma	Date of Measurement	04/11/2014

Company	Linx Printing	Stack Diameter (mm)	500	Pitot tube coefficient	1.00
Site	St Ives	Port Length (mm)		Pitot ID	489
Location	Production	Duct Length (mm) A		Stack Thermocouple ID	464
Stack	Main Vent	Duct width (mm) B		Stack Thermocouple Reader ID	370
Job No	P2208	Barometric Pressure. (mb)	984	Manometer ID	421
Operators	AB	Static Pressure. (mm $H_2$0) (= Pa/9.81)	0.3	Barometer ID	351

	Distance to Point (mm)	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test ° From Reference	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test ° From Reference
	55	A1	20.0	6.0	11	B1	20.0	21.0	5
	250	A2	20.0	14.0	5	-	-	-	-
	445	A2	20.0	20.0	5	B3	20.0	8.0	10
Total			60				40		
Max			20	20.0			20	21.0	
Min			20	6.0			20	8.0	
Average			20.0	13.3			20.00	14.50	

Average temp (K)	293

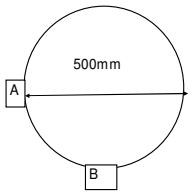
Suitability of Sampling Position	Actual Stack Conditons
Permitted highest:lowest flow pressure ratio =9:1	3.5:1
Average deviation of flow from axis <15°	OK
X-sectional area for stacks= πr^2	0.20 m^2
X-sectional area for ducts = L x B	0.000 m^2
Suitabilty of Position for Sampling	OK

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)	4.74	m/sec
Gas Velocity (Reference Conditions)	4.29	m/sec*
Volumetric Flowrate (as Measured)	0.9300	m^3/sec
Volumetric Flowrate (Reference Conditions)	0.8418	m^3/sec*

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

Diagram/ Description of Cross Section of Stack/Duct



Deviations from procedure/ non - conformities

Sample takes place from single point as difficult to secure probe.

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	5m
Nearest upstream disturbance	Bend	2m
Disturbances are classed as bends, fans or diameter variations		

FIELD CALIBRATION AND SAMPLING DATA

Linx Printing Technologies Ltd
Permit No : B04/94
Variation No : PPC10/08
Report Ref : P2208 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2014
Survey Dates : 4th November 2014
Report Issue Date. : 24th November 2014

TVOC - FIELD DATA SHEET

Client	Linx Printing
Site	St Ives
Date	04/11/2014
Location	Production
Stack ID	Main Vent
Stack Temp ℃	20
Ambient Temp (sampling)	1=7 2=6 3=8
Ambient Temp (sampling)	4=9 5=10 6=9
Job No	P2208
Operators	AB

Barometric Pressure mb	984	
Barometer ID	ECL/ID/ 351	
Analyser ID	ECL/ID/ 516	
Sonimix/ MFC ID	ECL/ID/ n/a	
Heated Line/ Controller ID	ECL/ID/ 354 & 355	
Heated Line Set Temp ℃	180	YES
Heated Line Length	10	m
Heated Probe Filter ID	ECL/ID/ 919	
Heated Filter Set Temp ℃	180	YES
Logger ID	924	

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)
Zero Gas (Synthetic Air)	Gas/ 1399	...	...
Hydrogen / Helium	Gas/ 1336	...	...
Propane (In Air)	Gas/ 1312	944.5 ppm	9.4

	Analyser Range	Span Gas value used
Propane	1000 ppm	944.5 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	07:27	07:31	07:32	07:37	07:38	07:43

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-Cal Ambient Temp ℃		PRE System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
7	6	Start Time	End Time	Start Time	End Time
ZERO / SPAN		07:44	07:49	07:51	07:56

Response Time SYSTEM Span Gas Cal		
Start Time	90% Time	less than 200s (Y/N)
07:50:00	07:50:30	Y

	Start Time	End Time	Location	Production Details
Sample Period	08:20	16:20	Main Vent	Normal
Sample Period				
Sample Period				
Sample Period				
Sample Period				
Sample Period				

Post-Cal Ambient Temp ℃		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
9	8	Start Time	End Time	Start Time	End Time
ZERO / SPAN		16:28	16:33	16:34	16:39

Process Details / Comments

Linx Printing Technologies Ltd
Permit No : B04/94
Variation No : PPC10/08
Report Ref : P2208 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2014
Survey Dates : 4th November 2014
Report Issue Date. : 24th November 2014

Calibration Summary		TVOC ppm
Analyser Range		1000
Repeatability at Zero		2
Span Gas Concentration Applied		944.5
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	944.5
	Zero	0.48
Difference (Zero)		0.4801
<2×Repeatability @ Zero?		YES
Pre Test (System)	Zero	0.20
	Span	945.2
Difference (Zero)		0.2021
<2% Relative to Direct Span		YES
Difference (Span)		0.6570
<2% Relative to Direct Span		YES
Post Test (System)	Zero	1.15
	Span	944.2
Difference (Zero)		0.9450
Zero Drift <2% of Applied Span?		YES
Difference (Span)		0.9602
Span Drift <2% of Applied Span?		YES
Zero and Span Drift <5% of Applied Span?		YES

Environmental Compliance Limited

Linx Printing Technologies Ltd		Installation Name	: Manufacturing Main Vent
Permit No	: B04/94	Visit Details	: Annual Compliance – 2014
Variation No	: PPC10/08	Survey Dates	: 4th November 2014
Report Ref	: P2208 : R001	Report Issue Date.	: 24th November 2014

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	04/11/2014

ECL/TPD/	27a	Time taken to change Ports?	Start Time	09:10	End Time	11:10	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	421	Stack Temp Reader ID	370	SOL/	n/a
Location	Production	Barometric Pressure (mb)	984	Barometer ID	351	Meter Thermocouple ID	367	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H^20) (Pa/9.81)	0.3	DGM Yd	0.9814	Meter Temp Reader ID	367	End Weight (g)	1.50
Test No.	TPM 1	Pitot coefficient	1	Nozzle ID	802	Dry Gas Meter ID	367	Total weight (g)	1.50
Job No	P2208	Balance ID	n/a	Nozzle Size (mm)	9.29	Timer ID	367		
ECL Site Staff	AB	Console ID	367	Filter ID	40	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	1651651.0				
Final Volume	1654120.0				
Total Volume	2469.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	2163.74
	Actual Sample Volume	2179.41
2469.0	Isokinetic Percentage	100.72

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	25			25
Time Of Leak Check	09:00			11:12
Leak % of set rate	0.4			0.4

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.09
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	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)	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.0
Velocity at Stack (m/s)	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	18.2	18.3	18.4	18.5	18.6	19.0	19.1	19.2	18.7
Meter (Tm)	3.00	4.00	5.00	7.00	9.00	14.00	16.00	18.00	9.5
Stack Temp (Ts)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.0

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)	14.00	14.00	14.00	14.00	14.00	14	14	14	14.0
Velocity at Stack (m/s)	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	19.3	19.4	19.6	19.6	19.7	19.8	19.9	20.0	19.7
Meter (Tm)	19.00	21.00	23.00	24.00	25.00	27	29	30	24.8
Stack Temp (Ts)	20.00	20.00	20.00	20.00	20.00	20	20	20	20.0

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)	14	14	14	14	14	14	14	14	14.0
Velocity at Stack (m/s)	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	19.9	20.0	20.0	20.1	20.1	20.1	20.2	20.3	20.1
Meter (Tm)	29	30	30	31	32	32	33	34	31.4
Stack Temp (Ts)	20	20	20	20	20	20	20	20	20.0

Acetone SOL/	2582
DI Rinse SOL/	2601

Original Flowrate Settings	
Tm	30
Ts	20
% moisture	0.1

Environmental Compliance Limited

Linx Printing Technologies Ltd		Installation Name	: Manufacturing Main Vent
Permit No	: B04/94	Visit Details	: Annual Compliance – 2014
Variation No	: PPC10/08	Survey Dates	: 4th November 2014
Report Ref	: P2208 : R001	Report Issue Date.	: 24th November 2014

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	04/11/2014

ECL/TPD/	27a	Time taken to change Ports?	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	421	Stack Temp Reader ID	370	SOL/	n/a
Location	Production	Barometric Pressure (mb)	984	Barometer ID	351	Meter Thermocouple ID	367	Start Weight (g)	0.00
Stack ID	Main Vent	Stat Pres. (mm H^20) (Pa/9.81)	0.3	DGM Yd	0.9814	Meter Temp Reader ID	367	End Weight (g)	1.50
Test No.	TPM 2	Pitot coefficient	1	Nozzle ID	802	Dry Gas Meter ID	367	Total weight (g)	1.50
Job No	P2208	Balance ID	n/a	Nozzle Size (mm)	9.29	Timer ID	367		
ECL Site Staff	AB	Console ID	367	Filter ID	41	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	1654135.0				
Final Volume	1656607.0				
Total Volume	2472.0	0.0	0.0	0.0	0.0

Total	Volume (litres) @ STP Dry	
	Expected Sample Volume	2163.68
	Actual Sample Volume	2085.13
2472.0	Isokinetic Percentage	96.37

Leak Check	First	Second	Third	Final
Leak Rate l/min	0.1			0.1
Set Rate (l/min)	25			25
Time Of Leak Check	11:14			13:16
Leak % of set rate	0.4			0.4

Maximum allowed leak rate is 2% of the set rate

Measured O_2	20.90	Moisture	0.09
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	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)	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.0
Velocity at Stack (m/s)	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	20.1	20.2	20.2	20.3	20.3	20.3	20.3	20.3	20.3
Meter (Tm)	32.00	33.00	33.00	34.00	34.00	34.00	35.00	35.00	33.8
Stack Temp (Ts)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.0

Acetone SOL/	2582
DI Rinse SOL/	2601

Original Flowrate Settings	
Tm	30
Ts	20
% 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)	14.00	14.00	14.00	14.00	14.00	14	14	14	14.0
Velocity at Stack (m/s)	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	20.3	20.3	20.3	20.3	20.3	20.4	20.4	20.4	20.4
Meter (Tm)	35.00	35.00	35.00	35.00	35.00	36	36	36	35.4
Stack Temp (Ts)	20.00	20.00	20.00	20.00	20.00	20	20	20	20.0

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)	14	14	14	14	14	14	14	14	14.0
Velocity at Stack (m/s)	4.90	4.90	4.90	4.90	4.90	4.90	4.90	4.90	
Sample Rate (l/min) 101.3 mbar, Tm, Dry Gas	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Meter (Tm)	37	37	37	38	38	38	38	38	37.6
Stack Temp (Ts)	20	20	20	20	20	20	20	20	20.0

LABORATORY ANALYSIS RESULTS

a CONCEPT LIFE SCIENCES company

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Report Number: 435062-1

Date of Report: 18-Nov-2014

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

Customer Contact: Mr Andrew Barnes

Customer Job Reference: P2208
Customer Purchase Order: E3370
Date Job Received at SAL: 10-Nov-2014
Date Analysis Started: 10-Nov-2014
Date Analysis Completed: 18-Nov-2014

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: 2014.11.24 09:46:51 GMT
Reason: Issued
Location: SAL

SAL Reference: 435062
Customer Reference: P2208

Filter Quartz 37mm Analysed as Filter Quartz 37mm
Miscellaneous

				SAL Reference	435062 001	435062 003	435062 005	435062 007
				Customer Sample Reference	ECL/14/5150	ECL/14/5152	ECL/14/5154	ECL/14/5156
				Test Sample	AR	AR	AR	AR
				Date Sampled	04-NOV-2014	04-NOV-2014	04-NOV-2014	04-NOV-2014
Determinand	**Method**	**LOD**	**Units**	**Symbol**				
Particulates (Total)	Grav (5 Dec)	0.05	mg	U	**0.38**	3.5	<0.05	<0.05

SAL Reference: 435062
Customer Reference: P2208

Wash(Acetone) Analysed as Wash(Acetone)
Miscellaneous

				SAL Reference	435062 002	435062 004	435062 006	435062 008	435062 009
				Customer Sample Reference	ECL/14/5151	ECL/14/5153	ECL/14/5155	ECL/14/5157	ECL/14/5158
				Test Sample	AR	AR	AR	AR	AR
				Date Sampled	04-NOV-2014	04-NOV-2014	04-NOV-2014	04-NOV-2014	04-NOV-2014
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Particulates (Total)	Grav	0.3	mg	U	**1.1**	<0.3	<0.3	<0.3	**0.6**

Index to symbols used in 435062-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

UNCERTAINTY CALCULATIONS

Linx Printing Technologies Ltd
Permit No : B04/94
Variation No : PPC10/08
Report Ref : P2208 : R001

Installation Name : Manufacturing Main Vent
Visit Details : Annual Compliance – 2014
Survey Dates : 4th November 2014
Report Issue Date. : 24th November 2014

TVOC Measurement Uncertainty

Main Vent - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges TVOC 0 - 15 mgC/m^3
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.73
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.35
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	9.93
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	4.38
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.30
Interferents[7]	u_i	Rectangular (Divisor = √3)	4.39
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	26.29

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 certified range
2 Expressed as maximum drift per 24hr period as percentage of the certified range
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m^3 / %Vol taking account of an additional uncertainty of 2% for gas blending
7 Expressed as a percentage of the certified range

Main Vent - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
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	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	1.49
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.38
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.039
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	15.18
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	15.27
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	30.53
Applied Span Concentration			1517.81
Measured Span Concentration, STP Dry Gas			1517.90
Expanded measurement uncertainty as % of Applied Span			2 %

* Signal 3030 FID

TVOC Uncertainty of Measurement Results

Main Vent - TVOC - Uncertainty of Measurement Results - 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	$\sqrt{3}$	0.73
Span drift[2]	$u_{d,s}$			0.35
Losses / leakage in the sample system[4]	u_{loss}			0.070
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	$\sqrt{3}$	0.064
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.060
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

Main Vent - TVOC - Uncertainty of Measurement Results - 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}	04/11/14 08:20 - 12:19	0.064
Standard Error of Measured Value	u_{SE}	04/11/14 08:20 - 12:19	3.72

Effect on Uncertainty Caused by Oxygen

$$uCorr_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} = 1.00$$

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

$$uf_{o_2} = \frac{uCorr_{O_2}}{f_{o_2}} \times 100 = 0.00 \ \%$$

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 $C_i = \frac{\partial f}{\partial x_i}$

Main Vent - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m³
Measured Concentration	04/11/14 08:20 - 12:19	91.33
Expanded Uncertainty as Percentage of Measured Concentration		8 %

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) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the applied span concentration
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of moisture is taken from the manual extract test calculations.
7 Expressed as a percentage of the certified range
8 Where no uncertainty is presented above, the uncertainty is >100%

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: B04/94**	**Visit Details**	**: Annual Compliance – 2014**
Variation No	**: PPC10/08**	**Survey Dates**	**: 4th November 2014**
Report Ref	**: P2208 : R001**	**Report Issue Date.**	**: 24th November 2014**

Main Vent - TVOC - Uncertainty of Measurement Results - 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	$\sqrt{3}$	0.73
Span drift[2]	$u_{d,s}$			0.35
Losses / leakage in the sample system[4]	u_{loss}			0.070
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 $\left|(x_{i,max} - x_{i,adj})\right| = \left|(x_{i,min} - x_{i,adj})\right|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

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	$\sqrt{3}$	0.064
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.060
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

Main Vent - TVOC - Uncertainty of Measurement Results - 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}	04/11/14 12:20 - 16:19	0.089
Standard Error of Measured Value	u_{SE}	04/11/14 12:20 - 16:19	8.69

Effect on Uncertainty Caused by Oxygen

$$uCorr_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} = 1.00$$

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

$$uf_{o_2} = \frac{uCorr_{O_2}}{f_{o_2}} \times 100 = 0.00 \ \%$$

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 $C_i = \frac{\partial f}{\partial x_i}$

Main Vent - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m^3
Measured Concentration	04/11/14 12:20 - 16:19	127.44
Expanded Uncertainty as Percentage of Measured Concentration		14 %

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) $U_{95\%} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the applied span concentration
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of moisture is taken from the manual extract test calculations.
7 Expressed as a percentage of the certified range
8 Where no uncertainty is presented above, the uncertainty is >100%

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
Permit No	**: B04/94**	**Visit Details**	**: Annual Compliance – 2014**
Variation No	**: PPC10/08**	**Survey Dates**	**: 4th November 2014**
Report Ref	**: P2208 : R001**	**Report Issue Date.**	**: 24th November 2014**

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	0.38	1.10	1.48	0.14	0.27	0.0700	0.14	0.15

	TPM 1		Standard Uncertainty @ 95%		
Sampled Volume (V_m)	2.47	m^3	uV_m	0.001	m^3
Meter Correction Factor (Yd)	0.98	...		...	...
Meter Temperature (T_m)	295.03	k	uT_m	1.5	k
Static Pressure of Stack P_{static}	0.30	mmH_2O	uP_{static}	0.25	mmH_2O
Absolute Stack Pressure ρ_s	738.06	mmHg	$u\rho_s$	0.8	mmHg
Barometric Pressure ρ_b	738.24	mmHg	$u\rho_b$	3.8	mmHg
Average Differential Pressure (ΔP) + ρs	98.59	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)	0.0853	% 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 uncertainty component (uT_m)

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.892$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.46	0.46	0.0000457	0.0000114
up_b	0.47	0.46	0.000621	0.00233
uT_m	0.46	0.46	0.000815	0.00122
H_2O	0.46	0.46	0.00463	0.000324

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00238$$

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

$$V_{std} = V_{measured} \times f_s = \quad 2.2013$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	2.21	2.20	2.47	0.00587
Effect of uV_m	2.20	2.20	0.89	0.000892

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0145$$

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)

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

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

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

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

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = \quad 0.67$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	0.74	0.60	0.45	0.0691
uV_{stp}	0.68	0.67	0.31	0.00443

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
0.07	**0.14**	**0.67**	**20.6%**

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	**20.6**	**0.0**	**20.6**

Linx Printing Technologies Ltd		**Installation Name**	**: Manufacturing Main Vent**
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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 2					
Particulates	3.50	0.30	3.80	0.14	0.27	0.0700	0.14	0.15

	TPM 2			Standard Uncertainty @ 95%	
Sampled Volume (V_m)	2.47	**m^3**	**uV_m**	0.001	**m^3**
Meter Correction Factor (Yd)	0.98	**...**		...	**...**
Meter Temperature (T_m)	308.73	**k**	**uT_m**	1.5	**k**
Static Pressure of Stack P_{static}	0.30	**mmH_2O**	**uP_{static}**	0.25	**mmH_2O**
Absolute Stack Pressure ρ_s	738.06	**mmHg**	**$u\rho_s$**	0.8	**mmHg**
Barometric Pressure ρ_b	738.24	**mmHg**	**$u\rho_b$**	3.8	**mmHg**
Average Differential Pressure (ΔP) + ρs	98.59	**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)	0.0891	**% 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 uncertainty component (uT_m)

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.852$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.45	0.45	0.0000446	0.0000111
up_b	0.45	0.45	0.000607	0.00227
uT_m	0.45	0.45	0.000777	0.00117
H_2O	0.45	0.45	0.00453	0.000330

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00219$$

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

$$V_{std} = V_{measured} \times f_s = \quad 2.1062$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	2.11	2.10	2.47	0.00543
Effect of uV_m	2.11	2.11	0.85	0.000852

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0134$$

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)

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

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

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

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

$$Conc = \frac{M_{Recovered}}{V_m \times f_s \times f_{O_2}} = \quad 1.80$$

	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	u mg/Nm³
uM	1.88	1.73	0.47	0.0722
uV_{stp}	1.82	1.79	0.86	0.0115

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
0.07	**0.15**	**1.80**	**8.1%**

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 ($U_{combined}$) %
Particulates	**8.1**	**0.0**	**8.1**