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**Stack Emissions Testing Report Commissioned by**  
Liberty Pressing Solutions Ltd

**Installation Name & Address**  
Liberty Pressing Solutions Ltd  
Burnsall Road  
Canley  
Coventry  
West Midlands  
CV5 6RT

PPC Permit: PPC/193

**Stack Reference**  
Burn Off Oven Exhaust

**Dates of the Monitoring Campaign**  
12th March 2018

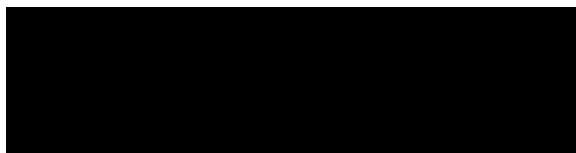
**Job Reference Number**  
CAT-4068

<b>Report Written by</b>
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<b>Report Date</b>
26th March 2018

<b>Version</b>
Version 1

<b>Signature of Report Approver</b>






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## Executive Summary

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### MONITORING OBJECTIVES

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust  
12th March 2018

#### Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Liberty Pressing Solutions Ltd to carry out stack emissions testing on the Burn Off Oven Exhaust at Coventry.

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values (ELVs) as specified in the Site's Permit.

#### Special Requirements

There were no special requirements.

#### Target Parameters

Total Particulate Matter, Total VOCs (as Carbon), Oxides of Nitrogen (as NO<sub>2</sub>), Carbon Monoxide

## Executive Summary

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### MONITORING RESULTS

Liberty Pressing Solutions Ltd, Coventry

Burn Off Oven Exhaust

12th March 2018

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter <sup>1</sup>	mg/m <sup>3</sup>	0.98	0.12	20	g/hr	0.57	0.08	-
Total VOCs (as Carbon)	mg/m <sup>3</sup>	13.3	0.95	20	g/hr	7.71	0.81	-
Oxides of Nitrogen (as NO <sub>2</sub> )	mg/m <sup>3</sup>	90.3	5.86	200	g/hr	52.3	5.24	-
Carbon Monoxide	mg/m <sup>3</sup>	156	9.11	200	g/hr	90.3	8.68	-
Carbon Dioxide	% v/v Dry	4.89	0.19					
Oxygen	% v/v Dry	12.2	0.61					
Water Vapour	% v/v	8.03	0.41					
Stack Gas Temperature	°C	752						
Stack Gas Velocity	m/s	5.31	0.33					
Volumetric Flow Rate (ACTUAL)	m <sup>3</sup> /hr	2400	183					
Volumetric Flow Rate (REF)	m <sup>3</sup> /hr	708	54.1					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM THE PRELIMINARY VELOCITY TRAVERSE.

<sup>1</sup> Reference Conditions (REF) are: 273K, 101.3kPa, dry gas, 11% oxygen.

## Executive Summary

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### MONITORING DATE(S) & TIMES

Liberty Pressing Solutions Ltd, Coventry  
 Burn Off Oven Exhaust  
 12th March 2018

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1 mg/m <sup>3</sup>	0.98	g/hr	0.57	12/03/2018	11:30 - 15:42	252
Total VOCs (as Carbon)	R1 mg/m <sup>3</sup>	13.3	g/hr	7.71	12/03/2018	11:30 - 15:42	252
Oxides of Nitrogen (as NO <sub>2</sub> )	R1 mg/m <sup>3</sup>	90.3	g/hr	52.3	12/03/2018	11:30 - 15:42	252
Carbon Monoxide	R1 mg/m <sup>3</sup>	156	g/hr	90.3	12/03/2018	11:30 - 15:42	252
Carbon Dioxide	R1 % v/v	4.89			12/03/2018	11:30 - 15:42	252
Oxygen	R1 % v/v	12.2			12/03/2018	11:30 - 15:42	252
Velocity Traverse	R1				12/03/2018	11:24 - 11:29	

All results are expressed at the respective reference conditions.

## Executive Summary

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### PROCESS DETAILS

Liberty Pressing Solutions Ltd, Coventry

Burn Off Oven Exhaust

12th March 2018

#### Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Standard Operating Capacity
Continuous or Batch Process	Batch
Feedstock (if applicable)	JLR Bars
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Natural Gas
Plume Appearance	Not Visible

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### MONITORING & ANALYTICAL METHODS

Liberty Pressing Solutions Ltd, Coventry

Burn Off Oven Exhaust

12th March 2018

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.05 mg/m <sup>3</sup>
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Total VOCs (as Carbon)	EN 12619:2013	CAT-TP-20	Yes	CAT	Flame Ionisation Detection by Sick 3006 FID				Yes	0.32 mg/m <sup>3</sup>
Oxides of Nitrogen (as NO <sub>2</sub> )	EN 14792	CAT-TP-39	Yes	CAT	Chemiluminescence by Horiba PG-350E				Yes	0.41 mg/m <sup>3</sup>
Carbon Monoxide	EN 15058	CAT-TP-39	Yes	CAT	NDIR by Horiba PG-350E				Yes	0.31 mg/m <sup>3</sup>
Carbon Dioxide	ISO 12039	CAT-TP-39	Yes	CAT	NDIR by Horiba PG-350E				Yes	0.10 % v/v
Oxygen	EN 14789	CAT-TP-39	Yes	CAT	Dry Paramagnetic Cell by Horiba PG-350E				Yes	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

### ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)

ISO 17025 Accreditation Number: 4279

### SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	1	One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to the minimum required by the Standard

## Executive Summary

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### SUITABILITY OF SAMPLING LOCATION

#### Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.40
Width	m	-
Area	m <sup>2</sup>	0.13
Port Depth	cm	0
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	3" Hole

#### Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	On Roof
Inside / Outside	Outside

#### Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

#### Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

#### EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

#### Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1					Required	Compliant
Lowest Differential Pressure	Pa	8.0					> 5 Pa	Yes
Mean Velocity	m/s	5.31					-	-
Lowest Gas Velocity	m/s	4.94					-	-
Highest Gas Velocity	m/s	5.81					-	-
Ratio of Above	: 1	1.18					< 3 : 1	Yes
Maximum Angle of Swirl	°	1					< 15°	Yes
No Local Negative Flow	-	Yes					-	Yes



# Executive Summary

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## PLANT PHOTOS

Photo 1



Photo 2



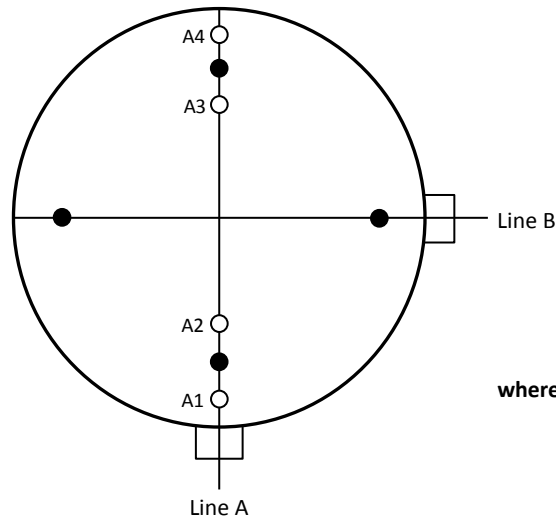
Photo 3



Photo 4



## SAMPLE POINTS



where

- = isokinetic point sampled at
- = isokinetic point not sampled at
- = combustion gases sample point
- = non-isokinetic sample point



## APPENDICES

### APPENDIX CONTENTS

APPENDIX 1 - Stack Emissions Monitoring Personnel, List of Equipment & Methods and Technical Procedures Used

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

### STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Harpreet Badwal	MCERTS Level 2	MM 03 149	TE1 TE2 TE3 TE4
Trainee	Lee Heaton	MCERTS Trainee	MM 17 1433	None

### LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.57	Horiba PG-350E	CAT 39.10	Digital Manometer (1)	CAT 3.142
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	CAT 3.144
Box Thermocouples (1)	CAT 3.146	Servomex 4900	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.84
Umbilical (1)	CAT 3.146	ABB AO2020-URAS26	-	Barometer	CAT 13.40
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.1153
Oven Box (1)	CAT 12.109	Ankersmid APS 313	CAT 4.847	Stack Thermocouple (2)	-
Oven Box (2)	-	Gasmet DX4000	-	Stack Thermocouple (3)	-
Heated Probe (1)	-	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	-	Bernath 3006 FID	CAT 8.31	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	CAT 12.107	1m Heated Line (3)	-
S-Pitot (1)	CAT 21S.57	Mass Flow Controller (1)	CAT 6.61	5m Heated Line (1)	-
S-Pitot (2)	CAT 21P.67	Mass Flow Controller (2)	CAT 6.62	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	-	20m Heated Line (1)	CAT 20.116
Site Balance	CAT 17.33	Mass View (2)	-	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.33 a & b	Hioki 5043 (V)	CAT 11.69	Dual Channel Heater Controller	-
Last Impinger Arm	-	Easylogger EN-EL-12 Bit	-	Single Channel Heater Controller	CAT 20.116
Callipers	CAT 23.40	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.45

### METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Water Vapour	EN 14790	CAT-TP-05
Total VOCs (as Carbon)	EN 12619:2013	CAT-TP-20
Oxides of Nitrogen (as NO <sub>2</sub> )	EN 14792	CAT-TP-39
Carbon Monoxide	EN 15058	CAT-TP-39
Carbon Dioxide	ISO 12039	CAT-TP-39
Oxygen	EN 14789	CAT-TP-39
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

**PRELIMINARY STACK SURVEY: CALCULATIONS**

**General Stack Details**

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.40
Stack Width, W	m	-
Stack Area, A	m <sup>2</sup>	0.13
Average Stack Gas Temperature, T <sub>a</sub>	°C	450
Average Stack Gas Pressure	Pa	9.28
Average Stack Static Pressure, P <sub>static</sub>	kPa	0.02
Average Barometric Pressure, P <sub>b</sub>	kPa	97.4
Average Pitot Tube Calibration Coefficient, C <sub>p</sub>	-	0.84

**Stack Gas Composition & Molecular Weights**

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m <sup>3</sup> ρ	Conc kg/m <sup>3</sup> P <sub>i</sub>
CO <sub>2</sub>	-	4.89	4.50	0.0489	44.01	1.9635	0.0960
O <sub>2</sub>	-	12.17	11.19	0.1217	32.00	1.4277	0.1737
N <sub>2</sub>	-	82.94	76.28	0.8294	28.01	1.2498	1.0366
Moisture (H <sub>2</sub> O)	-	-	8.03	0.0803	18.02	0.8037	0.0646

Where:  $\rho = M / 22.41$   
 $P_i = r \times \rho$

**Calculation of Stack Gas Densities**

Determinand	Units	Result
Dry Density (STP), P <sub>STD</sub>	kg/m <sup>3</sup>	1.3064
Wet Density (STP), P <sub>STW</sub>	kg/m <sup>3</sup>	1.2660
Dry Density (Actual), P <sub>Actual</sub>	kg/m <sup>3</sup>	0.4747
Average Wet Density (Actual), P <sub>ActualW</sub>	kg/m <sup>3</sup>	0.4600

Where: P<sub>STD</sub> = sum of component concentrations, kg/m<sup>3</sup> (not including water vapour)  
P<sub>STW</sub> = sum of all wet concentrations / 100 x density, kg/m<sup>3</sup> (including water vapour)  
 $P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$   
 $P_{ActualW} \text{ (at each sampling point)} = P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

**Calculation of Stack Gas Volumetric Flowrate, Q**

Duct gas flow conditions	Units	Actual	REF <sup>1</sup>
Temperature	°C	450	0.00
Total Pressure	kPa	97.4	101.3
Moisture	%	8.03	0.00
Oxygen (Dry)	%	12.2	11.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m <sup>3</sup> /hr	2400
Gas Volumetric Flowrate (STP, Wet)	m <sup>3</sup> /hr	872
Gas Volumetric Flowrate (STP, Dry)	m <sup>3</sup> /hr	802
Gas Volumetric Flowrate REF <sup>1</sup>	m <sup>3</sup> /hr	708

**PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)**

(1 of 1)

Parameter	Units	Value
Date of Survey	-	12/03/2018
Time of Survey	-	11:24 - 11:29
Atmospheric Pressure	kPa	97.4
Average Stack Static Pressure	Pa	17
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C <sub>p</sub>	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	1

Traverse Point	Depth m	Sampling Line A					Sampling Line B				
		ΔP Pa	Temp °C	Wet Density kg/m <sup>3</sup>	Velocity m/s	Swirl °	ΔP Pa	Temp °C	Wet Density kg/m <sup>3</sup>	Velocity m/s	Swirl °
<i>STATIC (Units: Pa)</i>		17.2									
<b>Mean</b>		<b>9.3</b>	<b>449.5</b>	<b>0.460</b>	<b>5.31</b>						
1	0.03	11.1	448.0	0.461	5.81	0.0					
2	0.10	9.7	449.0	0.460	5.44	1.0					
3	0.30	8.3	450.0	0.460	5.03	1.0					
4	0.37	8.0	451.0	0.459	4.94	0.0					

**PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY**

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	$u(k)$	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	$u(\Delta p_i)$	1.047	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.009	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	0.002	
- Overall corrections to dynamic measurements	$u(C_f)$	0.095	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00005	-
- $\phi_{O_2,w}$	-	11.192	
- $\phi_{CO_2,w}$	-	4.496	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.373	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.150	
- Water Vapour	$u(\phi_{H_2O})$	0.410	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.346	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.139	
Standard uncertainty associated with the stack temperature	$u(T_c)$	3.686	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.695	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.047	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00249	-
Standard uncertainty associated with the local velocities	$u(v_i)$	0.310	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	0.166	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.326	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	6.14	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	183.2	m <sup>3</sup> /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00152	
- $u^2(qV,w)$	-	8736	
- $u(qV,w)$	-	93.5	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	7.63	%

**TOTAL PARTICULATE MATTER: RESULTS SUMMARY**

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust

**Sample Runs**

Parameter	Units	Run 1	Mean
Concentration	mg/m <sup>3</sup>	0.98	0.98
Uncertainty	±mg/m <sup>3</sup>	0.12	0.12
Mass Emission	g/hr	0.57	0.57
Uncertainty	±g/hr	0.08	0.08

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	8.03	8.03
Uncertainty	±% v/v	0.41	0.41

**Blank Runs**

Parameter	Units	Blank 1	Maximum
Concentration	mg/m <sup>3</sup>	0.05	0.05

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

**General Sampling Information**

Parameter	Value
Standard	EN 13284-1
Technical Procedure	CAT-TP-01
Probe Material	Borosilicate Glass
Filter Housing Material	Borosilicate Glass
Positioning of Filter	Out Stack
Filter Size and Material	47mm Quartz Fibre
Number of Sampling Lines Used	1 / 2
Number of Sampling Points Used	4 / 4
Sample Point I.D.'s	A1, A2, A3 & A4

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

**Reference Conditions**

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

**TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS**

Test	Units	Run 1				
<b>Absolute pressure of stack gas, P<sub>s</sub></b>						
Barometric pressure, P <sub>b</sub>	mmHg	730.5				
Stack static pressure, P <sub>static</sub>	mmH <sub>2</sub> O	1.8				
$P_s = (P_b + (P_{static} / 13.6))$	mmHg	730.6				
<b>Volume of water vapour collected, V<sub>wstd</sub></b>						
Total mass collected in impingers (liquid trap)	g	220.9				
Total mass collected in impingers (silica trap)	g	22.2				
Total mass of liquid collected, V <sub>lc</sub>	g	243.1				
$V_{wstd} = (0.001246)(V_{lc})$	m <sup>3</sup>	0.3029				
<b>Volume of gas metered dry, V<sub>mstd</sub></b>						
Volume of gas sample through gas meter, V <sub>m</sub>	m <sup>3</sup>	3.8450				
Gas meter correction factor, Y <sub>d</sub>	-	0.9940				
Average dry gas meter temperature, T <sub>m</sub>	°C	16.9				
Average pressure drop across orifice, ΔH	mmH <sub>2</sub> O	23.2				
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m <sup>3</sup>	3.4680				
<b>Moisture content, B<sub>w0</sub> &amp; R<sub>wv</sub></b>						
$B_{w0} = V_{wstd} / (V_{mstd} + V_{wstd})$	m <sup>3</sup>	0.0803				
B <sub>w0</sub> as a percentage	% v/v	8.03				
Reported Water Vapour, checked with Tables in EN 14790, R <sub>wv</sub>	% v/v	8.03				
<b>Volume of gas metered wet, V<sub>mstw</sub></b>						
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m <sup>3</sup>	3.7709				
<b>Volume of gas metered at Oxygen Reference Conditions, V<sub>mstd@X%O<sub>2</sub></sub> &amp; V<sub>mstw@X%O<sub>2</sub></sub></b>						
IED & Incinerates Hazardous Material? (Yes = no positive O <sub>2</sub> correction)	-	No				
% wet oxygen measured in gas stream, ACT%O <sub>2w</sub>	% v/v	11.19				
% dry oxygen measured in gas stream, ACT%O <sub>2d</sub>	% v/v	12.17				
% oxygen reference condition, REF%O <sub>2</sub>	% v/v	11.00				
O <sub>2</sub> Reference Factor wet (O <sub>2REFw</sub> ) = (21 - REF%O <sub>2</sub> ) / (21 - ACT%O <sub>2w</sub> )	-	1.02				
O <sub>2</sub> Reference Factor dry (O <sub>2REFd</sub> ) = (21 - REF%O <sub>2</sub> ) / (21 - ACT%O <sub>2d</sub> )	-	1.13				
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m <sup>3</sup>	3.6984				
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m <sup>3</sup>	3.0623				
<b>Molecular weight of dry gas stream, M<sub>d</sub></b>						
CO <sub>2</sub>	% v/v	5.10				
O <sub>2</sub>	% v/v	12.17				
Total	% v/v	17.27				
N <sub>2</sub>	% v/v	82.73				
$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$	g/gmol	29.30				
<b>Molecular weight of stack gas (wet), M<sub>s</sub></b>						
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.39				
<b>Velocity of stack gas, V<sub>s</sub></b>						
Pitot tube velocity constant, K <sub>p</sub>	-	34.97				
Velocity pressure coefficient, C <sub>p</sub>	-	0.84				
Average of velocity heads, ΔP <sub>avg</sub>	mmH <sub>2</sub> O	0.89				
Average square root of velocity heads, √ΔP	√mmH <sub>2</sub> O	0.94				
Average stack gas temperature, T <sub>s</sub>	°C	751.5				
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (V(M_s)(P_s))$	m/s	6.15				
<b>Total flow of stack gas: Actual (Q<sub>a</sub>), Wet (Q<sub>stw</sub>), Dry (Q<sub>std</sub>), Wet@O<sub>2REF</sub> (Q<sub>stwO<sub>2</sub></sub>), Dry@O<sub>2REF</sub> (Q<sub>stdO<sub>2</sub></sub>)</b>						
Area of stack, A <sub>s</sub>	m <sup>2</sup>	0.13				
$Q_a = (60)(A_s)(V_s)$	m <sup>3</sup> /min	46.4				
Conversion factor (K/mm.Hg), C <sub>f</sub>	-	0.3592				
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m <sup>3</sup> /min	11.9				
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m <sup>3</sup> /min	10.9				
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m <sup>3</sup> /min	11.7				
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m <sup>3</sup> /min	9.7				
<b>Percent isokinetic, %I</b>						
Nozzle diameter, D <sub>n</sub>	mm	14.00				
Nozzle area, A <sub>n</sub>	mm <sup>2</sup>	153.96				
Total sampling time, q	min	252				
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	102.7				



**TOTAL PARTICULATE MATTER: SAMPLING DETAILS**

**Sample Runs**

Parameter	Units	Run 1				
Sampling Times	-	11:30 - 15:42				
Sampling Dates	-	12/03/2018				
Sampling Device	-	ISO				
Volume Sampled (REF)	m <sup>3</sup>	3.0623				
Filter I.D. Number	-	47-45651				
Start Filter Mass	g	0.15364				
End Filter Mass	g	0.15576				
Total Mass on Filter	g	0.00212				
Probe Rinse I.D. Number	-	PR-47-45651				
Start Probe Rinse Mass	g	3.00057				
End Probe Rinse Mass	g	3.00146				
Total Mass in Probe Rinse	g	0.00089				
Total Mass Collected	mg	3.01				
Calculated Concentration	mg/m <sup>3</sup>	0.98				
Balance Uncertainty / LOD	mg/m <sup>3</sup>	0.05				

**Where:** ISO stands for Manual Isokinetic Sampling Train

**Blank Runs**

Parameter	Units	Blank 1				
Blank Dates	-	12/03/2018				
Average Volume Sampled (REF)	m <sup>3</sup>	3.0623				
Filter I.D. Number	-	47-45652				
Start Filter Mass	g	0.15340				
End Filter Mass	g	0.15345				
Total Mass on Filter	g	0.00005				
Probe Rinse I.D. Number	-	PR-47-45652				
Start Probe Rinse Mass	g	2.82132				
End Probe Rinse Mass	g	2.82137				
Total Mass in Probe Rinse	g	0.00005				
Total Mass Collected	mg	0.10				
Calculated Concentration	mg/m <sup>3</sup>	0.03				
Balance Uncertainty / LOD	mg/m <sup>3</sup>	0.05				

**TOTAL PARTICULATE MATTER: QUALITY ASSURANCE**

(PAGE 1 OF 2)

**Sample Runs**

<b>Leak Test Results</b>	<b>Units</b>	<b>Run 1</b>				
Mean Sampling Rate	l/min	15.2				
Pre-Sampling Leak Rate	l/min	0.05				
Post-Sampling Leak Rate	l/min	0.05				
Allowable Leak Rate	l/min	0.30				
Leak Test Acceptable	-	Yes				
<b>Water Droplets</b>						
Are Water Droplets Present	-	No				
<b>MU (Concurrent Water Vapour)</b>						
Measurement Uncertainty (MU)	%	5.2				
Allowable MU	%	20				
MU Acceptable	%	Yes				
<b>Silica Gel (Concurrent Water Vapour)</b>						
Less than 50% Faded	%	Yes				
<b>Isokinetic Criterion Compliance</b>						
Isokinetic Variation	%	102.7				
Allowable Isokinetic Range	%	95 - 115				
Isokineticity Acceptable	-	Yes				
<b>Weighing Uncertainty Criteria</b>						
Overall Weighing Uncertainty	± mg	0.27				
Overall Weighing Uncertainty	± mg/m <sup>3</sup>	0.09				
ELV [Daily ELV for IED]	mg/m <sup>3</sup>	20.0				
Allowable Weighing Uncertainty	mg/m <sup>3</sup>	1.00				
Weighing Uncertainty Acceptable	-	Yes				
<b>Filter Temperatures</b>						
Pre-Conditioning Temperature	°C	180				
Post-Conditioning Temperature	°C	160				
Maximum Filter Temperature	°C	160				
<b>Test Conditions</b>						
Ambient Temperature Recorded?	-	Yes				

**TOTAL PARTICULATE MATTER: QUALITY ASSURANCE**

(PAGE 2 OF 2)

**Blank Runs**

Leak Test Results	Units	Blank 1				
Expected Sampling Rate	l/min	20.0				
Pre-Sampling Leak Rate	l/min	0.05				
Post-Sampling Leak Rate	l/min	0.05				
Allowable Leak Rate	l/min	0.40				
Leak Test Acceptable	-	Yes				

Validity of Blank vs ELV	Units	Blank 1				
Allowable Blank	mg/m <sup>3</sup>	2.0				
Blank Acceptable	-	Yes				

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

**Method Deviations**

Nature of Deviation	Run Number			
	(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1		
One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to the minimum required by the Standard	x			

**TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS**

Measured Quantities	Value					Standard uncertainty					
	Symbol	Run 1				Symbol	Units	Run 1			
Sampled Volume (Actual)	V <sub>m</sub>	3.85				uV <sub>m</sub>	m <sup>3</sup>	0.08			
Sampled Gas Temperature	T <sub>m</sub>	289.9				uT <sub>m</sub>	K	2.00			
Sampled Gas Pressure	ρ <sub>m</sub>	97.4				uρ <sub>m</sub>	kPa	0.50			
Sampled Gas Humidity	H <sub>m</sub>	0.00				uH <sub>m</sub>	% v/v	1.00			
Leak	L	0.33				uL	%	-			
Mass of Particulate	m	3.01				um	mg	0.14			
Uncollected Mass	UCM	0.10				uUCM	mg	-			

Measured Quantities	Uncertainty as a Percentage					Requirement of Standard
	Units	Run 1				
Sampled Volume (Actual)	%	2.00				≤2%
Sampled Gas Temperature	%	0.69				≤1%
Sampled Gas Pressure	%	0.51				≤1%
Sampled Gas Humidity	%	1.00				≤1%
Leak	%	0.33				≤2%
Mass of Particulate	%	0.23				<5% of ELV
Uncollected Mass	%	-				-

Measured Quantities	Uncertainty in Measurement Units					Sensitivity Coefficient				
	Symbol	Units	Run 1			Run 1				
Sampled Volume (STP)	V <sub>m</sub>	m <sup>3</sup>	3.47			0.28				
Leak	L	mg/m <sup>3</sup>	0.00			1.00				
Mass of Particulate	L <sub>r</sub>	mg	3.01			0.33				
Uncollected Mass	UCM	mg	0.06			0.33				

Measured Quantities	Uncertainty in Result				
	Units	Run 1			
Sampled Volume (STP)	mg/m <sup>3</sup>	0.03			
Leak	mg/m <sup>3</sup>	0.00			
Mass of Particulate	mg/m <sup>3</sup>	0.05			
Uncollected Mass	mg/m <sup>3</sup>	0.02			

Measured Quantities	Oxygen Correction Part of MU Budget				
	Units	Run 1			
O <sub>2</sub> Correction Factor	-	1.13			
Stack Gas O <sub>2</sub> Content	% v/v	12.2			
MU for O <sub>2</sub> Correction	-	0.06			
Overall MU For O <sub>2</sub> Measurement	%	5.66			

Parameter	Units	Run 1			
Combined uncertainty	mg/m <sup>3</sup>	0.06			
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m <sup>3</sup>	0.11			
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m <sup>3</sup>	0.12			
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m <sup>3</sup>	0.12			
Reported Uncertainty	mg/m <sup>3</sup>	0.12			
Expanded uncertainty (95% confidence), without Oxygen Correction	%	11.0			
Expanded uncertainty (95% confidence), with Oxygen Correction	%	12.4			
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	12.4			
Reported Uncertainty	%	12.4			

## TOTAL VOCs (as CARBON): RESULTS SUMMARY

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust

### Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m <sup>3</sup>	13.3	13.3
Uncertainty	±mg/m <sup>3</sup>	0.95	0.95
Mass Emission	g/hr	7.71	7.71
Uncertainty	±g/hr	0.81	0.81

### General Sampling Information

Parameter	Value
Standard	EN 12619:2013
Technical Procedure	CAT-TP-20
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Propane in 12% O <sub>2</sub> in N <sub>2</sub> (5 Grade)
Span Gas Reference Number	CYL 1.0119n in N <sub>2</sub>   CYL 1.0293a in AIR
Span Gas Expiry Date	23/12/2019   12/09/2021
Span Gas Start Pressure (bar)	90   10
Gas Cylinder Concentration (ppm)	83.42   79.9
Span Gas Set Point (ppm)	81.41
Span Gas Uncertainty (%)	2   2
Zero Gas Type	12% O <sub>2</sub> in N <sub>2</sub> (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A2

This is the blended concentration of both propane cylinders

FORMAT: Number Used / Number Required

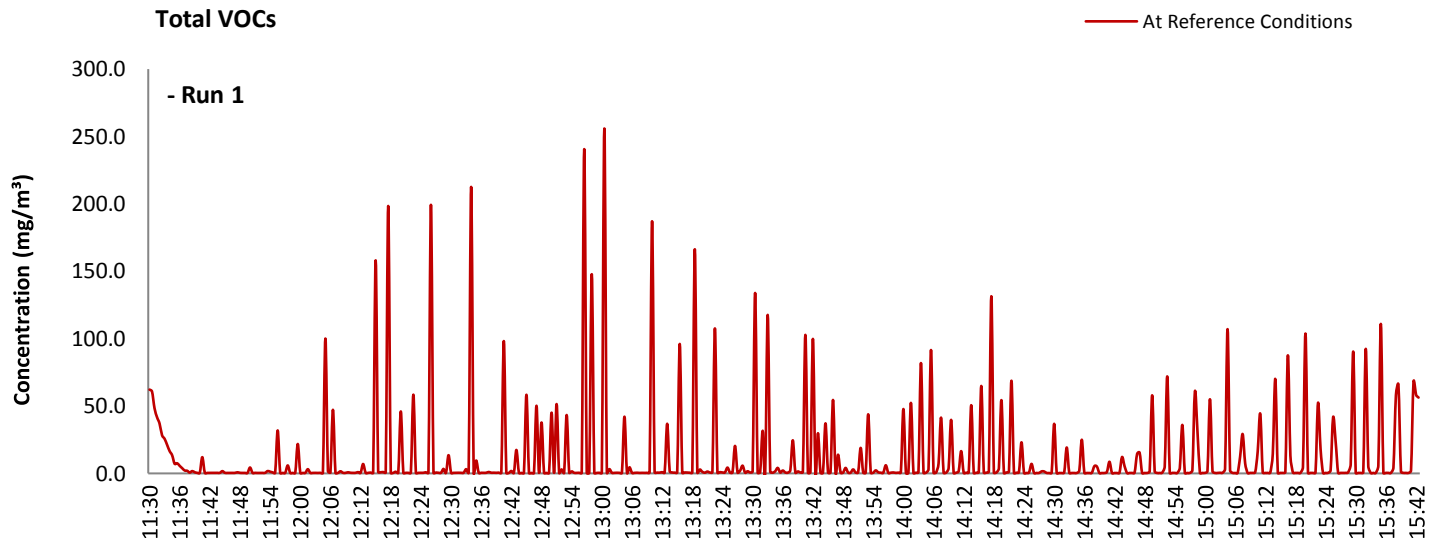
FORMAT: Number Used / Number Required

### Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

### TOTAL VOCs (as CARBON): DATA TREND

Graphical Trend of Data



**TOTAL VOCs (as CARBON): SAMPLING DETAILS & QUALITY ASSURANCE**

**Sampling Details**

Parameter	Units	Run 1		
Sampling Times	-	11:30 - 15:42		
Sampling Dates	-	12/03/2018		
Instrument Range	ppm	100		
Span Gas Value	ppm	81.4		

**Quality Assurance**

	Zero Drift	Units	Run 1		
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00		
	Zero Down Sampling Line (Post)	ppm	0.00		
	Zero Drift	ppm	0.00		
	Allowable Zero Drift	± ppm	4.07		
	Zero Drift Acceptable	-	Yes		

	Span Drift	Units	Run 1		
CAL 1	Span Down Sampling Line (Pre)	ppm	80.80		
	Span Down Sampling Line (Post)	ppm	81.70		
	Span Drift	ppm	0.90		
	Allowable Span Drift	± ppm	4.07		
	Span Drift Acceptable	-	Yes		

Test Conditions	Units	Run 1		
Run Ambient Temperature Range	°C	4 - 10		

**Method Deviations**

Nature of Deviation	Run Number		
	(x = deviation applies to the associated run)	1	
There are no deviations associated with the sampling employed.	x		

**TOTAL VOCs (as CARBON): MEASUREMENT UNCERTAINTY CALCULATIONS**

Performance characteristics	RUN 1		Units
Limit value	20.0		mg/m <sup>3</sup> (REF)
TGN M2 Allowable MU	15.0		%
Measured concentration	11.75		mg/m <sup>3</sup> (STP, dry)
Range Used	100.0		ppm
Range Used [A]	160.6		mg/m <sup>3</sup>
Cal gas conc.	81.4		ppm
Conversion	1.61		ppm to mg/m <sup>3</sup>
MCERTS Range [B]	15.0		mg/m <sup>3</sup>
Lower of [A] or [B]	15.0		mg/m <sup>3</sup>
Cal gas conc.	130.8		mg/m <sup>3</sup>

Performance characteristics	RUN 1		Units
Response time	45		seconds
Number of readings in measurement	252		-
Repeatability at zero	2.00		% full scale
Repeatability at span level	0.00		% full scale
Deviation from linearity	0.00		% of value
Zero drift	0.00		% full scale
Span drift	1.11		% full scale
Volume or pressure flow dependence	1.60		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	1.40		% full scale/10K
Combined interference	0.45		% range
Dependence on voltage	0.50		% full scale/10V
Losses in the line (leak)	0.74		% of value
Uncertainty of calibration gas	2.83		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m <sup>3</sup>
Standard deviation of repeatability at span level	0.00		mg/m <sup>3</sup>
Lack of fit	0.00		mg/m <sup>3</sup>
Drift	0.08		mg/m <sup>3</sup>
Volume or pressure flow dependence	0.00		mg/m <sup>3</sup>
Atmospheric pressure dependence	0.01		mg/m <sup>3</sup>
Ambient temperature dependence	0.20		mg/m <sup>3</sup>
Combined interference (from MCERTS Certificate)	0.04		mg/m <sup>3</sup>
Dependence on voltage	0.06		mg/m <sup>3</sup>
Losses in the line (leak)	0.05		mg/m <sup>3</sup>
Uncertainty of calibration gas	0.19		mg/m <sup>3</sup>

Measurement uncertainty	Result	RUN 1	Units
		11.75	mg/m <sup>3</sup>
Combined uncertainty		0.30	mg/m <sup>3</sup>
Expanded uncertainty	k = 1.96	0.60	mg/m <sup>3</sup>
Uncertainty corrected to std conds. (O <sub>2</sub> )		0.67	mg/m <sup>3</sup> (REF)

	RUN 1	Units
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	5.07	% of Value
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	2.98	% at ELV
Overall Allowable uncertainty (no O <sub>2</sub> ) - at 95% Confidence	15.0	% at ELV
<b>Result of Compliance with Uncertainty Requirement in M2</b>	N/A	-

	RUN 1	Units
Expanded uncertainty (with O <sub>2</sub> ) - at 95% Confidence	7.15	% of Value
Expanded uncertainty (with O <sub>2</sub> ) - at 95% Confidence	6.07	% at ELV
Overall Allowable uncertainty (with O <sub>2</sub> ) - at 95% Confidence	15.8	% at ELV
<b>Result of Compliance with Uncertainty Requirement in M2</b>	<b>COMPLIANT</b>	-

Requirement for SRM is that Uncertainty should be <15% of the value at the ELV, on a dry gas basis, or if O<sub>2</sub> correction is applied less than 15% + the uncertainty associated with the O<sub>2</sub> correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.



## OXIDES OF NITROGEN (as NO<sub>2</sub>): RESULTS SUMMARY

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust

### Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m <sup>3</sup>	90.3	90.3
Uncertainty	±mg/m <sup>3</sup>	5.86	5.86
Mass Emission	g/hr	52.3	52.3
Uncertainty	±g/hr	5.24	5.24

### General Sampling Information

Parameter	Value
Standard	EN 14792
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Date & Result of Last Converter Check	11/05/2017 - 95.9%
Span Gas Type	Nitrogen Monoxide
Span Gas Reference Number	CYL 4.0183
Span Gas Expiry Date	02/09/2020
Span Gas Start Pressure (bar)	50
Gas Cylinder Concentration (ppm)	403.92
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A2

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

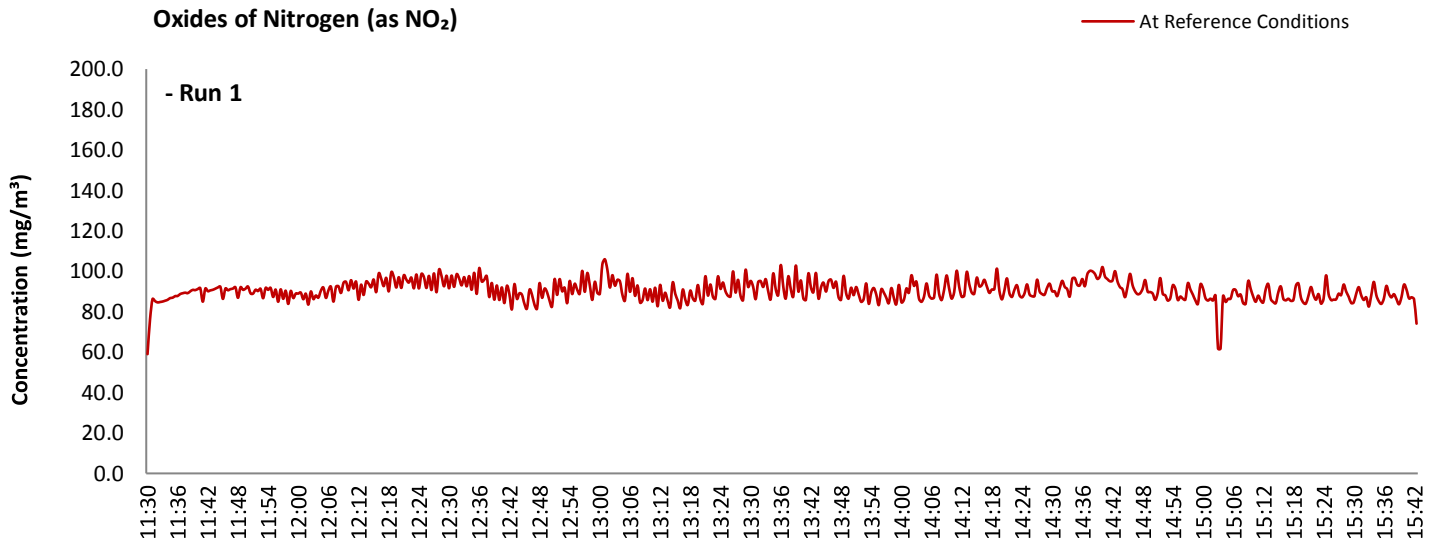
FORMAT: Number Used / Number Required

### Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

### OXIDES OF NITROGEN (as NO<sub>2</sub>): DATA TREND

Graphical Trend of Data



**OXIDES OF NITROGEN (as NO<sub>2</sub>): SAMPLING DETAILS & QUALITY ASSURANCE**

**Sampling Details**

Parameter	Units	Run 1		
Sampling Times	-	11:30 - 15:42		
Sampling Dates	-	12/03/2018		
Instrument Range	ppm	250		
Span Gas Value	ppm	97.5		

**Quality Assurance**

Conditioning Unit Temperature	Units	Run 1		
Average Temperature	°C	1.0		
Allowable Temperature	< °C	4.0		
Temperature Acceptable	-	Yes		

Zero Drift	Units	Run 1		
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00	
	Zero Down Sampling Line (Post)	ppm	0.00	
	Zero Drift	ppm	0.00	
	Allowable Zero Drift	± ppm	4.87	
	Zero Drift Acceptable	-	Yes	

Span Drift	Units	Run 1		
CAL 1	Span Down Sampling Line (Pre)	ppm	98.0	
	Span Down Sampling Line (Post)	ppm	97.0	
	Span Drift	ppm	-1.00	
	Allowable Span Drift	± ppm	4.87	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1		
Run Ambient Temperature Range	°C	4 - 10		

**Method Deviations**

Nature of Deviation	Run Number		
	(x = deviation applies to the associated run)	1	
There are no deviations associated with the sampling employed.	x		

**OXIDES OF NITROGEN (as NO<sub>2</sub>): MEASUREMENT UNCERTAINTY CALCULATIONS**

Performance characteristics	RUN 1		Units
Limit value	200.0		mg/m <sup>3</sup> (REF)
TGN M2 Allowable MU	10.0		%
Measured concentration	79.77		mg/m <sup>3</sup> (STP, dry)
Ration NO / NO <sub>2</sub>	5		%
Range Used	250.0		ppm
Range Used [A]	513.1		mg/m <sup>3</sup>
Cal gas conc.	97.5		ppm
Conversion	2.05		ppm to mg/m <sup>3</sup>
MCERTS Range [B]	205.0		mg/m <sup>3</sup>
Lower of [A] or [B]	205.0		mg/m <sup>3</sup>
Cal gas conc.	200.0		mg/m <sup>3</sup>

Performance characteristics	RUN 1		Units
Response time	31		seconds
Number of readings in measurement	252		-
Repeatability at zero	0.00		% full scale
Repeatability at span level	0.10		% full scale
Deviation from linearity	0.33		% of value
Zero drift	0.00		% full scale
Span drift	-1.02		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.10		% of value/kPa
Ambient temperature dependence	0.04		% full scale/10K
Combined interference	0.63		% range
Dependence on voltage	-0.23		% full scale/10V
Converter efficiency	95.9		%
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m <sup>3</sup>
Standard deviation of repeatability at span level	0.01		mg/m <sup>3</sup>
Lack of fit	0.39		mg/m <sup>3</sup>
Drift	-0.47		mg/m <sup>3</sup>
Volume or pressure flow dependence	0.00		mg/m <sup>3</sup>
Atmospheric pressure dependence	0.06		mg/m <sup>3</sup>
Ambient temperature dependence	0.01		mg/m <sup>3</sup>
Combined interference (from MCERTS Certificate)	0.75		mg/m <sup>3</sup>
Dependence on voltage	-0.03		mg/m <sup>3</sup>
Converter efficiency	0.09		mg/m <sup>3</sup>
Losses in the line (leak)	0.00		mg/m <sup>3</sup>
Uncertainty of calibration gas blending	0.64		mg/m <sup>3</sup>
Uncertainty of calibration gas	0.92		mg/m <sup>3</sup>

Measurement uncertainty	Result	RUN 1		Units
Combined uncertainty		79.77		mg/m <sup>3</sup>
Expanded uncertainty	k =	1.66		mg/m <sup>3</sup>
Expanded uncertainty		3.26		mg/m <sup>3</sup>
Uncertainty corrected to std conds. (O <sub>2</sub> )		3.69		mg/m <sup>3</sup> (REF)

	RUN 1		Units
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	4.08		% of Value
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	1.63		% at ELV
Overall Allowable uncertainty (no O <sub>2</sub> ) - at 95% Confidence	10.0		% at ELV
<b>Result of Compliance with Uncertainty Requirement in M2</b>	<b>N/A</b>		-

	RUN 1		Units
Expanded uncertainty (with O <sub>2</sub> ) - at 95% Confidence	6.49		% of Value
Expanded uncertainty (with O <sub>2</sub> ) - at 95% Confidence	5.37		% at ELV
Overall Allowable uncertainty (with O <sub>2</sub> ) - at 95% Confidence	11.2		% at ELV
<b>Result of Compliance with Uncertainty Requirement in M2</b>	<b>COMPLIANT</b>		-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O<sub>2</sub> correction is applied less than 10% + the uncertainty associated with the O<sub>2</sub> correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

## CARBON MONOXIDE: RESULTS SUMMARY

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust

### Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m <sup>3</sup>	156	156
Uncertainty	±mg/m <sup>3</sup>	9.11	9.11
Mass Emission	g/hr	90.3	90.3
Uncertainty	±g/hr	8.68	8.68

### General Sampling Information

Parameter	Value
Standard	EN 15058
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Carbon Monoxide
Span Gas Reference Number	CYL 2.0127
Span Gas Expiry Date	22/07/2021
Span Gas Start Pressure (bar)	70
Gas Cylinder Concentration (ppm)	401.3
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A2

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

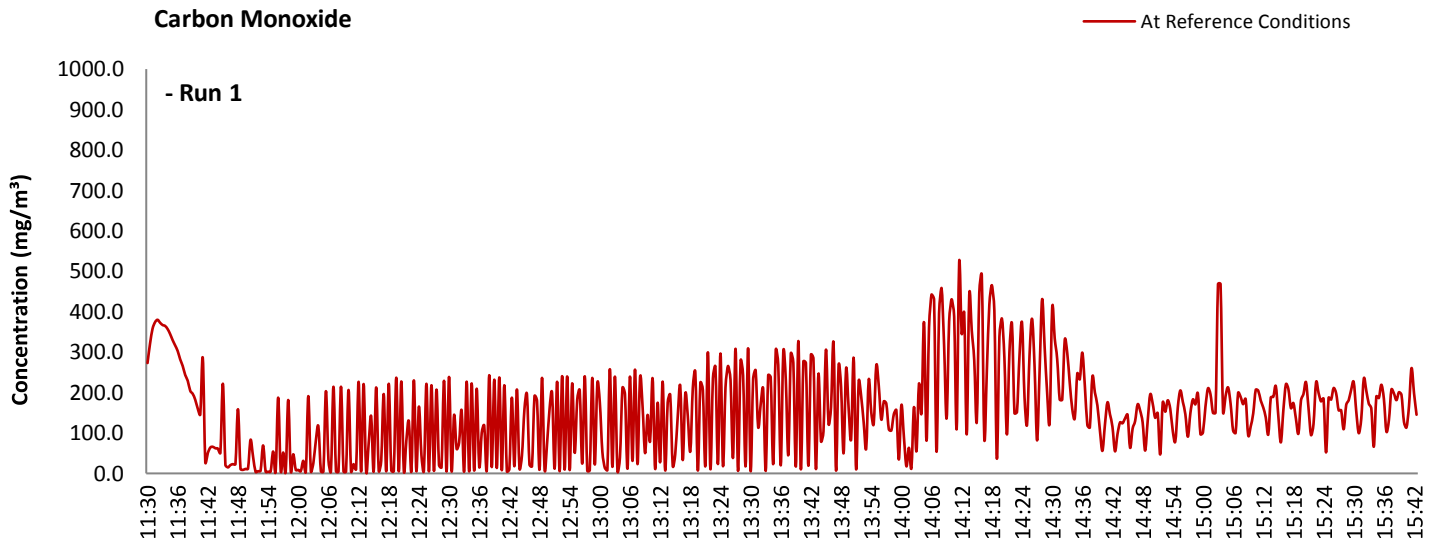
FORMAT: Number Used / Number Required

### Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

### CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



**CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE**

**Sampling Details**

Parameter	Units	Run 1		
Sampling Times	-	11:30 - 15:42		
Sampling Dates	-	12/03/2018		
Instrument Range	ppm	500		
Span Gas Value	ppm	160.1		

**Quality Assurance**

Conditioning Unit Temperature	Units	Run 1		
Average Temperature	°C	1.0		
Allowable Temperature	< °C	4.0		
Temperature Acceptable	-	Yes		

Zero Drift	Units	Run 1		
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00	
	Zero Down Sampling Line (Post)	ppm	0.40	
	Zero Drift	ppm	0.40	
	Allowable Zero Drift	± ppm	8.01	
	Zero Drift Acceptable	-	Yes	

Span Drift	Units	Run 1		
CAL 1	Span Down Sampling Line (Pre)	ppm	159.2	
	Span Down Sampling Line (Post)	ppm	159.6	
	Span Drift	ppm	0.40	
	Allowable Span Drift	± ppm	8.01	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1		
Run Ambient Temperature Range	°C	4 - 10		

**Method Deviations**

Nature of Deviation	Run Number		
	(x = deviation applies to the associated run)	1	
There are no deviations associated with the sampling employed.	x		

**CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS**

Performance characteristics	RUN 1		Units
Limit value	200.0		mg/m <sup>3</sup> (REF)
TGN M2 Allowable MU	6.0		%
Measured concentration	137.69		mg/m <sup>3</sup> (STP, dry)
Range Used	500.0		ppm
Range Used [A]	624.6		mg/m <sup>3</sup>
Cal gas conc.	160.1		ppm
Conversion	1.25		ppm to mg/m <sup>3</sup>
MCERTS Range [B]	75.0		mg/m <sup>3</sup>
Lower of [A] or [B]	75.0		mg/m <sup>3</sup>
Cal gas conc.	200.0		mg/m <sup>3</sup>

Performance characteristics	RUN 1		Units
Response time	28		seconds
Number of readings in measurement	252		-
Repeatability at zero	0.10		% full scale
Repeatability at span level	0.20		% full scale
Deviation from linearity	0.31		% of value
Zero drift	0.25		% full scale
Span drift	0.25		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.22		% of value/kPa
Ambient temperature dependence	-0.20		% full scale/10K
Combined interference	-0.48		% range
Dependence on voltage	-0.35		% full scale/10V
Losses in the line (leak)	0.56		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m <sup>3</sup>
Standard deviation of repeatability at span level	0.01		mg/m <sup>3</sup>
Lack of fit	0.13		mg/m <sup>3</sup>
Drift	0.49		mg/m <sup>3</sup>
Volume or pressure flow dependence	0.00		mg/m <sup>3</sup>
Atmospheric pressure dependence	0.05		mg/m <sup>3</sup>
Ambient temperature dependence	-0.03		mg/m <sup>3</sup>
Combined interference (from MCERTS Certificate)	-0.21		mg/m <sup>3</sup>
Dependence on voltage	-0.04		mg/m <sup>3</sup>
Losses in the line (leak)	0.45		mg/m <sup>3</sup>
Uncertainty of calibration gas blending	1.11		mg/m <sup>3</sup>
Uncertainty of calibration gas	1.59		mg/m <sup>3</sup>

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		137.69	mg/m <sup>3</sup>
Expanded uncertainty	k = 1.96	2.08	mg/m <sup>3</sup>
Expanded uncertainty		4.07	mg/m <sup>3</sup>
Uncertainty corrected to std conds. (O <sub>2</sub> )		4.61	mg/m <sup>3</sup> (REF)

	RUN 1	Units
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	2.96	% of Value
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	2.04	% at ELV
Overall Allowable uncertainty (no O <sub>2</sub> ) - at 95% Confidence	6.0	% at ELV
<b>Result of Compliance with Uncertainty Requirement in M2</b>	<b>N/A</b>	-

	RUN 1	Units
Expanded uncertainty (with O <sub>2</sub> ) - at 95% Confidence	5.84	% of Value
Expanded uncertainty (with O <sub>2</sub> ) - at 95% Confidence	5.54	% at ELV
Overall Allowable uncertainty (with O <sub>2</sub> ) - at 95% Confidence	7.8	% at ELV
<b>Result of Compliance with Uncertainty Requirement in M2</b>	<b>COMPLIANT</b>	-

Requirement for SRM is that Uncertainty should be <6% of the value at the ELV, on a dry gas basis, or if O<sub>2</sub> correction is applied less than 6% + the uncertainty associated with the O<sub>2</sub> correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.



## CARBON DIOXIDE: RESULTS SUMMARY

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust

### Sample Runs

Parameter	Units	Run 1	Mean
Concentration	% v/v	4.89	4.89
Uncertainty	±% v/v	0.19	0.19

### General Sampling Information

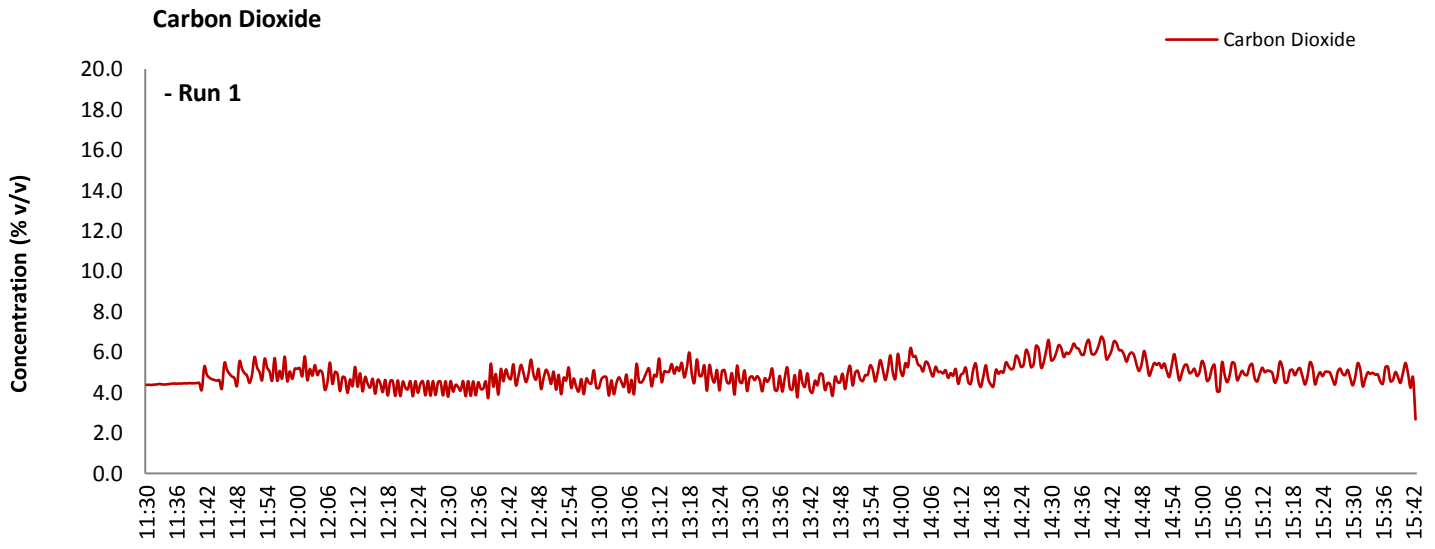
Parameter	Value
Standard	ISO 12039
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Carbon Dioxide
Span Gas Reference Number	CYL 6.0028
Span Gas Expiry Date	05/04/2021
Span Gas Start Pressure (bar)	170
Gas Cylinder Concentration (% v/v)	15.99
Span Gas Uncertainty (%)	2.00
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A2

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

### CARBON DIOXIDE: DATA TREND

Graphical Trend of Data



**CARBON DIOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE**

**Sampling Details**

Parameter	Units	Run 1		
Sampling Times	-	11:30 - 15:42		
Sampling Dates	-	12/03/2018		
Instrument Range	% v/v	20.0		
Span Gas Value	% v/v	16.0		

**Quality Assurance**

Conditioning Unit Temperature	Units	Run 1		
Average Temperature	°C	1.0		
Allowable Temperature	< °C	4.0		
Temperature Acceptable	-	Yes		

Zero Drift	Units	Run 1		
Zero Down Sampling Line (Pre)	% v/v	0.01		
Zero Down Sampling Line (Post)	% v/v	0.04		
Zero Drift	% v/v	0.03		
Allowable Zero Drift	± % v/v	0.80		
Zero Drift Acceptable	-	Yes		

CAL 1

Span Drift	Units	Run 1		
Span Down Sampling Line (Pre)	% v/v	16.02		
Span Down Sampling Line (Post)	% v/v	16.16		
Span Drift	% v/v	0.14		
Allowable Span Drift	± % v/v	0.80		
Span Drift Acceptable	-	Yes		

CAL 1

Test Conditions	Units	Run 1		
Run Ambient Temperature Range	°C	4 - 10		

**Method Deviations**

Nature of Deviation	Run Number		
	(x = deviation applies to the associated run)	1	
There are no deviations associated with the sampling employed.	x		

**CARBON DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS**

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	25.0		%
Measured concentration	4.89		%vol
Range Used	20.0		%vol
Cal gas conc.	16.0		%vol

Performance characteristics	RUN 1		Units
Response time	29		seconds
Number of readings in measurement	252		-
Repeatability at zero	0.00		% full scale
Repeatability at span level	0.10		% full scale
Deviation from linearity	0.34		% of value
Zero drift	0.19		% full scale
Span drift	0.87		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	-0.20		% full scale/10K
Combined interference	0.00		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.01		%vol
Lack of fit	0.04		%vol
Drift	0.04		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	-0.03		%vol
Combined interference (from MCERTS Certificate)	0.00		%vol
Dependence on voltage	0.05		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.06		%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		4.89	%vol
Expanded uncertainty	k = 1.96	0.10	%vol
		0.19	%vol

	RUN 1	Units
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	3.97	% of Value

**OXYGEN: RESULTS SUMMARY**

Liberty Pressing Solutions Ltd, Coventry  
Burn Off Oven Exhaust

**Sample Runs**

Parameter	Units	Run 1	Mean
Concentration	% v/v	12.2	12.2
Uncertainty	±% v/v	0.61	0.61

**General Sampling Information**

Parameter	Value
Standard	EN 14789
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Synthetic Air (5 Grade)
Span Gas Reference Number	CYL 11.0250
Span Gas Expiry Date	20/07/2021
Span Gas Start Pressure (bar)	40
Gas Cylinder Concentration (% v/v)	21.16
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A2

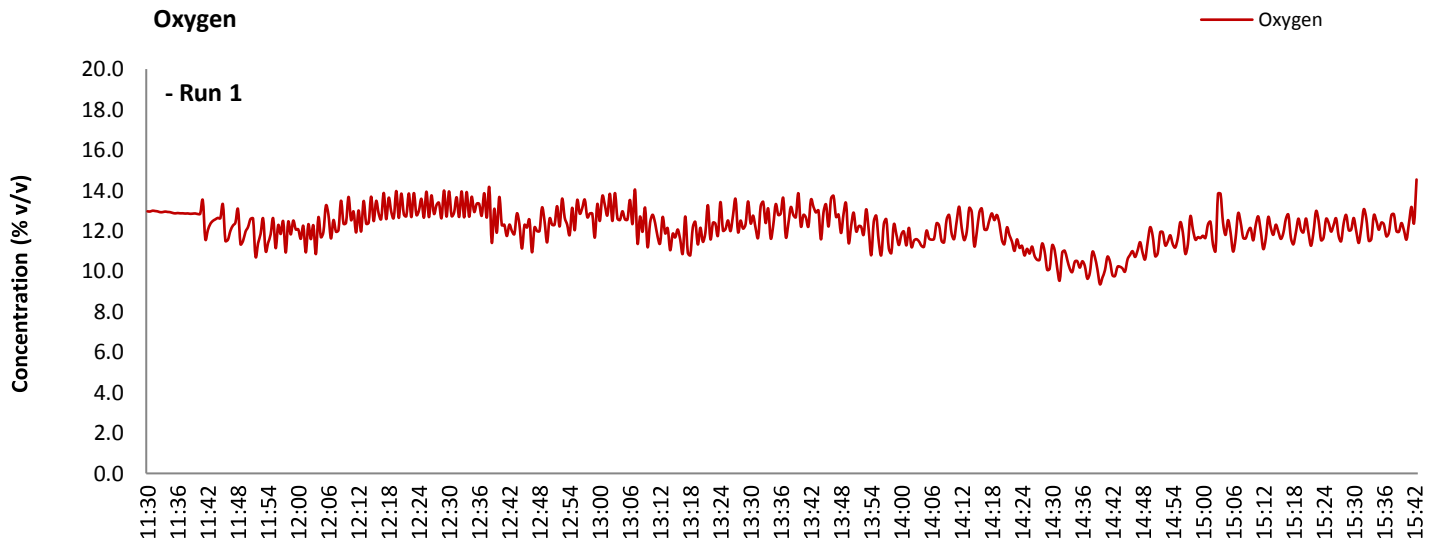
NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

**OXYGEN: DATA TREND**

**Graphical Trend of Data**



**OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE**

**Sampling Details**

Parameter	Units	Run 1		
Sampling Times	-	11:30 - 15:42		
Sampling Dates	-	12/03/2018		
Instrument Range	% v/v	25.0		
Span Gas Value	% v/v	11.0		

**Quality Assurance**

Conditioning Unit Temperature	Units	Run 1		
Average Temperature	°C	1.0		
Allowable Temperature	< °C	4.0		
Temperature Acceptable	-	Yes		

Zero Drift	Units	Run 1		
Zero Down Sampling Line (Pre)	% v/v	0.08		
Zero Down Sampling Line (Post)	% v/v	-0.13		
Zero Drift	% v/v	-0.21		
Allowable Zero Drift	± % v/v	0.55		
Zero Drift Acceptable	-	Yes		

CAL 1

Span Drift	Units	Run 1		
Span Down Sampling Line (Pre)	% v/v	11.01		
Span Down Sampling Line (Post)	% v/v	10.94		
Span Drift	% v/v	-0.07		
Allowable Span Drift	± % v/v	0.55		
Span Drift Acceptable	-	Yes		

CAL 1

Test Conditions	Units	Run 1		
Run Ambient Temperature Range	°C	4 - 10		

**Method Deviations**

Nature of Deviation	Run Number		
	(x = deviation applies to the associated run)	1	
There are no deviations associated with the sampling employed.	x		

**OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS**

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	6.0		%
Measured concentration	12.17		%vol
Range Used	25.0		%vol
Cal gas conc.	21.2		%vol

Performance characteristics	RUN 1		Units
Response time	41		seconds
Number of readings in measurement	252		-
Repeatability at zero	0.02		% full scale
Repeatability at span level	0.02		% full scale
Deviation from linearity	0.03		% of value
Zero drift	-1.91		% full scale
Span drift	-0.64		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.19		% of value/kPa
Ambient temperature dependence	-0.21		% full scale/10K
Combined interference	0.00		% range
Dependence on voltage	0.02		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.00		%vol
Lack of fit	0.00		%vol
Drift	-0.28		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.01		%vol
Ambient temperature dependence	-0.03		%vol
Combined interference (from MCERTS Certificate)	0.00		%vol
Dependence on voltage	0.00		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.14		%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		12.17	%vol
Expanded uncertainty	k = 1.96	0.31	%vol
		0.61	%vol

	RUN 1	Units
Expanded uncertainty (no O <sub>2</sub> ) - at 95% Confidence	5.04	% of Value
<b>Result of Compliance with Uncertainty Requirement in M2</b>	<b>COMPLIANT</b>	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.