Exova Catalyst, Unit 11, Aspen Close, Swindon, SN2 8AJ
T: 0800 328 1821 (or + 44 161 432 3286 from overseas)
E: paul.martin@exova.com
Your Exova Catalyst Contact: Paul Martin (07827 332630)

Stack Emissions Testing Report Commissioned by
Paxford Composites Ltd

Installation Name & Address
Paxford Composites Ltd
Red Wongs Way
Huntingdon
Cambridgeshire
PE29 7HB

PPC Permit: B01/02

Stack Reference
Spray Bake Booth

Dates of the Monitoring Campaign
6th March 2017

Job Reference Number
CSW-2678

Report Written by
Neil Teixeira Team Leader MCERTS Level 2 MM 05 583 TE1 TE2 TE3 TE4

Report Approved by
Martin Futter Deputy Regional Manager MCERTS Level 2 MM 03 216 TE1 TE2 TE3 TE4

Report Date
29th March 2017

Version
Version 1

Signature of Report Approver


CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

Executive Summary

(Page 1 of 7)

MONITORING OBJECTIVES

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
6th March 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Paxford Composites Ltd to carry out stack emissions testing on the Spray Bake Booth at Huntingdon.

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)

Executive Summary

MONITORING RESULTS

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
6th March 2017

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	1.6	1.3	50	g/hr	18.6	15.3	-
Total VOCs (as Carbon) [1]	mg/m³	23.1	0.9	100	g/hr	270.6	16.7	-
Water Vapour	% v/v	2.3	0.1					
Stack Gas Temperature	°C	20.0						
Stack Gas Velocity	m/s	12.2	0.23					
Volumetric Flow Rate (ACTUAL)	m³/hr	12441	612					
Volumetric Flow Rate (REF) [1]	m³/hr	11702	575					

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

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

Executive Summary

MONITORING DATE(S) & TIMES

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
6th March 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	1.6	g/hr	18.6	06/03/2017	14:02 - 14:36	32
Total VOCs (as Carbon)	R1	mg/m³	23.1	g/hr	270.6	06/03/2017	14:02 - 14:32	30
Velocity & Volumetric Flow Rate	R1					06/03/2017	09:30 - 09:40	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
6th March 2017

Standard Operating Conditions

Parameter	Value
Process Status	Operational
Capacity (of 100%) and Tonnes / Hour	N/A
Continuous or Batch Process	Batch
Feedstock (if applicable)	Composite Components Being Spray Painted
Abatement System	Filter Backed Booths
Abatement System Running Status	-
Fuel	N/A
Plume Appearance	None Visible From Sampling Location

Executive Summary

MONITORING & ANALYTICAL METHODS

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
6th March 2017

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.36 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Total VOCs (as Carbon)	EN 12619:2013	CAT-TP-20	Yes	CAT	Flame Ionisation Detection by Sick 3006 FID				Yes	0.45 mg/m³
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
All	1	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.60
Width	m	-
Area	m²	0.28
Port Depth	cm	9
Orientation of Duct	-	Vertical
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Inside

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	No

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

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	99.0		> 5 Pa	Yes
Mean Velocity	m/s	12.22		-	-
Lowest Gas Velocity	m/s	10.77		-	-
Highest Gas Velocity	m/s	14.11		-	-
Ratio of Above	: 1	1.31		< 3 : 1	Yes
Maximum Angle of Swirl	°	8		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

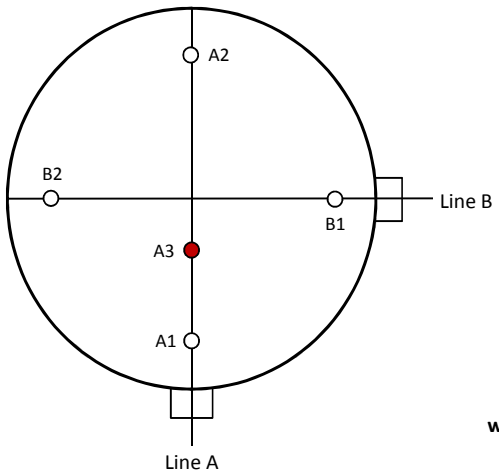
PLANT PHOTOS

Photo 1

Photo 2

Photo 3

SAMPLE POINTS



where ○ = isokinetic point sampled at
● = isokinetic point not sampled at
● = combustion gases sample point
● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Neil Teixeira	MCERTS Level 2	MM 05 583	TE1 TE2 TE3 TE4
Trainee	Alex Susanu	MCERTS Trainee	MM 16 1368	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.52
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.128
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.128
Umbilical (2)	-
Oven Box (1)	CAT 12.102
Oven Box (2)	-
Heated Probe (1)	CAT 5.122
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21P.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.25
500g / 1Kg Check Weights	CAT 17.25
Last Impinger Arm	-
Callipers	CAT 23.29
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
Ankersmid APS 313	-
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	CAT 8.6
M&C PSS	CAT 12.86
Mass Flow Controller (1)	CAT 6.51
Mass Flow Controller (2)	CAT 6.52
Mass View (1)	-
Mass View (2)	-
Hioki 5043 (V)	CAT 11.91
Hioki 5043 (V)	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.12
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.12
Stopwatch	CAT 14.78
Barometer	CAT 13.37
Stack Thermocouple (1)	CAT 4.805
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
2m Heated Line (1) (P&G)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
10m Heated Line (1)	-
20m Heated Line (1)	CAT 20.106
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.129
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.9

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
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	0.60
Stack Width, W	m	-
Stack Area, A	m^2	0.28
Average Stack Gas Temperature, T_a	°C	20.0
Average Stack Gas Pressure	Pa	128.8
Average Stack Static Pressure, P_{static}	kPa	0.061
Average Barometric Pressure, P_b	kPa	102.2
Average Pitot Tube Calibration Coefficient, C_p	-	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/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.31	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	77.28	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	2.35	0.0235	18.02	0.8037	0.01886

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.287
Wet Density (STP), P_{STW}	kg/m³	1.276
Dry Density (Actual), P_{Actual}	kg/m³	1.211
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.200

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (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 [1]
Temperature	°C	20.0	0.0
Total Pressure	kPa	102.3	101.3
Moisture	%	2.35	2.35

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	12441
Gas Volumetric Flowrate (STP, Wet)	m³/hr	11702
Gas Volumetric Flowrate (STP, Dry)	m³/hr	11427
Gas Volumetric Flowrate REF [1]	m³/hr	11702

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	06/03/2017
Time of Survey	-	09:30 - 09:40
Atmospheric Pressure	kPa	102.2
Average Stack Static Pressure	Pa	61
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*60.0*					*62.0*				
Mean		**146.5**	**20.0**	**1.200**	**13.06**		**111.0**	**20.0**	**1.200**	**11.39**	
1	0.09	123.0	20.0	1.200	12.00	6.0	99.0	20.0	1.200	10.77	5.0
2	0.51	170.0	20.0	1.200	14.11	8.0	123.0	20.0	1.200	12.00	8.0

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(Δpi)	2.017	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	1.726	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	1.257	
- Overall corrections to dynamic measurements	u(Cf)	3.068	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.312	
- $\varphi CO_2,w$	-	0.059	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.120	
- Oxygen, wet	u(ϕO_2,w)	0.622	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.495	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.698	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.426	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00646	-
Standard uncertainty associated with the local velocities	u(vi)	0.147	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.120	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.234	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	1.92	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	611.5	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00063	
- $u^2(qV,w)$	-	97347	
- u(qV,w)	-	312.0	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.92	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Bake Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	1.59		1.59
Uncertainty	±mg/m³	1.30		1.30
Mass Emission	g/hr	18.6		18.6
Uncertainty	±g/hr	15.3		15.3

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	2.3		2.3
Uncertainty	±% v/v	0.1		0.1

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.96		0.96

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2 - B1, B2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	766.5	
Stack static pressure, P_{static}	mmH_2O	6.1	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	767.0	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	2.2	
Total mass collected in impingers (silica trap)	g	5.1	
Total mass of liquid collected, V_{lc}	g	7.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0091	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.4130	
Gas meter correction factor, Y_d	-	0.9650	
Average dry gas meter temperature, T_m	°C	17.3	
Average pressure drop across orifice, ΔH	mmH_2O	16.5	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.3786	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0235	
B_{wo} as a percentage	% v/v	2.35	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	2.35	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.3877	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.59	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.82	
Average of velocity heads, ΔP_{avg}	mmH_2O	4.82	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	2.20	
Average stack gas temperature, T_s	°C	19.0	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	7.29	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.28	
$Q_a = (60)(A_s)(V_s)$	m^3/min	123.7	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	116.7	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	114.0	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	5.87	
Nozzle area, A_n	mm^2	27.10	
Total sampling time, q	min	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	108.3	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	14:02 - 14:36	
Sampling Dates	-	06/03/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.3877	
Filter I.D. Number	-	47-39871	
Start Filter Mass	g	0.14887	
End Filter Mass	g	0.14936	
Total Mass on Filter	g	0.00049	
Probe Rinse I.D. Number	-	PR-47-39871	
Start Probe Rinse Mass	g	3.17757	
End Probe Rinse Mass	g	3.17769	
Total Mass in Probe Rinse	g	0.00012	
Total Mass Collected	mg	0.62	
Calculated Concentration	mg/m^3	1.59	
Balance Uncertainty / LOD	mg/m^3	0.36	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	06/03/2017	
Average Volume Sampled (REF)	m^3	0.3877	
Filter I.D. Number	-	47-39840	
Start Filter Mass	g	0.14822	
End Filter Mass	g	0.14807	
Total Mass on Filter	g	-0.00015	
Probe Rinse I.D. Number	-	PR-47-39840	
Start Probe Rinse Mass	g	3.13511	
End Probe Rinse Mass	g	3.13563	
Total Mass in Probe Rinse	g	0.00052	
Total Mass Collected	mg	0.37	
Calculated Concentration	mg/m^3	0.96	
Balance Uncertainty / LOD	mg/m^3	0.36	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	12.45	
Pre-Sampling Leak Rate	l/min	0.20	
Post-Sampling Leak Rate	l/min	0.20	
Allowable Leak Rate	l/min	0.25	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.6	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	108.3	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.25	
Overall Weighing Uncertainty	± mg/m³	0.65	
ELV [Daily ELV for IED]	mg/m³	50.00	
Allowable Weighing Uncertainty	mg/m³	2.50	
Weighing Uncertainty Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	19	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.10	
Post-Sampling Leak Rate	l/min	0.10	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	5.0	
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	
There are no deviations associated with the sampling employed.	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.4130		uV_m	m³	0.0083	
Sampled Gas Temperature	T_m	290.3		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	102.3		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	1.61		uL	%	-	
Mass of Particulate	m	0.62		um	mg	0.14	
Uncollected Mass	UCM	0.37		uUCM	mg	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.69		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	1.61		≤2%
Mass of Particulate	%	0.72		<5% of ELV
Uncollected Mass	%	-		-

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m³	0.3786		4.20	
Leak	L	mg/m³	0.015		1.00	
Mass of Particulate	L_r	mg	0.617		2.58	
Uncollected Mass	UCM	mg	0.22		2.58	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m³	0.040	
Leak	mg/m³	0.0147	
Mass of Particulate	mg/m³	0.3611	
Uncollected Mass	mg/m³	0.5560	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m³	0.66	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	1.30	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	1.30	
Reported Uncertainty	mg/m³	1.30	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	81.9	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	81.9	
Reported Uncertainty	%	81.9	

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Bake Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	23.1		23.1
Uncertainty	±mg/m³	0.9		0.9
Mass Emission	g/hr	270.6		270.6
Uncertainty	±g/hr	16.7		16.7

General Sampling Information

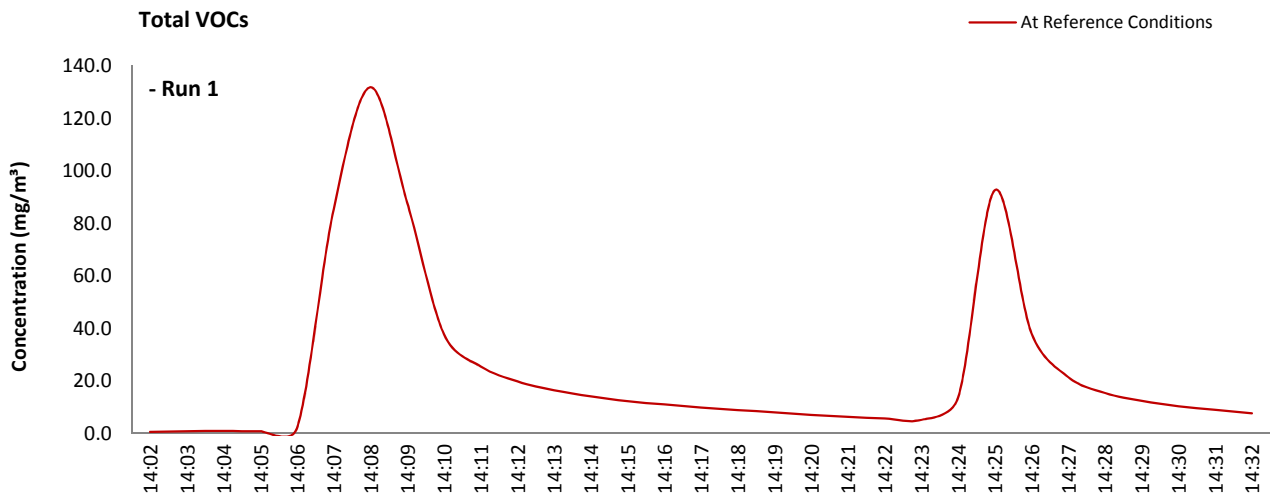
Parameter	Value	
Standard	EN 12619:2013	
Technical Procedure	CAT-TP-20	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Propane In Synthetic Air (5 Grade)	
Span Gas Reference Number	1.0204a	
Span Gas Expiry Date	10/01/2021	
Span Gas Start Pressure (bar)	120	
Gas Cylinder Concentration (ppm)	80.5	
Span Gas Set Point (ppm)	80.50	
Span Gas Uncertainty (%)	N/A	
Zero Gas Type	Synthetic Air (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

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	-	14:02 - 14:32	
Sampling Dates	-	06/03/2017	
Instrument Range	ppm	100	
Span Gas Value	ppm	80.5	

Quality Assurance

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.40	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.50	
CAL 1	Zero Drift	ppm	0.10	
	Allowable Zero Drift	± ppm	4.03	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	79.00	
CAL 1	Span Down Sampling Line (Post)	ppm	79.20	
CAL 1	Span Drift	ppm	0.20	
	Allowable Span Drift	± ppm	4.03	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	10 - 15	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 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	100.0		mg/m³ (REF)
TGN M2 Allowable MU	15.0		%
Measured concentration	23.68		mg/m³ (STP, dry)
Range Used	100.0		ppm
Range Used [A]	160.6		mg/m³
Cal gas conc.	80.5		ppm
Conversion	1.61		ppm to mg/m³
MCERTS Range [B]	15.0		mg/m³
Lower of [A] or [B]	15.0		mg/m³
Cal gas conc.	129.3		mg/m³

Performance characteristics	RUN 1		Units
Response time	45		seconds
Number of readings in measurement	30		-
Repeatability at zero	2.00		% full scale
Repeatability at span level	0.00		% full scale
Deviation from linearity	0.20		% of value
Zero drift	0.13		% full scale
Span drift	0.25		% 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)	1.86		% 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/m³
Standard deviation of repeatability at span level	0.00		mg/m³
Lack of fit	0.02		mg/m³
Drift	0.13		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.01		mg/m³
Ambient temperature dependence	0.20		mg/m³
Combined interference (from MCERTS Certificate)	0.04		mg/m³
Dependence on voltage	0.06		mg/m³
Losses in the line (leak)	0.25		mg/m³
Uncertainty of calibration gas	0.27		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	23.68		mg/m³
Combined uncertainty			0.45		mg/m³
Expanded uncertainty	k =	1.96	0.89		mg/m³
Uncertainty corrected to std conds. (O_2)			0.89		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.74		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	0.89		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	15.0		% at ELV
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <15% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 15% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

Exova Catalyst, Unit 11, Aspen Close, Swindon, SN2 8AJ
T: 0800 328 1821 (or + 44 161 432 3286 from overseas)
E: paul.martin@exova.com
Your Exova Catalyst Contact: Paul Martin (07827 332630)

Stack Emissions Testing Report Commissioned by
Paxford Composites Ltd

Installation Name & Address
Paxford Composites Ltd
Red Wongs Way
Huntingdon
Cambridgeshire
PE29 7HB

PPC Permit: B01/02 (Variation ref: PPC 10/15)

Stack Reference
Spray Booth No1 - Large Communal Booth

Dates of the Monitoring Campaign
7th March 2017

Job Reference Number
CSW-2678

Report Written by
Rob Hester Team Leader MCERTS Level 2 MM 06 766 TE1 TE2 TE3 TE4

Report Approved by
Martin Futter Deputy Regional Manager MCERTS Level 2 MM 03 216 TE1 TE2 TE3 TE4

Report Date
29th March 2017

Version
Version 1

Signature of Report Approver


CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

Executive Summary

(Page 1 of 7)

MONITORING OBJECTIVES

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth
7th March 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Paxford Composites Ltd to carry out stack emissions testing on the Spray Booth No1 - Large Communal Booth at Huntingdon.

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)

Executive Summary

MONITORING RESULTS

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth
7th March 2017

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	2.5	0.7	50	g/hr	39	11	-
Total VOCs (as Carbon) [1]	mg/m³	78.6	2.2	100	g/hr	1212	87	-
Water Vapour	% v/v	4.5	0.2					
Stack Gas Temperature	°C	17.0						
Stack Gas Velocity	m/s	5.2	0.25					
Volumetric Flow Rate (ACTUAL)	m³/hr	16332	1077					
Volumetric Flow Rate (REF) [1]	m³/hr	15414	1016					

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

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

Executive Summary

MONITORING DATE(S) & TIMES

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth
7th March 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	2.5	g/hr	39	07/03/2017	14:35 - 15:05	30
Total VOCs (as Carbon)	R1	mg/m³	78.6	g/hr	1212	07/03/2017	14:35 - 15:05	30
Velocity & Volumetric Flow Rate	R1					07/03/2017	13:30 - 13:40	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth
7th March 2017

Standard Operating Conditions

Parameter	Value
Process Status	Normal
Capacity (of 100%) and Tonnes / Hour	N/A
Continuous or Batch Process	Batch
Feedstock (if applicable)	Flight Simulator Component Parts
Abatement System	Cartridge Filters
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	Not visible from sample location

MONITORING & ANALYTICAL METHODS

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth
7th March 2017

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.35 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % 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/m³
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	Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Rectangular
Depth	m	0.99
Width	m	0.88
Area	m²	0.87
Port Depth	cm	0
Orientation of Duct	-	Horizontal
Sample Port Size	-	Hole

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	No
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	No
Safe Access Available	Yes
Easy Access Available	No

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

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)

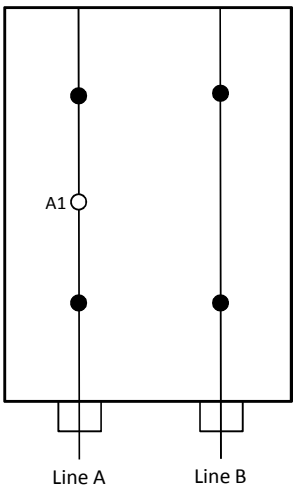
Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	22.5		> 5 Pa	Yes
Mean Velocity	m/s	5.21		-	-
Lowest Gas Velocity	m/s	5.21		-	-
Highest Gas Velocity	m/s	5.21		-	-
Ratio of Above	: 1	1.00		< 3 : 1	Yes
Maximum Angle of Swirl	°	12		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



where ○ = isokinetic point sampled at
● = isokinetic point not sampled at
● = combustion gases sample point
● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Rob Hester	MCERTS Level 2	MM 06 766	TE1 TE2 TE3 TE4
Technician	Wayne Gurbuz	MCERTS Level 1	MM 13 1252	TE1 & TE4

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.28
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.011
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.011
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.100
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21P.16
S-Pitot (2)	CAT 21P.81
L-Pitot	-
Site Balance	CAT 17.8
500g / 1Kg Check Weights	CAT 17.8
Last Impinger Arm	-
Callipers	CAT 23.32
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
Ankersmid APP100	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Hioki 5043 (V)	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.90
Digital Manometer (2)	CAT 3.35
Digital Temperature Meter	CAT 3.90
Stopwatch	CAT 14.53
Barometer	CAT 13.19
Stack Thermocouple (1)	CAT 4.576
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	CAT 20.18
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.4
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.34

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
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	0.99
Stack Width, W	m	0.88
Stack Area, A	m^2	0.87
Average Stack Gas Temperature, T_a	°C	17.0
Average Stack Gas Pressure	Pa	22.5
Average Stack Static Pressure, P_{static}	kPa	-0.140
Average Barometric Pressure, P_b	kPa	101.7
Average Pitot Tube Calibration Coefficient, C_p	-	0.85

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	19.85	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	75.54	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	4.55	0.0455	18.02	0.8037	0.03654

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.287
Wet Density (STP), P_{STW}	kg/m³	1.265
Dry Density (Actual), P_{Actual}	kg/m³	1.215
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.194

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (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 [1]
Temperature	°C	17.0	0.0
Total Pressure	kPa	101.6	101.3
Moisture	%	4.55	4.55

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	16332
Gas Volumetric Flowrate (STP, Wet)	m³/hr	15414
Gas Volumetric Flowrate (STP, Dry)	m³/hr	14714
Gas Volumetric Flowrate REF [1]	m³/hr	15414

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	07/03/2017
Time of Survey	-	13:30 - 13:40
Atmospheric Pressure	kPa	101.7
Average Stack Static Pressure	Pa	-140
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Horizontal
Pitot Tube, C_p	-	0.85
Number of Lines Available	-	1
Number of Lines Used	-	1

Sampling Line A

Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*-140.0*				
Mean		**22.5**	**17.0**	**1.194**	**5.21**	
1	0.50	22.5	17.0	1.194	5.21	12.0

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(Δpi)	1.069	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.053	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.006	
- Overall corrections to dynamic measurements	u(Cf)	0.143	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	19.855	
- $\varphi CO_2,w$	-	0.057	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.232	
- Oxygen, wet	u(ϕO_2,w)	0.610	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.480	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.695	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.069	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00643	-
Standard uncertainty associated with the local velocities	u(vi)	0.127	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.127	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.250	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	4.79	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	1076.9	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00113	
- $u^2(qV,w)$	-	301877	
- $u(qV,w)$	-	549.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	6.59	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	2.51		2.51
Uncertainty	±mg/m³	0.69		0.69
Mass Emission	g/hr	38.6		38.6
Uncertainty	±g/hr	11.0		11.0

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.5		4.5
Uncertainty	±% v/v	0.2		0.2

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.35		0.35

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	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.8	
Stack static pressure, P_{static}	mmH_2O	-4.6	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.4	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	-0.2	
Total mass collected in impingers (silica trap)	g	14.9	
Total mass of liquid collected, V_{lc}	g	14.7	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0183	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.4470	
Gas meter correction factor, Y_d	-	0.9180	
Average dry gas meter temperature, T_m	°C	19.8	
Average pressure drop across orifice, ΔH	mmH_2O	18.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.3846	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0455	
B_{wo} as a percentage	% v/v	4.55	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.55	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4029	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.35	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.85	
Average of velocity heads, ΔP_{avg}	mmH_2O	1.58	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.26	
Average stack gas temperature, T_s	°C	21.2	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	4.36	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.87	
$Q_a = (60)(A_s)(V_s)$	m^3/min	228.1	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	212.3	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	202.7	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	8.06	
Nozzle area, A_n	mm^2	51.03	
Total sampling time, q	min	30	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	108.0	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	14:35 - 15:05	
Sampling Dates	-	07/03/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.4029	
Filter I.D. Number	-	47-37910	
Start Filter Mass	g	0.14704	
End Filter Mass	g	0.14777	
Total Mass on Filter	g	0.00073	
Probe Rinse I.D. Number	-	PR-47-37910	
Start Probe Rinse Mass	g	2.88037	
End Probe Rinse Mass	g	2.88065	
Total Mass in Probe Rinse	g	0.00028	
Total Mass Collected	mg	1.01	
Calculated Concentration	mg/m^3	2.51	
Balance Uncertainty / LOD	mg/m^3	0.35	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	07/03/2017	
Average Volume Sampled (REF)	m^3	0.4029	
Filter I.D. Number	-	47-39842	
Start Filter Mass	g	0.14739	
End Filter Mass	g	0.14736	
Total Mass on Filter	g	-0.00003	
Probe Rinse I.D. Number	-	PR-47-39842	
Start Probe Rinse Mass	g	3.08179	
End Probe Rinse Mass	g	3.08182	
Total Mass in Probe Rinse	g	0.00003	
Total Mass Collected	mg	0.00	
Calculated Concentration	mg/m^3	0.01	
Balance Uncertainty / LOD	mg/m^3	0.35	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	13.68	
Pre-Sampling Leak Rate	l/min	0.03	
Post-Sampling Leak Rate	l/min	0.09	
Allowable Leak Rate	l/min	0.27	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.4	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	108.0	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.25	
Overall Weighing Uncertainty	± mg/m³	0.62	
ELV [Daily ELV for IED]	mg/m³	50.00	
Allowable Weighing Uncertainty	mg/m³	2.50	
Weighing Uncertainty Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	22	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	20.00	
Pre-Sampling Leak Rate	l/min	0.09	
Post-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.40	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	5.0	
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 (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.4470		uV_m	m^3	0.0089	
Sampled Gas Temperature	T_m	292.8		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.7		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.66		uL	%	-	
Mass of Particulate	m	1.01		um	mg	0.14	
Uncollected Mass	UCM	0.00		uUCM	mg	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.66		≤2%
Mass of Particulate	%	0.69		<5% of ELV
Uncollected Mass	%	-		-

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.3846		6.52	
Leak	L	mg/m^3	0.010		1.00	
Mass of Particulate	L_r	mg	1.010		2.48	
Uncollected Mass	UCM	mg	0.00		2.48	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.067	
Leak	mg/m^3	0.0095	
Mass of Particulate	mg/m^3	0.3474	
Uncollected Mass	mg/m^3	0.0048	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.35	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.69	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.69	
Reported Uncertainty	mg/m^3	0.69	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	27.7	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	27.7	
Reported Uncertainty	%	27.7	

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Booth No1 - Large Communal Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	78.6		78.6
Uncertainty	±mg/m³	2.2		2.2
Mass Emission	g/hr	1212		1212
Uncertainty	±g/hr	87		87

General Sampling Information

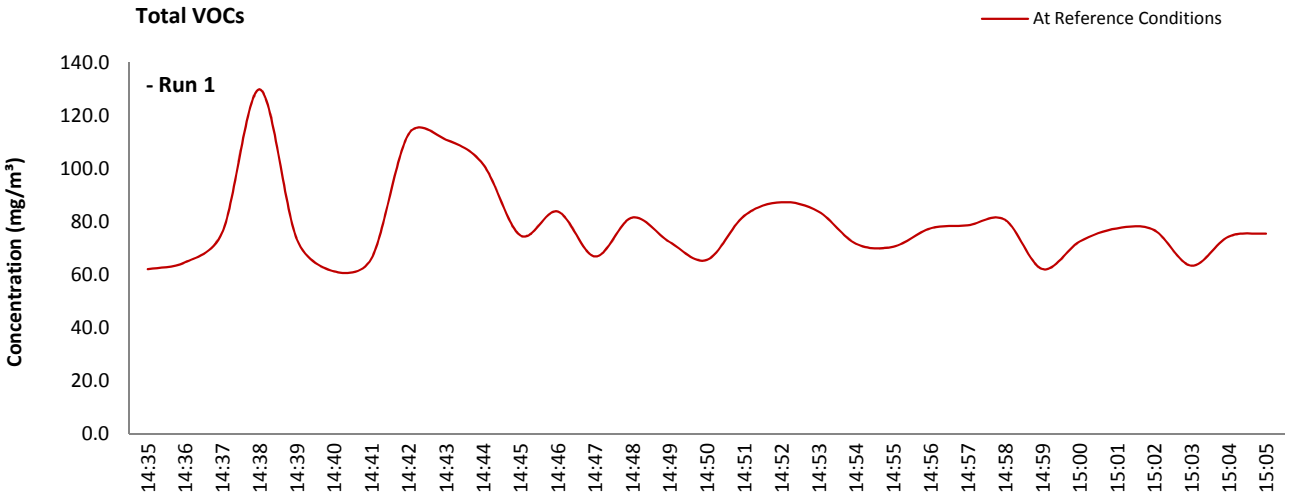
Parameter	Value	
Standard	EN 12619:2013	
Technical Procedure	CAT-TP-20	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Propane In Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 1.0204a	
Span Gas Expiry Date	18/11/2020	
Span Gas Start Pressure (bar)	120	
Gas Cylinder Concentration (ppm)	80.2	
Span Gas Set Point (ppm)	80.20	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Synthetic Air (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

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	-	14:35 - 15:05	
Sampling Dates	-	07/03/2017	
Instrument Range	ppm	100	
Span Gas Value	ppm	80.2	

Quality Assurance

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.20	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.40	
CAL 1	Zero Drift	ppm	0.20	
	Allowable Zero Drift	± ppm	4.01	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	79.80	
CAL 1	Span Down Sampling Line (Post)	ppm	80.40	
CAL 1	Span Drift	ppm	0.60	
	Allowable Span Drift	± ppm	4.01	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	12 - 13	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 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	100.0		mg/m³ (REF)
TGN M2 Allowable MU	15.0		%
Measured concentration	82.34		mg/m³ (STP, dry)
Range Used	100.0		ppm
Range Used [A]	160.6		mg/m³
Cal gas conc.	80.2		ppm
Conversion	1.61		ppm to mg/m³
MCERTS Range [B]	15.0		mg/m³
Lower of [A] or [B]	15.0		mg/m³
Cal gas conc.	128.8		mg/m³

Performance characteristics	RUN 1		Units
Response time	45		seconds
Number of readings in measurement	30		-
Repeatability at zero	2.00		% full scale
Repeatability at span level	0.00		% full scale
Deviation from linearity	0.07		% of value
Zero drift	0.25		% full scale
Span drift	0.75		% 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)	0.75		% 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/m³
Standard deviation of repeatability at span level	0.00		mg/m³
Lack of fit	0.01		mg/m³
Drift	0.54		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.01		mg/m³
Ambient temperature dependence	0.20		mg/m³
Combined interference (from MCERTS Certificate)	0.04		mg/m³
Dependence on voltage	0.06		mg/m³
Losses in the line (leak)	0.36		mg/m³
Uncertainty of calibration gas	0.95		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	82.34		mg/m³
Combined uncertainty			1.17		mg/m³
Expanded uncertainty	k =	1.96	2.30		mg/m³
Uncertainty corrected to std conds. (O_2)			2.30		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.79		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	2.30		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	15.0		% at ELV
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <15% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 15% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

Exova Catalyst, Unit 11, Aspen Close, Swindon, SN2 8AJ
T: 0800 328 1821 (or + 44 161 432 3286 from overseas)
E: paul.martin@exova.com
Your Exova Catalyst Contact: Paul Martin (07827 332630)

Stack Emissions Testing Report Commissioned by
Paxford Composites Ltd

Installation Name & Address
Paxford Composites Ltd
Red Wongs Way
Huntingdon
Cambridgeshire
PE29 7HB

PPC Permit: B01/02 (Variation ref: PPC 10/15)

Stack Reference
Spray Booth No 2 - Cyclone 2 Booth

Dates of the Monitoring Campaign
7th March 2017

Job Reference Number
CSW-2678

Report Written by
Rob Hester Team Leader MCERTS Level 2 MM 06 766 TE1 TE2 TE3 TE4

Report Approved by
Martin Futter Deputy Regional Manager MCERTS Level 2 MM 03 216 TE1 TE2 TE3 TE4

Report Date
29th March 2017

Version
Version 1

Signature of Report Approver


CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

Executive Summary

MONITORING OBJECTIVES

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth
7th March 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Paxford Composites Ltd to carry out stack emissions testing on the Spray Booth No 2 - Cyclone 2 Booth at Huntingdon.

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)

Executive Summary

MONITORING RESULTS

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth
7th March 2017

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	4.1	0.7	50	g/hr	25.2	5.3	-
Total VOCs (as Carbon) [1]	mg/m³	93.0	2.6	100	g/hr	577.1	63.4	-
Water Vapour	% v/v	3.4	0.2					
Stack Gas Temperature	°C	17.0						
Stack Gas Velocity	m/s	3.6	0.35					
Volumetric Flow Rate (ACTUAL)	m³/hr	6575	700					
Volumetric Flow Rate (REF) [1]	m³/hr	6206	660					

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

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

Executive Summary

MONITORING DATE(S) & TIMES

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth
7th March 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	4.1	g/hr	25.2	07/03/2017	16:13 - 16:43	30
Total VOCs (as Carbon)	R1	mg/m³	93.0	g/hr	577.1	07/03/2017	16:13 - 16:43	30
Velocity & Volumetric Flow Rate	R1					07/03/2017	15:50 - 16:00	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth
7th March 2017

Standard Operating Conditions

Parameter	Value
Process Status	Normal
Capacity (of 100%) and Tonnes / Hour	N/A
Continuous or Batch Process	Batch
Feedstock (if applicable)	Flight Simulator Component Parts
Abatement System	Cartridge Filters
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	Not visible from sample location

Executive Summary

MONITORING & ANALYTICAL METHODS

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth
7th March 2017

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.35 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % 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/m³
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	Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.

Executive Summary

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.80
Width	m	-
Area	m²	0.50
Port Depth	cm	0
Orientation of Duct	-	Vertical
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	No
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	No
Safe Access Available	Yes
Easy Access Available	No

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

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	11.0		> 5 Pa	Yes
Mean Velocity	m/s	3.63		-	-
Lowest Gas Velocity	m/s	3.63		-	-
Highest Gas Velocity	m/s	3.63		-	-
Ratio of Above	: 1	1.00		< 3 : 1	Yes
Maximum Angle of Swirl	°	12		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

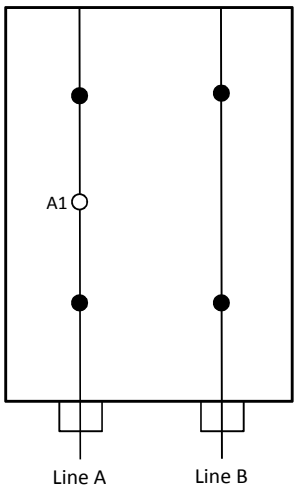
Photo 1

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

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Rob Hester	MCERTS Level 2	MM 06 766	TE1 TE2 TE3 TE4
Technician	Wayne Gurbuz	MCERTS Level 1	MM 13 1252	TE1 & TE4

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.28
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.011
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.011
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.100
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21P.16
S-Pitot (2)	CAT 21P.81
L-Pitot	-
Site Balance	CAT 17.8
500g / 1Kg Check Weights	CAT 17.8
Last Impinger Arm	-
Callipers	CAT 23.32
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
Ankersmid APP100	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Hioki 5043 (V)	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.90
Digital Manometer (2)	CAT 3.35
Digital Temperature Meter	CAT 3.90
Stopwatch	CAT 14.53
Barometer	CAT 13.19
Stack Thermocouple (1)	CAT 4.576
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	CAT 20.18
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.4
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.34

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
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	0.80
Stack Width, W	m	-
Stack Area, A	m^2	0.50
Average Stack Gas Temperature, T_a	°C	17.0
Average Stack Gas Pressure	Pa	11.0
Average Stack Static Pressure, P_{static}	kPa	-0.140
Average Barometric Pressure, P_b	kPa	101.7
Average Pitot Tube Calibration Coefficient, C_p	-	0.85

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.09	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	76.46	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	3.39	0.0339	18.02	0.8037	0.02726

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.287
Wet Density (STP), P_{STW}	kg/m³	1.271
Dry Density (Actual), P_{Actual}	kg/m³	1.215
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.199

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (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 [1]
Temperature	°C	17.0	0.0
Total Pressure	kPa	101.6	101.3
Moisture	%	3.39	3.39

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	6575
Gas Volumetric Flowrate (STP, Wet)	m³/hr	6206
Gas Volumetric Flowrate (STP, Dry)	m³/hr	5995
Gas Volumetric Flowrate REF [1]	m³/hr	6206

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	07/03/2017
Time of Survey	-	15:50 - 16:00
Atmospheric Pressure	kPa	101.7
Average Stack Static Pressure	Pa	-140
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.85
Number of Lines Available	-	1
Number of Lines Used	-	1

Sampling Line A

Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*-140.0*				
Mean		**11.0**	**17.0**	**1.199**	**3.63**	
1	0.40	11.0	17.0	1.199	3.63	12.0

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(Δpi)	1.071	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.013	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.049	
- Overall corrections to dynamic measurements	u(Cf)	0.146	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.095	
- $\varphi CO_2,w$	-	0.058	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.173	
- Oxygen, wet	u(ϕO_2,w)	0.616	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.480	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.695	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.071	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00646	-
Standard uncertainty associated with the local velocities	u(vi)	0.179	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.179	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.350	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	9.63	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	699.8	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00295	
- $u^2(qV,w)$	-	127489	
- $u(qV,w)$	-	357.1	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	10.64	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	4.06		4.06
Uncertainty	±mg/m³	0.74		0.74
Mass Emission	g/hr	25.2		25.2
Uncertainty	±g/hr	5.3		5.3

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	3.4		3.4
Uncertainty	±% v/v	0.2		0.2

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.35		0.35

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	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.8	
Stack static pressure, P_{static}	mmH_2O	-12.6	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	761.8	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	16.7	
Total mass collected in impingers (silica trap)	g	-5.7	
Total mass of liquid collected, V_{lc}	g	11.0	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0137	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.4570	
Gas meter correction factor, Y_d	-	0.9180	
Average dry gas meter temperature, T_m	°C	22.0	
Average pressure drop across orifice, ΔH	mmH_2O	21.2	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.3904	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0339	
B_{wo} as a percentage	% v/v	3.39	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.39	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4041	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.47	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.85	
Average of velocity heads, ΔP_{avg}	mmH_2O	1.79	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.34	
Average stack gas temperature, T_s	°C	23.2	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	4.65	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.50	
$Q_a = (60)(A_s)(V_s)$	m^3/min	140.2	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	129.6	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	125.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	8.06	
Nozzle area, A_n	mm^2	51.03	
Total sampling time, q	min	30	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	102.4	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	16:13 - 16:43	
Sampling Dates	-	07/03/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.4041	
Filter I.D. Number	-	47-39844	
Start Filter Mass	g	0.14862	
End Filter Mass	g	0.15025	
Total Mass on Filter	g	0.00163	
Probe Rinse I.D. Number	-	PR-47-39844	
Start Probe Rinse Mass	g	2.90467	
End Probe Rinse Mass	g	2.90468	
Total Mass in Probe Rinse	g	0.00001	
Total Mass Collected	mg	1.64	
Calculated Concentration	mg/m^3	4.06	
Balance Uncertainty / LOD	mg/m^3	0.35	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	07/03/2017	
Average Volume Sampled (REF)	m^3	0.4041	
Filter I.D. Number	-	47-39843	
Start Filter Mass	g	0.14677	
End Filter Mass	g	0.14671	
Total Mass on Filter	g	-0.00006	
Probe Rinse I.D. Number	-	PR-47-39843	
Start Probe Rinse Mass	g	3.01204	
End Probe Rinse Mass	g	3.01203	
Total Mass in Probe Rinse	g	-0.00001	
Total Mass Collected	mg	-0.07	
Calculated Concentration	mg/m^3	-0.17	
Balance Uncertainty / LOD	mg/m^3	0.35	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	13.98	
Pre-Sampling Leak Rate	l/min	0.08	
Post-Sampling Leak Rate	l/min	0.09	
Allowable Leak Rate	l/min	0.28	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.5	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	102.4	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.25	
Overall Weighing Uncertainty	± mg/m³	0.62	
ELV [Daily ELV for IED]	mg/m³	50.00	
Allowable Weighing Uncertainty	mg/m³	2.50	
Weighing Uncertainty Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	24	

Test Conditions	Units	Run 1	
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	20.00	
Pre-Sampling Leak Rate	l/min	0.10	
Post-Sampling Leak Rate	l/min	0.10	
Allowable Leak Rate	l/min	0.40	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	5.0	
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	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.4570		uV_m	m^3	0.0091	
Sampled Gas Temperature	T_m	295.0		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.64		uL	%	-	
Mass of Particulate	m	1.64		um	mg	0.14	
Uncollected Mass	UCM	-0.07		uUCM	mg	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.64		≤2%
Mass of Particulate	%	0.69		<5% of ELV
Uncollected Mass	%	-		-

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.3904		10.39	
Leak	L	mg/m^3	0.015		1.00	
Mass of Particulate	L_r	mg	1.640		2.47	
Uncollected Mass	UCM	mg	-0.04		2.47	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.109	
Leak	mg/m^3	0.0151	
Mass of Particulate	mg/m^3	0.3464	
Uncollected Mass	mg/m^3	-0.1000	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.38	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.74	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.74	
Reported Uncertainty	mg/m^3	0.74	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	18.2	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	18.2	
Reported Uncertainty	%	18.2	

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Booth No 2 - Cyclone 2 Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	93.0		93.0
Uncertainty	±mg/m³	2.6		2.6
Mass Emission	g/hr	577.1		577.1
Uncertainty	±g/hr	63.4		63.4

General Sampling Information

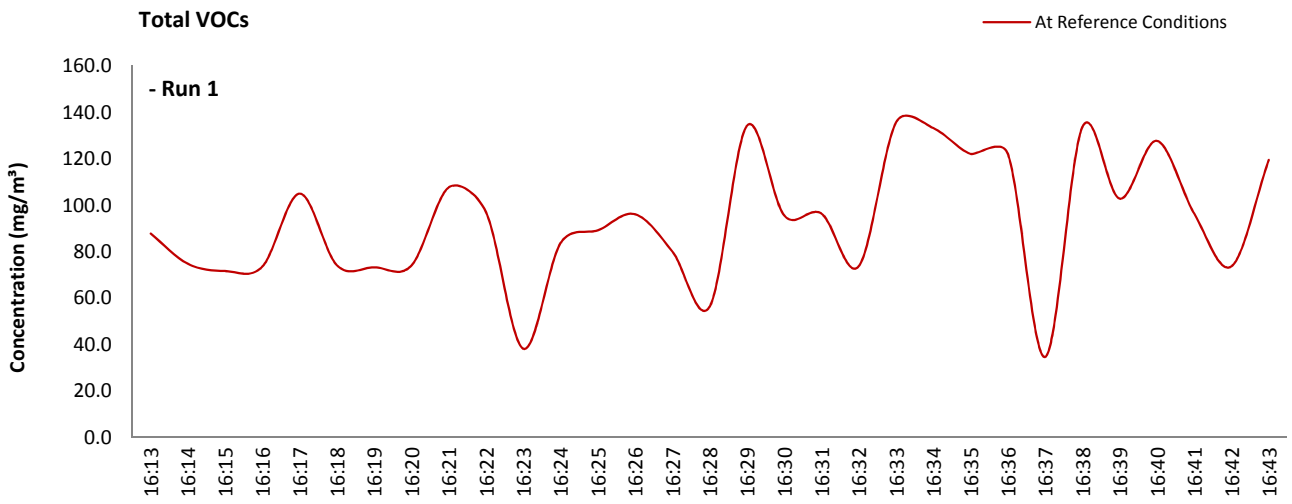
Parameter	Value	
Standard	EN 12619:2013	
Technical Procedure	CAT-TP-20	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Propane In Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 1.0204a	
Span Gas Expiry Date	18/11/2020	
Span Gas Start Pressure (bar)	120	
Gas Cylinder Concentration (ppm)	80.2	
Span Gas Set Point (ppm)	80.20	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Synthetic Air (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

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	-	16:13 - 16:43	
Sampling Dates	-	07/03/2017	
Instrument Range	ppm	100	
Span Gas Value	ppm	80.2	

Quality Assurance

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.20	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.40	
CAL 1	Zero Drift	ppm	0.20	
	Allowable Zero Drift	± ppm	4.01	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	79.80	
CAL 1	Span Down Sampling Line (Post)	ppm	80.40	
CAL 1	Span Drift	ppm	0.60	
	Allowable Span Drift	± ppm	4.01	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	12 - 13	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 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	100.0		mg/m³ (REF)
TGN M2 Allowable MU	15.0		%
Measured concentration	96.26		mg/m³ (STP, dry)
Range Used	100.0		ppm
Range Used [A]	160.6		mg/m³
Cal gas conc.	80.2		ppm
Conversion	1.61		ppm to mg/m³
MCERTS Range [B]	15.0		mg/m³
Lower of [A] or [B]	15.0		mg/m³
Cal gas conc.	128.8		mg/m³

Performance characteristics	RUN 1		Units
Response time	45		seconds
Number of readings in measurement	30		-
Repeatability at zero	2.00		% full scale
Repeatability at span level	0.00		% full scale
Deviation from linearity	0.07		% of value
Zero drift	0.25		% full scale
Span drift	0.75		% 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)	0.75		% 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/m³
Standard deviation of repeatability at span level	0.00		mg/m³
Lack of fit	0.01		mg/m³
Drift	0.60		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.01		mg/m³
Ambient temperature dependence	0.20		mg/m³
Combined interference (from MCERTS Certificate)	0.04		mg/m³
Dependence on voltage	0.06		mg/m³
Losses in the line (leak)	0.42		mg/m³
Uncertainty of calibration gas	1.11		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	96.26		mg/m³
Combined uncertainty			1.35		mg/m³
Expanded uncertainty	k =	1.96	2.64		mg/m³
Uncertainty corrected to std conds. (O_2)			2.64		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.75		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	2.64		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	15.0		% at ELV
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <15% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 15% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

Exova Catalyst, Unit 11, Aspen Close, Swindon, SN2 8AJ
E: paul.martin@exova.com
Your Exova Catalyst Contact: Paul Martin (07827 332 630)

Stack Emissions Testing Report Commissioned by
Paxford Composites Ltd

Installation Name & Address
Paxford Composites Ltd
Red Wongs Way
Huntingdon
Cambridgeshire
PE29 7HB

PPC Permit: B01/02

Stack Reference
Spray Bake Booth

Dates of the Monitoring Campaign
27th September 2017

Job Reference Number
CSW-2967

Report Written by
David Guy Team Leader MCERTS Level 2 MM 09 1044 TE1 TE2 TE3 TE4

Report Approved by
Matthew Hopes Team Leader MCERTS Level 2 MM 06 688 TE1 TE2 TE3 TE4

Report Date
2nd October 2017

Version
Version 1

Signature of Report Approver


CONTENTS

MONITORING OBJECTIVES

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
27th September 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Paxford Composites Ltd to carry out stack emissions testing on the Spray Bake Booth at Huntingdon.

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

Isocyanates

Executive Summary

(Page 2 of 7)

MONITORING RESULTS

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
27th September 2017

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Isocyanates [1]	mg/m³	0.049	0.013	0.10	g/hr	0.48	0.13	-
Water Vapour	% v/v	1.0	0.06					
Stack Gas Temperature	°C	20.0						
Stack Gas Velocity	m/s	10.3	0.20					
Volumetric Flow Rate (ACTUAL)	m³/hr	10466	516					
Volumetric Flow Rate (REF) [1]	m³/hr	9767	481					

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

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

Executive Summary

MONITORING DATE(S) & TIMES

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
27th September 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Isocyanates	R1	mg/m³	0.049	g/hr	0.48	27/09/2017	09:14 - 09:30; 09:32 - 09:48	32
Velocity & Volumetric Flow Rate	R1					27/09/2017	08:35 - 08:45	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
27th September 2017

Standard Operating Conditions

Parameter	Value
Process Status	Operational
Capacity (of 100%) and Tonnes / Hour	N/A
Continuous or Batch Process	Batch
Feedstock (if applicable)	Composite Components Being Spray Painted
Abatement System	Filter Backed Booths
Abatement System Running Status	Operational
Fuel	N/A
Plume Appearance	None Visible From Sampling Location

Executive Summary

MONITORING & ANALYTICAL METHODS

Paxford Composites Ltd, Huntingdon
Spray Bake Booth
27th September 2017

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Isocyanates	US EPA CTM36	CAT-TP-17	Yes	CAT	M119	HPLC	Yes	RPS	Yes	0.0006 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % 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
RPS Laboratories Ltd (RPS)	ISO 17025 Accreditation Number: 0605

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Isocyanates	All	The blank result was higher than 10% of the ELV, however it should be noted that the results were of an extremely low order.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.60
Width	m	-
Area	m²	0.28
Port Depth	cm	9
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Inside

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	No

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

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	88.0		> 5 Pa	Yes
Mean Velocity	m/s	10.28		-	-
Lowest Gas Velocity	m/s	10.17		-	-
Highest Gas Velocity	m/s	10.40		-	-
Ratio of Above	: 1	1.02		< 3 : 1	Yes
Maximum Angle of Swirl	°	8		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

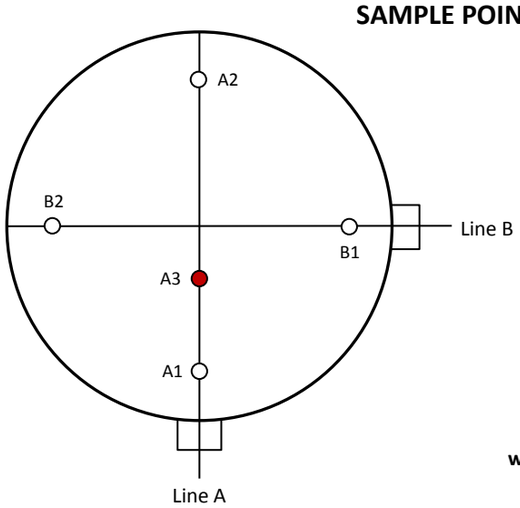
PLANT PHOTOS

Photo 1

Photo 2

Photo 3

SAMPLE POINTS



where
- ○ = isokinetic point sampled at
- ● = isokinetic point not sampled at
- ● = combustion gases sample point
- ● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	David Guy	MCERTS Level 2	MM 09 1044	TE1 TE2 TE3 TE4
Technician	William Trueman	MCERTS Level 1	MM 06 753	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.7
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.20
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.20
Umbilical (2)	-
Oven Box (1)	CAT 12.60
Oven Box (2)	-
Heated Probe (1)	-
Heated Probe (2)	CAT 5.69
Heated Probe (3)	-
S-Pitot (1)	CAT 21P.52
S-Pitot (2)	CAT 21P.64/21P.66
L-Pitot	-
Site Balance	CAT 17.3
500g / 1Kg Check Weights	CAT 17.3
Last Impinger Arm	-
Callipers	-
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250 SRM	-
Servomex 5200 MP	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	CAT 8.2
Ankersmid APP100	CAT 12.73
Mass Flow Controller (1)	CAT 6.13
Mass Flow Controller (2)	CAT 6.14
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	CAT 11.1
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.55
Digital Manometer (2)	CAT 3.101
Digital Temperature Meter	CAT 3.55
Stopwatch	AT 14.12/14.14/14.5
Barometer	CAT 13.3
Stack Thermocouple (1)	CAT 4.415 / 4.536
Stack Thermocouple (2)	CAT 4.432 / 4.499
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	CAT 20.7
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	
Tape Measure	CAT 16.1 / 16.37

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Isocyanates	US EPA CTM36	CAT-TP-17
Water Vapour	EN 14790	CAT-TP-05
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	0.60
Stack Width, W	m	-
Stack Area, A	m^2	0.28
Average Stack Gas Temperature, T_a	°C	20.0
Average Stack Gas Pressure	Pa	90.0
Average Stack Static Pressure, P_{static}	kPa	0.053
Average Barometric Pressure, P_b	kPa	101.4
Average Pitot Tube Calibration Coefficient, C_p	-	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/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.90	20.68	0.2090	32.00	1.4277	0.29838
N_2	-	79.04	78.22	0.7904	28.01	1.2498	0.98788
Moisture (H_2O)	-	-	1.04	0.0104	18.02	0.8037	0.00837

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.287
Wet Density (STP), P_{STW}	kg/m³	1.282
Dry Density (Actual), P_{Actual}	kg/m³	1.201
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.197

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (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 [1]
Temperature	°C	20.0	0.0
Total Pressure	kPa	101.5	101.3
Moisture	%	1.04	1.04

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	10466
Gas Volumetric Flowrate (STP, Wet)	m³/hr	9767
Gas Volumetric Flowrate (STP, Dry)	m³/hr	9665
Gas Volumetric Flowrate REF [1]	m³/hr	9767

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	27/09/2017
Time of Survey	-	08:35 - 08:45
Atmospheric Pressure	kPa	101.4
Average Stack Static Pressure	Pa	53
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	Yes
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	1

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*50.0*					*55.0*				
Mean		**89.0**	**20.0**	**1.197**	**10.22**		**91.0**	**20.0**	**1.197**	**10.34**	
1	0.09	88.0	20.0	1.197	10.17	5.0	90.0	20.0	1.197	10.28	7.0
2	0.51	90.0	20.0	1.197	10.28	5.0	92.0	20.0	1.197	10.40	8.0

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(Δpi)	1.594	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.843	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.614	
- Overall corrections to dynamic measurements	u(Cf)	1.542	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.682	
- $\varphi CO_2,w$	-	0.059	
- Oxygen, dry	u(ϕO_2,d)	0.640	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.053	
- Oxygen, wet	u(ϕO_2,w)	0.633	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.495	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.699	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.594	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00645	-
Standard uncertainty associated with the local velocities	u(vi)	0.129	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.102	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.201	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	1.95	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	515.9	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00063	
- $u^2(qV,w)$	-	69290	
- u(qV,w)	-	263.2	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.93	%

ISOCYANATES: RESULTS SUMMARY

Paxford Composites Ltd, Huntingdon
Spray Bake Booth

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.049		0.049
Uncertainty	±mg/m³	0.013		0.013
Mass Emission	g/hr	0.48		0.48
Uncertainty	±g/hr	0.13		0.13

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.04		1.04
Uncertainty	±% v/v	0.06		0.06

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.026		0.026

General Sampling Information

Parameter	Value	
Standard	US EPA CTM36	
Technical Procedure	CAT-TP-17	
Name of Analytical Laboratory	RPS	
Analytical Laboratory's Procedure	M119	
ISO 17025 Accredited Analysis?	Yes	
Date of Sample Analysis	02/10/2017	
Probe Material	Titanium	
Filter Housing / Nozzle Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	1 2-PP Impregnated 47mm Glass Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1 & B2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

ISOCYANATES: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	761.3	
Stack static pressure, P_{static}	mmH_2O	5.1	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	761.6	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	4.0	
Total mass collected in impingers (silica trap)	g	1.6	
Total mass of liquid collected, V_{lc}	g	5.6	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0070	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.6890	
Gas meter correction factor, Y_d	-	1.0280	
Average dry gas meter temperature, T_m	°C	20.6	
Average pressure drop across orifice, ΔH	mmH_2O	51.4	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.6630	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0104	
B_{wo} as a percentage	% v/v	1.04	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	1.04	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.6700	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.90	
Total	% v/v	20.96	
N_2	% v/v	79.04	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.73	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	8.22	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	2.87	
Average stack gas temperature, T_s	°C	32.9	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	9.96	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.28	
$Q_a = (60)(A_s)(V_s)$	m^3/min	168.9	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	151.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	149.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	7.00	
Nozzle area, A_n	mm^2	38.49	
Total sampling time, q	min	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	101.8	

ISOCYANATES: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	09:14 - 09:30; 09:32 - 09:48	
Sampling Dates	-	27/09/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.6700	
Methyl Diisocyanate (MDI)	µg	< 0.14	
Hexamethylene Diisocyanate (HDI)	µg	< 0.14	
Toluene Diisocyanates (TDI)	µg	32.68	
Total Mass Collected	µg	32.96	
Calculated Concentration	mg/m^3	0.049	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	27/09/2017	
Average Volume Sampled (REF)	m^3	0.6700	
Methyl Diisocyanate (MDI)	µg	< 0.14	
Hexamethylene Diisocyanate (HDI)	µg	< 0.14	
Toluene Diisocyanates (TDI)	µg	17.37	
Total Mass Collected	µg	17.65	
Calculated Concentration	mg/m^3	0.026	

ISOCYANATES: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	22.13	
Pre-Sampling Leak Rate	l/min	0.10	
Post-Sampling Leak Rate	l/min	0.10	
Allowable Leak Rate	l/min	0.44	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	6.1	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	101.8	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Maximum Filter Temperature	°C	35	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	18.00	
Sampling Leak Rate	l/min	0.10	
Allowable Leak Rate	l/min	0.36	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	0.010	
Blank Acceptable	-	No	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
The blank result was higher than 10% of the ELV, however it should be noted that the results were of an extremely low order.	x	

ISOCYANATES: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.6890		uV_m	m^3	0.0138	
Sampled Gas Temperature	T_m	293.6		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.45		uL	%	-	
Laboratory Result	L_r	10.00		uL_r	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.45		≤2%
Laboratory Result	%	10.00		No Requirement

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.6630		0.07	
Leak	L	mg/m^3	0.000		1.00	
Laboratory Result	L_r	mg/m^3	0.005		1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.001	
Leak	mg/m^3	0.0001	
Laboratory Result	mg/m^3	0.0049	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.005	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.010	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.013	
Reported Uncertainty	mg/m^3	0.013	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	20.2	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	26.2	
Reported Uncertainty	%	26.2	