



Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
T: 0800 328 1821 (or + 44 161 432 3286 from overseas)
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Enviro Solution

Installation Name & Address
Rapid Precision Engineering Ltd
Unit 16 Brickfields
Wilson Road
Huyton Business Park
Liverpool
L36 6HY

PPC Permit: None

Stack Reference
Paint Stack

Dates of the Monitoring Campaign
17th February 2017

Job Reference Number
CAT-3250

Report Written by
Danny Pryke Team Leader MCERTS Level 2 MM 03 163 TE1 TE2 TE3 TE4

Report Approved by
Derek Myers Team Leader MCERTS Level 2 MM 02 115 TE1 TE2 TE3 TE4

Report Date
15th March 2017

Version
Version 1

Signature of Report Approver

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Executive Summary

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MONITORING OBJECTIVES

Rapid Precision Engineering Ltd, Liverpool

Paint Stack

17th February 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Enviro Solution to carry out stack emissions testing for Rapid Precision Engineering Ltd on the Paint Stack at Liverpool.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, Total VOCs (as Carbon)

Executive Summary

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MONITORING RESULTS

Rapid Precision Engineering Ltd, Liverpool

Paint Stack

17th February 2017

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter	¹ mg/m ³	2.6	0.38	-	g/hr	20.8	3.2	-
Total VOCs (as Carbon)	¹ mg/m ³	13.3	0.50	-	g/hr	105	6.6	-
Water Vapour	% v/v	5.0	0.25					
Stack Gas Temperature	°C	15.0						
Stack Gas Velocity	m/s	8.0	0.16					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	8450	418					
Volumetric Flow Rate (REF)	¹ m ³ /hr	7940	393					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

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

Executive Summary

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MONITORING DATE(S) & TIMES

Rapid Precision Engineering Ltd, Liverpool

Paint Stack

17th February 2017

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1 mg/m ³	2.6	g/hr	20.8	17/02/2017	09:45 - 10:15, 10:17 - 10:47	60
Total VOCs (as Carbon)	R1 mg/m ³	13.3	g/hr	105	17/02/2017	09:45 - 10:45	60
Velocity & Volumetric Flow Rate	R1				17/02/2017	10:18 - 10:32	

All results are expressed at the respective reference conditions.

Executive Summary

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PROCESS DETAILS

Rapid Precision Engineering Ltd, Liverpool

Paint Stack

17th February 2017

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Full Capacity
Continuous or Batch Process	Continuous Batch
Feedstock (if applicable)	Plane Parts
Abatement System	Bag Filter
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	None Visible

Executive Summary

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MONITORING & ANALYTICAL METHODS

Rapid Precision Engineering Ltd, Liverpool

Paint Stack

17th February 2017

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.1 mg/m ³
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/m ³
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
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SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All	There are no deviations associated with the sampling employed.

Executive Summary

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SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.61
Width	m	-
Area	m ²	0.29
Port Depth	cm	9
Orientation of Duct	-	Vertical
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Temporary
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	Yes

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	55.0	> 5 Pa	Yes
Mean Velocity	m/s	8.29	-	-
Lowest Gas Velocity	m/s	8.07	-	-
Highest Gas Velocity	m/s	8.64	-	-
Ratio of Above	: 1	1.07	< 3 : 1	Yes
Maximum Angle of Swirl	°	4	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

Executive Summary

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PLANT PHOTOS

Photo 1



Photo 2



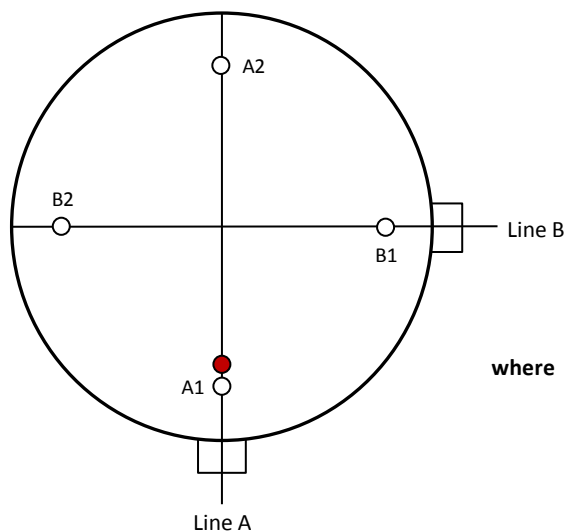
Photo 3



Photo 4



SAMPLE POINTS



- where
- = isokinetic point sampled at
 - = isokinetic point not sampled at
 - (red) = combustion gases sample point
 - (blue) = non-isokinetic sample point



APPENDICES

APPENDIX CONTENTS

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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Danny Pryke	MCERTS Level 2	MM 03 163	TE1 TE2 TE3 TE4
Technician	Craig Macdonald	MCERTS Level 1	MM 11 1130	None

LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.62	Horiba PG-250	-	Digital Manometer (1)	CAT 3.25
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	-
Box Thermocouples (1)	-	Servomex 4900	-	Digital Temperature Meter	CAT 3.25
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.72
Umbilical (1)	CAT 7.62	ABB AO2020-URAS26	-	Barometer	CAT 13.38
Umbilical (2)	-	Servomex 5200MP	-	Stack Thermocouple (1)	-
Oven Box (1)	CAT DP	JCT JCC P1 Cooler	-	Stack Thermocouple (2)	-
Oven Box (2)	-	Gasmet DX4000	-	Stack Thermocouple (3)	-
Heated Probe (1)	CAT 5.12	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	-	Bernath 3006 FID	CAT 8.61	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	-	1m Heated Line (3)	-
S-Pitot (1)	-	Mass Flow Controller (1)	CAT 6.48	10m Heated Line (1)	CAT 20.69
S-Pitot (2)	-	Mass Flow Controller (2)	CAT 6.49	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	CAT 25.46	20m Heated Line (1)	-
Site Balance	CAT 17.26	Mass View (2)	CAT 25.47	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.26	Easylogger EN-EL-12 Bit	-	Dual Channel Heater Controller	-
Last Impinger Arm	-	Easylogger EN-EL-12 Bit	-	Single Channel Heater Controller	-
Callipers	CAT 23.27	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.31

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	0.61
Stack Width, W	m	-
Stack Area, A	m ²	0.29
Average Stack Gas Temperature, T _a	°C	15.2
Average Stack Gas Pressure	Pa	58.0
Average Stack Static Pressure, P _{static}	kPa	0.044
Average Barometric Pressure, P _b	kPa	100.4
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/m ³ p	Conc kg/m ³ p _i
CO ₂ (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O ₂ (Estimated)	-	20.80	19.76	0.2080	32.00	1.4277	0.29696
N ₂	-	79.14	75.19	0.7914	28.01	1.2498	0.98913
Moisture (H ₂ O)	-	-	4.99	0.0499	18.02	0.8037	0.04013

Where: $p = M / 22.41$
 $p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P _{STD}	kg/m ³	1.287
Wet Density (STP), P _{STW}	kg/m ³	1.263
Dry Density (Actual), P _{Actual}	kg/m ³	1.209
Average Wet Density (Actual), P _{ActualW}	kg/m ³	1.186

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	15.2	0.0
Total Pressure	kPa	100.4	101.3
Moisture	%	4.99	4.99

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	8720
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	8189
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	7780
Gas Volumetric Flowrate REF ¹	m ³ /hr	8189

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	17/02/2017
Time of Survey	-	10:18 - 10:32
Atmospheric Pressure	kPa	100.4
Average Stack Static Pressure	Pa	44
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	-	2

Traverse Point	Depth m	Sampling Line A					Sampling Line B				
		ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °
<i>STATIC (Units: Pa)</i>		45.0					43.0				
Mean		56.5	15.3	1.186	8.18		59.5	15.2	1.186	8.39	
1	0.09	55.0	15.2	1.186	8.07	2.0	56.0	15.1	1.187	8.14	2.0
2	0.52	58.0	15.3	1.186	8.29	4.0	63.0	15.3	1.186	8.64	4.0

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	$u(k)$	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	$u(\Delta p_i)$	1.215	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.350	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	0.042	
- Overall corrections to dynamic measurements	$u(C_f)$	0.477	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00004	-
- $\varphi_{O_2,w}$	-	19.762	
- $\varphi_{CO_2,w}$	-	0.057	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.637	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.002	
- Water Vapour	$u(\phi_{H_2O})$	0.255	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.607	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.002	
Standard uncertainty associated with the stack temperature	$u(T_c)$	1.471	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.694	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	0.859	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00640	-
Standard uncertainty associated with the local velocities	$u(v_i)$	0.113	Pa
Standard uncertainty associated with the mean velocity	$u(\underline{v})$	0.085	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.166	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	2.01	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	431.7	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00064	
- $u^2(qV,w)$	-	48517	
- $u(qV,w)$	-	220.3	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	4.95	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Rapid Precision Engineering Ltd, Liverpool
Paint Stack

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	2.6	2.6
Uncertainty	±mg/m ³	0.38	0.38
Mass Emission	g/hr	20.8	20.8
Uncertainty	±g/hr	3.2	3.2

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	5.0	5.0
Uncertainty	±% v/v	0.25	0.25

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	0.26	0.26

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
Number of Sampling Points Used	4 / 4
Sample Point I.D.'s	A1, A2, B1 & B2

FORMAT: Number Used / Number Required

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	753.0	
Stack static pressure, P _{static}	mmH ₂ O	4.6	
P _s = (P _b + (P _{static} / 13.6))	mmHg	753.3	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	53.5	
Total mass collected in impingers (silica trap)	g	3.3	
Total mass of liquid collected, V _{lc}	g	56.8	
V _{wstd} = (0.001246)(V _{lc})	m ³	0.0708	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V _m	m ³	1.4090	
Gas meter correction factor, Y _d	-	1.0090	
Average dry gas meter temperature, T _m	°C	14.3	
Average pressure drop across orifice, ΔH	mmH ₂ O	64.8	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/13.6))(Y _d)) / (T _m + 273)	m ³	1.3468	
Moisture content, B_{wv} & R_{wv}			
B _{wv} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³	0.0499	
B _{wv} as a percentage	% v/v	4.99	
Reported Water Vapour, checked with Tables in EN 14790, R _{wv}	% v/v	4.99	
Volume of gas metered wet, V_{mstw}			
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³	1.4175	
Volume of gas metered at Oxygen Reference Conditions, V_{mstd@X%O₂} & V_{mstw@X%O₂}			
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	28.30	
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 ₂ O	5.53	
Average square root of velocity heads, √ΔP	√mmH ₂ O	2.35	
Average stack gas temperature, T _s	°C	15.0	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s	8.03	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO₂}), Dry@O_{2REF} (Q_{stdO₂})			
Area of stack, A _s	m ²	0.29	
Q _a = (60)(A _s)(V _s)	m ³ /min	140.8	
Conversion factor (K/mm.Hg), C _f	-	0.3592	
Q _{stw} = ((Q _a)(P _s)(C _f)) / ((T _s + 273))	m ³ /min	132.3	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273))	m ³ /min	125.7	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s + 273)) / (O _{2REFw})	m ³ /min	N/A	
Q _{stdO₂} = ((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	7.98	
Nozzle area, A _n	mm ²	50.06	
Total sampling time, q	min	60	
%I = (4.6398E ⁶)(T _s +273)(V _{mstd}) / (P _s)(V _s)(A _n)(q)(1 - (R _{wv} /100))	%	104.2	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	09:45 - 10:15, 10:17 - 10:47
Sampling Dates	-	17/02/2017
Sampling Device	-	ISO
Volume Sampled (REF)	m ³	1.4175
Filter I.D. Number	-	47 - 40503
Start Filter Mass	g	0.14194
End Filter Mass	g	0.14281
Total Mass on Filter	g	0.00088
Probe Rinse I.D. Number	-	PR-47 - 40503
Start Probe Rinse Mass	g	2.96636
End Probe Rinse Mass	g	2.96919
Total Mass in Probe Rinse	g	0.00283
Total Mass Collected	mg	3.71
Calculated Concentration	mg/m ³	2.62
Balance Uncertainty / LOD	mg/m ³	0.10

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	17/02/2017
Average Volume Sampled (REF)	m ³	1.4175
Filter I.D. Number	-	47 - 40502
Start Filter Mass	g	0.14285
End Filter Mass	g	0.14297
Total Mass on Filter	g	0.00012
Probe Rinse I.D. Number	-	PR-47 - 40502
Start Probe Rinse Mass	g	3.05813
End Probe Rinse Mass	g	3.05838
Total Mass in Probe Rinse	g	0.00025
Total Mass Collected	mg	0.37
Calculated Concentration	mg/m ³	0.26
Balance Uncertainty / LOD	mg/m ³	0.10

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	23.69	
Pre-Sampling Leak Rate	l/min	0.13	
Post-Sampling Leak Rate	l/min	0.14	
Allowable Leak Rate	l/min	0.47	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
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	%	104.2	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.25	
Overall Weighing Uncertainty	± mg/m ³	0.18	
ELV [Daily ELV for IED]	mg/m ³	N/A	
Allowable Weighing Uncertainty	mg/m ³	N/A	
Weighing Uncertainty Acceptable	-	N/A	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	15	

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	0.12	
Post-Sampling Leak Rate	l/min	0.13	
Allowable Leak Rate	l/min	0.40	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m ³	N/A	
Blank Acceptable	-	N/A	

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.	wx

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value			Standard uncertainty			
	Symbol	Run 1		Symbol	Units	Run 1	
Sampled Volume (Actual)	V _m	1.4090		uV _m	m ³	0.0282	
Sampled Gas Temperature	T _m	287.3		uT _m	K	2.0	
Sampled Gas Pressure	p _m	100.5		up _m	kPa	0.5	
Sampled Gas Humidity	H _m	0.0		uH _m	% v/v	1.0	
Leak	L	0.59		uL	%	-	
Mass of Particulate	m	3.71		um	mg	0.14	
Uncollected Mass	UCM	0.37		uUCM	mg	-	

Measured Quantities	Uncertainty as a Percentage			Requirement of Standard
	Units	Run 1		
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.70		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.59		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1		Run 1	
Sampled Volume (STP)	V _m	m ³	1.3468		1.94	
Leak	L	mg/m ³	0.009		1.00	
Mass of Particulate	L _r	mg	3.710		0.71	
Uncollected Mass	UCM	mg	0.21		0.71	

Measured Quantities	Uncertainty in Result		
	Units	Run 1	
Sampled Volume (STP)	mg/m ³	0.065	
Leak	mg/m ³	0.0089	
Mass of Particulate	mg/m ³	0.0988	
Uncollected Mass	mg/m ³	0.1507	

Measured Quantities	Oxygen Correction Part of MU Budget		
	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	0.19	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	0.38	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.38	
Reported Uncertainty	mg/m ³	0.38	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	14.4	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.4	
Reported Uncertainty	%	14.4	

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Rapid Precision Engineering Ltd, Liverpool
Paint Stack

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	13.3	13.3
Uncertainty	±mg/m ³	0.50	0.50
Mass Emission	g/hr	105	105
Uncertainty	±g/hr	6.6	6.6

General Sampling Information

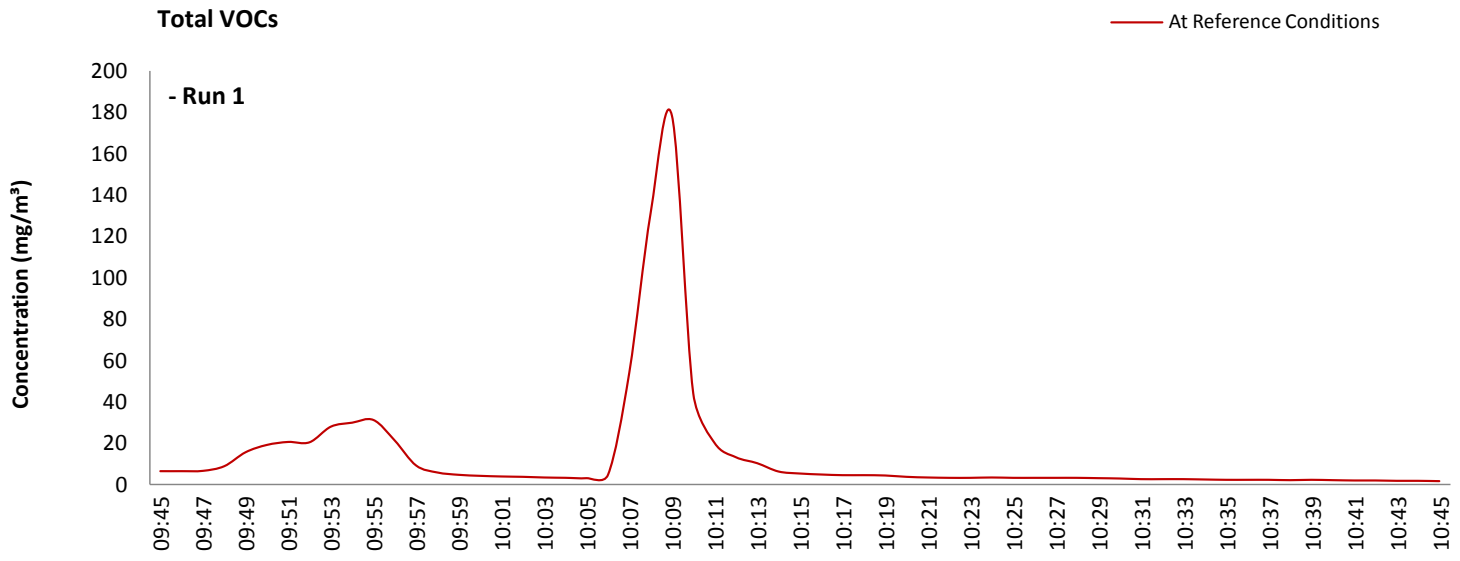
Parameter	Value	
Standard	EN 12619:2013	
Technical Procedure	CAT-TP-20	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Propane In Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 1.0190a	
Span Gas Expiry Date	24/08/2020	
Span Gas Start Pressure (bar)	120	
Gas Cylinder Concentration (ppm)	80.6	
Span Gas Set Point (ppm)	80.60	
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	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	-	09:45 - 10:45	
Sampling Dates	-	17/02/2017	
Instrument Range	ppm	100	
Span Gas Value	ppm	80.6	

Quality Assurance

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00	
	Zero Down Sampling Line (Post)	ppm	0.01	
	Zero Drift	ppm	0.01	
	Allowable Zero Drift	± ppm	4.03	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	80.59	
	Span Down Sampling Line (Post)	ppm	80.58	
	Span Drift	ppm	-0.01	
	Allowable Span Drift	± ppm	4.03	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	10 - 13	

Method Deviations

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

TOTAL VOCs (as CARBON): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	-	mg/m ³ (REF)
TGN M2 Allowable MU	15.0	%
Measured concentration	13.95	mg/m ³ (STP, dry)
Range Used	100.0	ppm
Range Used [A]	160.6	mg/m ³
Cal gas conc.	80.6	ppm
Conversion	1.61	ppm to mg/m ³
MCERTS Range [B]	15.0	mg/m ³
Lower of [A] or [B]	15.0	mg/m ³
Cal gas conc.	129.5	mg/m ³

Performance characteristics	RUN 1	Units
Response time	45	seconds
Number of readings in measurement	60	-
Repeatability at zero	2.00	% full scale
Repeatability at span level	0.00	% full scale
Deviation from linearity	0.00	% of value
Zero drift	0.01	% full scale
Span drift	-0.01	% 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)	0.01	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	mg/m ³
Standard deviation of repeatability at span level	0.00	mg/m ³
Lack of fit	0.00	mg/m ³
Drift	0.01	mg/m ³
Volume or pressure flow dependence	0.00	mg/m ³
Atmospheric pressure dependence	0.01	mg/m ³
Ambient temperature dependence	0.20	mg/m ³
Combined interference (from MCERTS Certificate)	0.04	mg/m ³
Dependence on voltage	0.06	mg/m ³
Losses in the line (leak)	0.00	mg/m ³
Uncertainty of calibration gas	0.16	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		13.95	mg/m ³
Expanded uncertainty		0.27	mg/m ³
Expanded uncertainty	k = 1.96	0.53	mg/m ³
Uncertainty corrected to std conds. (O ₂)		0.53	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.81	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	N/A	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	N/A	-

	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 O₂ correction is applied less than 15% + the uncertainty associated with the O₂ correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.