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Stack Emissions Testing Report

Operator & Address:
Glynwed Pipe Systems Limited
St. Peters Road
Huntingdon
Cambridgeshire
PE29 7DA

Authorisation:
EPR Permit: B22/93

Release Point:
Dinamec Type B Fluidised Bed Furnace

Sampling Date/s:
1st March 2011

Job Number:
LCH 00277

Report Date: Version:	14th March 2011 1
Report By: MCERTS Number: MCERTS Level: Technical Endorsements:	Nik Agopian MM 08 902 MCERTS Level 2 - Team Leader 1 & 4
Report Approved By: MCERTS Number: Business Title: Technical Endorsements: Signature:	Adrian Moss MM 02 041 MCERTS Level 2 - Team Leader 1, 2, 3 & 4

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EXECUTIVE SUMMARY

Stack Emissions Monitoring Objectives

Glynwed Pipe Systems Limited operates a manufacture of high performance polyethylene pipe systems at Huntingdon which is subject to EPR Permit B22/93, under the Environmental Permitting Regulations 2010.

Environmental Scientifics Group Limited were commissioned by PCME Limited to carry out stack emissions monitoring to determine the release of prescribed pollutants from the following Plant under normal operating conditions.

The results of these tests shall be used to demonstrate compliance with a set of emission limit values for prescribed pollutants as specified in the Plant's EPR Permit, B22/93.

Plant

Dinamec Type B Fluidised Bed Furnace

Operator

Glynwed Pipe Systems Limited
St. Peters Road
Huntingdon
Cambridgeshire
PE29 7DA

EPR Permit: B22/93

Stack Emissions Monitoring

Environmental Scientifics Group Limited - Southeast
Unit 20 The Falcon Business Centre
Ashton Road
Romford
RM3 8UN
UKAS and MCERTS Accreditation Number: 1015

EXECUTIVE SUMMARY

Emissions Summary

Parameter	Units	Result	Uncertainty +/-	Limit
Total Particulate Matter	mg/m³	7.2	0.84	20
Particulate Emission Rate	g/hr	88	10	-
Volatile Organic Compounds	mg/m³	38	1.7	20
Volatile Organic Compounds Emission Rate	g/hr	556	24	-
Moisture	%	1.3	0.05	-
Stack Gas Temperature	°C	99	-	-
Stack Gas Velocity	m/s	16.7	-	-
Gas Volumetric Flow Rate (Actual)	m³/hr	19793	-	-
Gas Volumetric Flow Rate (STP, Wet)	m³/hr	14561	-	-
Gas Volumetric Flow Rate (STP, Dry)	m³/hr	14289	-	-
Gas Volumetric Flow Rate (@ref conditions)	m³/hr	14561	-	-

ND = None Detected,

Results at or below the limit of detection are highlighted by bold italic text.

The above volumetric flow rate is calculated using data from the preliminary survey. Mass emissions for non isokinetic tests are calculated using these values. For all isokinetic testing the mass emission is calculated using test specific values.

Reference conditions are 273K, 101.3Pa, without correction for water vapour content

EXECUTIVE SUMMARY

Monitoring Times

Parameter	Sampling Date	Sampling Times	Sampling Duration
Total Particulate Matter Run 1	01 March 2011	12:27 - 13:29	60 minutes
Total Particulate Matter Run 2	01 March 2011	13:40 - 14:42	60 minutes
Total Particulate Matter Run 3	01 March 2011	14:51 - 15:53	60 minutes
Volatile Organic Compounds Run 1	01 March 2011	13:07 - 14:07	60 minutes

EXECUTIVE SUMMARY

Process Details

Parameter	Process Details
Process Status	Normal
Percentage of capacity or Tonnes / Hour	N/A
Continuous or Batch Process	Batch
Feedstock (if applicable)	Coloured Polyethylene, Nylon Pellets, ABS and Polypropylene
Abatement System	Cyclone
Abatement System Running Status	On
Fuel	Natural Gas
Plume Appearance	None Visible From Sampling Location

EXECUTIVE SUMMARY

Monitoring Methods

The selection of standard methods employed by Environmental Scientifics Group Limited is determined, wherever possible by the hierarchy of method selection outlined in Environment Agency Technical Guidance Document (Monitoring) M2. i.e. CEN, ISO, BS, US EPA etc.

The tables below summarise the monitoring methods, techniques and technical procedures employed, and details any deviations from the aforementioned hierarchy:

Sampling Methods with Subsequent Analysis

Species	Method Standard Reference Method / Alternative Reference Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	MU of Method +/- %	MU +/- %
TPM	SRM - BS EN 13284-1	AE 006	1015	Yes	0.39 mg/m³	30%	11.7 %

On-Site Testing

Species	Method Standard Reference Method / Alternative Reference Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	MU of Method +/- %	MU +/- %
VOCs	SRM - BS EN 13526	AE 054	1015	Yes	0.22 mg/m³	20%	4.4 %
H_2O	SRM - BS EN 14790	AE 004	1015	Yes	0.0001 %	10%	3.8%

BS EN 14790 has been validated over a range of 4 - 40%. It is however the prefered method of the Environment Agency for concentrations below 4%

EXECUTIVE SUMMARY

Analytical Methods

The following tables list the analytical methods employed together with the custody and archiving details:

Sampling Methods with Subsequent Analysis

Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	UKAS Accredited Analysis	Laboratory	Sample Archive Location	Archive Period
TPM	Gravimetric	AE 006	1015	Yes	Mitcheldean	Mitcheldean	3 months

On-Site Testing

Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	MCERTS Accredited Analysis	Laboratory	Sample Archive Location	Span Gas
VOCs	Flame Ionisation Detection	AE 054	1015	Yes	Romford	N/A	83.71 ppm
H_2O	Gravimetric	AE 004	1015	Yes	Romford	N/A	N/A

EXECUTIVE SUMMARY

Sampling Location

Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	196	Pa	>= 5 Pa	Yes	BS EN 13284 - 1
Lowest Gas Velocity	16.26	m/s	-	-	-
Highest Gas Velocity	17.29	m/s	-	-	-
Ratio of Above	1.06	: 1	< 3 : 1	Yes	BS EN 13284 - 1
Mean Velocity	16.66	m/s	-	-	-
Angle of flow with regard to duct axis	0	^{o}	< 15^{o}	Yes	BS EN 13284 - 1
No local negative flow	-	-	-	Yes	BS EN 13284 - 1

Duct Characteristics

	Value	Units
Type	Rectangular	-
Depth	0.55	m
Width	0.60	m
Area	0.33	m^2
Port Depth	40	mm

Sampling Lines & Sample Points

	Isokinetic (CEN Methods)	Isokinetic (ISO Methods)	Non-Iso & Gases
Sample Port Size	4 inch BSP	-	4 inch BSP
Number Used	2	-	1
Orientation	Horizontal	-	Horizontal
Number Points / Line	2	-	1
Filtration for TPM	In Stack	-	-

Sampling Platform

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

M1 Platform requirements	
Minimum Platform Area 5 m^2	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	Yes
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = Minimum of 2m or Probe Length + 1m	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements as specified in EA Guidance Note M1.

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

In this instance there were no deviations from the sampling methods employed.

APPENDICES

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APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

Monitoring Schedule

Species	Method Standard Reference Method / Alternative Reference Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Number of Samples
TPM	SRM - BS EN 13284-1	AE 006	1015	Yes	3

CALIBRATEABLE EQUIPMENT CHECKLIST

Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	**Equipment I.D.**	**Equipment**	**Equipment I.D.**	**Equipment**	**Equipment I.D.**
Control Box DGM	LSW 13-05	Horiba PG-250 Analyser	-	Laboratory Balance	LCH 55-01
Box Thermocouples	LSW 03-09	JCT JCC P-1 Cooler	-	Tape Measure	LAB 1177
Meter In Thermocouple	LSW 13-03	MAK 10 Cooler	-	Stopwatch	-
Meter Out Thermocouple	LSW 13-04	FT-IR	-	Protractor	-
Control Box Timer	LSW 17-08	FT-IR Oven Box	-	Barometer	LSW 08-01
Oven Box	LSW 09-11	Bernath 3006 FID	LCH 21-01	Digital Micromanometer	LSW 01-06
Probe	LSW 11-30	Signal 3030 FID	-	Digital Temperature Meter	-
Probe Thermocouple	LSW 10-79	Servomex	-	Stack Thermocouple	-
Probe	-	JCT Heated Head Filter	-	Mass Flow Controller	-
Probe Thermocouple	-	Thermo FID	-	Mass Flow Control Box	-
S-Pitot	-	Stackmaster	-	1m Heated Line (1)	-
L-Pitot	-	FTIR Heater Box for Heated Line	-	1m Heated Line (2)	-
Site Balance	LSW 14-05		-	1m Heated Line (3)	-
Last Impinger Arm	-		-	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-		-	10m Heated Line (1)	-
Callipers	LCH 30-02		-	10m Heated Line (2)	-
Small DGM	-		-	15m Heated Line (1)	LCH 18-03
Heater Controller	-		-	20m Heated Line (1)	-
			-	20m Heated Line (2)	-

NOTE: If the equipment I.D is represented by a dash (-), then this piece of equipment has not been used for this test.

CALIBRATION GASES

Gas	Cylinder I.D. Number	Supplier	ppm	%	Analytical Tolerance +/- %
Propane	LSW 160	Cryoservice	83.71	-	2

All the above gases are traceable to ISO 17025.

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

STACK EMISSIONS MONITORING TEAM

Team Leader	Nik Agopian MCERTS Level 2, Technical Endorsements 1 & 4 MM 08 902
Technician	Phil Smith MCERTS Trainee MM 09 1045

TOTAL PARTICULATE MATTER SUMMARY

Test, Method and Technical Procedure No.	Sampling Times	Concentration mg/m³	LOD mg/m³	Limit mg/m³	Emission Rate g/hr
Run 1	12:27 - 13:29 01 March 2011	11	0.48	20	136
Run 2	13:40 - 14:42 01 March 2011	5.6	0.35	20	65
Run 3	14:51 - 15:53 01 March 2011	5.3	0.33	20	63
Blank	-	1.15	-	-	-

Reference conditions are 273K, 101.3Pa, without correction for water vapour content

Acetone Blank Value mg/l	Acceptable Value mg/l
none detected	10

ISOKINETIC SAMPLING EQUATIONS- RUN 1

TPM

Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mm Hg	759.76
Stack static pressure, P_{static}	mm H_2O	25.49
$P_s = \frac{P_b + (P_{static})}{13.6}$	mm Hg	761.63
Vol. of water vapour collected, V_{wstd}		
Moisture trap weight increase,Vlc	g	11.3
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0140798
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m		0.764
Gas meter correction factor, Y_d		0.997
Mean dry gas meter temperature, T_m		8.708
Mean pressure drop across orifice, ΔH	mmH_2O	14.871
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$		0.740
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = V_{mstd} + V_{wstd}$	m^3	0.7537
Vol. of gas metered at O_2 Ref. Cond., $V_{mstd@X\%O2}$		
Is the process burning hazardous waste? *(If yes, no favourable oxygen correction)*		No
% oxygen measured in gas stream, act%O_2		21.0
% oxygen reference condition		21
O_2 Reference Factor $O2\ Ref = \frac{21.0 - act\%O2}{21.0 - ref\%O2}$		No O2 Ref
$V_{mstd@X\%oxygen} = (V_{mstd})\ (O_{2\ Ref})$	m^3	No O2 Ref
Moisture content, B_{wo}		
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$		0.0187
	%	1.87
Moisture by FTIR	%	-
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p		34.97
Velocity pressure coefficient, C_p		0.80
Mean of velocity heads, ΔP_{avg}	mm H_2O	16.50
Mean square root of velocity heads, $\sqrt{\Delta P}$		4.06
Mean stack gas temperature, T_s	°C	108
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{(T_s + 273)})}{(M_s)(P_s)}$	m/s	15.01

Molecular weight of dry gas, M_d		
CO_2	%	0.03
O_2	%	21.00
Total	%	21.03
N_2 (100 -Total)	%	78.97
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$		28.84
Molecular weight of wet gas, M_s		
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	g/gmol	28.64
Actual flow of stack gas, Q_a		
Area of stack, A_s	m^2	0.33
$Q_a = (60)(A_s)(V_s)$	m^3/min	297.3
Total flow of stack gas, Q		
Conversion factor (K/mm.Hg)		0.3592
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) +273}$	Dry	209.6
$Q_{stdO2} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})(O_2REF)}{(T_s) +273}$	@O2ref	No O2 Ref
$Q_{stw} = \frac{(Q_a)P_s(0.3592)}{(T_s) +273}$	Wet	213.59
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	4.72
Nozzle area, A_n	mm^2	17.50
Total sampling time, θ	min	60
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	%	110.9
Acceptable isokinetic range 95% to 115%		Yes
Particulate Concentration, C		
Mass collected on filter, M_f	g	0.0059
Mass collected in probe, M_p	g	0.0021
Total mass collected, M_n	g	0.0080
$C_{wet} = \frac{M_n}{V_{mstw}}$	mg/m^3	10.614
$C_{dry} = \frac{M_n}{V_{mstd}}$	mg/m^3	10.816
$C_{dry@X\%O2} = \frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m^3	No O2 Ref
Particulate Emission Rates, E		
$E = [(C_{wet})(Q_{stw})(60)] / 1000$		136.02

ISOKINETIC SAMPLING EQUATIONS - RUN 2

TPM

Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mm Hg	759.76
Stack static pressure, P_{static}	mm H_2O	25.49
$P_s = \frac{P_b + (P_{static})}{13.6}$	mm Hg	761.63
Vol. of water vapour collected, V_{wstd}		
Moisture trap weight increase,Vlc	g	7.9
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0098434
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m		1.104
Gas meter correction factor, Y_d		0.973
Mean dry gas meter temperature, T_m		11.208
Mean pressure drop across orifice, ΔH	mmH_2O	31.318
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$		1.034
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = V_{mstd} + V_{wstd}$	m^3	1.0443
Vol. of gas metered at O_2 Ref. Cond., $V_{mstd@X\%O2}$		
Is the process burning hazardous waste? *(If yes, no favourable oxygen correction)*		No
% oxygen measured in gas stream, act%O_2		21
% oxygen reference condition		21
O_2 Reference Factor $O2\ Ref = \frac{21.0 - act\%O2}{21.0 - ref\%O2}$		No O2 Ref
$V_{mstd@X\%oxygen} = (V_{mstd})\ (O_{2\ Ref})$	m^3	No O2 Ref
Moisture content, B_{wo}		
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$		0.0094
	%	0.94
Moisture by FTIR	%	-
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p		34.97
Velocity pressure coefficient, C_p		0.80
Mean of velocity heads, ΔP_{avg}	mm H_2O	13.25
Mean square root of velocity heads, $\sqrt{\Delta P}$		3.64
Mean stack gas temperature, T_s	°C	96
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{(T_s + 273)})}{(M_s)(P_s)}$	m/s	13.22

Molecular weight of dry gas, M_d		
CO_2	%	0.03
O_2	%	21.00
Total	%	21.03
N_2 (100 -Total)	%	78.97
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$		28.84
Molecular weight of wet gas, M_s		
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	g/gmol	28.74
Actual flow of stack gas, Q_a		
Area of stack, A_s	m^2	0.33
$Q_a = (60)(A_s)(V_s)$	m^3/min	261.8
Total flow of stack gas, Q		
Conversion factor (K/mm.Hg)		0.3592
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) +273}$	Dry	192.2
$Q_{stdO2} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})(O_2REF)}{(T_s) +273}$	@O2ref	No O2 Ref
$Q_{stw} = \frac{(Q_a)P_s(0.3592)}{(T_s) +273}$	Wet	194.04
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	5.97
Nozzle area, A_n	mm^2	28.00
Total sampling time, θ	min	60
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	%	105.7
Acceptable isokinetic range 95% to 115%		Yes
Particulate Concentration, C		
Mass collected on filter, M_f	g	0.0043
Mass collected in probe, M_p	g	0.0015
Total mass collected, M_n	g	0.00580
$C_{wet} = \frac{M_n}{V_{mstw}}$	mg/m^3	5.55
$C_{dry} = \frac{M_n}{V_{mstd}}$	mg/m^3	5.61
$C_{dry@X\%O2} = \frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m^3	No O2 Ref
Particulate Emission Rates, E		
$E = [(C_{wet})(Q_{stw})(60)] / 1000$		64.66

ISOKINETIC SAMPLING EQUATIONS - RUN 3

TPM

Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mm Hg	759.76
Stack static pressure, P_{static}	mm H_2O	25.49
$P_s = \frac{P_b + (P_{static})}{13.6}$	mm Hg	761.63
Vol. of water vapour collected, V_{wstd}		
Moisture trap weight increase,Vlc	g	8.4
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0104664
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m		1.141
Gas meter correction factor, Y_d		0.973
Mean dry gas meter temperature, T_m		11.500
Mean pressure drop across orifice, ΔH	mmH_2O	33.150
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$		1.068
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = V_{mstd} + V_{wstd}$	m^3	1.0789
Vol. of gas metered at O_2 Ref. Cond., $V_{mstd@X\%O2}$		
Is the process burning hazardous waste? *(If yes, no favourable oxygen correction)*		No
% oxygen measured in gas stream, act%O_2		21
% oxygen reference condition		21
O_2 Reference Factor $O2\ Ref = \frac{21.0 - act\%O2}{21.0 - ref\%O2}$		No O2 Ref
$V_{mstd@X\%oxygen} = (V_{mstd})\ (O_{2\ Ref})$	m^3	No O2 Ref
Moisture content, B_{wo}		
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$		0.0097
	%	0.97
Moisture by FTIR	%	-
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p		34.97
Velocity pressure coefficient, C_p		0.80
Mean of velocity heads, ΔP_{avg}	mm H_2O	13.52
Mean square root of velocity heads, $\sqrt{\Delta P}$		3.68
Mean stack gas temperature, T_s	°C	83
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{(T_s + 273)})}{(M_s)(P_s)}$	m/s	13.13

Molecular weight of dry gas, M_d		
CO_2	%	0.03
O_2	%	21.00
Total	%	21.03
N_2 (100 -Total)	%	78.97
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$		28.84
Molecular weight of wet gas, M_s		
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	g/gmol	28.74
Actual flow of stack gas, Q_a		
Area of stack, A_s	m^2	0.33
$Q_a = (60)(A_s)(V_s)$	m^3/min	259.9
Total flow of stack gas, Q		
Conversion factor (K/mm.Hg)		0.3592
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) +273}$	Dry	197.6
$Q_{stdO2} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})(O_2REF)}{(T_s) +273}$	@O2ref	No O2 Ref
$Q_{stw} = \frac{(Q_a)P_s(0.3592)}{(T_s) +273}$	Wet	199.50
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	5.97
Nozzle area, A_n	mm^2	28.00
Total sampling time, θ	min	60
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	%	106.2
Acceptable isokinetic range 95% to 115%		Yes
Particulate Concentration, C		
Mass collected on filter, M_f	g	0.0043
Mass collected in probe, M_p	g	0.0014
Total mass collected, M_n	g	0.00570
$C_{wet} = \frac{M_n}{V_{mstw}}$	mg/m^3	5.28
$C_{dry} = \frac{M_n}{V_{mstd}}$	mg/m^3	5.33
$C_{dry@X\%O2} = \frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m^3	No O2 Ref
Particulate Emission Rates, E		
$E = [(C_{wet})(Q_{stw})(60)] / 1000$		63.24

TOTAL PARTICULATE MATTER QUALITY ASSURANCE CHECKLIST

Leak Rate

Run	Mean Sampling Rate litre/min	Pre-sampling Leak Rate litre/min	Post-sampling Leak Rate litre/min	Maximum Vacuum mm Hg	Acceptable Leak Rate litre/min	Leak Tests Acceptable?
Run 1	12.71	0.12	0.12	-15	0.25	Yes
Run 2	17.90	0.1	0.1	-15	0.36	Yes
Run 3	18.51	0.09	0.09	-14	0.37	Yes

Isokineticity

Run	Isokinetic Variation %	Acceptable Isokineticity
Run 1	110.90	Yes
Run 2	105.72	Yes
Run 3	106.25	Yes

Acceptable isokinetic range 95% to 115%

Total Mass greater than 20 times the LOD

Run	LOD g	Total Mass g	Is the total mass greater than 20 times LOD?
Run 1	0.0005	0.008	No
Run 2	0.0005	0.0058	No
Run 3	0.0005	0.0057	No

Blank Value

Run	Overall Blank Value mg/m^3	Daily Emission Limit Value mg/m^3	Acceptable Blank Value mg/m^3	Overall Blank Acceptable mg/m^3
Blank 1	1.15	20	2	Yes

Filters

Run	Filter Material	Filter Size mm	Max Filtration Temperature ℃	Pre-conditioning Filter Temperature ℃	Post conditioning Filtration Temperature ℃
Run 1	QF	47	128	180	160
Run 2	QF	47	131	180	160
Run 3	QF	47	94	180	160

GF = Glass Fibre

QF = Quartz Fibre

VOLATILE ORGANIC COMPOUNDS SUMMARY

Test	Sampling Times	Concentration mg/m³	LOD mg/m³	Limit mg/m³	Emission Rate g/hr
Run 1	13:07 - 14:07 01 March 2011	38	0.22	20	556

Reference conditions are 273K, 101.3Pa, without correction for water vapour content

INSTRUMENTAL SPAN & ZERO CHECKS

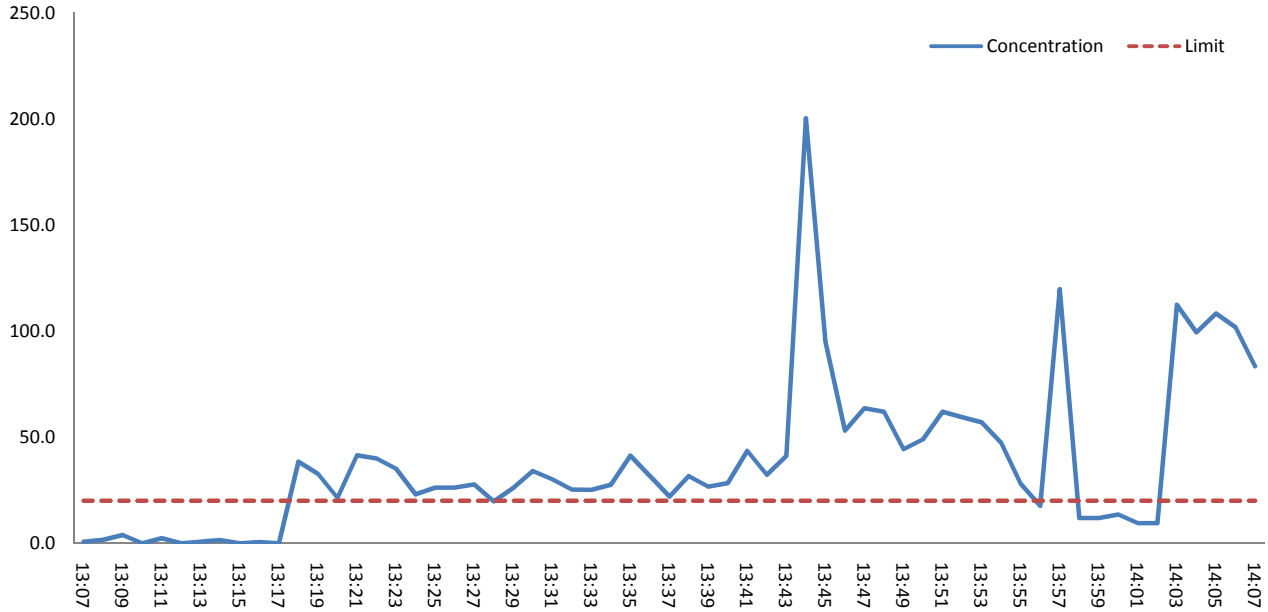
PRE-SAMPLING CALIBRATION CHECKS

Gas	Cylinder Ref No	Gas Conc (ppm)	Start Time	End Time	Range	Instrument Zero Reading	Instrument Span Reading	Span down line reading
Propane	LSW 160	83.71	12:30	13:00	100	0	82.5	83.2

POST-SAMPLING CALIBRATION CHECKS

Gas	Start Time	End Time	Instrument Zero Reading	Zero Drift (%)	Instrument Span Reading	Span Drift (%)	Span down line reading	Zero Drift ppm
Propane	14:10	14:30	0.1	0.1	83.6	1	83.7	-0.1

VOLATILE ORGANIC COMPOUNDS EMISSIONS CHART



Reference conditions are 273K, 101.3Pa, without correction for water vapour content

PRELIMINARY STACK SURVEY

Stack Diameter / Depth, D	0.55	m
Stack Width, W	0.6	m
Stack Area, A	0.33	m^2
Average stack gas temperature	99	^oC
Pitot static pressure	0.25	kPa
Barometric Pressure	101.3	kPa
Pitot tube calibration coefficient, K_{pt}	0.80	-

Stack Gas Composition & Molecular Weights

Component	Molar Mass M	Density kg/m^3 p	Conc Dry % Vol	Dry Volume Fraction r	Dry Conc kg/m^3 pi	Conc Wet % Vol	Wet Volume Fraction r	Wet Conc kg/m^3 pi
CO_2	44	1.963059	0.030000	0.000300	0.000589	0.029622	0.000296	0.000581
O_2	32	1.427679	21.000000	0.210000	0.299813	20.735349	0.207353	0.296034
N_2	28	1.249219	78.970000	0.789700	0.986508	77.974788	0.779748	0.974076
H_2O	18	0.803070	-	-	-	1.260241	0.012602	0.010121

Where:
p = M / 22.41
p*i* = r x p

Calculation of Stack Gas Densities

Determinand	Result	Units
Dry Density (STP), P_{STD}	1.2869	kg/m^3
Wet Density (STP), P_{STW}	1.2808	kg/m^3
Dry Density (Actual), P_{Actual}	0.9468	kg/m^3
Average Wet Density (Actual), $P_{ActualW}$	0.942	kg/m^3

PRELIMINARY STACK SURVEY

TRAVERSE 1

Date of Survey	01 March 2011
Time of Survey	11:40 - 12:10
Velocity Measurement Device:	S-Type

Sampling Line A							
Traverse Point	Distance into duct (m)	ΔPpt mmH_2O	ΔPpt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	0.03	20.5	201	100	16.51	-	0
2	0.08	22.0	216	100	17.10	-	0
3	0.14	20.5	201	100	16.51	-	0
4	0.19	21.0	206	99	16.68	-	0
5	0.25	20.5	201	99	16.48	-	0
6	0.30	21.5	211	100	16.90	-	0
7	0.36	22.0	216	99	17.08	-	0
8	0.41	21.0	206	98	16.66	-	0
9	0.47	20.5	201	98	16.46	-	0
10	0.52	20.5	201	97	16.44	-	0
Mean	-	21.0	206	99	16.68	-	

Sampling Line B							
Traverse Point	Distance into duct (m)	ΔPpt mmH_2O	ΔPpt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	0.03	20.5	201	97	16.44	-	0
2	0.08	20.5	201	98	16.46	-	0
3	0.14	21.0	206	100	16.71	-	0
4	0.19	21.0	206	100	16.71	-	0
5	0.25	22.0	216	100	17.10	-	0
6	0.30	22.5	221	100	17.29	-	0
7	0.36	21.0	206	99	16.68	-	0
8	0.41	20.0	196	100	16.30	-	0
9	0.47	20.5	201	98	16.46	-	0
10	0.52	20.0	196	98	16.26	-	0
Mean	-	20.9	205	99	16.64	-	

PRELIMINARY STACK SURVEY (CONTINUED)

TRAVERSE 1 CONTINUED

Sampling Line C							
Traverse Point	Distance into duct (m)	ΔPpt mmH_2O	ΔPpt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	

Sampling Line D							
Traverse Point	Distance into duct (m)	ΔPpt mmH_2O	ΔPpt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	

PRELIMINARY STACK SURVEY (CONTINUED)

Sampling Plane Validation Criteria

EA Technical Guidance Document (Monitoring) M1	Result	Units	Requirement	Compliant
Lowest Differential Pressure	196	Pa	>= 5 Pa	Yes
Lowest Gas Velocity	16.26	m/s	-	-
Highest Gas Velocity	17.29	m/s	-	-
Ratio of Above	1.06	-	< 3 : 1	Yes
Angle of flow with regard to duct axis	0	°	< 15°	Yes
No local negative flow	-	-	-	Yes

Other Sampling Method Criteria	Result	Units	Requirement	Compliant
Mean Velocity	16.66	m/s	-	-
Standard Deviation of Velocity from Mean	1.74	%	< 10%	Yes
Mean Oxygen	-	%	-	-
Standard Deviation of Oxygen from Mean	-	%	< 15%	-
Homogeneous flow stream / gas velocity	-	-	-	Yes

Where:

P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = (P_{STD} + p*i* of H_2O) / (1 + (p*i* of H_2O / 0.8036))

P_{Actual} = P_{STD} x (Ts / Ps) x (Pa / Ta)

$P_{ActualW}$ (at each sampling point) = P_{STW} x (Ts / Ps) x (Pa / Ta)

Calculation of Stack Gas Velocity, V

Velocity at Traverse Point, $V = K_{pt} \times (1-\varepsilon) * \sqrt{(2 * \Delta P_{pt} / P_{ActualW})}$

Where:

K_{pt} = Pitot tube calibration coefficient

(1-ε) = Compressibility correction factor, assumed at a constant 0.998

Average Stack Gas Velocity, Va	**16.66**	m/s

PRELIMINARY STACK SURVEY (CONTINUED)

Calculation of Stack Gas Volumetric Flowrate, Q

Sampling plane reference conditions

Duct gas flow conditions	Actual	Reference	Units
Temperature	99	0	^{o}C
Total Pressure	101.55	101.3	kPa
Oxygen	21	21	%
Moisture	1.87	1.87	%

Gas Volumetric Flowrate	Result	Units
Gas Volumetric Flowrate (Actual), Q_{Actual}	19793	m^3/hr
Gas Volumetric Flowrate (STP, Wet), Q_{STP}	14561	m^3/hr
Gas Volumetric Flowrate (STP, Dry), $Q_{STP,Dry}$	14289	m^3/hr
Gas Volumetric Flowrate (REF), Q_{Ref}	14561	m^3/hr

Where:

Q_{Actual} = Va x A x 3600

Q_{STP} = Q (Actual) x (Ts / Ta) x (Pa / Ps) x 3600

$Q_{STP,Dry}$ = Q (STP) / (100 - (100 / Ma)) x 3600

Q_{Ref} = Q (STP) x ((100 - Ma) / (100 - Ms)) x ((20.9 - O_2a) / (20.9 - O_2s))

Nomenclature:

Ts = Absolute Temperature, Standard Conditions, 273 K

Ps = Absolute Pressure, Standard Conditions, 101.3 kPa

Ta = Absolute Temperature, Actual Conditions, K

Pa = Absolute Pressure, Actual Conditions, kPa

Ma = Water vapour, Actual Conditions, % Vol

Ms = Water vapour, Reference Conditions, % Vol

O_2a = Oxygen, Actual Conditions, % Vol

O_2s = Oxygen, Reference Conditions, % Vol

STACK DIAGRAM

	Value	Units
Stack Depth	0.55	m
Stack Width	0.60	m
Area	0.33	m^2

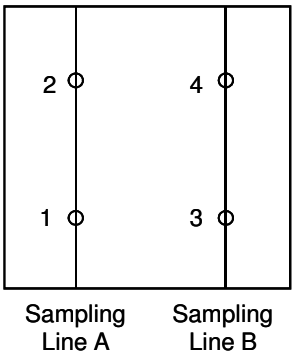
Non-Isokinetic Sampling

Sampling Point	Distance (% of Depth)	Distance into Stack	Units
-	-	-	-

Isokinetic Sampling CEN Methods

Sampling Point	Distance (% of Depth)	Distance into Stack (m)	Swirl °
1	25.0	0.14	0
2	75.0	0.41	0
3	25.0	0.14	0
4	75.0	0.41	0

Rectangle 2 line 4 points



MEASUREMENT UNCERTAINTY BUDGET - TOTAL PARTICULATE MATTER

Run	Sampled Volume	Sampled Gas Temp	Sampled Gas Pressure	Sampled Gas Humidity	Oxygen Content	Limit of Detection	Leak	Uncollected Mass
	m^3	K	kPa	% by volume	% by volume	% by mass	%	mg
MU required	**≤ 2%**	**≤ 2%**	**≤ 1%**	**≤ 1%**	**≤ 10%**	**≤ 5% of ELV**	**≤ 2%**	**≤ 10% of ELV**
Run 1	0.001	2	0.5	1	N/A	0.3606	-	-
as a %	0.13	0.71	0.49	1.00	N/A	2.39184	0.94	0.01
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**
Run 2	0.001	2	0.5	1.00	N/A	0.361	-	-
as a %	0.10	0.70	0.49	1.00	N/A	1.726	0.56	0.01
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**
Run 3	0.001	2	0.5	1	N/A	0.3606	-	-
as a %	0.09	0.70	0.49	1.00	N/A	1.67087	0.49	0.01
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**

Run	Volume (STP)	Mass of particulate	O2 Correction	Leak	Uncollected Mass	Combined uncertainty
	m^3	mg	-	mg/m^3	mg	
Run 1	0.73	8.0000	1.00	0.058	0.001	-
MU as mg/m^3	0.14	0.4784	-	0.058	0.001	**0.50**
MU as %	1.33	4.5069	-	0.545	0.01	-
Run 2	1.01	5.8000	1.00	0.018	0.001	-
MU as mg/m^3	0.07	0.3453	-	0.018	0.001	**0.35**
MU as %	1.3	6.2165	-	0.323	0.01	-
Run 3	1.04	5.7000	1.00	0.015	0.00	-
MU as mg/m^3	0.07	0.3342	-	0.015	0.00	**6.47**
MU as %	1.32	6.3255	-	0.281	0.011	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**1.00**	**mg/m^3**	**9.46**	**%**
R2 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.71**	**mg/m^3**	**12.73**	**%**
R3 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.68**	**mg/m^3**	**12.94**	**%**

(k is a coverage factor which gives a 95% confidence in the quoted figures)

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MEASUREMENT UNCERTAINTY BUDGET - MOISTURE

Run	Sampled Volume	Sampled Gas Temp	Sampled Gas Pressure	Sampled Gas Humidity	Oxygen Content	Leak
	m^3	K	kPa	% by volume	% by volume	%
MU required	**≤ 2%**	**≤ 2%**	**≤ 1%**	**≤ 1%**	**≤ 10%**	**≤ 2%**
Run 1	0.001	2.0	0.5	1.0	N/A	-
as a %	0.13	0.71	0.49	1.00	N/A	0.94
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**
Run 2	0.001	2.0	0.5	1.0	N/A	-
as a %	0.10	0.70	0.49	1.00	N/A	0.56
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**
Run 3	0.001	2.0	0.5	1.0	N/A	-
as a %	0.09	0.70	0.49	1.00	N/A	0.49
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**
Run	Volume (STP)	Mass Gained	O2 Correction	Leak	Uncollected Mass	Combined uncertainty
	m^3	mg	-	mg/m^3	mg	
Run 1	0.73	11300.00	1.00	81.74	57.74	-
MU as % v/v	0.03	0.02	-	0.01	0.010	**0.03**
MU as %	1.33	0.88	-	0.55	0.51	-
Run 2	1.01	7900.00	1.00	24.40	57.74	-
MU as % v/v	0.01	0.01	-	0.00	0.01	**0.02**
MU as %	1.32	1.27	-	0.32	0.73	-
Run 3	1.04	8400.00	1.00	21.86	57.74	-
MU as % v/v	0.01	0.01	-	0.00	0.01	**0.02**
MU as %	1.32	1.19	-	0.28	0.69	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.07**	**% v/v**	**3.53**	**%**
R2 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.04**	**% v/v**	**3.99**	**%**
R3 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.04**	**% v/v**	**3.85**	**%**

Appendix 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VOLATILE ORGANIC COMPOUNDS RUN 1

Measured Concentration	38	mg/m^3
Limit	20	mg/m^3
Calibration Gas Concentration	134	mg/m^3
Range	160	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	21	seconds	<180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.70	% of value	<2 % range	Yes
Zero drift	0.10	% full scale	<2% range / 24hr	Yes
Span drift	1.00	% full scale	<2% range/24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.80	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.10	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.84	% of value	< 2% of span gas value	Yes
Uncertainty of calibration gas	2.0	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.02
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	0.65
Drift	u0dr	0.22
volume or pressure flow dependence	uspres	0.00
atmopsheric pressure dependence	uapres	0.04
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.14
losses in the line (leak)	uleak	0.19
Uncertainty of calibration gas	ucalib	0.44
Uncertainty in factor	uf	0.00

Measurement uncertainty Measured Concentration	38	mg/m^3
Combined uncertainty	0.85	mg/m^3
Expanded uncertainty	1.7	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**8.47**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**1.69**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**4.43**	**% value**

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Stack Emissions Testing Report

Operator & Address:
Glynwed Pipe Systems Limited
St Peter's Road
Huntingdon
Cambridgeshire
PE29 7DA

Permit:
EPR Permit: B22/93

Report Date:	1st June 2011
Version:	1
Report By:	Phil Smith
MCERTS Number:	MM 09 1045
MCERTS Level:	MCERTS Level 1
Technical Endorsements:	-
Report Approved By:	Mark Allison
MCERTS Number:	MM 03 162
Business Title:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Signature:	

Release Point:
Dinamec Type B Fluidised Bed Furnace

Sampling Date/s:
12th May 2011

Job Number:
LCH 00314

CONTENTS

EXECUTIVE SUMMARY

Stack Emissions Monitoring Objectives

Glynwed Pipe Systems Limited operates a manufacture of high performance polyethylene pipe systems process at Huntingdon which is subject to EPR Permit B22/93, under the Environmental Permitting Regulations 2010.

Environmental Scientifics Group Limited were commissioned by Glynwed Pipe Systems Limited to carry out stack emissions monitoring to determine the release of prescribed pollutants from the following Plant under normal operating conditions.

The results of these tests shall be used to demonstrate compliance with a set of emission limit values for prescribed pollutants as specified in the Plant's EPR Permit, B22/93.

Plant

Dinamec Type B Fluidised Bed Furnace

Operator

Glynwed Pipe Systems Limited
St Peter's Road
Huntingdon
Cambridgeshire
PE29 7DA

EPR Permit: B22/93

Stack Emissions Monitoring

Environmental Scientifics Group Limited - Southeast
Unit 20 The Falcon Business Centre
Ashton Road
Romford
RM3 8UN
UKAS and MCERTS Accreditation Number: 1015

EXECUTIVE SUMMARY

Emissions Summary

Parameter	Units	Result	Uncertainty +/-	Limit
Volatile Organic Compounds	mg/m³	432	189	20
Volatile Organic Compounds Emission Rate	g/hr	6285	2747	-
Oxygen	% v/v	19.9	0.94	-
Stack Gas Temperature	°C	99	-	-
Stack Gas Velocity	m/s	16.7	-	-
Gas Volumetric Flow Rate (Actual)	m³/hr	19793	-	-
Gas Volumetric Flow Rate (STP, Wet)	m³/hr	14562	-	-
Gas Volumetric Flow Rate (@ref conditions)	m³/hr	14562	-	-

ND = None Detected,
Results at or below the limit of detection are highlighted by bold italic text.
The above volumetric flow rate is calculated using data from the preliminary survey. Mass emissions for non isokinetic tests are calculated using these values. For all isokinetic testing the mass emission is calculated using test specific values.
Reference conditions are 273K, 101.3kPa, wet gas, 11% Oxygen.

EXECUTIVE SUMMARY

Monitoring Times

Parameter	Sampling Date	Sampling Times	Sampling Duration
Volatile Organic Compounds Run 1	12 May 2011	11:56 - 12:56	60 minutes
Combustion Gases	12 May 2011	11:56 - 12:56	60 minutes

Process Details

Parameter	Process Details
Description of process	Normal
Continuous or batch	N/A
Batch Details	Batch
Part of batch to be sampled during monitoring	Coloured Polyethylene, Nylon Pellets, ABS and Polypropylene
Normal load, throughput or continuous rating	Cyclone
Fuel requirements during monitoring	On
Abatement	Natural Gas
Plume Appearance	None Visible From Sampling Location

EXECUTIVE SUMMARY

Monitoring Methods

The selection of standard methods employed by Environmental Scientifics Group Limited is determined, wherever possible by the hierarchy of method selection outlined in Environment Agency Technical Guidance Document (Monitoring) M2. i.e. CEN, ISO, BS, US EPA etc.

The tables below summarise the monitoring methods, techniques and technical procedures employed, and details any deviations from the aforementioned hierarchy:

Sampling Methods with Subsequent Analysis

Species	Method Standard Reference Method / Alternative Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	MU of Method +/- %	MU +/- %
-	-	-	-	-	-	-	-

On-Site Testing

Species	Method Standard Reference Method / Alternative Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	MU of Method +/- %	MU +/- %
VOCs	SRM - BS EN 13526	AE 054	1015	Yes	0.22 mg/m³	20%	43.7 %
O_2	SRM - BS EN 14789	AE 007 / 015	1015	Yes	0.01%	10%	4.7%

EXECUTIVE SUMMARY

Analytical Methods

The following tables list the analytical methods employed together with the custody and archiving details:

Sampling Methods with Subsequent Analysis

Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	UKAS Accredited Analysis	Laboratory	Sample Archive Location	Archive Period
-	-	-	-	-	-	-	-

On-Site Testing

Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	MCERTS Accredited Analysis	Laboratory	Sample Archive Location	Span Gas
VOCs	Flame Ionisation Detection	AE 054	1015	Yes	Romford	N/A	79.55 ppm
O_2	Zirconia Cell	AE 007 / 015	1015	Yes	Romford	N/A	20.95 %
-	-	-	-	-	-	-	-

EXECUTIVE SUMMARY

Sampling Location

Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	196	Pa	>= 5 Pa	Yes	BS EN 13284 - 1
Lowest Gas Velocity	16.26	m/s	-	-	-
Highest Gas Velocity	17.29	m/s	-	-	-
Ratio of Above	1.06	: 1	< 3 : 1	Yes	BS EN 13284 - 1
Mean Velocity	16.66	m/s	-	-	-
Angle of flow with regard to duct axis	0	^{o}	< 15^{o}	Yes	BS EN 13284 - 1
No local negative flow	-	-	-	Yes	BS EN 13284 - 1

Duct Characteristics

	Value	Units
Type	Rectangular	-
Depth	0.55	m
Width	0.60	m
Area	0.33	m^2
Port Depth	40	mm

Sampling Lines & Sample Points

	Isokinetic (CEN Methods)	Isokinetic (ISO Methods)	Non-Iso & Gases
Sample Port Size	-	-	4 inch BSP
Number Used	-	-	2
Orientation	-	-	Horizontal
Number Points / Line	-	-	2

Sampling Platform

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

M1 Platform requirements	
Minimum Platform Area 5 m^2	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	Yes
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = Minimum of 2m or Probe Length + 1m	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements as specified in EA Guidance Note M1.

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

In this instance there were no deviations from the sampling methods employed.

APPENDICES

CONTENTS

CONTENTS

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

Monitoring Schedule

Species	Method Standard Reference Method / Alternative Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Number of Samples
VOCs	SRM - BS EN 13526	AE 054	1015	Yes	1
O_2	SRM - BS EN 14789	AE 007 / 015	1015	Yes	1

CALIBRATEABLE EQUIPMENT CHECKLIST

Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	**Equipment I.D.**	**Equipment**	**Equipment I.D.**	**Equipment**	**Equipment I.D.**
Control Box DGM	-	Horiba PG-250 Analyser	LSW 21-07	Laboratory Balance	-
Box Thermocouples	-	JCT JCC P-1 Cooler	LSW 21-14	Tape Measure	-
Meter In Thermocouple	-	MAK 10 Cooler	-	Stopwatch	-
Meter Out Thermocouple	-	FT-IR	-	Protractor	-
Control Box Timer	-	FT-IR Oven Box	-	Barometer	LSW 08-01
Oven Box	-	Bernath 3006 FID	LCH 21-01	Digital Micromanometer	-
Probe	-	Signal 3030 FID	-	Digital Temperature Meter	-
Probe Thermocouple	-	Servomex	-	Stack Thermocouple	-
Probe	-	JCT Heated Head Filter	-	Mass Flow Controller	-
Probe Thermocouple	-	Thermo FID	-	Mass Flow Control Box	-
S-Pitot	-	Stackmaster	-	1m Heated Line (1)	-
L-Pitot	-	FTIR Heater Box for Heated Line	-	1m Heated Line (2)	-
Site Balance	-		-	1m Heated Line (3)	-
Last Impinger Arm	-		-	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-		-	10m Heated Line (1)	-
Callipers	-		-	10m Heated Line (2)	-
Small DGM	-		-	15m Heated Line (1)	LCH 18-01
Heater Controller	-		-	20m Heated Line (1)	-
			-	20m Heated Line (2)	-

NOTE: If the equipment I.D is represented by a dash (-), then this piece of equipment has not been used for this test.

CALIBRATION GASES

Gas	Cylinder I.D. Number	Supplier	ppm	%	Analytical Tolerance +/- %
Oxygen	Fresh Air	Fresh Air	-	20.95	-
Propane	LSW 104	Cryoservice	79.55	-	2

All the above gases are traceable to ISO 17025.

STACK EMISSIONS MONITORING TEAM

Team Leader	Adrian Moss MCERTS Level 2, Technical Endorsements 1, 2, 3 & 4 MM 02 041
Technician	Phil Smith MCERTS Trainee MM 09 1045

VOLATILE ORGANIC COMPOUNDS SUMMARY

Test	Sampling Times	Concentration mg/m³	LOD mg/m³	Limit mg/m³	Emission Rate g/hr
Run 1	11:56 - 12:56 12 May 2011	432	0.22	20	6285

Reference conditions are 273K, 101.3kPa, wet gas, 11% Oxygen.

INSTRUMENTAL SPAN & ZERO CHECKS

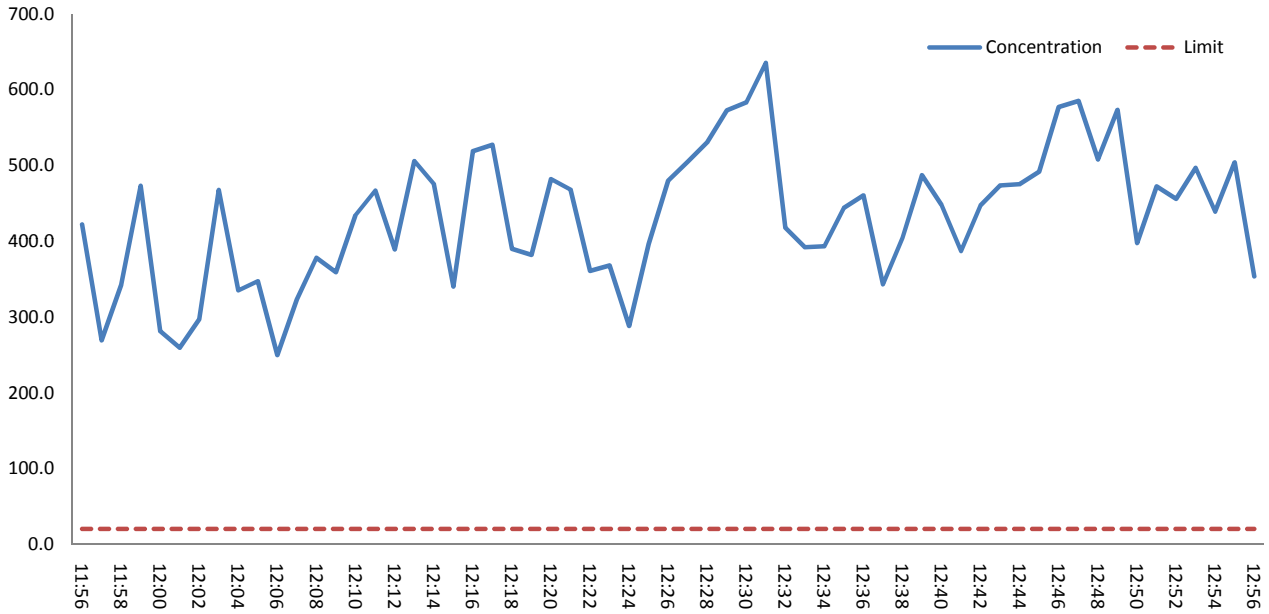
PRE-SAMPLING CALIBRATION CHECKS

Gas	Cylinder Ref No	Gas Conc (ppm)	Start Time	End Time	Range	Instrument Zero Reading	Instrument Span Reading	Span down line reading
Propane	LSW 104	79.55	11:20	11:35	100	0	80	80

POST-SAMPLING CALIBRATION CHECKS

Gas	Start Time	End Time	Instrument Zero Reading	Zero Drift (%)	Instrument Span Reading	Span Drift (%)	Span down line reading	Zero Drift ppm
Propane	13:01	13:08	0	0	79	-1	79	0

VOLATILE ORGANIC COMPOUNDS EMISSIONS CHART



Reference conditions are 273K, 101.3kPa, wet gas, 11% Oxygen.

COMBUSTION GASES SUMMARY

Test	Sampling Times	Concentration %	LOD %
O_2	11:56 - 12:56 12 May 2011	19.92	0.003

Reference conditions are 273K, 101.3kPa, wet gas, 11% Oxygen.

PRE-SAMPLING CALIBRATION DATA

Date	12 May 2011
Start Time	11:20
End Time	11:35

Cooler Temp. (°C)	1.1

(should be < 4°C)

Gas	Range (ppm)	Zero Reading at analyser	Span Reading at analyser	Zero Check at analyser	Zero Check down line	Span Check down line	Response Time (Secs)	Leak Rate %
O2	25	0	20.95	0.01	0.03	20.92	45	-0.14

POST-SAMPLING CALIBRATION DATA

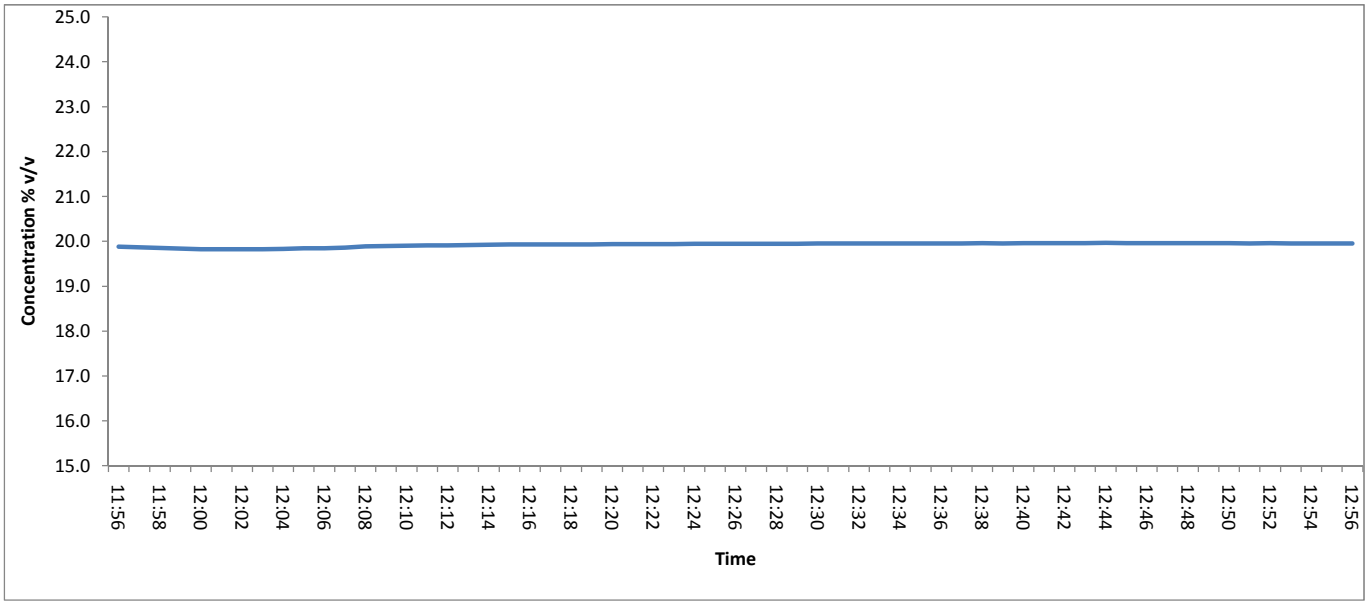
Date	12 May 2011
Start Time	12:58
End Time	13:10

Cooler Temp. (°C)	1.6

(should be < 4°C)

Gas	Zero Check down line	Span Check down line	Zero Drift (%)	Span Drift (%)
O2	0.06	21.04	0.12	0.57

OXYGEN EMISSIONS CHART



APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY

Stack Characteristics

Stack Diameter / Depth, D	0.55	m
Stack Width, W	0.6	m
Stack Area, A	0.33	m^2
Average stack gas temperature	99	^oC
Pitot static pressure	0.25	kPa
Barometric Pressure	101.3	kPa
Pitot tube calibration coefficient, K_{pt}	0.80	-

Stack Gas Composition & Molecular Weights

Component	Molar Mass M	Density kg/m^3 p	Conc Dry % Vol	Dry Volume Fraction r	Dry Conc kg/m^3 pi	Conc Wet % Vol	Wet Volume Fraction r	Wet Conc kg/m^3 pi
CO_2	44	1.963059	0.030000	0.000300	0.000589	0.029610	0.000296	0.000581
O_2	32	1.427679	21.000000	0.210000	0.299813	20.727000	0.207270	0.295915
N_2	28	1.249219	78.970000	0.789700	0.986508	77.943390	0.779434	0.973684
H_2O	18	0.803070	-	-	-	1.300000	0.013000	0.010440

Where: p = M / 22.41 p*i* = r x p

Calculation of Stack Gas Densities

Determinand	Result	Units
Dry Density (STP), P_{STD}	1.2869	kg/m^3
Wet Density (STP), P_{STW}	1.2806	kg/m^3
Dry Density (Actual), P_{Actual}	0.9468	kg/m^3
Average Wet Density (Actual), $P_{ActualW}$	0.942	kg/m^3

PRELIMINARY STACK SURVEY

TRAVERSE 1

Date of Survey	01 March 2011
Time of Survey	11:40 - 12:10
Velocity Measurement Device:	S-Type

Sampling Line A

Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	0.03	20.5	201	100	16.51	-	0
2	0.08	22.0	216	100	17.10	-	0
3	0.14	20.5	201	100	16.51	-	0
4	0.19	21.0	206	99	16.68	-	0
5	0.25	20.5	201	99	16.48	-	0
6	0.30	21.5	211	100	16.90	-	0
7	0.36	22.0	216	99	17.08	-	0
8	0.41	21.0	206	98	16.66	-	0
9	0.47	20.5	201	98	16.46	-	0
10	0.52	20.5	201	97	16.44	-	0
Mean	-	21.0	206	99	16.68	-	

Sampling Line B

Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	0.03	20.5	201	97	16.44	-	0
2	0.08	20.5	201	98	16.46	-	0
3	0.14	21.0	206	100	16.71	-	0
4	0.19	21.0	206	100	16.71	-	0
5	0.25	22.0	216	100	17.10	-	0
6	0.30	22.5	221	100	17.29	-	0
7	0.36	21.0	206	99	16.68	-	0
8	0.41	20.0	196	100	16.30	-	0
9	0.47	20.5	201	98	16.46	-	0
10	0.52	20.0	196	98	16.26	-	0
Mean	-	20.9	205	99	16.64	-	

PRELIMINARY STACK SURVEY (CONTINUED)

TRAVERSE 1 CONTINUED

Sampling Line C							
Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp ^oC	Velocity m/s	O_2 % Vol	Angle of Swirl ^{o}
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	

Sampling Line D							
Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp ^oC	Velocity m/s	O_2 % Vol	Angle of Swirl ^{o}
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	

PRELIMINARY STACK SURVEY (CONTINUED)

Sampling Plane Validation Criteria

EA Technical Guidance Document (Monitoring) M1	Result	Units	Requirement	Compliant
Lowest Differential Pressure	196	Pa	>= 5 Pa	Yes
Lowest Gas Velocity	16.26	m/s	-	-
Highest Gas Velocity	17.29	m/s	-	-
Ratio of Above	1.06	-	< 3 : 1	Yes
Angle of flow with regard to duct axis	0	°	< 15°	Yes
No local negative flow	-	-	-	Yes

Other Sampling Method Criteria	Result	Units	Requirement	Compliant
Mean Velocity	16.66	m/s	-	-
Standard Deviation of Velocity from Mean	1.74	%	< 10%	Yes
Mean Oxygen	21.00	%	-	-
Standard Deviation of Oxygen from Mean	-	%	< 15%	-
Homogeneous flow stream / gas velocity	-	-	-	Yes

Where:

P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

$P_{STW} = (P_{STD} + pi \text{ of } H_2O) / (1 + (pi \text{ of } H_2O / 0.8036))$

$P_{Actual} = P_{STD}$ x (Ts / Ps) x (Pa / Ta)

$P_{ActualW}$ (at each sampling point) = P_{STW} x (Ts / Ps) x (Pa / Ta)

Calculation of Stack Gas Velocity, V

Velocity at Traverse Point, $V = K_{pt} \times (1-\varepsilon) * \sqrt{(2 * \Delta P_{pt} / P_{ActualW})}$

Where:

K_{pt} = Pitot tube calibration coefficient

$(1-\varepsilon)$ = Compressibility correction factor, assumed at a constant 0.998

Average Stack Gas Velocity, Va	**16.66**	m/s

PRELIMINARY STACK SURVEY (CONTINUED)

Calculation of Stack Gas Volumetric Flowrate, Q

Sampling plane reference conditions

Duct gas flow conditions	Actual	Reference	Units
Temperature	99	0	^{o}C
Total Pressure	101.55	101.3	kPa
Oxygen	20	11	%
Moisture	-	-	%

Gas Volumetric Flowrate	Result	Units
Gas Volumetric Flowrate (Actual), Q_{Actual}	19793	m^3/hr
Gas Volumetric Flowrate (STP, Wet), Q_{STP}	14562	m^3/hr

Where:

Q_{Actual} = Va x A x 3600

Q_{STP} = Q (Actual) x (Ts / Ta) x (Pa / Ps) x 3600

$Q_{STP,Dry}$ = Q (STP) / (100 - (100 / Ma)) x 3600

Q_{Ref} = Q (STP) x ((100 - Ma) / (100 - Ms)) x ((20.9 - O_2a) / (20.9 - O_2s))

Nomenclature:

Ts = Absolute Temperature, Standard Conditions, 273 K

Ps = Absolute Pressure, Standard Conditions, 101.3 kPa

Ta = Absolute Temperature, Actual Conditions, K

Pa = Absolute Pressure, Actual Conditions, kPa

Ma = Water vapour, Actual Conditions, % Vol

Ms = Water vapour, Reference Conditions, % Vol

O_2a = Oxygen, Actual Conditions, % Vol

O_2s = Oxygen, Reference Conditions, % Vol

STACK DIAGRAM

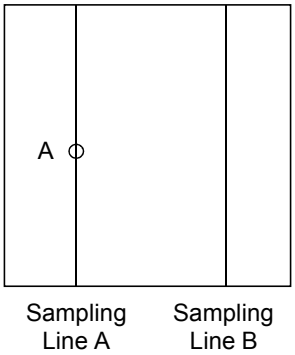
	Value	Units
Stack Depth	0.55	m
Stack Width	0.60	m
Area	0.33	m^2

Non-Isokinetic Sampling

Sampling Point	Distance (% of Depth)	Distance into Stack	Units
A	50	0.28	m

Isokinetic Sampling CEN Methods

Sampling Point	Distance (% of Depth)	Distance into Stack (m)	Swirl °
-	-	-	-



Appendix 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VOLATILE ORGANIC COMPOUNDS RUN 1

Measured Concentration	431.6	mg/m^3
Limit	20	mg/m^3
Calibration Gas Concentration	127.28	mg/m^3
Range	160	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	32	seconds	<180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.70	% of value	<2 % range	Yes
Zero drift	0.00	% full scale	<2% range / 24hr	Yes
Span drift	-1.00	% full scale	<2% range/24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.80	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.10	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.00	% of value	< 2% of span gas value	Yes
Uncertainty of calibration gas	2.0	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.02
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	0.65
Drift	u0dr	-1.96
volume or pressure flow dependence	uspres	0.00
atmopsheric pressure dependence	uapres	0.04
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.14
losses in the line (leak)	uleak	0.00
Uncertainty of calibration gas	ucalib	4.98
Uncertainty in factor	uf	94.11

Measurement uncertainty Measured Concentration	431.62	mg/m^3
Combined uncertainty	94.27	mg/m^3
Expanded uncertainty	188.53	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**942.65**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**188.53**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**43.68**	**% value**

Developed for the STA by R Robinson, NPL

Appendix 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - OXYGEN

Reference	11	%vol
Measured concentration	19.92	%vol
Calibration gas	20.95	%vol
Full Scale	25	%vol

Performance characteristics	Value	Units	specification	MU Met?
Response time	45	seconds	< 200 s	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.015	% by volume	<0.2 % range	Yes
Repeatability at span level	0.014	% by volume	<0.4 % range	Yes
Deviation from linearity	0.13	% vol	<0.3 % volume	Yes
Zero drift (during measurement period)	0.12	% vol at zero level	<2% of volume / 24hr	Yes
Span drift (during measurement period)	0.57	% vol at span level	<2% volume/24hr	Yes
volume or pressure flow dependence	0.02	% of fs / 10l/h	<1% range	Yes
atmospheric pressure dependence	0.80	% of fs/kPa	< 1.5 % range	Yes
ambient temperature dependence	0.01	% by volume /10K	<0.3% volume 10 K	Yes
Combined interference	0.14	% range	<2% range	Yes
Dependence on voltage	0.10	% by volume /10V	< 0.1%vol /10 volt	Yes
Losses in the line (leak)	-0.14	% of value	< 2% of value	Yes
Uncertainty of calibration gas	2.00	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	-
Standard deviation of repeatability at span level	urs	0.0018
Lack of fit	ufit	0.0751
Drift	u0dr	0.3838
volume or pressure flow dependence	uspres	0.00003
atmospheric pressure dependence	uapres	0.0122
ambient temperature dependence	utemp	0.0005
Combined interference (from mcerts)	-	0.0808
dependence on voltage	uvolt	0.0862
losses in the line (leak)	uleak	-0.0165
Uncertainty of calibration gas	ucalib	0.2301

Measurement uncertainty (Concentration Measured)	19.92	%vol
Combined uncertainty	0.47	%vol
% of value	2.36	%

Expanded uncertainty expressed with a level of confidence of 95%	**4.71**	**% of value**

Expanded uncertainty expressed with a level of confidence of 95%	**0.939**	**% vol**

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