



Exova
CATALYST



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Stack Emissions Testing Report Commissioned by

ATI Environment UK Ltd

Installation Name & Address

Ipswich Borough Council
Ipswich Crematorium
Cemetery Lane
Ipswich
IP4 2TQ

LAPPC Guidance Note: PG 5/2 (12)

Stack Reference

Mercury Abatement Outlet

Dates of the Monitoring Campaign

21st March 2014

Job Reference Number

CSW-1389

Report Written by
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Version 1

Signature of Report Approver

CAT-RT (Version BD)

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MONITORING OBJECTIVES

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
21st March 2014

Overall Aim of the Monitoring Campaign

Catalyst Environmental Ltd - an Exova Group Company were commissioned by ATI Environment UK Ltd to carry out stack emissions testing for Ipswich Borough Council on the Mercury Abatement Outlet at Ipswich Crematorium.

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, Hydrogen Chloride, Mercury, Total VOCs (as Carbon), Carbon Monoxide

MONITORING RESULTS

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
21st March 2014

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	3.1	0.44	20	g/hr	6.3	0.91	-
Hydrogen Chloride	¹ mg/m ³	7.3	1.1	30	g/hr	14.9	2.2	-
Mercury	¹ mg/m ³	0.012	0.0015	0.05	g/hr	0.024	0.0031	-
Total VOCs (as Carbon)	¹ mg/m ³	0.65	0.21	20	g/hr	1.3	0.42	-
Carbon Monoxide	¹ mg/m ³	12.7	2.7	100	g/hr	25.9	5.4	-
Oxygen	% v/v	Dry 14.3	0.29					
Water Vapour	% v/v	7.7	0.40					
Stack Gas Temperature	°C	152						
Stack Gas Velocity	m/s	10.0						
Volumetric Flow Rate (ACTUAL)	m ³ /hr	5213						
Volumetric Flow Rate (REF)	¹ m ³ /hr	2038						

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

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

MONITORING DATE(S) & TIMES

Ipswich Borough Council, Ipswich Crematorium
 Mercury Abatement Outlet
 21st March 2014

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1 mg/m ³	3.1	g/hr	6.3	21/03/2014	11:52 - 12:52	60
Hydrogen Chloride	R1 mg/m ³	7.3	g/hr	14.9	21/03/2014	11:52 - 12:52	60
Mercury	R1 mg/m ³	0.012	g/hr	0.024	21/03/2014	14:16 - 15:16	60
Total VOCs (as Carbon)	R1 mg/m ³	0.65	g/hr	1.3	21/03/2014	11:52 - 12:52	60
Carbon Monoxide	R1 mg/m ³	17.6	g/hr	35.9	21/03/2014	11:52 - 12:22	60
	R2 mg/m ³	7.6	g/hr	15.5	21/03/2014	12:22 - 12:32	60
Oxygen	R1 % v/v	14.4			21/03/2014	11:52 - 12:52	60
Oxygen	R2 % v/v	14.2			21/03/2014	14:16 - 15:16	60
Velocity & Volumetric Flow Rate	R1				21/03/2014	11:30 - 11:35	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
21st March 2014

Standard Operating Conditions

Parameter	Value
Process Status	Normal
Capacity (of 100%) and Tonnes / Hour	2 Cremators Operational
Continuous or Batch Process	Batch
Feedstock (if applicable)	N/A
Abatement System	Dosing and Filtration System
Abatement System Running Status	On
Fuel	Natural Gas
Plume Appearance	None Visible

Site Specific Operating Conditions

Parameter	Status
Coffin Type	Standard (Standard) / Standard (Wicker)
Sex	Female (Male) / Male (Female)
Temperature in Primary Chamber	890 / 887
Temperature in Secondary Chamber	895 / 1015
Cremation Number	127569 (127568) / 127571 (127570)
Size	Medium (Medium) / Medium (Medium)

MONITORING & ANALYTICAL METHODS

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
21st March 2014

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	UKAS Testing	Testing Lab	Analytical Procedure	Analytical Technique	UKAS Analysis	Analysis Lab		
Total Particulate Matter	BS EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.14 mg/m ³
Hydrogen Chloride	BS EN 1911	CAT-TP-11	Yes	CAT	CAT-AP-01	IC	Yes	CAT	Yes	0.03 mg/m ³
Mercury	BS EN 13211	CAT-TP-06	Yes	CAT	M112	CV-AFS	Yes	RPS	Yes	0 mg/m ³
Water Vapour	BS EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Total VOCs (as Carbon)	BS EN 12619:2013	CAT-TP-20	Yes	CAT	Flame Ionisation Detection by Sick 3006 FID				Yes	0.16 mg/m ³
Carbon Monoxide	BS EN 15058	CAT-TP-25	Yes	CAT	GFC-IR by Servomex 4900				Yes	0.44 mg/m ³
Oxygen	BS EN 14789	CAT-TP-25	Yes	CAT	Dry Paramagnetic Cell by Servomex 4900				Yes	0.01 %
Velocity & Vol. Flow Rate	BS EN 13284-1	CAT-TP-04	Yes	CAT	Pitot Tube and Thermocouple				Yes	N/A

ANALYSIS LABORATORIES

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

Catalyst Environmental Ltd (CAT)	UKAS Accreditation Number: 4279
RPS Laboratories Ltd (RPS)	UKAS Accreditation Number: 0605

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter, Mercury	All	One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to meet the requirements of the Standard.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.43
Width	m	-
Area	m ²	0.15
Port Depth	cm	15
Orientation of Duct	-	Horizontal
Sample Port Size	-	4" BSP

Location of Sampling Platform

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

Platform Details

EA Technical Guidance Note M1 / BS 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)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	No
There are no obstructions present which hamper insertion of sampling equipment	No
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 BS EN 15259.

BS EN 15259 Homogeneity Test Requirements

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

Sampling Plane Validation Criteria (from EA Technical Guidance Document (Monitoring) M1)

Criteria in M1	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	76.0	> 5 Pa	Yes
Mean Velocity	m/s	12.60	-	-
Lowest Gas Velocity	m/s	11.28	-	-
Highest Gas Velocity	m/s	14.24	-	-
Ratio of Above	: 1	1.26	< 3 : 1	Yes
Maximum Angle of Swirl	°	3	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

Photo 1



Photo 2



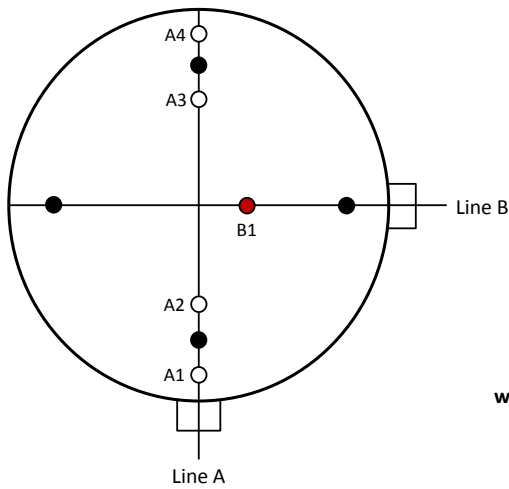
Photo 3



Photo 4



SAMPLE POINTS



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

APPENDIX CONTENTS

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	Matthew Hopes	MCERTS Level 2	MM 06 688	TE1 TE2 TE3 TE4
Team Leader	David Guy	MCERTS Level 2	MM 09 1044	TE1 TE2 TE3 TE4

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	CAT 7.9	Horiba PG-250	-	Digital Manometer (1)	CAT 3.23
Box Thermocouples	CAT 3.22	Servomex 4900	CAT 24.2	Digital Manometer (2)	-
Umbilical	CAT 3.22	Eco Physics CLD 822Mh	-	Digital Temperature Meter	CAT 3.23
Oven Box	CAT 12.24	Testo 350 XL	-	Stopwatch	CAT 14.54 / 14.55
Probe	CAT 5.102	Servomex 5200MP	-	Barometer	CAT 13.8
S-Pitot (1)	CAT 21P.20 / 21.P42	JCT JCC P1 Cooler	CAT 4.46	Stack Thermocouple (1)	CAT 4.426
S-Pitot (2)	CAT 21S.17	FT-IR	-	Stack Thermocouple (2)	CAT 4.14
L-Pitot	-	FT-IR Sampling System	-	1m Heated Line (1)	-
500g Check Weight	CAT 17.8	Bernath 3006 FID	CAT 8.9	1m Heated Line (2)	-
1Kg Check Weight	CAT 17.8	Heated Head Filter	CAT 12.22	1m Heated Line (3)	-
Last Impinger Arm	CAT 4.83 / 4.84	Mass Flow Controller (1)	CAT 6.30	5m Heated Line (1)	-
Callipers	CAT 23.9	Mass Flow Controller (2)	CAT 6.31	15m Heated Line (1)	-
Tubes Kit Thermocouple	-	Mass View (1)	-	15m Heated Line (2)	-
Laboratory Balance	CAT 1.18 / 1.18a	Mass View (2)	-	20m Heated Line (1)	CAT 20.24
Tape Measure	CAT 16.19	Easylogger EN-EL-12 Bit	CAT 11.24	Dual Channel Heater Controller	-

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	BS EN 13284-1	CAT-TP-01
Hydrogen Chloride	BS EN 1911	CAT-TP-11
Mercury	BS EN 13211	CAT-TP-06
Water Vapour	BS EN 14790	CAT-TP-05
Total VOCs (as Carbon)	BS EN 12619:2013	CAT-TP-20
Carbon Monoxide	BS EN 15058	CAT-TP-25
Oxygen	BS EN 14789	CAT-TP-25
Velocity & Vol. Flow Rate	BS EN 13284-1	CAT-TP-04

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.43
Stack Width, W	m	-
Stack Area, A	m ²	0.15
Average Stack Gas Temperature, T _a	°C	150.0
Average Stack Gas Pressure	Pa	95.1
Average Stack Static Pressure, P _{static}	kPa	-0.050
Average Barometric Pressure, P _b	kPa	101.1
Average Pitot Tube Calibration Coefficient, C _p	-	0.83

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)	-	5.00	4.62	0.0500	44.01	1.9635	0.09818
O ₂	-	14.31	13.21	0.1431	32.00	1.4277	0.20429
N ₂	-	80.69	74.50	0.8069	28.01	1.2498	1.00851
Moisture (H ₂ O)	-	-	7.67	0.0767	18.02	0.8037	0.06165

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	1.311
Wet Density (STP), P _{STW}	kg/m ³	1.272
Dry Density (Actual), P _{Actual}	kg/m ³	0.844
Average Wet Density (Actual), P _{ActualW}	kg/m ³	0.819

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	150.0	0.0
Total Pressure	kPa	101.1	101.3
Moisture	%	7.67	0.00
Oxygen (Dry)	%	14.3	11.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	6590
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	4242
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	3917
Gas Volumetric Flowrate REF ¹	m ³ /hr	2621

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE

(1 of 1)

Parameter	Units	Value
Date of Survey	-	21/03/2014
Time of Survey	-	11:30 - 11:35
Atmospheric Pressure	kPa	101.1
Stack Static Pressure	Pa	-50
Type of Pitot Used	-	S-Type Pitot
Are Water Droplets Present?	-	No

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Horizontal
Pitot Tube, C _p	-	0.83
Number of Lines Available	-	2
Number of Lines Used	-	2

Swirl Point (taken at the sampling points used during testing)																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Angle of Swirl (°)	1	3	2	2																

Traverse Point	Depth m	Sampling Line A				Sampling Line B			
		ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s
1	0.02	88.0	150.0	0.819	12.14	83.0	150.0	0.819	11.79
2	0.06	76.0	150.0	0.819	11.28	97.0	150.0	0.819	12.75
3	0.11	98.0	150.0	0.819	12.81	95.0	150.0	0.819	12.62
4	0.15	90.0	150.0	0.819	12.28	84.0	150.0	0.819	11.86
5	0.19	76.0	150.0	0.819	11.28	90.0	150.0	0.819	12.28
6	0.24	103.0	150.0	0.819	13.14	102.0	150.0	0.819	13.07
7	0.28	106.0	150.0	0.819	13.33	105.0	150.0	0.819	13.26
8	0.32	105.0	150.0	0.819	13.26	121.0	150.0	0.819	14.24
9	0.37	99.0	150.0	0.819	12.88	98.0	150.0	0.819	12.81
10	0.41	100.0	150.0	0.819	12.94	86.0	150.0	0.819	12.00
Mean		94.1	150.0	0.819	12.54	96.1	150.0	0.819	12.67

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	3.1	3.1
Uncertainty	±mg/m ³	0.44	0.44
Mass Emission	g/hr	6.3	6.3
Uncertainty	±g/hr	0.91	0.91

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	7.8	7.8
Uncertainty	±% v/v	0.41	0.41

Blank Runs

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

General Sampling Information

Parameter	Value	
Standard	BS 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	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, A3 & A4	

Reference Conditions

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

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P _b	mmHg	750.8	
Stack static pressure, P _{static}	mmH ₂ O	-5.1	
P _s = (P _b + (P _{static} / 13.6))	mmHg	750.4	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	74.6	
Total mass collected in impingers (silica trap)	g	11.8	
Total mass of liquid collected, V _{lc}	g	86.4	
V _{wstd} = (0.001246)(V _{lc})	m ³	0.1077	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V _m	m ³	1.4190	
Gas meter correction factor, Y _d	-	0.9930	
Average dry gas meter temperature, T _m	°C	27.5	
Average pressure drop across orifice, ΔH	mmH ₂ O	59.8	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/13.6))(Y _d)) / (T _m + 273)	m ³	1.2721	
Moisture content, B_{wo} & R_{wv}			
B _{wo} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³	0.0780	
B _{wo} as a percentage	% v/v	7.80	
Reported Water Vapour, checked with Tables in BS EN 14790, R _{wv}	% v/v	7.80	
Volume of gas metered wet, V_{mstw}			
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³	1.3797	
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	13.27	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	14.37	
% oxygen reference condition, REF%O ₂	% v/v	11.00	
O ₂ Reference Factor wet (O _{2REFw}) = (21 - REF%O ₂) / (21 - ACT%O _{2w})	-	1.29	
O ₂ Reference Factor dry (O _{2REFd}) = (21 - REF%O ₂) / (21 - ACT%O _{2d})	-	1.51	
V _{mstw@X%oxygen} = (V _{mstw}) / (O _{2REFw})	m ³	1.0668	
V _{mstd@X%oxygen} = (V _{mstd}) / (O _{2REFd})	m ³	0.8433	
Molecular weight of dry gas stream, M_d			
CO ₂ (Estimated)	% v/v	7.00	
O ₂	% v/v	14.37	
Total	% v/v	21.37	
N ₂	% v/v	78.63	
M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	g/gmol	29.69	
Molecular weight of stack gas (wet), M_s			
M _s = M _d (1 - (R _{wv} /100)) + 18(R _{wv} /100)	g/gmol	28.78	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K _p	-	34.97	
Velocity pressure coefficient, C _p	-	0.83	
Average of velocity heads, ΔP _{avg}	mmH ₂ O	7.50	
Average square root of velocity heads, √ΔP	√mmH ₂ O	2.74	
Average stack gas temperature, T _s	°C	155.0	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s	11.19	
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	0.15	
Q _a = (60)(A _s)(V _s)	m ³ /min	97.5	
Conversion factor (K/mm.Hg), C _f	-	0.3592	
Q _{stw} = ((Q _a)(P _s)(C _f)) / ((T _s + 273))	m ³ /min	61.4	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273))	m ³ /min	56.6	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s + 273)(O _{2REFw})	m ³ /min	47.5	
Q _{stdO₂} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273)(O _{2REFd})	m ³ /min	37.5	
Percent isokinetic, %I			
Nozzle diameter, D _n	mm	8.01	
Nozzle area, A _n	mm ²	50.44	
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))	%	107.8	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	11:52 - 12:52	
Sampling Dates	-	21/03/2014	
Sampling Device	-	ISO	
Volume Sampled (REF)	m ³	0.8433	
Filter I.D. Number	-	47-17930	
Start Filter Mass	g	0.14374	
End Filter Mass	g	0.14563	
Total Mass on Filter	g	0.00189	
Probe Rinse I.D. Number	-	PR-47-17930	
Start Probe Rinse Mass	g	7.00230	
End Probe Rinse Mass	g	7.00300	
Total Mass in Probe Rinse	g	0.00070	
Total Mass Collected	mg	2.59	
Calculated Concentration	mg/m ³	3.07	
Balance Uncertainty / LOD	mg/m ³	0.14	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	21/03/2014	
Average Volume Sampled (REF)	m ³	0.8433	
Filter I.D. Number	-	47-17836	
Start Filter Mass	g	0.13943	
End Filter Mass	g	0.13947	
Total Mass on Filter	g	0.00004	
Probe Rinse I.D. Number	-	PR-47-17836	
Start Probe Rinse Mass	g	2.97141	
End Probe Rinse Mass	g	2.97159	
Total Mass in Probe Rinse	g	0.00018	
Total Mass Collected	mg	0.22	
Calculated Concentration	mg/m ³	0.26	
Balance Uncertainty / LOD	mg/m ³	0.14	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	23.48	
Pre-Sampling Leak Rate	l/min	0.14	
Post-Sampling Leak Rate	l/min	0.14	
Allowable Leak Rate	l/min	0.47	
Leak Test Acceptable	-	Yes	
Water Droplets			
Are Water Droplets Present	-	No	
MU (Concurrent Water Vapour)			
Measurement Uncertainty (MU)	%	5.2	
Allowable MU	%	20	
MU Acceptable	%	Yes	
Silica Gel (Concurrent Water Vapour)			
Less than 50% Faded	%	Yes	
Isokinetic Criterion Compliance			
Isokinetic Variation	%	107.8	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	
Weighing Uncertainty Criteria			
Overall Weighing Uncertainty	± mg	0.24	
Overall Weighing Uncertainty	± mg/m ³	0.28	
ELV [Daily ELV for IED]	mg/m ³	20.00	
Allowable Weighing Uncertainty	mg/m ³	1.00	
Weighing Uncertainty Acceptable	-	Yes	
Filter Temperatures			
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	155	
Test Conditions			
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	18.00	
Pre-Sampling Leak Rate	l/min	0.10	
Post-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/m ³	2.0	
Blank Acceptable	-	Yes	

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

Method Deviations

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

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value			Standard uncertainty			
	Symbol	Run 1		Symbol	Units	Run 1	
Sampled Volume (Actual)	V _m	1.4190		uV _m	m ³	0.0284	
Sampled Gas Temperature	T _m	300.5		uT _m	K	2.0	
Sampled Gas Pressure	ρ _m	100.1		uρ _m	kPa	0.5	
Sampled Gas Humidity	H _m	0.0		uH _m	% v/v	1.0	
Leak	L	0.60		uL	%	-	
Mass of Particulate	m	2.59		um	mg	0.12	
Oxygen Content	O _{2,m}	14.37		uO _{2,m}	% v/v	0.10	
Uncollected Mass	UCM	0.22		uUCM	mg	-	

Measured Quantities	Uncertainty as a Percentage			Requirement of Standard
	Units	Run 1		
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.67		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.60		≤2%
Mass of Particulate	%	0.71		<5% of ELV
Oxygen Content	%	0.70		≤5%
Uncollected Mass	%	-		-

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1		Run 1	
Sampled Volume (STP)	V _m	m ³	1.2721		2.41	
Leak	L	mg/m ³	0.011		1.00	
Mass of Particulate	L _r	mg	2.590		1.19	
Factor for O ₂ Correction	O _{2,m}	% v/v	1.51		2.04	
Uncollected Mass	UCM	mg	0.13		1.19	

Measured Quantities	Uncertainty in Result		
	Units	Run 1	
Sampled Volume (STP)	mg/m ³	0.079	
Leak	mg/m ³	0.0106	
Mass of Particulate	mg/m ³	0.1423	
Factor for O ₂ Correction	mg/m ³	0.0463	
Uncollected Mass	mg/m ³	0.1506	

Parameter	Units	Run 1	
Combined uncertainty	mg/m ³	0.23	
Expanded uncertainty (95% confidence)	mg/m ³	0.44	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.44	
Reported Uncertainty	mg/m ³	0.44	
Expanded uncertainty (95% confidence)	%	14.5	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.5	
Reported Uncertainty	%	14.5	

HYDROGEN CHLORIDE: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	7.3	7.3
Uncertainty	±mg/m ³	1.1	1.1
Mass Emission	g/hr	14.9	14.9
Uncertainty	±g/hr	2.2	2.2

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	7.8	7.8
Uncertainty	±% v/v	0.41	0.41

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	< 0.018	< 0.018

General Sampling Information

Parameter	Value
Standard	BS EN 1911
Technical Procedure	CAT-TP-11
Name of Analytical Laboratory	CAT
Analytical Laboratory's Procedure	CAT-AP-01
UKAS Accredited Analysis?	Yes
Date of Sample Analysis	28/03/2014
Probe Material	Titanium
Filter Housing Material	Titanium
Impinger Material	Borosilicate Glass
Absorption Solution	HPLC Grade Water
Positioning of Filter	In Stack
Filter Size and Material	47mm Glass Fibre
Number of Sampling Lines Used	1 / 2
Number of Sampling Points Used	4 / 4
Sample Point I.D.'s	A1, A2, A3 & A4

FORMAT: Number Used / Number Required

Reference Conditions

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

HYDROGEN CHLORIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P _b	mmHg	750.8	
Stack static pressure, P _{static}	mmH ₂ O	-5.1	
P _s = (P _b + (P _{static} / 13.6))	mmHg	750.4	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	74.6	
Total mass collected in impingers (silica trap)	g	11.8	
Total mass of liquid collected, V _{lc}	g	86.4	
V _{wstd} = (0.001246)(V _{lc})	m ³	0.1077	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V _m	m ³	1.4190	
Gas meter correction factor, Y _d	-	0.9930	
Average dry gas meter temperature, T _m	°C	27.5	
Average pressure drop across orifice, ΔH	mmH ₂ O	59.8	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/13.6))(Y _d)) / (T _m + 273)	m ³	1.2721	
Moisture content, B_{wo} & R_{wv}			
B _{wo} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³	0.0780	
B _{wo} as a percentage	% v/v	7.80	
Reported Water Vapour, checked with Tables in BS EN 14790, R _{wv}	% v/v	7.80	
Volume of gas metered wet, V_{mstw}			
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³	1.3797	
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	13.27	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	14.37	
% oxygen reference condition, REF%O ₂	% v/v	11.00	
O ₂ Reference Factor wet (O _{2REFw}) = (21 - REF%O ₂) / (21 - ACT%O _{2w})	-	1.29	
O ₂ Reference Factor dry (O _{2REFd}) = (21 - REF%O ₂) / (21 - ACT%O _{2d})	-	1.51	
V _{mstw@X%oxygen} = (V _{mstw}) / (O _{2REFw})	m ³	1.0668	
V _{mstd@X%oxygen} = (V _{mstd}) / (O _{2REFd})	m ³	0.8433	
Molecular weight of dry gas stream, M_d			
CO ₂ (Estimated)	% v/v	7.00	
O ₂	% v/v	14.37	
Total	% v/v	21.37	
N ₂	% v/v	78.63	
M _d = 0.44(%CO ₂) + 0.32(%O ₂) + 0.28(%N ₂)	g/gmol	29.69	
Molecular weight of stack gas (wet), M_s			
M _s = M _d (1 - (R _{wv} /100)) + 18(R _{wv} /100)	g/gmol	28.78	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K _p	-	34.97	
Velocity pressure coefficient, C _p	-	0.83	
Average of velocity heads, ΔP _{avg}	mmH ₂ O	7.50	
Average square root of velocity heads, √ΔP	√mmH ₂ O	2.74	
Average stack gas temperature, T _s	°C	155.0	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s	11.19	
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	0.15	
Q _a = (60)(A _s)(V _s)	m ³ /min	97.5	
Conversion factor (K/mm.Hg), C _f	-	0.3592	
Q _{stw} = ((Q _a)(P _s)(C _f)) / ((T _s + 273))	m ³ /min	61.4	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273))	m ³ /min	56.6	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s + 273)(O _{2REFw})	m ³ /min	47.5	
Q _{stdO₂} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273)(O _{2REFd})	m ³ /min	37.5	
Percent isokinetic, %I			
Nozzle diameter, D _n	mm	8.01	
Nozzle area, A _n	mm ²	50.44	
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))	%	107.8	

HYDROGEN CHLORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	11:52 - 12:52	
Sampling Dates	-	21/03/2014	
Sampling Device	-	ISO	
Volume Sampled (REF)	m ³	0.8433	
Laboratory Result for Front Impingers	µg/ml	16.79	
Laboratory Result for Back Impinger	µg/ml	0.05	
Volume in Front Impingers	ml	365.5	
Volume in Back Impinger	ml	141.8	
Mass in Front Impingers	µg	6136.7	
Mass in Back Impinger	µg	< 7.1	
Total Mass Collected	µg	6143.8	
Calculated Concentration	mg/m ³	7.29	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	21/03/2014	
Average Volume Sampled (REF)	m ³	0.8433	
Laboratory Result for Impingers	µg/ml	< 0.05	
Volume in Impingers	ml	301.2	
Total Mass Collected	µg	< 15.1	
Calculated Concentration	mg/m ³	< 0.018	

HYDROGEN CHLORIDE: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	23.48	
Pre-Sampling Leak Rate	l/min	0.14	
Post-Sampling Leak Rate	l/min	0.14	
Allowable Leak Rate	l/min	0.47	
Leak Test Acceptable	-	Yes	

Absorption Efficiency	Units	Run 1	
Absorption Efficiency	%	100.0	
Allowable Absorption Efficiency	%	N/A ¹	
Absorption Efficiency Acceptable	-	N/A ¹	

¹ The concentration in the last absorber was less than 5 times the analytical detection limit.

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.2	
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	%	107.8	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Maximum Filter Temperature	°C	155	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

HYDROGEN CHLORIDE: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	18.00	
Pre-Sampling Leak Rate	l/min	0.10	
Post-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/m ³	3.0	
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	

HYDROGEN CHLORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value			Standard uncertainty			
	Symbol	Run 1		Symbol	Units	Run 1	
Sampled Volume (Actual)	V _m	1.4190		uV _m	m ³	0.0284	
Sampled Gas Temperature	T _m	300.5		uT _m	K	2.0	
Sampled Gas Pressure	ρ _m	100.1		uρ _m	kPa	0.5	
Sampled Gas Humidity	H _m	0.0		uH _m	% v/v	1.0	
Leak	L	0.60		uL	%	-	
Laboratory Result	L _r	6.80		uL _r	%	-	
Oxygen Content	O _{2,m}	14.37		uO _{2,m}	% v/v	0.10	

Uncertainty as a Percentage			
Measured Quantities	Units	Run 1	Requirement of Standard
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.60	≤2%
Laboratory Result	%	6.80	No Requirement
Oxygen Content	%	0.70	≤5%

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient	
	Symbol	Units	Run 1	Run 1	
Sampled Volume (STP)	V _m	m ³	1.2721	5.73	
Leak	L	mg/m ³	0.0251	1.00	
Laboratory Result	L _r	mg/m ³	0.495	1.00	
Factor for O ₂ Correction	O _{2,m}	% v/v	1.51	4.83	

Uncertainty in Result			
Measured Quantities	Units	Run 1	
Sampled Volume (STP)	mg/m ³	0.1882	
Leak	mg/m ³	0.025	
Laboratory Result	mg/m ³	0.495	
Factor for O ₂ Correction	mg/m ³	0.11	

Parameter	Units	Run 1	
Combined uncertainty	mg/m ³	0.54	
Expanded uncertainty (95% confidence)	mg/m ³	1.06	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	1.06	
Reported Uncertainty	mg/m ³	1.06	
Expanded uncertainty (95% confidence)	%	14.6	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.6	
Reported Uncertainty	%	14.6	

MERCURY: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	0.012	0.012
Uncertainty	±mg/m ³	0.0015	0.0015
Mass Emission	g/hr	0.024	0.024
Uncertainty	±g/hr	0.0031	0.0031

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	7.4	7.4
Uncertainty	±% v/v	0.39	0.39

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	0.00030	0.00030

General Sampling Information

Parameter	Value
Standard	BS EN 13211
Technical Procedure	CAT-TP-06
Name of Analytical Laboratory	RPS
Analytical Laboratory's Procedure	M112
UKAS Accredited Analysis?	Yes
Date of Sample Analysis	28/03/2014
Probe Material	Titanium
Filter Housing Material	Borosilicate Glass
Impinger Material	Borosilicate Glass
Absorption Solution	Potassium Dichromate
Positioning of Filter	Out Stack
Filter Size and Material	47mm Quartz Fibre
Number of Sampling Lines Used	1 / 2
Number of Sampling Points Used	4 / 4
Sample Point I.D.'s	A1, A2, A3 & A4

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

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

MERCURY: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P _b	mmHg	758.3	
Stack static pressure, P _{static}	mmH ₂ O	-5.1	
P _s = (P _b + (P _{static} / 13.6))	mmHg	757.9	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	52.8	
Total mass collected in impingers (silica trap)	g	3.5	
Total mass of liquid collected, V _{lc}	g	56.3	
V _{wstd} = (0.001246)(V _{lc})	m ³	0.0701	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V _m	m ³	0.9780	
Gas meter correction factor, Y _d	-	0.9930	
Average dry gas meter temperature, T _m	°C	29.4	
Average pressure drop across orifice, ΔH	mmH ₂ O	28.8	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/13.6))(Y _d)) / (T _m + 273)	m ³	0.8771	
Moisture content, B_{w0} & R_{wv}			
B _{w0} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³	0.0741	
B _{w0} as a percentage	% v/v	7.41	
Reported Water Vapour, checked with Tables in BS EN 14790, R _{wv}	% v/v	7.41	
Volume of gas metered wet, V_{mstw}			
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³	0.9472	
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	13.13	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	14.22	
% oxygen reference condition, REF%O ₂	% v/v	11.00	
O ₂ Reference Factor wet (O _{2REFw}) = (21 - REF%O ₂) / (21 - ACT%O _{2w})	-	1.27	
O ₂ Reference Factor dry (O _{2REFd}) = (21 - REF%O ₂) / (21 - ACT%O _{2d})	-	1.47	
V _{mstw@X%oxygen} = (V _{mstw}) / (O _{2REFw})	m ³	0.7459	
V _{mstd@X%oxygen} = (V _{mstd}) / (O _{2REFd})	m ³	0.5950	
Molecular weight of dry gas stream, M_d			
CO ₂ (Estimated)	% v/v	6.00	
O ₂	% v/v	14.22	
Total	% v/v	20.22	
N ₂	% v/v	79.78	
M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	g/gmol	29.53	
Molecular weight of stack gas (wet), M_s			
M _s = M _d (1 - (R _{wv} /100)) + 18(R _{wv} /100)	g/gmol	28.67	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K _p	-	34.97	
Velocity pressure coefficient, C _p	-	0.83	
Average of velocity heads, ΔP _{avg}	mmH ₂ O	3.50	
Average square root of velocity heads, √ΔP	√mmH ₂ O	1.87	
Average stack gas temperature, T _s	°C	144.8	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s	7.53	
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	0.15	
Q _a = (60)(A _s)(V _s)	m ³ /min	65.6	
Conversion factor (K/mm.Hg), C _f	-	0.3592	
Q _{stw} = ((Q _a)(P _s)(C _f)) / ((T _s + 273))	m ³ /min	42.8	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273))	m ³ /min	39.6	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s + 273)(O _{2REFw})	m ³ /min	33.7	
Q _{stdO₂} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273)(O _{2REFd})	m ³ /min	26.9	
Percent isokinetic, %I			
Nozzle diameter, D _n	mm	8.01	
Nozzle area, A _n	mm ²	50.44	
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))	%	106.3	

MERCURY: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	14:16 - 15:16	
Sampling Dates	-	21/03/2014	
Sampling Device	-	ISO	
Volume Sampled (REF)	m ³	0.5950	
Mass on Filter / in Rinse	µg	< 0.030	
Mass in Front Impinger/s	µg	6.81	
Mass in Final Impinger	µg	0.15	
Total Mass Collected	µg	6.99	
Calculated Concentration	mg/m ³	0.012	
Reported Concentration	mg/m ³	0.012	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	21/03/2014	
Average Volume Sampled (REF)	m ³	0.5950	
Mass on Filter / in Rinse	µg	0.030	
Mass in Front Impinger/s	µg	< 0.098	
Mass in Final Impinger	µg	< 0.048	
Total Mass Collected	µg	0.18	
Calculated Concentration	mg/m ³	0.00030	
Reported Concentration	mg/m ³	0.00030	

MERCURY: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	16.19	
Pre-Sampling Leak Rate	l/min	0.18	
Post-Sampling Leak Rate	l/min	0.14	
Allowable Leak Rate	l/min	0.32	
Leak Test Acceptable	-	Yes	

Absorption Efficiency	Units	Run 1	
Absorption Efficiency	%	97.9	
Allowable Absorption Efficiency	%	N/A	
Absorption Efficiency Acceptable	-	N/A	

Where the emissions are < 30% of the ELV, MID 14385 does not require the 95% absorption efficiency requirement to be applied

Concentration in Final Impinger	Units	Run 1	
Concentration in Final Impinger	µg/m ³	0.25	
Allowable Concentration	µg/m ³	2.0	
Concentration Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.3	
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	%	106.3	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Maximum Filter Temperature	°C	187	

Impingers Exit Temperature	Units	Run 1	
Maximum Temperature Recorded	°C	24	
Maximum Allowable Temperature	°C	30	
Exit Temperature Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

MERCURY: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	18.00	
Pre-Sampling Leak Rate	l/min	0.10	
Post-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/m ³	0.0050	
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
Only one sampling line was installed on the stack, however the number of sample points used on the available line were increased to meet the requirements of the Standard.	wx

MERCURY: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value			Standard uncertainty			
	Symbol	Run 1		Symbol	Units	Run 1	
Sampled Volume (Actual)	V _m	0.9780		uV _m	m ³	0.0196	
Sampled Gas Temperature	T _m	302.4		uT _m	K	2.0	
Sampled Gas Pressure	ρ _m	101.1		uρ _m	kPa	0.5	
Sampled Gas Humidity	H _m	0.0		uH _m	% v/v	1.0	
Leak	L	0.86		uL	%	-	
Laboratory Result	L _r	6.00		uL _r	%	-	
Oxygen Content	O _{2,m}	14.22		uO _{2,m}	% v/v	0.10	

Measured Quantities	Uncertainty as a Percentage			Requirement of Standard
	Units	Run 1		
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.66		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.86		≤2%
Laboratory Result	%	6.00		No Requirement
Oxygen Content	%	0.70		≤5%

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1		Run 1	
Sampled Volume (STP)	V _m	m ³	0.8771		0.013	
Leak	L	mg/m ³	0.0001		1.00	
Laboratory Result	L _r	mg/m ³	0.0007		1.00	
Factor for O ₂ Correction	O _{2,m}	% v/v	1.47		0.008	

Measured Quantities	Uncertainty in Result		
	Units	Run 1	
Sampled Volume (STP)	mg/m ³	0.0003	
Leak	mg/m ³	0.0001	
Laboratory Result	mg/m ³	0.0007	
Factor for O ₂ Correction	mg/m ³	0.0002	

Parameter	Units	Run 1	
Combined uncertainty	mg/m ³	0.0008	
Expanded uncertainty (95% confidence)	mg/m ³	0.0015	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.0015	
Reported Uncertainty	mg/m ³	0.0015	
Expanded uncertainty (95% confidence)	%	13.2	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	13.2	
Reported Uncertainty	%	13.2	

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	0.65	0.65
Uncertainty	±mg/m ³	0.21	0.21
Mass Emission	g/hr	1.3	1.3
Uncertainty	±g/hr	0.42	0.42

General Sampling Information

Parameter	Value
Standard	BS 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 Reference Number	CYL 1.0072
Span Gas Expiry Date	16/10/2017
Span Gas Start Pressure (bar)	INPUT
Gas Cylinder Concentration (ppm)	80.3
Span Gas Uncertainty (%)	2
Zero Gas Type	Synthetic Air (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	B1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

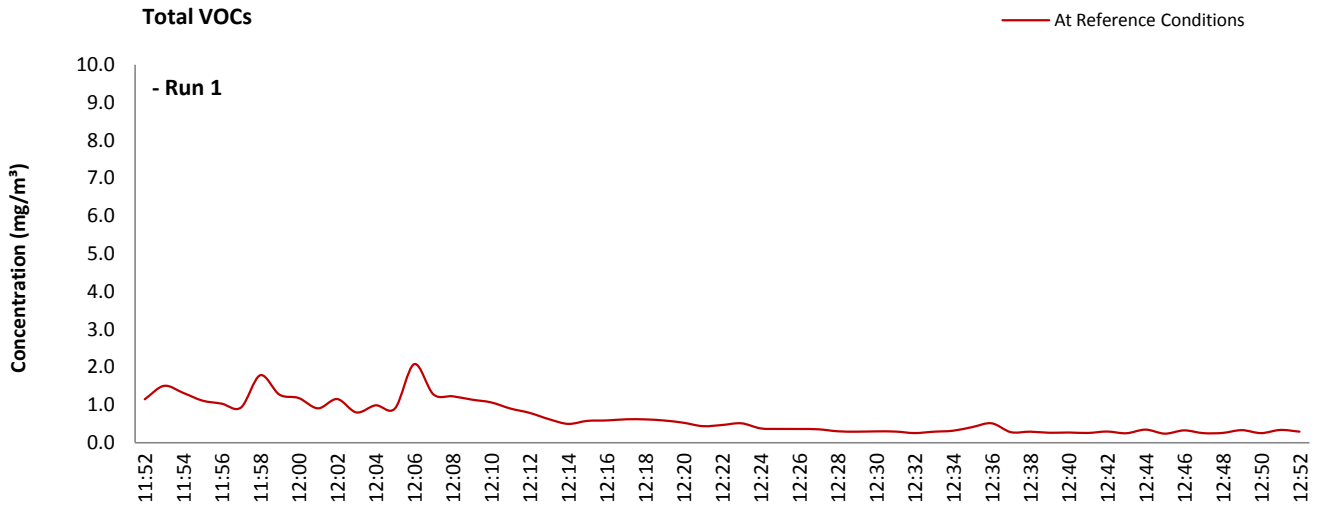
FORMAT: Number Used / Number Required

Reference Conditions

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

TOTAL VOCs (as CARBON): DATA TREND

Graphical Trend of Data



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

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	11:52 - 12:52	
Sampling Dates	-	21/03/2014	
Instrument Range	ppm	100	
Span Gas Value	ppm	80.3	

Quality Assurance

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00	
	Zero Down Sampling Line (Post)	ppm	1.00	
	Zero Drift	ppm	1.00	
	Allowable Zero Drift	± ppm	4.02	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	79.00	
	Span Down Sampling Line (Post)	ppm	76.90	
	Span Drift	ppm	-2.10	
	Allowable Span Drift	± ppm	4.02	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	13.0 - 15.5	

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

Measured Quantities	Value			
	Units	Run 1	Run 2	Run 3
MCERTS Certified Range of Analyser	ppm	9.3		
Operational Range of Analyser	ppm	100.0		
Measured Reading	ppm	0.2		

Measured Quantities	Individual Errors as Standard Uncertainties			
	Units	Run 1	Run 2	Run 3
Nonlinearity	ppm	0.010		
Temperature Dependent Zero Drift	ppm	0.027		
Temperature Dependent Span Drift	ppm	0.027		
Cross-Sensitivity	ppm	0.0057		
Leak	ppm	0.0023		
Calibration Gas Uncertainty	ppm	0.0015		
Mass Flow Controllers (dilution) Uncertainty	ppm	0.0020		

Parameter	Units	Run 1	Run 2	Run 3
Combined uncertainty	ppm	0.040		
Expanded uncertainty (95% confidence)	ppm	0.078		
Expanded uncertainty (95% confidence), estimated with Method Deviations	ppm	0.078		
Reported Uncertainty	ppm	0.078		
Expanded uncertainty (95% confidence)	%	31.5		
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	31.5		
Reported Uncertainty	%	31.5		

CARBON MONOXIDE: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	12.7	12.7
Uncertainty	±mg/m ³	2.7	2.66
Mass Emission	g/hr	25.9	25.9
Uncertainty	±g/hr	5.4	5.4

General Sampling Information

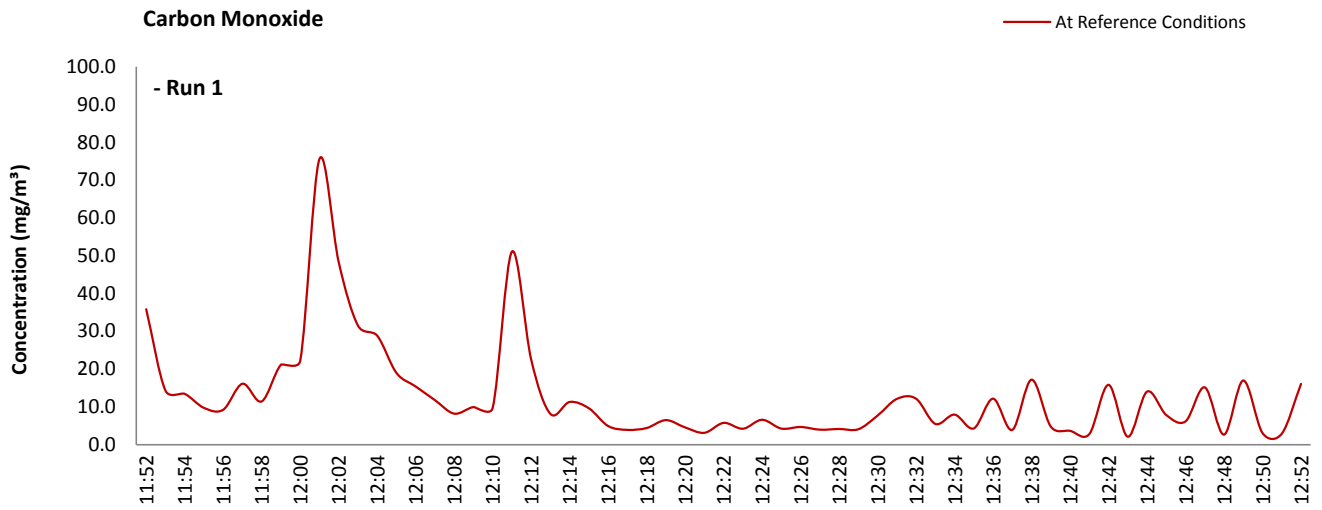
Parameter	Value	
Standard	BS EN 15058	
Technical Procedure	CAT-TP-25	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Reference Number	CYL 2.0076	
Span Gas Expiry Date	31/07/2018	
Span Gas Start Pressure (bar)	140	
Gas Cylinder Concentration (ppm)	403.11	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (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	B1	

Reference Conditions

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

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	11:52 - 12:52	
Sampling Dates	-	21/03/2014	
Instrument Range	ppm	200	
Span Gas Value	ppm	80.1	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	2.7	
Allowable Temperature	< °C	4.0	
Temperature Acceptable	-	Yes	

Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.49
	Zero Down Sampling Line (Post)	ppm	-0.20
	Zero Drift	ppm	-0.69
	Allowable Zero Drift	± ppm	4.00
	Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	79.79
	Span Down Sampling Line (Post)	ppm	78.49
	Span Drift	ppm	-1.30
	Allowable Span Drift	± ppm	4.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	13.0 - 15.5	

Method Deviations

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

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		
	Units	Run 1	
MCERTS Certified Range of Analyser	ppm	60.0	
Operational Range of Analyser	ppm	200.0	
Measured Reading	ppm	6.7	

Measured Quantities	Individual Errors as Standard Uncertainties		
	Units	Run 1	
Nonlinearity	ppm	0.180	
Temperature Dependent Zero Drift	ppm	-0.520	
Temperature Dependent Span Drift	ppm	0.454	
Cross-Sensitivity	ppm	0.070	
Leak	ppm	0.015	
Calibration Gas Uncertainty	ppm	0.040	
Mass Flow Controllers (dilution) Uncertainty	ppm	0.055	

Parameter	Units	Run 1	
Combined uncertainty	ppm	0.72	
Expanded uncertainty (95% confidence)	ppm	1.41	
Expanded uncertainty (95% confidence), estimated with Method Deviations	ppm	1.41	
Reported Uncertainty	ppm	1.41	
Expanded uncertainty (95% confidence)	%	21.0	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	21.0	
Reported Uncertainty	%	21.0	

Although measured concentrations greater than the MCERTS Certified range of the analyser (75 mg/m³) were recorded, Catalyst's Internal Annual Systems Checks cover the use of the analyser up to 625 mg/m³.

OXYGEN: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

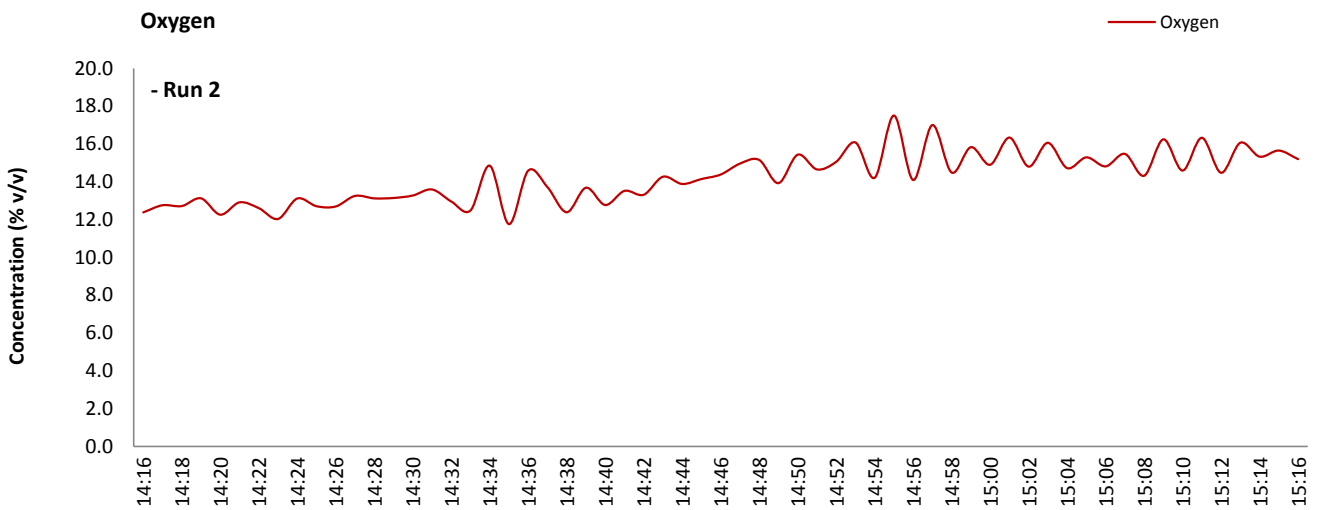
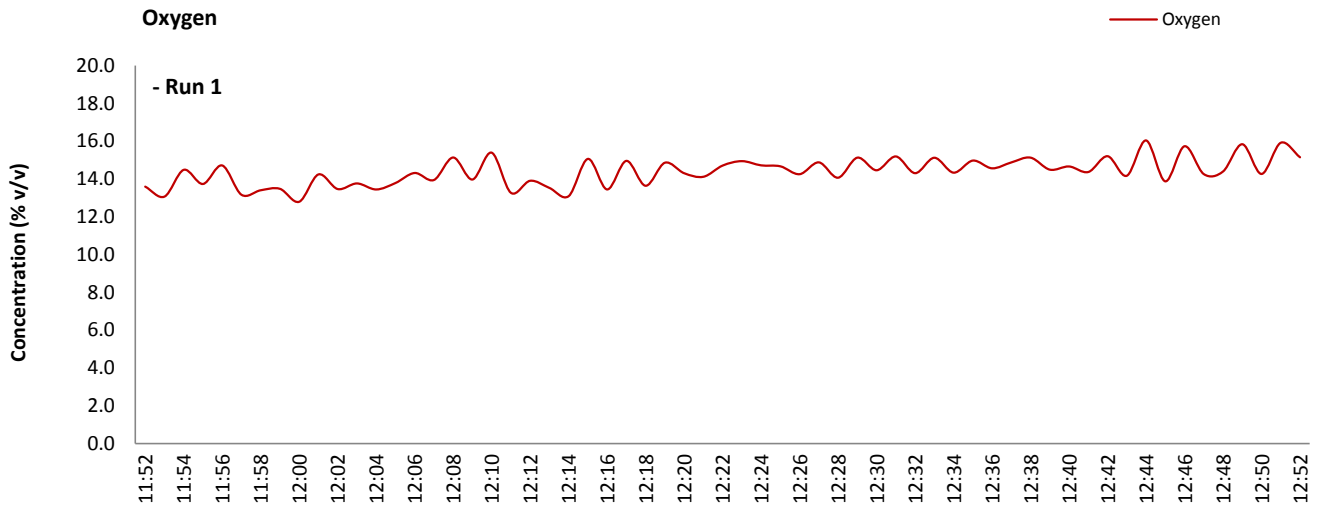
Parameter	Units	Run 1	Run 2		Mean
Concentration	% v/v	14.4	14.2		14.3
Uncertainty	±% v/v	0.29	0.29		0.29

General Sampling Information

Parameter	Value	
Standard	BS EN 14789	
Technical Procedure	CAT-TP-25	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Reference Number	CYL 11.0144	
Span Gas Expiry Date	16/10/2018	
Span Gas Start Pressure (bar)	80	
Gas Cylinder Concentration (% v/v)	20.71	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (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	B1	

OXYGEN: DATA TREND

Graphical Trend of Data



OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	
Sampling Times	-	11:52 - 12:52	14:16 - 15:16	
Sampling Dates	-	21/03/2014	21/03/2014	
Instrument Range	% v/v	25	25	
Span Gas Value	% v/v	13.00	13.00	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	
Average Temperature	°C	2.7	2.7	
Allowable Temperature	< °C	4.0	4.0	
Temperature Acceptable	-	Yes	Yes	

Zero Drift	Units	Run 1	Run 2	
Zero Down Sampling Line (Pre)	% v/v	0.13	0.13	
Zero Down Sampling Line (Post)	% v/v	0.04	0.04	
Zero Drift	% v/v	-0.09	-0.09	
Allowable Zero Drift	± % v/v	0.65	0.65	
Zero Drift Acceptable	-	Yes	Yes	

CAL 1

Span Drift	Units	Run 1	Run 2	
Span Down Sampling Line (Pre)	% v/v	12.70	12.70	
Span Down Sampling Line (Post)	% v/v	12.53	12.53	
Span Drift	% v/v	-0.17	-0.17	
Allowable Span Drift	± % v/v	0.65	0.65	
Span Drift Acceptable	-	Yes	Yes	

CAL 1

Test Conditions	Units	Run 1	Run 2	
Run Ambient Temperature Range	°C	13.0 - 15.5	13.0 - 15.5	

Method Deviations

Nature of Deviation	Run Number		
	1	2	
(x = deviation applies to the associated run)			
There are no deviations associated with the sampling employed.	x	x	

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		
	Units	Run 1	Run 2
Operational Range of Analyser	% v/v	25.0	25.0
Measured Reading	% v/v	14.4	14.2

Measured Quantities	Individual Errors as Standard Uncertainties		
	Units	Run 1	Run 2
Nonlinearity	% v/v	0.023	0.023
Temperature Dependent Zero Drift	% v/v	0.000	0.000
Temperature Dependent Span Drift	% v/v	0.012	0.012
Cross-Sensitivity	% v/v	0.000	0.000
Leak	% v/v	0.000	0.000
Calibration Gas Uncertainty	% v/v	0.085	0.084
Mass Flow Controllers (dilution) Uncertainty	% v/v	0.117	0.116

Parameter	Units	Run 1	Run 2
Combined uncertainty	% v/v	0.15	0.15
Expanded uncertainty (95% confidence)	% v/v	0.29	0.29
Expanded uncertainty (95% confidence), estimated with Method Deviations	% v/v	0.29	0.29
Reported Uncertainty	% v/v	0.29	0.29
Expanded uncertainty (95% confidence)	%	2.0	2.0
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	2.0	2.0
Reported Uncertainty	%	2.0	2.0