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Stack Emissions Testing Report Commissioned by
ATI Environment UK Ltd

Installation Name & Address
Ipswich Borough Council
Cemetery Lane
Ipswich
IP4 2TQ

LAPPC Guidance Note: PG 5/2 (12)

Stack Reference
Mercury Abatement Outlet

Dates of the Monitoring Campaign
28th March 2013


Job Reference Number
CSW-1087

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Signature of Report Approver




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Executive Summary

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MONITORING OBJECTIVES

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
28th March 2013

Overall Aim of the Monitoring Campaign

Catalyst Environmental Ltd 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

Mercury

Executive Summary

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MONITORING RESULTS

Ipswich Borough Council, Ipswich Crematorium
 Mercury Abatement Outlet
 28th March 2013

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Mercury (Run 1)	¹ mg/m ³	0.0094	0.0009	0.05	g/hr	0.0115	0.0011	-
Mercury (Run 2)	¹ mg/m ³	0.0039	0.0009	0.05	g/hr	0.0047	0.0011	-
Oxygen	% v/v	Dry 13.7	0.29					
Water Vapour	% v/v	7.4	0.4					
Stack Gas Temperature	°C	100.4						
Stack Gas Velocity	m/s	4.7						
Volumetric Flow Rate (ACTUAL)	m ³ /hr	2484						
Volumetric Flow Rate (REF)	¹ m ³ /hr	1221						

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.

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MONITORING DATE(S) & TIMES

Ipswich Borough Council, Ipswich Crematorium
 Mercury Abatement Outlet
 28th March 2013

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins	
Mercury	R1	mg/m ³	0.0094	g/hr	0.0115	28/03/2013	10:36 - 11:36	60
Mercury	R2	mg/m ³	0.0039	g/hr	0.0047	28/03/2013	12:52 - 13:52	60
Oxygen	R1	% v/v	13.4			28/03/2013	10:36 - 11:36	60
Oxygen	R2	% v/v	13.9			28/03/2013	12:52 - 13:52	60
Velocity & Volumetric Flow Rate	R1					28/03/2013	09:20 - 09:30	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
28th March 2013

Standard Operating Conditions

Parameter	Value
Process Status	Normal
Capacity (of 100%) and Tonnes / Hour	Run 1 - Single Cremation, Run 2 - Similtaneous Cremations
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
Sex	Male / Male
Temperature in Primary Chamber	665 / 668
Temperature in Secondary Chamber	886 / 904
Cremation Number	126642 / 126644
Size	Medium / Medium
Run 1	Cremator 1 Only
Run 2	Cremator 1 & 2 in Operation (Cremator 1 Lead Cremator)

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MONITORING & ANALYTICAL METHODS

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet
28th March 2013

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	UKAS Testing	Testing Lab	Analytical Procedure	Analytical Technique	UKAS Analysis	Analysis Lab		
Mercury	BS EN 13211	CAT-TP-06	Yes	CAT	M112	CV-AFS	Yes	RPS	Yes	0.00034 mg/m ³
Water Vapour	BS EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Oxygen	BS EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				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
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	On Ground
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	8.0	> 5 Pa	Yes
Mean Velocity	m/s	4.33	-	-
Lowest Gas Velocity	m/s	3.39	-	-
Highest Gas Velocity	m/s	5.08	-	-
Ratio of Above	: 1	1.50	< 3 : 1	Yes
Maximum Angle of Swirl	°	6	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

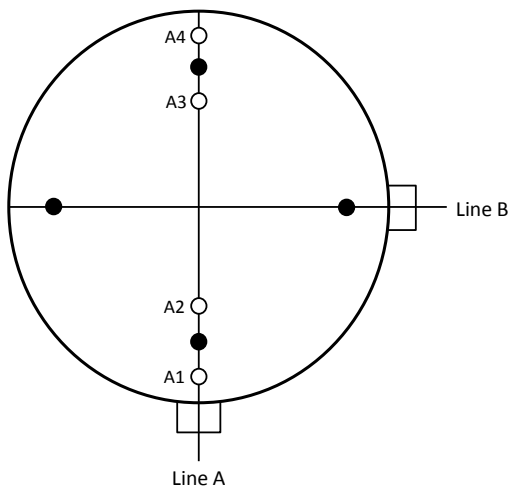
Photo 1



Photo 2



SAMPLE POINTS



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



APPENDICES



APPENDIX CONTENTS

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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Matthew Hopes	MCERTS Level 2	MM 06 688	TE1 TE2 TE3 TE4
Technician	Daniele Benucci	MCERTS Level 1	MM 12 1082	None

LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM	CAT 7.9	Horiba PG-250	CAT 9.6	Digital Manometer (1)	CAT 3.23
Box Thermocouples	CAT 3.22	Servomex 4900	-	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	JCT JCC P1 Cooler	-	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	-	1m Heated Line (2)	-
1Kg Check Weight	CAT 17.8	Heated Head Filter	-	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)	-
Tape Measure	CAT 19.8	Easylogger EN-EL-12 Bit	-	Dual Channel Heater Controller	-

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Mercury	BS EN 13211	CAT-TP-06
Water Vapour	BS EN 14790	CAT-TP-05
Oxygen	BS EN 14789	CAT-TP-21
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	88.0
Average Stack Gas Pressure	Pa	13.3
Average Stack Static Pressure, P _{static}	kPa	-0.055
Average Barometric Pressure, P _b	kPa	100.4
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)	-	6.00	5.56	0.0600	44.01	1.9635	0.11781
O ₂	-	13.66	12.65	0.1366	32.00	1.4277	0.19500
N ₂	-	80.34	74.41	0.8034	28.01	1.2498	1.00414
Moisture (H ₂ O)	-	-	7.38	0.0738	18.02	0.8037	0.05935

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	1.317
Wet Density (STP), P _{STW}	kg/m ³	1.279
Dry Density (Actual), P _{Actual}	kg/m ³	0.987
Average Wet Density (Actual), P _{ActualW}	kg/m ³	0.958

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} x (T_s / P_s) x (P_a / T_a)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF ¹
Temperature	°C	88.0	0.0
Total Pressure	kPa	100.3	101.3
Moisture	%	7.38	0.00
Oxygen (Dry)	%	13.7	11.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	2264
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	1696
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	1571
Gas Volumetric Flowrate REF ¹	m ³ /hr	1153

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE

(1 of 1)

Parameter	Units	Value
Date of Survey	-	28/03/2013
Time of Survey	-	09:20 - 09:30
Atmospheric Pressure	kPa	100.4
Stack Static Pressure	Pa	-55
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 (°)	4	6	5	6																

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	15.0	87.0	0.961	4.63	9.0	89.0	0.956	3.60
2	0.06	16.0	87.0	0.961	4.78	8.0	89.0	0.956	3.39
3	0.11	18.0	87.0	0.961	5.07	14.0	89.0	0.956	4.48
4	0.15	15.0	87.0	0.961	4.63	17.0	89.0	0.956	4.94
5	0.19	13.0	87.0	0.961	4.31	14.0	89.0	0.956	4.48
6	0.24	14.0	87.0	0.961	4.47	12.0	89.0	0.956	4.15
7	0.28	12.0	87.0	0.961	4.14	18.0	89.0	0.956	5.08
8	0.32	13.0	87.0	0.961	4.31	9.0	89.0	0.956	3.60
9	0.37	14.0	87.0	0.961	4.47	13.0	89.0	0.956	4.32
10	0.41	10.0	87.0	0.961	3.78	11.0	89.0	0.956	3.97
Mean		14.0	87.0	0.961	4.46	12.5	89.0	0.956	4.20

MERCURY: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Run 2	Mean
Concentration	mg/m ³	0.0094	0.0039	0.0066
Uncertainty	±mg/m ³	0.0012	0.00050	0.00086
Mass Emission	g/hr	0.012	0.0047	0.0081
Uncertainty	±g/hr	0.0015	0.00062	0.0011

Parameter	Units	Run 1	Run 2	Mean
Water Vapour	% v/v	7.5	7.3	7.4
Uncertainty	±% v/v	0.37	0.36	0.37

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	0.00018	0.00018

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	11/04/2013
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	Run 2	
Absolute pressure of stack gas, P_s				
Barometric pressure, P _b	mmHg	753.0	753.0	
Stack static pressure, P _{static}	mmH ₂ O	-5.6	-5.6	
P _s = (P _b + (P _{static} / 13.6))	mmHg	752.6	752.6	
Volume of water vapour collected, V_{wstd}				
Total mass collected in impingers (liquid trap)	g	79.5	69.5	
Total mass collected in impingers (silica trap)	g	8.3	14.1	
Total mass of liquid collected, V _{lc}	g	87.8	83.6	
V _{wstd} = (0.001246)(V _{lc})	m ³	0.1094	0.1042	
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V _m	m ³	1.3917	1.3790	
Gas meter correction factor, Y _d	-	1.0320	1.0320	
Average dry gas meter temperature, T _m	°C	16.3	18.7	
Average pressure drop across orifice, ΔH	mmH ₂ O	54.8	62.0	
V _{mstd} = ((0.3592)(V _m (P _b + (ΔH/13.6))(Y _d)) / (T _m + 273))	m ³	1.3500	1.3276	
Moisture content, B_{w0} & R_{wv}				
B _{w0} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³	0.0750	0.0728	
B _{w0} as a percentage	% v/v	7.50	7.28	
Reported Water Vapour, checked with Tables in BS EN 14790, R _{wv}	% v/v	7.50	7.27	
Volume of gas metered wet, V_{mstw}				
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³	1.4594	1.4317	
Volume of gas metered at Oxygen Reference Conditions, V_{mstd@X%O₂} & V_{mstw@X%O₂}				
WID & Incinerates Hazardous Material? (Yes = no positive O ₂ correction)	-	No	No	
% wet oxygen measured in gas stream, ACT%O _{2w}	% v/v	12.45	12.85	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	13.44	13.88	
% oxygen reference condition, REF%O ₂	% v/v	11.00	11.00	
O ₂ Reference Factor wet (O _{2REFw}) = (21 - REF%O ₂) / (21 - ACT%O _{2w})	-	1.17	1.40	
O ₂ Reference Factor dry (O _{2REFd}) = (21 - REF%O ₂) / (21 - ACT%O _{2d})	-	1.32	1.40	
V _{mstw@X%oxygen} = (V _{mstw}) / (O _{2REFw})	m ³	1.2479	1.0199	
V _{mstd@X%oxygen} = (V _{mstd}) / (O _{2REFd})	m ³	1.0204	0.9458	
Molecular weight of dry gas stream, M_d				
CO ₂ (Estimated)	% v/v	7.00	7.00	
O ₂	% v/v	13.44	13.88	
Total	% v/v	20.44	20.88	
N ₂	% v/v	79.56	79.12	
M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	g/gmol	29.66	29.68	
Molecular weight of stack gas (wet), M_s				
M _s = M _d (1 - (R _{wv} /100)) + 18(R _{wv} /100)	g/gmol	28.78	28.83	
Velocity of stack gas, V_s				
Pitot tube velocity constant, K _p	-	34.97	34.97	
Velocity pressure coefficient, C _p	-	0.83	0.83	
Average of velocity heads, ΔP _{avg}	mmH ₂ O	1.45	1.67	
Average square root of velocity heads, √ΔP	√mmH ₂ O	1.20	1.29	
Average stack gas temperature, T _s	°C	95.8	105.0	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s	4.55	4.95	
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	0.15	
Q _a = (60)(A _s)(V _s)	m ³ /min	39.7	43.1	
Conversion factor (K/mm.Hg), C _f	-	0.3592	0.3592	
Q _{stw} = ((Q _a)(P _s)(C _f)) / ((T _s + 273))	m ³ /min	29.1	30.8	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273))	m ³ /min	26.9	28.6	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s + 273)(O _{2REFw})	m ³ /min	24.9	22.0	
Q _{stdO₂} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273)(O _{2REFd})	m ³ /min	20.3	20.4	
Percent isokinetic, %I				
Nozzle diameter, D _n	mm	12.05	12.05	
Nozzle area, A _n	mm ²	113.99	113.99	
Total sampling time, q	min	60	60	
%I = (4.6398E ⁶)(T _s +273)(V _{mstd}) / (P _s)(V _s)(A _n)(q)(1 - (R _{wv} /100))	%	106.5	98.6	

MERCURY: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	
Sampling Times	-	10:36 - 11:36	12:52 - 13:52	
Sampling Dates	-	28/03/2013	28/03/2013	
Sampling Device	-	ISO	ISO	
Volume Sampled (REF)	m ³	1.0204	0.9464	
Mass on Filter / in Rinse	µg	0.13	< 0.03	
Mass in Front Impinger/s	µg	9.23	3.34	
Mass in Final Impinger	µg	0.26	0.30	
Total Mass Collected	µg	9.62	3.67	
Calculated Concentration	mg/m ³	0.0094	0.0039	
Reported Concentration	mg/m ³	0.0094	0.0039	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	28/03/2013	
Average Volume Sampled (REF)	m ³	0.9834	
Mass on Filter / in Rinse	µg	< 0.030	
Mass in Front Impinger/s	µg	0.10	
Mass in Final Impinger	µg	< 0.053	
Total Mass Collected	µg	0.18	
Calculated Concentration	mg/m ³	0.00018	
Reported Concentration	mg/m ³	0.00018	

MERCURY: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	Run 2	
Mean Sampling Rate	l/min	23.94	23.72	
Pre-Sampling Leak Rate	l/min	0.15	0.20	
Post-Sampling Leak Rate	l/min	0.16	0.18	
Allowable Leak Rate	l/min	0.48	0.47	
Leak Test Acceptable	-	Yes	Yes	

Absorption Efficiency	Units	Run 1	Run 2	
Absorption Efficiency	%	97.3	91.9	
Allowable Absorption Efficiency	%	N/A	N/A	
Absorption Efficiency Acceptable	-	N/A	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	Run 2	
Concentration in Final Impinger	µg/m ³	0.25	0.32	
Allowable Concentration	µg/m ³	2.0	2.0	
Concentration Acceptable	-	Yes	Yes	

Water Droplets	Units	Run 1	Run 2	
Are Water Droplets Present	-	No	No	

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	
Measurement Uncertainty (MU)	%	5.0	5.0	
Allowable MU	%	20	20	
MU Acceptable	%	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	
Less than 50% Faded	%	Yes	Yes	

Isokinetic Criterion Compliance	Units	Run 1	Run 2	
Isokinetic Variation	%	106.5	98.6	
Allowable Isokinetic Range	%	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	

Filter Temperatures	Units	Run 1	Run 2	
Maximum Filter Temperature	°C	184	184	

Impingers Exit Temperature	Units	Run 1	Run 2	
Maximum Temperature Recorded	°C	11	13	
Maximum Allowable Temperature	°C	30	30	
Exit Temperature Acceptable	-	Yes	Yes	

Test Conditions	Units	Run 1	Run 2	
Ambient Temperature Recorded?	-	Yes	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	0.20	
Post-Sampling Leak Rate	l/min	0.22	
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	
	1	2
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)		
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.	x	x

MERCURY: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value				Standard uncertainty			
	Symbol	Run 1	Run 2		Symbol	Units	Run 1	Run 2
Sampled Volume (Actual)	V _m	1.3917	1.3790		uV _m	m ³	0.0278	0.0276
Sampled Gas Temperature	T _m	289.3	291.7		uT _m	K	2.0	2.0
Sampled Gas Pressure	ρ _m	100.4	100.4		uρ _m	kPa	0.5	0.5
Sampled Gas Humidity	H _m	0.0	0.0		uH _m	% v/v	1.0	1.0
Leak	L	0.67	0.76		uL	%	-	-
Laboratory Result	L _r	6.00	6.00		uL _r	%	-	-
Oxygen Content	O _{2,m}	13.44	13.88		uO _{2,m}	% v/v	0.10	0.10

Measured Quantities	Uncertainty as a Percentage				Requirement of Standard
	Units	Run 1	Run 2		
Sampled Volume (Actual)	%	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.69	0.69		≤1%
Sampled Gas Pressure	%	0.50	0.50		≤1%
Sampled Gas Humidity	%	1.00	1.00		≤1%
Leak	%	0.67	0.76		≤2%
Laboratory Result	%	6.00	6.00		No Requirement
Oxygen Content	%	0.74	0.72		≤5%

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1	Run 2	Run 1	Run 2
Sampled Volume (STP)	V _m	m ³	1.3500	1.3284	0.01	0.00
Leak	L	mg/m ³	0.0000	0.0000	1.00	1.00
Laboratory Result	L _r	mg/m ³	0.0006	0.0002	1.00	1.00
Factor for O ₂ Correction	O _{2,m}	% v/v	1.32	1.40	0.01	0.00

Measured Quantities	Uncertainty in Result		
	Units	Run 1	Run 2
Sampled Volume (STP)	mg/m ³	0.0002	0.0001
Leak	mg/m ³	0.0000	0.0000
Laboratory Result	mg/m ³	0.0006	0.0002
Factor for O ₂ Correction	mg/m ³	0.0001	0.0001

Parameter	Units	Run 1	Run 2
Combined uncertainty	mg/m ³	0.0006	0.0003
Expanded uncertainty (95% confidence)	mg/m ³	0.0012	0.0005
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.0012	0.0005
Reported Uncertainty	mg/m ³	0.0012	0.0005
Expanded uncertainty (95% confidence)	%	13.0	13.0
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	13.0	13.0
Reported Uncertainty	%	13.0	13.0

OXYGEN: RESULTS SUMMARY

Ipswich Borough Council, Ipswich Crematorium
Mercury Abatement Outlet

Sample Runs

Parameter	Units	Run 1	Run 2		Mean
Concentration	% v/v	13.4	13.9		13.7
Uncertainty	±% v/v	0.29	0.30		0.29

General Sampling Information

Parameter	Value
Standard	BS EN 14789
Technical Procedure	CAT-TP-21
Probe Material	Titanium
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	No
Heated Line Temperature	Orsat Used
Span Gas Reference Number	CYL 11.0091
Span Gas Expiry Date	14/11/2017
Span Gas Start Pressure (bar)	60
Gas Cylinder Concentration (% v/v)	20.93
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	4 / 1
Sample Point I.D.'s	A1, A2, A3, & A4

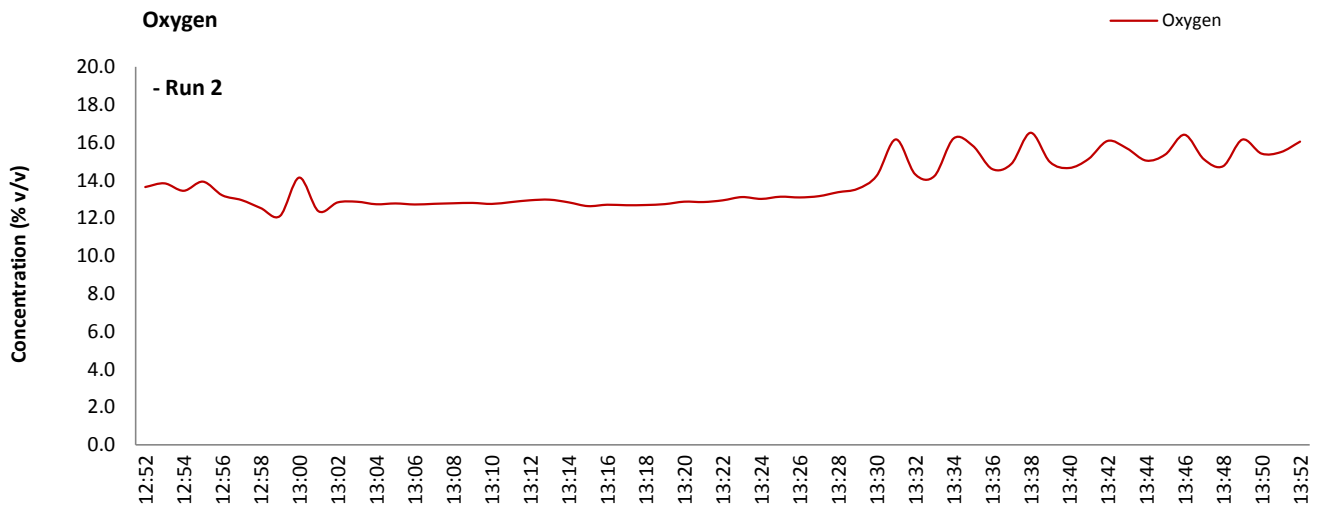
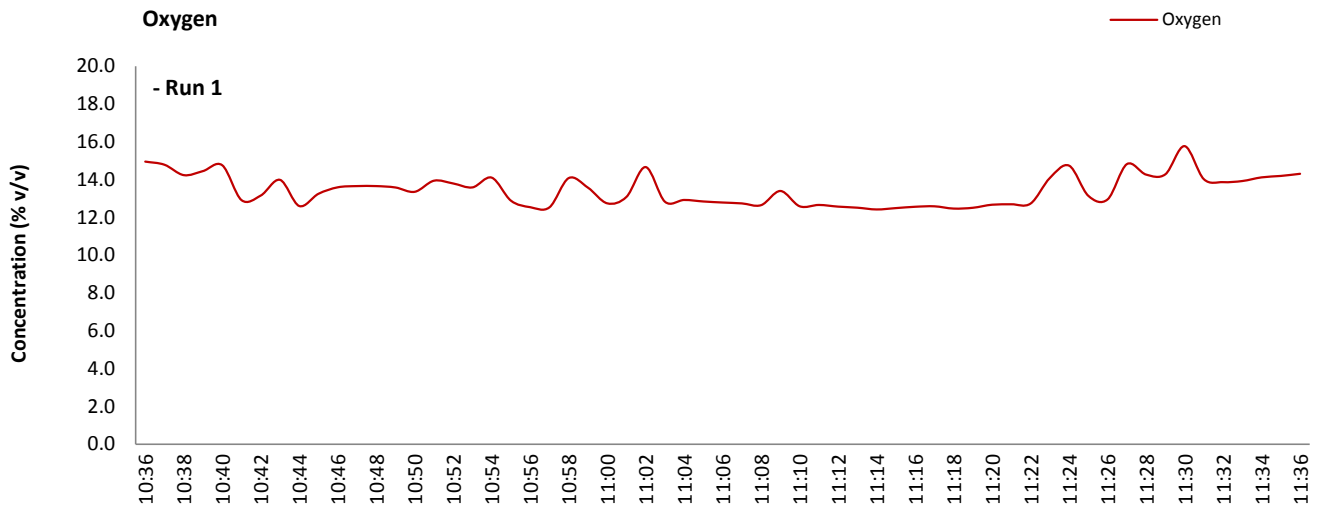
NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

OXYGEN: DATA TREND

Graphical Trend of Data



OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	
Sampling Times	-	10:36 - 11:36	12:52 - 13:52	
Sampling Dates	-	28/03/2013	28/03/2013	
Instrument Range	% v/v	25	25	
Span Gas Value	% v/v	11.00	11.00	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	
Average Temperature	°C	N/A	N/A	
Allowable Temperature	< °C	N/A	N/A	
Temperature Acceptable	-	N/A	N/A	

Zero Drift	Units	Run 1	Run 2		
CAL 1	Zero Down Sampling Line (Pre)	% v/v	0.00	0.00	
	Zero Down Sampling Line (Post)	% v/v	0.02	0.02	
	Zero Drift	% v/v	0.02	0.02	
CAL 2	Zero Down Sampling Line (Pre)	% v/v			
	Zero Down Sampling Line (Post)	% v/v			
	Zero Drift	% v/v			
CAL 3	Zero Down Sampling Line (Pre)	% v/v			
	Zero Down Sampling Line (Post)	% v/v			
	Zero Drift	% v/v			
Allowable Zero Drift	± % v/v	0.55	0.55		
Zero Drift Acceptable	-	Yes	Yes		

Span Drift	Units	Run 1	Run 2		
CAL 1	Span Down Sampling Line (Pre)	% v/v	10.61	10.61	
	Span Down Sampling Line (Post)	% v/v	10.63	10.63	
	Span Drift	% v/v	0.02	0.02	
CAL 2	Span Down Sampling Line (Pre)	% v/v			
	Span Down Sampling Line (Post)	% v/v			
	Span Drift	% v/v			
CAL 3	Span Down Sampling Line (Pre)	% v/v			
	Span Down Sampling Line (Post)	% v/v			
	Span Drift	% v/v			
Allowable Span Drift	± % v/v	0.55	0.55		
Span Drift Acceptable	-	Yes	Yes		

Test Conditions	Units	Run 1	Run 2	
Run Ambient Temperature Range	°C	18.1 - 19.9	18.1 - 19.9	

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	13.4	13.9

Measured Quantities	Individual Errors as Standard Uncertainties		
	Units	Run 1	Run 2
Nonlinearity	% v/v	0.032	0.032
Temperature Dependent Zero Drift	% v/v	-0.004	-0.004
Temperature Dependent Span Drift	% v/v	-0.010	-0.010
Cross-Sensitivity	% v/v	0.047	0.048
Leak	% v/v	0.014	0.015
Calibration Gas Uncertainty	% v/v	0.079	0.082
Mass Flow Controllers (dilution) Uncertainty	% v/v	0.110	0.113

Parameter	Units	Run 1	Run 2
Combined uncertainty	% v/v	0.15	0.15
Expanded uncertainty (95% confidence)	% v/v	0.29	0.30
Expanded uncertainty (95% confidence), estimated with Method Deviations	% v/v	0.29	0.30
Reported Uncertainty	% v/v	0.29	0.30
Expanded uncertainty (95% confidence)	%	2.2	2.2
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	2.2	2.2
Reported Uncertainty	%	2.2	2.2