



Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL

T: 0800 328 1821

E: toby.campbell@cat-env.com

Your Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by

Furness Brick and Tile Company Ltd

Installation Name & Address

Furness Brick and Tile Company Ltd

Dalton Road

Askam-In-Furness

Cumbria

LA16 7HF

PPC Permit: PPC/A2/01

Stack Reference

Main Kiln Stack

Dates of the Monitoring Campaign

11th - 12th December 2012

Job Reference Number

CAT-1380

Report Written by

Brian Jacob

Team Leader

MCERTS Level 2

MM 06 693

TE1 TE2 TE3 TE4

Report Approved by

James Eldridge

Team Leader

MCERTS Level 2

MM 05 641

TE1 TE2 TE3 TE4

Report Date

10th January 2013

Version

Version 2

Signature of Report Approver



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Executive Summary

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MONITORING OBJECTIVES

Furness Brick and Tile Company Ltd, Askam-In-Furness

Main Kiln Stack

11th - 12th December 2012

Overall Aim of the Monitoring Campaign

Catalyst Environmental Ltd were commissioned by Furness Brick and Tile Company Ltd to carry out stack emissions testing on the Main Kiln Stack at Askam-In-Furness.

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 Fluoride

Executive Summary

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MONITORING RESULTS

Furness Brick and Tile Company Ltd, Askam-In-Furness

Main Kiln Stack

11th - 12th December 2012

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter	¹ mg/m ³	34.7	1.9	100	g/hr	3226	172	-
Hydrogen Fluoride	¹ mg/m ³	2.1	0.31	10	g/hr	198	28.8	-
Water Vapour	% v/v	3.1	0.15					
Stack Gas Temperature	°C	37.8						
Stack Gas Velocity	m/s	6.2						
Volumetric Flow Rate (ACTUAL)	m ³ /hr	104753						
Volumetric Flow Rate (REF)	¹ m ³ /hr	92840						

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

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

Executive Summary

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MONITORING DATE(S) & TIMES

Furness Brick and Tile Company Ltd, Askam-In-Furness

Main Kiln Stack

11th - 12th December 2012

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter (Concurrent with HF test R2)	R2	mg/m³	27.8	g/hr	2577	11/12/2012	15:33 - 18:33	180
Total Particulate Matter (Concurrent with HF test R5)	R3	mg/m³	41.7	g/hr	3875	12/12/2012	08:55 - 11:55	180
Hydrogen Fluoride (concurrent with TPM isokinetic test)	R1	mg/m³	1.9	g/hr	179	11/12/2012	12:11 - 15:11	180
Hydrogen Fluoride (concurrent with TPM isokinetic test)	R2	mg/m³	2.0	g/hr	187	11/12/2012	15:33 - 18:33	180
Hydrogen Fluoride (seperate non-isokinetic test)	R3	mg/m³	3.2	g/hr	295	11/12/2012	18:57 - 22:57	240
Hydrogen Fluoride (seperate non-isokinetic test)	R4	mg/m³	1.9	g/hr	181	11 - 12/12/2012	23:06 - 08:36	570
Hydrogen Fluoride (concurrent with TPM isokinetic test)	R5	mg/m³	1.6	g/hr	145	12/12/2012	08:55 - 11:55	180
Velocity & Volumetric Flow Rate	R1					11/12/2012	11:52 - 11:56	

All results are expressed at the respective reference conditions.

Executive Summary

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PROCESS DETAILS

Furness Brick and Tile Company Ltd, Askam-In-Furness

Main Kiln Stack

11th - 12th December 2012

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	5 week cycles
Continuous or Batch Process	Continuous Batch
Feedstock (if applicable)	Bricks
Abatement System	None
Abatement System Running Status	N/A
Fuel	Coal
Plume Appearance	Slight steam plume visible whilst team on site

Executive Summary

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MONITORING & ANALYTICAL METHODS

Furness Brick and Tile Company Ltd, Askam-In-Furness

Main Kiln Stack

11th - 12th December 2012

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 ISO 9096	CAT-TP-02	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.1 mg/m ³
Hydrogen Fluoride	BS ISO 15713	CAT-TP-10	Yes	CAT	AP-01	IC	Yes	CAT	Yes	0.01 mg/m ³
Hydrogen Fluoride	BS ISO 15713	CAT-TP-10	Yes	CAT	AP-01	IC	Yes	CAT	Yes	0.01 mg/m ³
Water Vapour	BS EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
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
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SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	All	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.

Executive Summary

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SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Rectangular
Depth	m	1.57
Width	m	2.97
Area	m ²	4.66
Port Depth	cm	87
Orientation of Duct	-	Vertical
Sample Port Size	-	4" BSP

Location of Sampling Platform

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

Platform Details

EA Technical Guidance Note M1 / BS EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	No
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

In the interest of improved Health and Safety, it would be advantageous to install some form of chain or self closing gate at the top of the sampling platform ladder.

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	40.4		> 5 Pa	Yes
Mean Velocity	m/s	7.74		-	-
Lowest Gas Velocity	m/s	7.22		-	-
Highest Gas Velocity	m/s	8.61		-	-
Ratio of Above	: 1	1.19		< 3 : 1	Yes
Maximum Angle of Swirl	°	8		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

Executive Summary

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PLANT PHOTOS

Photo 1



Photo 2

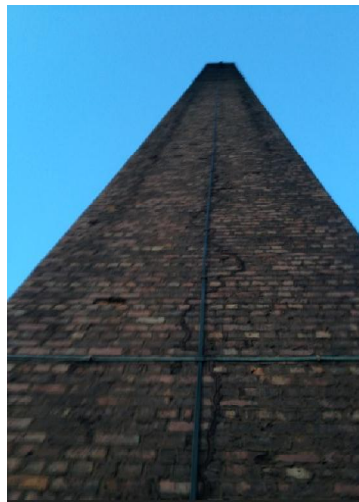


Photo 3

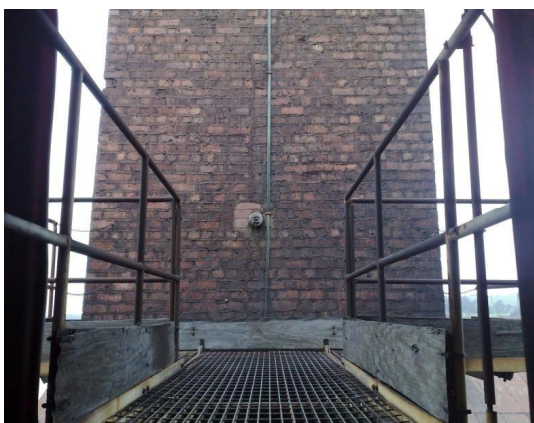
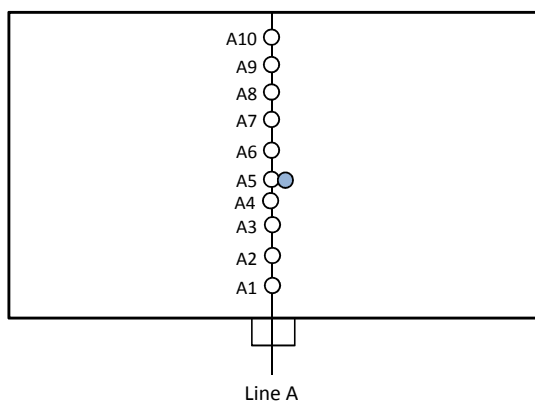


Photo 4



SAMPLE POINTS



where

- = isokinetic point sampled at
- = isokinetic point not sampled at
- = 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

APPENDIX 1

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Technician	Antony Ward	MCERTS Level 1	MM 10 1096	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 7.6	Horiba PG-250	-	Digital Manometer (1)	CAT 3.25
Box Thermocouples	CAT 7.6	Servomex 4900	-	Digital Manometer (2)	-
Umbilical	CAT 3.10	Eco Physics CLD 822Mh	-	Digital Temperature Meter	CAT 3.25
Oven Box	-	Testo 350 XL	-	Stopwatch	CAT 14.41
Probe	CAT 5.33	Servomex 5200MP	-	Barometer	CAT 13.9
S-Pitot (1)	CAT 21P.23	JCT JCC P1 Cooler	-	Stack Thermocouple (1)	CAT 4.263
S-Pitot (2)	-	FT-IR	-	Stack Thermocouple (2)	-
L-Pitot	-	FT-IR Sampling System	-	1m Heated Line (1)	-
500g Check Weight	CAT 17.13	Bernath 3006 FID	-	1m Heated Line (2)	-
1Kg Check Weight	CAT 17.13	Heated Head Filter	-	1m Heated Line (3)	-
Last Impinger Arm	CAT 4.17	Mass Flow Controller (1)	-	5m Heated Line (1)	-
Callipers	CAT 23.10	Mass Flow Controller (2)	-	15m Heated Line (1)	-
Tubes Kit Thermocouple	-	Mass View (1)	CAT 25.15	15m Heated Line (2)	-
Laboratory Balance	CAT 1.18 / 1.18a	Mass View (2)	CAT 25.16	20m Heated Line (1)	-
Tape Measure	CAT 16.14	Easylogger EN-EL-12 Bit	-	Dual Channel Heater Controller	CAT 3.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	BS ISO 9096	CAT-TP-02
Hydrogen Fluoride	BS ISO 15713	CAT-TP-10
Water Vapour	BS EN 14790	CAT-TP-05
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	1.57
Stack Width, W	m	2.97
Stack Area, A	m ²	4.66
Average Stack Gas Temperature, T _a	°C	45.6
Average Stack Gas Pressure	Pa	46.6
Average Stack Static Pressure, P _{static}	kPa	-0.016
Average Barometric Pressure, P _b	kPa	102.5
Average Pitot Tube Calibration Coefficient, C _p	-	0.85

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m ³ p	Conc kg/m ³ p _i
CO ₂ (Estimated)	-	3.00	2.91	0.0300	44.01	1.9635	0.05891
O ₂ (Estimated)	-	18.00	17.45	0.1800	32.00	1.4277	0.25698
N ₂	-	79.00	76.59	0.7900	28.01	1.2498	0.98738
Moisture (H ₂ O)	-	-	3.05	0.0305	18.02	0.8037	0.02453

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	1.303
Wet Density (STP), P _{STW}	kg/m ³	1.288
Dry Density (Actual), P _{Actual}	kg/m ³	1.130
Average Wet Density (Actual), P _{ActualW}	kg/m ³	1.116

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	45.6	0.0
Total Pressure	kPa	102.5	101.3
Moisture	%	3.05	3.05

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	129926
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	112621
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	109184
Gas Volumetric Flowrate REF ¹	m ³ /hr	112621

APPENDIX 2

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE

(1 of 1)

Parameter	Units	Value
Date of Survey	-	11/12/2012
Time of Survey	-	11:52 - 11:56
Atmospheric Pressure	kPa	102.5
Stack Static Pressure	Pa	-16
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	-	Vertical
Pitot Tube, C _p	-	0.85
Number of Lines Available	-	1
Number of Lines Used	-	1

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 (°)	5	4	5	6	6	3	0	7	7	8										

Sampling Line A					
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s
1	0.08	41.2	45.2	1.118	7.28
2	0.24	47.2	45.3	1.118	7.80
3	0.39	42.2	45.4	1.117	7.37
4	0.55	52.1	45.5	1.117	8.19
5	0.71	50.5	45.7	1.116	8.07
6	0.86	57.4	45.9	1.116	8.61
7	1.02	40.4	45.9	1.116	7.22
8	1.18	49.4	45.9	1.116	7.98
9	1.33	43.0	45.8	1.116	7.45
10	1.49	42.8	45.7	1.116	7.43
Mean		46.6	45.6	1.116	7.74

APPENDIX 2

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Furness Brick and Tile Company Ltd, Askam-In-Furness
Main Kiln Stack

Sample Runs

Parameter	Units		Run 2	Run 3		Mean
Concentration	mg/m ³		27.8	41.7		34.7
Uncertainty	±mg/m ³		1.5	2.2		1.9
Mass Emission	g/hr		2577	3875		3226
Uncertainty	±g/hr		137	207		172

Parameter	Units		Run 2	Run 3		Mean
Water Vapour	% v/v		2.3	2.8		2.5
Uncertainty	±% v/v		0.12	0.15		0.14

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m ³	0.33		0.33

General Sampling Information

Parameter	Value	
Standard	BS ISO 9096	
Technical Procedure	CAT-TP-02	
Probe Material	Monel	
Filter Housing Material	Monel	
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	10 / 10	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1 - A10	

Reference Conditions

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

APPENDIX 2

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units		Run 2	Run 3	
Absolute pressure of stack gas, P_s					
Barometric pressure, P _b	mmHg		768.8	764.3	
Stack static pressure, P _{static}	mmH ₂ O		-1.6	-1.6	
P _s = (P _b + (P _{static} / 13.6))	mmHg		768.6	764.1	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g		25.3	27.3	
Total mass collected in impingers (silica trap)	g		9.8	12.0	
Total mass of liquid collected, V _{lc}	g		35.1	39.3	
V _{wstd} = (0.001246)(V _{lc})	m ³		0.0437	0.0490	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V _m	m ³		1.9935	1.8320	
Gas meter correction factor, Y _d	-		0.9780	0.9780	
Average dry gas meter temperature, T _m	°C		19.3	14.0	
Average pressure drop across orifice, ΔH	mmH ₂ O		12.0	10.4	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/13.6))(Y _d)) / (T _m + 273)	m ³		1.8442	1.7155	
Moisture content, B_{wv} & R_{wv}					
B _{wv} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³		0.0232	0.0278	
B _{wv} as a percentage	% v/v		2.32	2.78	
Reported Water Vapour, checked with Tables in BS EN 14790, R _{wv}	% v/v		2.32	2.78	
Volume of gas metered wet, V_{mstw}					
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³		1.8879	1.7645	
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		N/A	N/A	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v		N/A	N/A	
% oxygen reference condition, REF%O ₂	% v/v		N/A	N/A	
O ₂ Reference Factor wet (O _{2REFw}) = (21 - REF%O ₂) / (21 - ACT%O _{2w})	-		N/A	N/A	
O ₂ Reference Factor dry (O _{2REFd}) = (21 - REF%O ₂) / (21 - ACT%O _{2d})	-		N/A	N/A	
V _{mstw@X%oxygen} = (V _{mstw}) / (O _{2REFw})	m ³		N/A	N/A	
V _{mstd@X%oxygen} = (V _{mstd}) / (O _{2REFd})	m ³		N/A	N/A	
Molecular weight of dry gas stream, M_d					
CO ₂ (Estimated)	% v/v		3.00	3.00	
O ₂ (Estimated)	% v/v		18.00	18.00	
Total	% v/v		21.00	21.00	
N ₂	% v/v		79.00	79.00	
M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	g/gmol		29.20	29.20	
Molecular weight of stack gas (wet), M_s					
M _s = M _d (1 - (R _{wv} /100)) + 18(R _{wv} /100)	g/gmol		28.94	28.89	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K _p	-		34.97	34.97	
Velocity pressure coefficient, C _p	-		0.85	0.85	
Average of velocity heads, ΔP _{avg}	mmH ₂ O		3.13	2.74	
Average square root of velocity heads, √ΔP	√mmH ₂ O		1.77	1.66	
Average stack gas temperature, T _s	°C		37.8	34.2	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s		6.21	5.80	
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		4.66	4.66	
Q _a = (60)(A _s)(V _s)	m ³ /min		1738.6	1623.7	
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		1544.6	1451.0	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273))	m ³ /min		1508.8	1410.8	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s + 273)(O _{2REFw}))	m ³ /min		N/A	N/A	
Q _{stdO₂} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s + 273)(O _{2REFd}))	m ³ /min		N/A	N/A	
Percent isokinetic, %I					
Nozzle diameter, D _n	mm		6.23	6.23	
Nozzle area, A _n	mm ²		30.49	30.49	
Total sampling time, q	min		180	180	
%I = (4.6398E ⁶)(T _s +273)(V _{mstd}) / (P _s)(V _s)(A _n)(q)(1 - (R _{wv} /100))	%		103.9	103.3	

APPENDIX 2

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units		Run 2	Run 3	
Sampling Times	-		15:33 - 18:33	08:55 - 11:55	
Sampling Dates	-		11/12/2012	12/12/2012	
Sampling Device	-		ISO	ISO	
Volume Sampled (REF)	m ³		1.8878	1.7645	
Filter I.D. Number	-		47-11152	47-11365	
Start Filter Mass	g		0.15680	0.15506	
End Filter Mass	g		0.18034	0.19560	
Total Mass on Filter	g		0.02354	0.04054	
Probe Rinse I.D. Number	-		PR-47-11152	PR-47-11365	
Start Probe Rinse Mass	g		3.15745	2.91725	
End Probe Rinse Mass	g		3.18631	2.95035	
Total Mass in Probe Rinse	g		0.02886	0.03310	
Total Mass Collected	mg		52.40	73.64	
Calculated Concentration	mg/m ³		27.76	41.73	
Balance Uncertainty / LOD	mg/m ³		0.10	0.10	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	11/12/2012	
Average Volume Sampled (REF)	m ³	1.8992	
Filter I.D. Number	-	47-11123	
Start Filter Mass	g	0.15810	
End Filter Mass	g	0.15833	
Total Mass on Filter	g	0.00023	
Probe Rinse I.D. Number	-	PR-47-11123	
Start Probe Rinse Mass	g	3.04069	
End Probe Rinse Mass	g	3.04109	
Total Mass in Probe Rinse	g	0.00040	
Total Mass Collected	mg	0.63	
Calculated Concentration	mg/m ³	0.33	
Balance Uncertainty / LOD	mg/m ³	0.09	

APPENDIX 2

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units		Run 2	Run 3	
Mean Sampling Rate	l/min		10.83	9.95	
Pre-Sampling Leak Rate	l/min		0.21	0.19	
Post-Sampling Leak Rate	l/min		0.12	0.16	
Allowable Leak Rate	l/min		0.22	0.20	
Leak Test Acceptable	-		Yes	Yes	
Water Droplets	Units		Run 2	Run 3	
Are Water Droplets Present	-		No	No	
MU (Concurrent Water Vapour)	Units		Run 2	Run 3	
Measurement Uncertainty (MU)	%		5.2	5.4	
Allowable MU	%		20	20	
MU Acceptable	%		Yes	Yes	
Silica Gel (Concurrent Water Vapour)	Units		Run 2	Run 3	
Less than 50% Faded	%		Yes	Yes	
Isokinetic Criterion Compliance	Units		Run 2	Run 3	
Isokinetic Variation	%		103.9	103.3	
Allowable Isokinetic Range	%		95 - 115	95 - 115	
Isokineticity Acceptable	-		Yes	Yes	
Weighing Uncertainty Criteria	Units		Run 2	Run 3	
Overall Weighing Uncertainty	± mg		0.31	0.31	
Overall Weighing Uncertainty	± mg/m ³		0.17	0.18	
ELV [Daily ELV for WID]	mg/m ³		100	100	
Allowable Weighing Uncertainty	mg/m ³		5.00	5.00	
Weighing Uncertainty Acceptable	-		Yes	Yes	
Filter Temperatures	Units		Run 2	Run 3	
Pre-Conditioning Temperature	°C		180	180	
Post-Conditioning Temperature	°C		160	160	
Maximum Filter Temperature	°C		38	34	
Test Conditions	Units		Run 2	Run 3	
Ambient Temperature Recorded?	-		Yes	Yes	

APPENDIX 2

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.21	
Post-Sampling Leak Rate	l/min	0.20	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m ³	10.0	
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		
	2	3	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)			
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	wx	

APPENDIX 2

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value				Standard uncertainty					
	Symbol		Run 2	Run 3		Symbol	Units		Run 2	Run 3
Sampled Volume (Actual)	V _m		1.9935	1.8320		uV _m	m ³		0.0399	0.0366
Sampled Gas Temperature	T _m		292.3	287.0		uT _m	K		2.0	2.0
Sampled Gas Pressure	p _m		102.5	101.9		up _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		1.11	1.61		uL	%		-	-
Mass of Particulate	m		52.40	73.64		um	mg		0.18	0.18
Oxygen Content	O _{2,m}		N/A	N/A		uO _{2,m}	% v/v		N/A	N/A
Uncollected Mass	UCM		0.63	0.63		uUCM	mg		-	-

Measured Quantities	Uncertainty as a Percentage				Requirement of Standard
	Units		Run 2	Run 3	
Sampled Volume (Actual)	%		2.00	2.00	≤2%
Sampled Gas Temperature	%		0.68	0.70	≤1%
Sampled Gas Pressure	%		0.49	0.49	≤1%
Sampled Gas Humidity	%		1.00	1.00	≤1%
Leak	%		1.11	1.61	≤2%
Mass of Particulate	%		0.10	0.10	<5% of ELV
Oxygen Content	%		N/A	N/A	≤5%
Uncollected Mass	%		-	-	-

Measured Quantities	Uncertainty in Measurement Units					Sensitivity Coefficient		
	Symbol	Units		Run 2	Run 3		Run 2	Run 3
Sampled Volume (STP)	V _m	m ³		1.8441	1.7155		15.05	24.33
Leak	L	mg/m ³		0.178	0.387		1.00	1.00
Mass of Particulate	L _r	mg		52.400	73.640		0.53	0.57
Factor for O ₂ Correction	O _{2,m}	% v/v		N/A	N/A		N/A	N/A
Uncollected Mass	UCM	mg		0.36	0.36		0.53	0.57

Measured Quantities	Uncertainty in Result			
	Units		Run 2	Run 3
Sampled Volume (STP)	mg/m ³		0.701	1.047
Leak	mg/m ³		0.1775	0.3873
Mass of Particulate	mg/m ³		0.0953	0.1020
Factor for O ₂ Correction	mg/m ³		N/A	N/A
Uncollected Mass	mg/m ³		0.1927	0.2061

Parameter	Units		Run 2	Run 3
Combined uncertainty	mg/m ³		0.75	1.14
Expanded uncertainty (95% confidence)	mg/m ³		1.48	2.23
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³		1.48	2.23
Reported Uncertainty	mg/m ³		1.48	2.23
Expanded uncertainty (95% confidence)	%		5.3	5.4
Expanded uncertainty (95% confidence), estimated with Method Deviations	%		5.3	5.4
Reported Uncertainty	%		5.3	5.4

APPENDIX 2

HYDROGEN FLUORIDE: RESULTS SUMMARY

Furness Brick and Tile Company Ltd, Askam-In-Furness
Main Kiln Stack

Sample Runs

Parameter	Units	Run 1	Run 2	Run 5		Mean
Concentration	mg/m ³	1.9	2.0	1.6		1.8
Uncertainty	±mg/m ³	0.29	0.30	0.23		0.27
Mass Emission	g/hr	179	187	145		170
Uncertainty	±g/hr	26.5	27.6	21.5		25.2

Parameter	Units	Run 1	Run 2	Run 5		Mean
Water Vapour	% v/v	3.5	2.3	2.8		2.9
Uncertainty	±% v/v	0.19	0.12	0.15		0.15

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m ³	< 0.01		< 0.01

General Sampling Information

Parameter	Value
Standard	BS ISO 15713
Technical Procedure	CAT-TP-10
Name of Analytical Laboratory	CAT
Analytical Laboratory's Procedure	AP-01
UKAS Accredited Analysis?	Yes
Date of Sample Analysis	18/12/2012
Probe Material	Monel
Filter Housing Material	Monel
Impinger Material	Quartz Glass
Absorption Solution	0.1 mol/l Sodium Hydroxide
Positioning of Filter	In Stack
Filter Size and Material	47mm Glass Fibre
Number of Sampling Lines Used	1 / 2
Number of Sampling Points Used	10 / 10
Sample Point I.D.'s	A1 - A10

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

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

APPENDIX 2

HYDROGEN FLUORIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	Run 5	
Absolute pressure of stack gas, P_s					
Barometric pressure, P _b	mmHg	768.8	768.8	764.3	
Stack static pressure, P _{static}	mmH ₂ O	-1.6	-1.6	-1.6	
P _s = (P _b + (P _{static} / 13.6))	mmHg	768.6	768.6	764.1	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	42.6	25.3	27.3	
Total mass collected in impingers (silica trap)	g	15.3	9.8	12.0	
Total mass of liquid collected, V _{lc}	g	57.9	35.1	39.3	
V _{wstd} = (0.001246)(V _{lc})	m ³	0.0721	0.0437	0.0490	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V _m	m ³	2.1090	1.9935	1.8320	
Gas meter correction factor, Y _d	-	0.9780	0.9780	0.9780	
Average dry gas meter temperature, T _m	°C	16.0	19.3	14.0	
Average pressure drop across orifice, ΔH	mmH ₂ O	13.4	12.0	10.4	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/13.6))(Y _d)) / (T _m + 273)	m ³	1.9732	1.8442	1.7155	
Moisture content, B_{wv} & R_{wv}					
B _{wv} = V _{wstd} / (V _{mstd} + V _{wstd})	m ³	0.0353	0.0232	0.0278	
B _{wv} as a percentage	% v/v	3.53	2.32	2.78	
Reported Water Vapour, checked with Tables in BS EN 14790, R _{wv}	% v/v	3.53	2.32	2.78	
Volume of gas metered wet, V_{mstw}					
V _{mstw} = (V _{mstd})(100/(100 - R _{wv}))	m ³	2.0453	1.8879	1.7645	
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	No	
% wet oxygen measured in gas stream, ACT%O _{2w}	% v/v	N/A	N/A	N/A	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	N/A	N/A	N/A	
% oxygen reference condition, REF%O ₂	% v/v	N/A	N/A	N/A	
O ₂ Reference Factor wet (O _{2REFw}) = (21 - REF%O ₂) / (21 - ACT%O _{2w})	-	N/A	N/A	N/A	
O ₂ Reference Factor dry (O _{2REFd}) = (21 - REF%O ₂) / (21 - ACT%O _{2d})	-	N/A	N/A	N/A	
V _{mstw@X%oxygen} = (V _{mstw}) / (O _{2REFw})	m ³	N/A	N/A	N/A	
V _{mstd@X%oxygen} = (V _{mstd}) / (O _{2REFd})	m ³	N/A	N/A	N/A	
Molecular weight of dry gas stream, M_d					
CO ₂ (Estimated)	% v/v	3.00	3.00	3.00	
O ₂ (Estimated)	% v/v	18.00	18.00	18.00	
Total	% v/v	21.00	21.00	21.00	
N ₂	% v/v	79.00	79.00	79.00	
M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	g/gmol	29.20	29.20	29.20	
Molecular weight of stack gas (wet), M_s					
M _s = M _d (1 - (R _{wv} /100)) + 18(R _{wv} /100)	g/gmol	28.80	28.94	28.89	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K _p	-	34.97	34.97	34.97	
Velocity pressure coefficient, C _p	-	0.85	0.85	0.85	
Average of velocity heads, ΔP _{avg}	mmH ₂ O	3.58	3.13	2.74	
Average square root of velocity heads, √ΔP	√mmH ₂ O	1.89	1.77	1.66	
Average stack gas temperature, T _s	°C	41.5	37.8	34.2	
V _s = ((K _p)(C _p)(√ΔP)(√T _s + 273)) / (√(M _s)(P _s))	m/s	6.70	6.21	5.80	
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	4.66	4.66	4.66	
Q _a = (60)(A _s)(V _s)	m ³ /min	1875.3	1738.6	1623.7	
Conversion factor (K/mm.Hg), C _f	-	0.3592	0.3592	0.3592	
Q _{stw} = ((Q _a)(P _s)(C _f)) / ((T _s) + 273)	m ³ /min	1646.3	1544.6	1451.0	
Q _{std} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s) + 273)	m ³ /min	1588.3	1508.8	1410.8	
Q _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s) + 273)(O _{2REFw})	m ³ /min	N/A	N/A	N/A	
Q _{stdO₂} = ((Q _a)(P _s)(C _f)(1 - (R _{wv} /100))) / ((T _s) + 273)(O _{2REFd})	m ³ /min	N/A	N/A	N/A	
Percent isokinetic, %I					
Nozzle diameter, D _n	mm	6.23	6.23	6.23	
Nozzle area, A _n	mm ²	30.49	30.49	30.49	
Total sampling time, q	min	180	180	180	
%I = (4.6398E ⁶)(T _s +273)(V _{mstd}) / (P _s)(V _s)(A _n)(q)(1 - (R _{wv} /100))	%	105.6	103.9	103.3	

APPENDIX 2

HYDROGEN FLUORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 5	
Sampling Times	-	12:11 - 15:11	15:33 - 18:33	08:55 - 11:55	
Sampling Dates	-	11/12/2012	11/12/2012	12/12/2012	
Sampling Device	-	ISO	ISO	ISO	
Volume Sampled (REF)	m ³	2.0453	1.8878	1.7645	
Laboratory Result for Front Impingers	µg/ml	15.22	9.27	6.23	
Laboratory Result for Back Impinger	µg/ml	0.05			
Volume in Front Impingers	ml	258.8	410.4	443.2	
Volume in Back Impinger	ml	139.7			
Mass in Front Impingers	µg	3938.9	3804.4	2761.1	
Mass in Back Impinger	µg	7.0			
Total Mass Collected	µg	3945.9	3804.4	2761.1	
Calculated Concentration	mg/m ³	1.93	2.02	1.56	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	11/12/2012	
Average Volume Sampled (REF)	m ³	1.8992	
Laboratory Result for Impingers	µg/ml	< 0.05	
Volume in Impingers	ml	312.0	
Total Mass Collected	µg	< 15.6	
Calculated Concentration	mg/m ³	< 0.01	

APPENDIX 2

HYDROGEN FLUORIDE: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 5	
Mean Sampling Rate	l/min	11.46	10.83	9.95	
Pre-Sampling Leak Rate	l/min	0.21	0.21	0.19	
Post-Sampling Leak Rate	l/min	0.20	0.12	0.16	
Allowable Leak Rate	l/min	0.23	0.22	0.20	
Leak Test Acceptable	-	Yes	Yes	Yes	

Absorption Efficiency	Units	Run 1	
Absorption Efficiency	%	99.8	
Allowable Absorption Efficiency	%	N/A ²	
Absorption Efficiency Acceptable	-	N/A ²	

² The concentration is less than 30% of the ELV, therefore no assessment against an allowable efficiency is required.

Water Droplets	Units	Run 1	Run 2	Run 5	
Are Water Droplets Present	-	No	No	No	

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 5	
Measurement Uncertainty (MU)	%	5.4	5.2	5.4	
Allowable MU	%	20	20	20	
MU Acceptable	%	Yes	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 5	
Less than 50% Faded	%	Yes	Yes	Yes	

Isokinetic Criterion Compliance	Units	Run 1	Run 2	Run 5	
Isokinetic Variation	%	105.6	103.9	103.3	
Allowable Isokinetic Range	%	95 - 115	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	Yes	

Filter Temperatures	Units	Run 1	Run 2	Run 5	
Maximum Filter Temperature	°C	42	38	34	

Test Conditions	Units	Run 1	Run 2	Run 5	
Ambient Temperature Recorded?	-	Yes	Yes	Yes	

APPENDIX 2

HYDROGEN FLUORIDE: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.21	
Post-Sampling Leak Rate	l/min	0.20	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m ³	1.0	
Blank Acceptable	-	Yes	

Method Deviations

Nature of Deviation	Run Number			
	1	2	5	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)				
There are no deviations associated with the sampling employed.	wx	wx	wx	

APPENDIX 2

HYDROGEN FLUORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value					Standard uncertainty					
	Symbol	Run 1	Run 2	Run 5		Symbol	Units	Run 1	Run 2	Run 5	
Sampled Volume (Actual)	V _m	2.1090	1.9935	1.8320		uV _m	m ³	0.0422	0.0399	0.0366	
Sampled Gas Temperature	T _m	289.0	292.3	287.0		uT _m	K	2.0	2.0	2.0	
Sampled Gas Pressure	p _m	102.5	102.5	101.9		up _m	kPa	0.5	0.5	0.5	
Sampled Gas Humidity	H _m	0.0	0.0	0.0		uH _m	% v/v	1.0	1.0	1.0	
Leak	L	1.75	1.11	1.61		uL	%	-	-	-	
Laboratory Result	L _r	7.05	7.05	7.05		uL _r	%	-	-	-	
Oxygen Content	O _{2,m}	N/A	N/A	N/A		uO _{2,m}	% v/v	N/A	N/A	N/A	

Measured Quantities	Uncertainty as a Percentage					Requirement of Standard
	Units	Run 1	Run 2	Run 5		
Sampled Volume (Actual)	%	2.00	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.69	0.68	0.70		≤1%
Sampled Gas Pressure	%	0.49	0.49	0.49		≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00		≤1%
Leak	%	1.75	1.11	1.61		≤2%
Laboratory Result	%	7.05	7.05	7.05		No Requirement
Oxygen Content	%	N/A	N/A	N/A		≤5%

Measured Quantities	Uncertainty in Measurement Units						Sensitivity Coefficient			
	Symbol	Units	Run 1	Run 2	Run 5		Run 1	Run 2	Run 5	
Sampled Volume (STP)	V _m	m ³	1.9732	1.8441	1.7155		0.98	1.09	0.91	
Leak	L	mg/m ³	0.0194	0.0129	0.0145		1.00	1.00	1.00	
Laboratory Result	L _r	mg/m ³	0.136	0.142	0.110		1.00	1.00	1.00	
Factor for O ₂ Correction	O _{2,m}	% v/v	N/A	N/A	N/A		N/A	N/A	N/A	

Measured Quantities	Uncertainty in Result				
	Units	Run 1	Run 2	Run 5	
Sampled Volume (STP)	mg/m ³	0.0484	0.0509	0.0392	
Leak	mg/m ³	0.019	0.013	0.015	
Laboratory Result	mg/m ³	0.136	0.142	0.110	
Factor for O ₂ Correction	mg/m ³	N/A	N/A	N/A	

Parameter	Units	Run 1	Run 2	Run 5	
Combined uncertainty	mg/m ³	0.15	0.15	0.12	
Expanded uncertainty (95% confidence)	mg/m ³	0.29	0.30	0.23	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.29	0.30	0.23	
Reported Uncertainty	mg/m ³	0.29	0.30	0.23	
Expanded uncertainty (95% confidence)	%	14.8	14.7	14.8	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.8	14.7	14.8	
Reported Uncertainty	%	14.8	14.7	14.8	

APPENDIX 2

HYDROGEN FLUORIDE: RESULTS SUMMARY

Furness Brick and Tile Company Ltd, Askam-In-Furness
Main Kiln Stack

Sample Runs

Parameter	Units	Run 3	Run 4		Mean
Concentration	mg/m ³	3.2	1.9		2.6
Uncertainty	±mg/m ³	0.46	0.28		0.37
Mass Emission	g/hr	295	181		238
Uncertainty	±g/hr	42.4	26.0		34.2

Parameter	Units	Run 3	Run 4		Mean
Water Vapour	% v/v	4.1	3.4		3.7
Uncertainty	±% v/v	0.17	0.14		0.15

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m ³	< 0.01		< 0.01

General Sampling Information

Parameter	Value	
Standard	BS ISO 15713	
Technical Procedure	CAT-TP-10	
Name of Analytical Laboratory	CAT	
Analytical Laboratory's Procedure	AP-01	
UKAS Accredited Analysis?	Yes	
Date of Sample Analysis	18/12/2012	
Probe Material	Monel	
Filter Housing Material	Monel	
Impinger Material	Quartz Glass	
Absorption Solution	0.1 mol/l Sodium Hydroxide	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
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	A5	

Reference Conditions

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

APPENDIX 2

HYDROGEN FLUORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 3	Run 4	
Sampling Times	-	18:57 - 22:57	23:06 - 08:36	
Sampling Dates	-	11/12/2012	11 - 12/12/2012	
Sampling Device	-	MFC / MV	MFC / MV	
Duration	mins	240	570	
Volume Sampled (STP, Dry)	m ³	1.3429	2.8830	
Volume Sampled (STP, Wet)	m ³	1.3999	2.9846	
Volume Sampled (REF)	m ³	1.3999	2.9846	
Sample Flow Rate	l/min	5.54	5.01	
Laboratory Result for Front Impingers	µg/ml	19.15	16.00	
Laboratory Result for Back Impinger	µg/ml	0.10	< 0.05	
Volume in Front Impingers	ml	231.9	363.0	
Volume in Back Impinger	ml	107.9	100.2	
Mass in Front Impingers	µg	4440.9	5808.0	
Mass in Back Impinger	µg	10.8	< 5.0	
Total Mass Collected	µg	4451.7	5813.0	
Calculated Concentration	mg/m ³	3.18	1.95	
Liquid Trap Start Mass	g	1899.0	1902.2	
Liquid Trap End Mass	g	1930.8	1957.1	
Silica Trap Start Mass	g	768.5	809.6	
Silica Trap End Mass	g	782.4	836.3	
Total Mass Of Water Vapour	g	45.7	81.6	
Calculated Water Vapour	% v/v	4.07	3.41	

Where: MFC stands for Mass Flow Controller, MV stands for Mass View Flowmeter

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	11/12/2012	
Average Volume Sampled (REF)	m ³	2.1922	
Laboratory Result for Impingers	µg/ml	< 0.05	
Volume in Impingers	ml	312.0	
Total Mass Collected	µg	< 15.6	
Calculated Concentration	mg/m ³	< 0.01	

APPENDIX 2

HYDROGEN FLUORIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 3	Run 4	
Mean Sampling Rate	l/min	5.54	5.01	
Pre-Sampling Leak Rate	l/min	0.01	0.01	
Post-Sampling Leak Rate	l/min	0.01	0.01	
Allowable Leak Rate	l/min	0.11	0.10	
Leak Test Acceptable	-	Yes	Yes	
Absorption Efficiency	Units	Run 3	Run 4	
Absorption Efficiency	%	99.8	99.9	
Allowable Absorption Efficiency	%	95	95	
Absorption Efficiency Acceptable	-	Yes	Yes	
Water Droplets	Units	Run 3	Run 4	
Are Water Droplets Present	-	No	No	
MU (Concurrent Water Vapour)	Units	Run 3	Run 4	
Measurement Uncertainty (MU)	%	4.1	4.1	
Allowable MU	%	20	20	
MU Acceptable	%	Yes	Yes	
Silica Gel (Concurrent Water Vapour)	Units	Run 3	Run 4	
Less than 50% Faded	%	Yes	Yes	
Test Conditions	Units	Run 1	Run 2	
Ambient Temperature Recorded?	-	Yes	Yes	

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	10.00	
Pre-Sampling Leak Rate	l/min	0.01	
Post-Sampling Leak Rate	l/min	0.01	
Allowable Leak Rate	l/min	0.20	
Leak Test Acceptable	-	Yes	
Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m ³	1.0	
Blank Acceptable	-	Yes	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number	
	3	4
There are no deviations associated with the sampling employed.	wx	wx

APPENDIX 2

HYDROGEN FLUORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value				Standard uncertainty				
	Symbol	Run 3	Run 4		Symbol	Units	Run 3	Run 4	
Sampled Volume (STP)	V _m	1.3429	2.8830		uV _m	m ³	0.0269	0.0577	
Leak	L	0.18	0.20		uL	%	-	-	
Laboratory Result	L _r	7.05	7.05		uL _r	%	-	-	
Oxygen Content	O _{2,m}	N/A	N/A		uO _{2,m}	% v/v	N/A	N/A	

Uncertainty as a Percentage					Requirement of Standard
Measured Quantities	Units	Run 3	Run 4		
Sampled Volume (STP)	%	2.00	2.00		≤2%
Leak	%	0.18	0.20		≤2%
Laboratory Result	%	7.05	7.05		No Requirement
Oxygen Content	%	N/A	N/A		≤5%

Uncertainty in Measurement Units					Sensitivity Coefficient		
Measured Quantities	Symbol	Units	Run 3	Run 4		Run 3	Run 4
Sampled Volume (STP)	V _m	m ³	1.3429	2.8830		2.37	0.68
Leak	L	mg/m ³	0.003	0.002		1.00	1.00
Laboratory Result	L _r	mg/m ³	0.224	0.137		1.00	1.00
Factor for O ₂ Correction	O _{2,m}	% v/v	N/A	N/A		N/A	N/A

Uncertainty in Result				
Measured Quantities	Units	Run 3	Run 4	
Sampled Volume (STP)	mg/m ³	0.0636	0.0390	
Leak	mg/m ³	0.0033	0.0022	
Laboratory Result	mg/m ³	0.2242	0.1373	
Factor for O ₂ Correction	mg/m ³	N/A	N/A	

Parameter	Units	Run 3	Run 4	
Combined uncertainty	mg/m ³	0.23	0.14	
Expanded uncertainty (95% confidence)	mg/m ³	0.46	0.28	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.46	0.28	
Reported Uncertainty	mg/m ³	0.46	0.28	
Expanded uncertainty (95% confidence)	%	14.4	14.4	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.4	14.4	
Reported Uncertainty	%	14.4	14.4	