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Report for the Periodic Monitoring of Emissions to Air

Part 1: Executive Summary

Permit Number:	EPR/ZP3939GL
Operator:	Western Bio-energy Ltd
Installation:	Main Stack

Our Reference:	ALL54208/18/PR
Monitoring Dates:	10 & 12/04/2018
Client / Organisation:	Mr Mark Watkin / Mr Stephen Grylls
Address:	Western Bio-Energy Plant
	Margam
	Port Talbot
	SA13 2NR
Date of Report:	08/05/2018
Report Approved By:	Phillip Ruck <i>BSc AFOH</i>
MCERTS Number/Level/Technical Endorsement	MM 17 1117 Level 2, TE1, TE2, TE3, TE4
Designation:	Stack Emissions Co-ordinator
Signed:	
Reviewed:	

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N/A	Main Stack details including gas measurements (29 pages)
N/A	Appendix 3 (Uncertainty)
N/A	Appendix 4 (Subcontracted analysis results)
N/A	Appendix 5 (Instrumental analyser details)
N/A	Appendix 6 (Annual calibration details & analysis data retained at permanent laboratory)



Monitoring objectives

At the request of Mr Mark Watkin of Western Bio-energy Ltd, Anchem Laboratories Limited has carried out an “emissions to atmosphere” monitoring regime in the exhaust ductwork of the main stack at their Margam plant. This is the first of two emissions monitoring regimes to be carried out on a biannual basis throughout 2018 and has been undertaken to meet the requirements of their Environment Agency Permit.

Emission point	Reference number	Substance to be monitored	Special requirements
Main Stack	87308/1	Dioxins & Furans	Minimum 6 hours
	87308/2	Metals & Mercury	Minimum 30 minutes
	87308/3	Particulate	Minimum 1 hour
	87308/4	Hydrogen chloride	Minimum 1 hour
	87308/5	Oxides of nitrogen*	Minimum 1 hour
		Sulphur dioxide	Minimum 4 hours
		Carbon monoxide	Minimum 1 hour

*Oxides of Nitrogen results refer to total NO_x expressed as NO₂



Monitoring results

Emission Point	Main Stack	
Reference Number	87308/1	
Substance to be Monitored	Dioxins & Furans	
Emission Limit Value	N/A	
Periodic Monitoring Result	Lower Bound Result	Upper Bound Result
	<0.001	0.001
Uncertainty	<0.001	<0.001
Units	ng/Nm ³	
Reference Conditions	273K, 101.3kPa, 6% oxygen & dry gas	
Date of Sampling	12/04/2018	
Start/End Time	10:35 – 16:35	
Average Volumetric flow @ reference conditions / m³/hr	44069.9	
Standard Reference Method	BS EN 1948	
Technical Procedure Reference	ANC/S/14	
Accreditation Status	MCERTS	
Process Status (Load/Feedstock)	See Process Status (page 8)	



Monitoring results continued

Emission Point	Main Stack		
Reference Number	87308/2		
Substance to be Monitored	Total Metals	Cadmium & Thallium	Mercury
Emission Limit Value	N/A	N/A	N/A
Periodic Monitoring Result	0.07	<0.01	<0.01
Uncertainty	<0.01	<0.01	<0.01
Units	mg/Nm ³		
Reference Conditions	273K, 101.3kPa, 6% oxygen & dry gas		
Date of Sampling	10/04/2018		
Start/End Time	13:21 – 14:21		
Average Volumetric flow @ reference conditions / m³/hr	63644.2		
Standard Reference Method	BS EN 14385		BS EN 13211
Technical Procedure Reference	ANC/S/9		
Accreditation Status	MCERTS		
Process Status (Load/Feedstock)	See Process Status (page 8)		



Monitoring results continued

Emission Point	Main Stack	
Reference Number	87308/3	87308/4
Substance to be Monitored	Particulate	Hydrogen Chloride
Emission Limit Value	15	N/A
Periodic Monitoring Result	1.32	0.34
Uncertainty	±0.06	±0.04
Units	mg/Nm ³	
Reference Conditions	273K, 101.3kPa, 6% oxygen & dry gas	
Date of Sampling	10/04/2018	
Start/End Time	11:51 – 12:51	
Average Volumetric flow @ reference conditions / m³/hr	63644.2	
Standard Reference Method	BS EN 13284-1	BS EN 1911
Technical Procedure Reference	ANC/S/6	ANC/S/34
Accreditation Status	MCERTS	
Process Status (Load/Feedstock)	See Process Status (page 8)	



Monitoring results continued

Emission Point	Main Stack		
Reference Number	87308/5		
Substance to be Monitored	Carbon monoxide	Oxides of nitrogen	Sulphur dioxide
Emission Limit Value	250	300	N/A
Periodic Monitoring Result	114.9	201.0	2.7
Uncertainty	±0.8	±4.5	±0.6
Units	mg/Nm ³		
Reference Conditions	273K, 101.3kPa, 6% oxygen & dry gas		
Date of Sampling	10/04/2018		
Start/End Time	11:45 – 15:45		
Average Volumetric flow @ reference conditions / m³/hr	63644.2		
Standard Reference Method	BS EN 15058	BS EN 14792	E.A. MID M21
Technical Procedure Reference	ANC/S/29		
Accreditation Status	MCERTS		
Process Status (Load/Feedstock)	See Process Status (page 8)		



Process status

With regards to the sampling carried out on the Main Stack on the 10th April, the process ran continuously during the various sampling regimes and no unusual occurrences were noted. Detailed process information was unavailable however, the process was confirmed as operational prior to monitoring.

With regards to the sampling carried out on the Main Stack on the 12th April, the process ran continuously during the sampling regime, but at a reduced load due to demand. The testing was performed with the boiler operating below 60% MCR at the request of the client. Detailed process information was unavailable however, the process was confirmed as operational prior to monitoring.



Operating information

Nature of process (continuous or batch)	Continuous
What part of the batch was sampled or whole batch (if applicable)	Not applicable as the process tested is continuous. In the event that any known gaps in production have occurred during the sampling regime, they have been detailed in the Process Status section.
What fuel was used (if applicable)	The fuel used was a blend of virgin and recycled wood of eight parts to one part by weight.
What feedstock was used during the monitoring (if applicable)	Not applicable
“Normal” load, throughput or continuous rating of plant	The process exhibited normal throughput during the sampling regime carried out on the 10 th April, but at a lower than normal throughput during the sampling regime carried out in the 12 th April.
What type of abatement system and whether operating	The main stack is abated using bag filtration which was operational during all monitoring tests.
The periodic monitoring result and the results from the operators CEMS	N/A



Monitoring Deviations:

Why any substance(s) in the monitoring objectives were not monitored.

N/A

Why any substance(s) were not monitored in accordance with the monitoring method and any other issues relevant to the monitoring results.

Due to the high velocities and the very high moisture content (between 20-30%) of the stack gas it was decided that a nozzle <6mm would be used for the dioxins and furans monitoring. This was to reduce the amount of moisture collected and eliminate the need of emptying the condensate trap during monitoring and hence minimising any potential for contamination. This is a deviation from documented in-house method ANC/S/14

The sampling carried out on the main stack for particulate, hydrogen chloride, metals, mercury and combustion gases did not deviate from the procedural requirements of documented in-house methods ANC/S/6, ANC/S/9, ANC/S/11, ANC/S/26, ANC/S/29 and ANC/S/34



Part 2: Supporting information

APPENDIX 1



Sampling personnel

Name	Function	MCERTS number	MCERTS level	Technical endorsements
P Ruck	Team Leader	MM 11 1117	Level 2	TE1, TE2, TE3, TE4
R Lethbridge	Team Leader	MM 05 575	Level 2	TE1, TE2, TE3, TE4
D Oliver	Emissions Analyst	MM 17 1452	Trainee	N/A



Method specifications:

Substance	Standard reference method	Anchem technical procedure
Dioxins & furans	BS EN 1948	ANC/S/14
Metals	BS EN 14385	ANC/S/9
Mercury	BS EN 13211	ANC/S/9
Particulate	BS EN 13284-1	ANC/S/6
Carbon monoxide	BS EN 15058	ANC/S/29
Oxides of nitrogen	BS EN 14792	ANC/S/29
Sulphur dioxide	E.A. MID M21	ANC/S/29
Hydrogen chloride	BS EN 1911	ANC/S/34
Oxygen	BS EN 14789	ANC/S/26
Moisture	BS EN 14790	ANC/S/11



Equipment checklist

Please see relevant appendices and site specific protocol associated with monitoring campaign for equipment utilised during monitoring & checklist.



APPENDIX 2

Main Stack

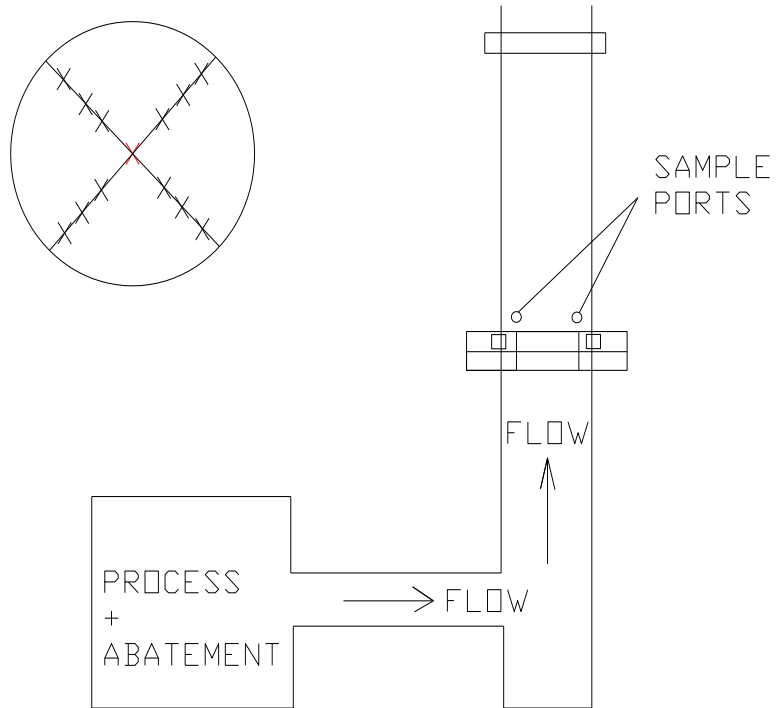
(29 Pages)



Stack diagram

X = DIOXINS,
PARTICULATE & METALS
SAMPLE POINT

X = DIOXINS,
PARTICULATE, METALS,
COMBUSTION GAS &
HYDROGEN CHLORIDE
SAMPLE POINT



Stack Dimension (m)	1.60m
Homogeneity test previously carried out (yes/no)	No
Is the gas stream homogeneous? (yes/no/unknown)	Unknown



Dioxins & furans monitoring sampling data

Client	Billfinger
Site	Margam
Emission Point	Main Stack
Date	12/04/2018
Reference Number	87308/1
Determinand	Dioxins & Furans
Run	1
Team Leader	RJL
Analyst(s)	EJ, DO
X-Sectional Area	2.0106
$\Delta H@$	45.44
Y_d	0.9833
C_p	0.83
k Factor	2.40
Duct static pressure (mmH ₂ O)	18
Absolute stack gas pressure (mm Hg)	756.3
Total gas volume sampled at STP (Litres)	4996.9
Total sampling time (minutes)	360
Moisture (%)	21.5
Dessicant discolouration less than 50%	Yes
Velocity at stack conditions (m/s)	12.12
Volumetric flow at stack conditions (m ³ /s)	24
Volumetric Flow at STP Wet Gas (m ³ /hr)	61132
Volumetric Flow at reference conditions (m ³ /hr)	44070
% Isokinetic	102.0
Oxygen calibration gas concentration/reference	296945 (6.01%)
% Uncertainty of Measurement	23.30

Dioxins & Furans results summary at reference conditions

Dioxins & Furans (Lower Bound)	
Concentration (ng/Nm ³) @ reference conditions	0.000
Emission Rate (ng/h) @ reference conditions	0.35

Dioxins & Furans (Upper Bound)	
Concentration (ng/Nm ³) @ reference conditions	0.001
Emission Rate (ng/h) @ reference conditions	38.22

Blank (Lower Bound)	
Concentration (ng/Nm ³) @ reference conditions	0.000

Blank (Upper Bound)	
Concentration (ng/Nm ³) @ reference conditions	0.001

Ref No	87308/1
Date	12/04/2018
Client	Billfinger
Site	Margam
Emission Point	Main Stack
Determinand	Dioxins & Furans
Methodology Used	BS EN 1948
Hot Box Setting °C	120
Probe Length (m)	2.0
Pitot no	A/S144
Probe Material	Titanium
Probe Setting (°C)	120
Nozzle diam (mm) & no	6.6

Blank Filter	1003blk	K Factor	
Filter Code	1003	2.40	
Run No	1		
Field Blank Leak Check			
	Open	Sealed	% Leak over 30 secs
Pre-Test	16.3	0.05	0.6
Post-Test	16.3	0.08	1.0
Sample Leak Check			
	Open	Sealed	% Leak over 30 secs
Pre-Test	16.3	0.05	0.6
Post-Test	16.3	0.1	1.2
Console Pump / Orifice Leak Check			Yes

Test Start	10:35:00
Test End	16:35:00

Field Blank Pitot Leak Check	
Pre Test	Post Test
Yes	Yes

Sample Pitot Leak Check	
Pre Test	Post Test
Yes	Yes

Sample Temperature Info:	Temp Unit A/S No	A/L164	Thermocouple A/S No	A/L164	End of Test Temperature (°C)	12	Return to Laboratory Temperature (°C)	10
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Traverse Point	Minute per Point - (Min) Clock Time	Pump Vacuum	Velocity Head DP (mmH ₂ O)	$\sqrt{\Delta P}$	DH (mmH ₂ O)	Initial DGM Reading	Stack Temp (°C)	Probe Temp (°C)	Filter Temp (°C)	Impinger Temp (°C)	Gas Sample Temperature at Dry Gas Meter		Gas Readings			Dioxins Condensate Temp (°C)
						21419					Inlet (°C)	Outlet (°C)	% O ₂	% CO ₂	%CO	
						DGM Readings										
1	30	25	8.0	2.83	19	21826	120	120	120	8	12	12	7.2	13.1	0.0	14
2	60	25	9.0	3.00	22	22259	120	120	120	10	13	12	7.4	13.1	0.0	14
3	90	25	10.0	3.16	24	22718	118	120	120	10	14	12	7.3	12.9	0.0	15
4	120	25	11.0	3.32	26	23201	118	120	120	10	15	13	7.5	13.3	0.0	15
5	150	25	11.0	3.32	26	23686	117	120	120	11	16	13	6.9	13.8	0.0	16
6	180	25	11.0	3.32	26	24170	117	120	120	12	17	13	7.3	13.5	0.0	17
T1 Average			10.0	3.2	24.0	2751	118	120	120	10	15	13	7.3	13.3	0.0	15

Traverse 1 Leak Check	Open	Sealed	% Leak over 30s	Max Vacuum
	16	0.1	1.0	55

T2 Initial DGM Reading						24200											
1	210	30	8.0	2.83	19	24616	116	120	120	13	17	14	7.3	12.9	0.0	18	
2	240	30	9.0	3.00	22	25059	116	120	120	13	18	14	7.1	13.1	0.0	18	
3	270	30	9.0	3.00	22	25503	116	120	120	14	18	15	6.9	13.4	0.0	17	
4	300	30	10.0	3.16	24	25973	115	120	120	14	19	15	7.0	13.5	0.0	17	
5	330	30	9.0	3.00	22	26420	115	120	120	15	20	16	7.4	13.0	0.0	16	
6	360	30	8.0	2.83	19	26840	115	120	120	15	20	16	7.3	13.1	0.0	16	
T2 Average			8.8	3.0	21	2640	116	120	120	14	19	15	7.2	13.2	0.0	17	

Traverse 2 Leak Check	Open	Sealed	% Leak over 30s #DIV/0!	Max Vacuum

T3 Initial DGM Reading																	
T3 Average			#DIV/0!	#DIV/0!	#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Test Average			9.4	3.1	22.6	5391	117	120	120	12	17	14	7.2	13.2	0.0	16	

Combustion Gas Monitoring Summary

Reference number	87308/1
Date	12/04/2018
Customer name	Billfinger
Site location	Margam
Emission point	Main Stack
Emission point dimension (m)	1.6m
Emission point C.S.A. (m ²)	2.0106
Team leader	Robert Lethbridge
Analyst(s)	Phillip Ruck / Dean Oliver
Average Ambient pressure (mb)	1006.5
Average Ambient temperature (°C)	12.5
Instrument number	A/S545 (PG-350)
Probe length (m)	2.0m
Timer	A/L179
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	10:35:00
Test end time	16:35:00
Volumetric flow @ reference conditions (m ³ /hour)	44069.9

Reference conditions

Temperature (K)	273
Pressure (kPa)	101.3
Moisture	Dry
Oxygen (%)	6

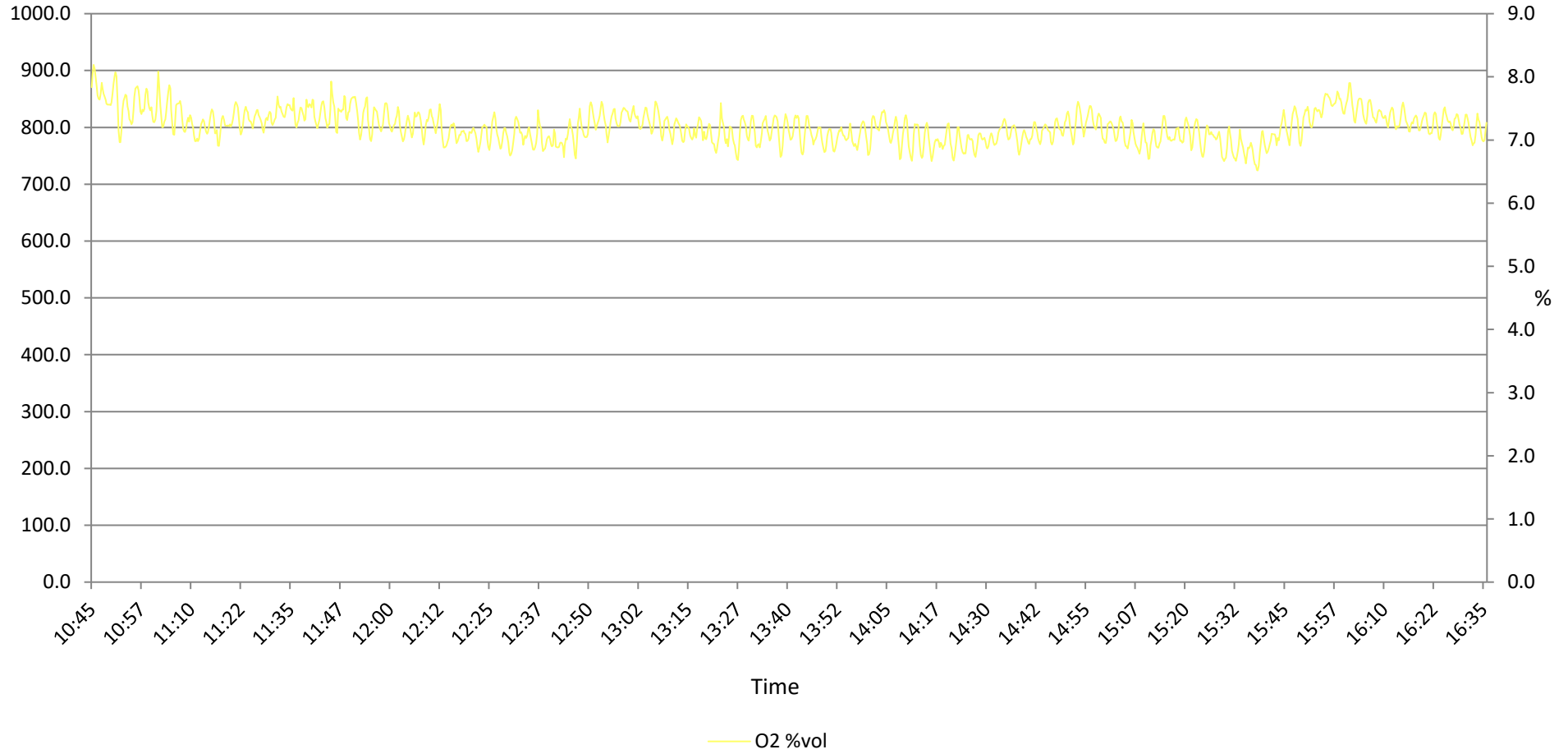
Oxygen

Average concentration O₂ (% vol)	7.2
Maximum concentration O₂ (% vol)	8.2
Minimum concentration O₂ (% Vol)	6.5
% Uncertainty of measurement	0.1
Uncertainty Concentration % vol	0.0

Oxygen concentrations measured on the Main Stack, at Billfinger, Margam
 on the 12/4/2018
 Reference No: 87308/1

Concentration	CO mg/m ³	30 Minute Rolling Mean	NOx mg/m ³	30 Minute Rolling Mean	SO2 mg/m ³	30 Minute Rolling Mean	O ₂ %vol
Minimum							6.5
Maximum							8.2
Average							7.2

Oxygen concentrations measured on the Main Stack, at Billfinger, Margam
on the 12/4/2018
Reference No: 87308/1



Combustion Gas Site Data

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Customer	Billfinger
Emission Point	Main Stack
Date	12/04/2018
Reference No	87308/1

Pre test				
ANALYTE	CO	NO	SO ₂	O ₂
Span Through analyser (ppm)				6.0
Zero Through line (ppm)				0.01
Span Through line (ppm)				6.0
Residence Time (seconds)				15.0
System T90 (seconds)				75
T90 Value (ppm)				5.4
Initial leak test				0.2
Post test				
ANALYTE	CO	NO	SO ₂	O ₂
Zero Through Line				0.01
Span Through line (ppm)				5.97
Span Drift (%)				0.6
Zero Drift (%)				0.0

Oxygen cylinder grade/reference	296945 (6.01%)
Nitrogen Monoxide cylinder grade/reference	n/a
Sulphur Dioxide cylinder grade/reference	n/a
Carbon Monoxide cylinder grade/reference	n/a

Gas conditioning Temperature Validation

Temperature @ Start of Test (°C)	n/a
Temperature During Test (°C)	n/a
Temperature @ End of Test (°C)	n/a

Stratification Data

Point	CO ppm	NO ppm	SO ₂ ppm	O ₂ % vol
1				7.84
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Metals monitoring sampling data

Client	Bilfinger
Site	Margam
Emission Point	Main Stack
Date	10/04/2018
Reference Number	87308/2
Determinand	Metals & Hg
Run	1
Team Leader	PR
Analyst(s)	RJL DO
X-Sectional Area	2.0106
$\Delta H@$	45.44
Y_d	0.9833
C_p	0.83
k Factor	2.36
Duct static pressure (mmH ₂ O)	30
Absolute stack gas pressure (mm Hg)	751.5
Total gas volume sampled at STP (Litres)	1256.9
Total sampling time (minutes)	60
Moisture (%)	20.75
Dessicant discolouration less than 50%	Yes
Velocity at stack conditions (m/s)	18.89
Volumetric Flow at STP Wet Gas (m ³ /hr)	90240
Volumetric Flow at reference conditions (m ³ /hr)	63396
% Isokinetic	103.3
Oxygen calibration gas concentration/reference	296945 (6.01%)
% Uncertainty of Measurement	3.17

Metals results summary at reference conditions

Total Metals (Sb, As, Cr, Co, Cu,Pb, Mn, Ni, V)	
Concentration (mg/Nm ³) at Reference Conditions	0.07
Blank Concentration (mg/Nm ³) at Reference Conditions	0.02
Emission Rate (Kg/h) at Reference Conditions	0.00

Mercury	
Concentration (mg/Nm ³) at Reference Conditions	0.00
Blank Concentration (mg/Nm ³) at Reference Conditions	0.00
Emission Rate (Kg/h) at Reference Conditions	0.00

Cadmium & Thallium	
Concentration (mg/Nm ³) at Reference Conditions	0.00
Blank Concentration (mg/Nm ³) at Reference Conditions	0.00
Emission Rate (Kg/h) at Reference Conditions	0.00

Client	Bilfinger
Site	Margam
Emission Point	Main Stack
Date	10/04/2018
Reference Number	87308/2
Team Leader	PR
Analyst(s)	RJL DO

DGM Inlet (°C)	16
DGM Outlet (°C)	16
Mean Temp (°C)	16
Bar Pressure (mb)	998
Moisture (%)	20.75
Duct Shape	Circular
Stack C.S.A (m ²)	2.0106

Gas Flow	Out
Port Nipple (cm)	21
Console No.	A/S137
Filter Box No.	A/S137
Tape Measure	A/S383
Timer	A/L179
Barometer No.	A/SS42

Stack Internal Area Check
Yes

Field Repeatability
N/A

Static Pressure Check
Yes

% O ₂	% CO ₂	% CO
8.0	12.2	0.0

Traverse Line 1

Traverse Line 2

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch
1	7.0	15.0	3.9	129	14	N/A
2	23.4	15.0	3.9	129	11	N/A
3	47.3	18.9	4.3	129	10	N/A
4	112.7	21.3	4.6	129	8	N/A
5	136.6	24.0	4.9	129	7	N/A
6	153.0	24.9	5.0	129	11	N/A

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch
1	7.0	16.0	4.0	129	13	N/A
2	23.4	24.0	4.9	129	10	N/A
3	47.3	25.3	5.0	129	8	N/A
4	112.7	24.9	5.0	129	7	N/A
5	136.6	26.0	5.1	129	9	N/A
6	153.0	26.0	5.1	129	12	N/A

Average ΔP (mmH ₂ O)
21.78

Average sqrt DP
4.67

Average Stack Temp (°C)
129

Traverse Line 3

Traverse Line 4

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Is negative flow present?
No

Minimum velocity >5Pa
Yes

Ratio of gas velocities <3:1
Yes

Swirl <15°
Yes

Particulate summary results page at reference conditions

Customer	Bilfinger
Site	Margam
Emission Point	Main Stack
Date Sampled	10-Apr-18
Reference Number	87308/3 & 4
Determinand	Particulate
Run	1
Team Leader	PR
Analyst(s)	RJL DO
X-Sectional Area (m ²)	2.0106
$\Delta H@$	45.44
Y_d	0.9833
Cp	0.83
k Factor	2.35
Duct Static Pressure (mmH ₂ O)	30.0
Absolute Stack Gas Pressure (mm Hg)	751.5
Total Particulate Gain (mg)	1.48
Probe Rinse (mg)	0.42
Blank Weight Gain (mg)	0.29
Reagent Blank (mg)	0.58
Total Gas Volume Sampled at STP (Litres)	1250.1
% Isokinetic	102.6
% Oxygen	7.61
Oxygen calibration gas concentration/reference	296945(6.01%)
Stack moisture (%)	20.75
Dessicant discolouration less than 50%	Yes
Velocity at Stack conditions (m/s)	18.80
Particulate Concentration @ Reference Conditions (mg/Nm ³)	1.32
Blank Concentration @ Reference Conditions (mg/Nm ³)	0.26
Volumetric Flow at Reference Conditions (m ³ /hr)	63893
Particulate Emission Rate (g/h) @ Reference Conditions	85
% Uncertainty of Measurement	4.59

Reference Number	87308/3 & 4	Customer	Bilfinger	Emission Point	Main Stack
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Filter Number (ST)	925	Date of Initial Weighing	14/02/2018	Temp (°C)	18	Pressure (mb)	998
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Initial Weighing

Weight After 1 Minute (mg)	1	543.68
Weight after 2 Minutes (mg)	2	543.69
Weight After 3 Minutes (mg)	3	543.70

Person Carrying Out Initial Weighings	DO	Zero Wt	543.67
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Post Test Weighing

Date of Final Weighing	13/04/2018
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Weight After 1 Minute (mg)	1	544.63
Weight after 2 Minutes (mg)	2	544.63
Weight After 3 Minutes (mg)	3	544.63

Person Carrying Out Final Weighings	PR	Zero Wt	544.63
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Probe Rinse

Acetone Batch Number	1724832
Reagent Blank (mg)	0.58

Weight After 1 Minute (g)	1	34.80355
Weight after 2 Minutes (g)	2	34.80354
Weight After 3 Minutes (g)	3	34.80353

Person Carrying Out Initial Rinse Weighings	PR
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Extrapolated Weight to Zero (g)	34.80356
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Crucible Cleaned & Re-Conditioned

Weight After 1 Minute (g)	1	34.80250
Weight after 2 Minutes (g)	2	34.80251
Weight After 3 Minutes (g)	3	34.80252

Temp (°C)	19	Pressure (mb)	1008
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Person Carrying Out Final Rinse Weighings	DO
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Extrapolated Weight to Zero (g)	34.80249
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Blank Probe Rinse

Weight After 1 Minute (g)	1	37.43348
Weight after 2 Minutes (g)	2	37.43348
Weight After 3 Minutes (g)	3	37.43348

Temp (°C)	20	Pressure (mb)	1004
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Person Carrying Out Initial Blank Rinse Weighings	PR
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Extrapolated Weight to Zero (g)	37.43348
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Crucible Cleaned & Re-Conditioned

Weight After 1 Minute (g)	1	37.43248
Weight after 2 Minutes (g)	2	37.43250
Weight After 3 Minutes (g)	3	37.43254

Temp (°C)	19	Pressure (mb)	1008
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Person Carrying Out Final Blank Rinse Weighings	DO
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Extrapolated Weight to Zero (g)	37.43245
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Control Weight Processing

	Pre	Post		Pre	Post		Pre	Post	St filter control
C1 1 minute	21.56879	21.56877	C2 1 Minute	21.14999	21.14993	C3 1 Minute	22.36370	22.36357	505.96
C1 2 Minutes	21.56880	21.56877	C2 2 Minutes	21.15000	21.14993	C3 2 Minutes	22.36370	22.36358	Fn Filter control
C1 3 Minutes	21.56881	21.56877	C2 3 Minutes	21.15001	21.14993	C3 3 Minutes	22.36370	22.36359	505.87
Extrapolated	21.56878	21.56877		21.14998	21.14993		22.36370	22.36356	Correction
Wt Change C1	0.00001		Wt Change C2	0.00005		Wt Change C3	0.00014		-0.09

Correction Value to be applied to weight gain	0.00007
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Client	Bilfinger
Site	Margam
Emission Point	Main Stack
Date	10/04/2018
Reference Number	87308/3 & 4
Team Leader	PR
Analyst(s)	RJL DO

DGM Inlet (°C)	16
DGM Outlet (°C)	16
Mean Temp (°C)	16
Bar Pressure (mb)	998
Moisture (%)	20.75
Duct Shape	Circular
Stack C.S.A (m ²)	2.0106

Gas Flow	Out
Port Nipple (cm)	21
Console No.	A/S137
Filter Box No.	A/S137
Tape Measure	A/S383
Timer	A/L179
Barometer No.	A/SS42

Stack Internal Area Check
Yes

Field Repeatability
N/A

Static Pressure Check
Yes

% O ₂	% CO ₂	% CO
8.0	12.2	0.0

Traverse Line 1

Traverse Line 2

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch
1	7.0	15.0	3.9	129	14	N/A
2	23.4	15.0	3.9	129	11	N/A
3	47.3	18.9	4.3	129	10	N/A
4	112.7	21.3	4.6	129	8	N/A
5	136.6	24.0	4.9	129	7	N/A
6	153.0	24.9	5.0	129	11	N/A

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch
1	7.0	16.0	4.0	129	13	N/A
2	23.4	24.0	4.9	129	10	N/A
3	47.3	25.3	5.0	129	8	N/A
4	112.7	24.9	5.0	129	7	N/A
5	136.6	26.0	5.1	129	9	N/A
6	153.0	26.0	5.1	129	12	N/A

Average ΔP (mmH ₂ O)
21.78

Average sqrt DP
4.67

Average Stack Temp (°C)
129

Traverse Line 3

Traverse Line 4

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Sampling Point	Distance (cm)	Average Velocity Head ΔP (mmH ₂ O)	$\sqrt{\Delta P}$	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Is negative flow present?
No

Minimum velocity >5Pa
Yes

Ratio of gas velocities <3:1
Yes

Swirl <15°
Yes

Wet chemistry monitoring sampling data (Isokinetic)

Client	Bilfinger
Site	Margam
Emission Point	Main Stack
Date	10/04/2018
Reference Number	87308/3 & 4
Determinand	Particulate & HCl
Run	1
Team Leader	PR
Analyst(s)	RJL DO
X-Sectional Area	2.0106
$\Delta H@$	45.44
Y_d	0.9833
C_p	0.83
k Factor	2.35
Duct static pressure (mmH ₂ O)	30
Absolute stack gas pressure (mm Hg)	751.5
Total gas volume sampled at STP (Litres)	1250.1
Total sampling time (minutes)	60
Moisture (%)	20.75
Dessicant discolouration less than 50%	Yes
Velocity at stack conditions (m/s)	18.80
Volumetric flow at stack conditions (m ³ /s)	38
Volumetric Flow at STP Wet Gas (m ³ /hr)	90377
Volumetric Flow at reference conditions (m ³ /hr)	63893
% Isokinetic	102.6
Absorption efficiency check (%)	99.67
Oxygen calibration gas concentration/reference	296945(6.01%)
% Uncertainty of Measurement	10.79

Results summary at reference conditions

Chloride	
Concentration (mg/Nm ³) @ reference conditions	0.34
Emission Rate (g/h) @ reference conditions	21.53

Blank	
Concentration (mg/Nm ³) @ reference conditions	0.00

Combustion Gas Monitoring Summary

Reference number	87308/5
Date	10/04/2018
Customer name	WBOC
Site location	Margam
Emission point	Main Stack
Emission point dimension (m)	1.6m
Emission point C.S.A. (m ²)	2.0106
Team leader	Robert Lethbridge
Analyst(s)	Phil Ruck / Elliot Jones
Average Ambient pressure (mb)	998
Average Ambient temperature (°C)	14.5
Instrument number	A/S545 (PG-350)
Probe length (m)	2.5m
Timer	A/S277
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	11:45:00
Test end time	15:45:00
Volumetric flow @ reference conditions (m ³ /hour)	63644.2

Reference conditions

Temperature (K)	273
Pressure (kPa)	101.3
Moisture	Dry
Oxygen (%)	6

Carbon Monoxide

Average concentration CO (mg/m ³)	114.9
Maximum concentration CO (mg/m ³)	166.9
Minimum concentration CO (mg/m ³)	98.8
Mass Emission CO (Kg/hour)	7.32
% Uncertainty of measurement	0.7
Uncertainty Concentration mg/m ³	0.8

Sulphur Dioxide

Average concentration SO ₂ (mg/m ³)	2.7
Maximum concentration SO ₂ (mg/m ³)	11.5
Minimum concentration SO ₂ (mg/m ³)	0.3
Mass Emission SO ₂ (Kg/hour)	0.17
% Uncertainty of measurement	21.5
Uncertainty Concentration mg/m ³	0.6

Oxygen

Average concentration O ₂ (% vol)	7.7
Maximum concentration O ₂ (% vol)	8.6
Minimum concentration O ₂ (% Vol)	7.1
% Uncertainty of measurement	0.2
Uncertainty Concentration % vol	0.0

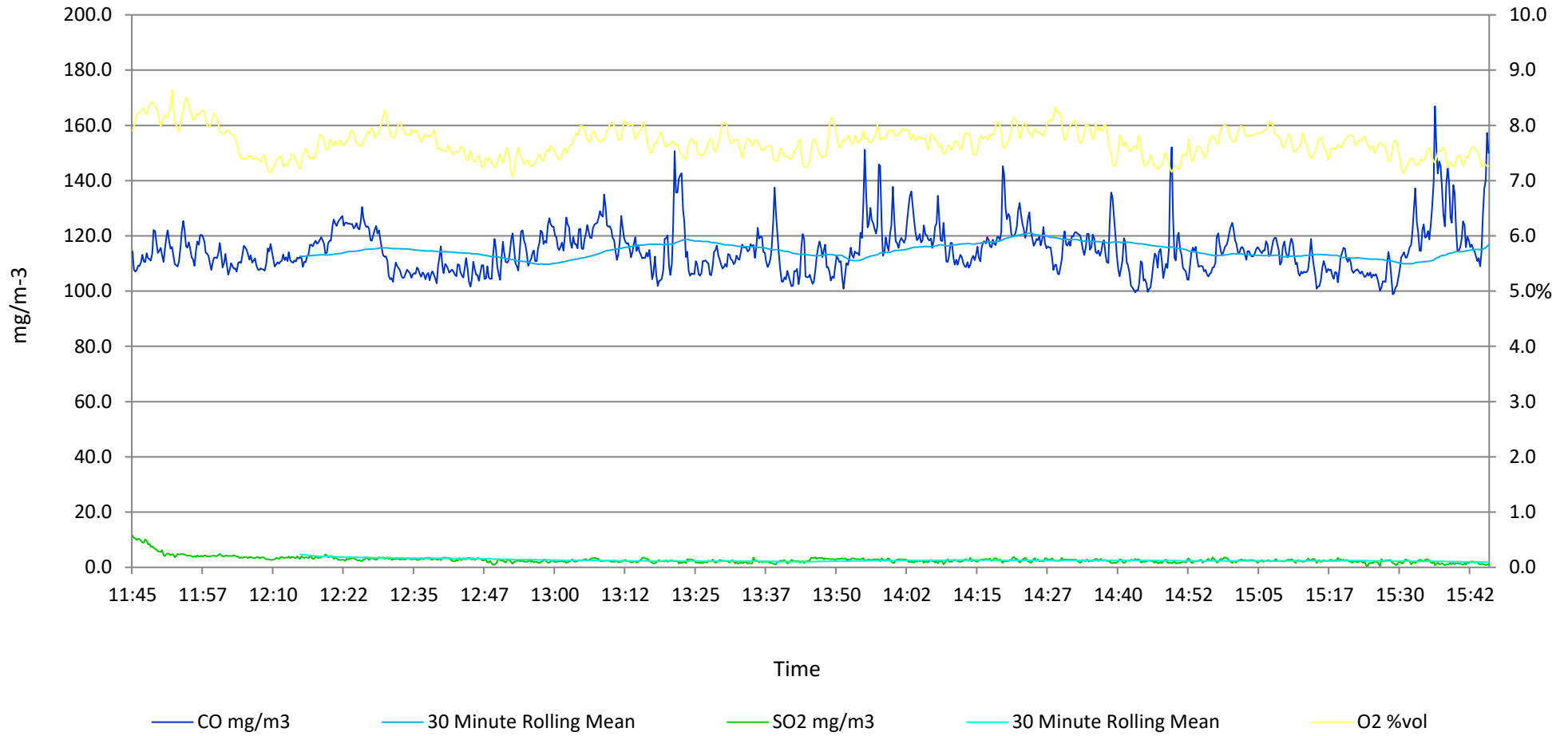
Combustion Gas concentrations measured on the Main Stack, at WBOC, Margam
 on the 10/4/2018
 Reference No: 87308/5

Concentration	CO mg/m ³	30 Minute Rolling Mean	NOx mg/m ³	30 Minute Rolling Mean	SO2 mg/m ³	30 Minute Rolling Mean	O ₂ %vol
Minimum	98.8	109.7			0.3	1.9	7.1
Maximum	166.9	121.0			11.5	4.7	8.6
Average	114.9	114.6			2.7	2.6	7.7

Combustion Gas concentrations measured on the Main Stack, at WBOC, Margam

on the 10/4/2018

Reference No: 87308/5



Combustion Gas Site Data

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Customer	WBOC
Emission Point	Main Stack
Date	10/04/2018
Reference No	87308/5

Pre test				
ANALYTE	CO	NO	SO ₂	O ₂
Span Through analyser (ppm)	100.7	102.4	103.6	6.0
Zero Through line (ppm)	0.00	0.00	0.80	0.00
Span Through line (ppm)	100.6	102.5	102.8	6.0
Residence Time (seconds)	15.0	15.0	30.0	15.0
System T90 (seconds)	75	75	90	75
T90 Value (ppm)	90.6	92.2	93.2	5.4
Initial leak test	0.1	0.1	0.8	0.2
Post test				
ANALYTE	CO	NO	SO ₂	O ₂
Zero Through Line	0.40	0.30	0.37	0.04
Span Through line (ppm)	100.8	99.10	101.90	5.98
Span Drift (%)	0.2	3.3	0.9	0.4
Zero Drift (%)	0.4	0.3	0.4	0.7

Oxygen cylinder grade/reference	296945
Nitrogen Monoxide cylinder grade/reference	5700688
Sulphur Dioxide cylinder grade/reference	5700688
Carbon Monoxide cylinder grade/reference	5700688

Gas conditioning Temperature Validation

Temperature @ Start of Test (°C)	N/A
Temperature During Test (°C)	N/A
Temperature @ End of Test (°C)	N/A

Stratification Data

Point	CO ppm	NO ppm	SO ₂ ppm	O ₂ % vol
1	81.13	86.70	3.57	7.90
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Combustion Gas Monitoring Summary

Reference number	87308/5
Date	10/04/2018
Customer name	WBOC
Site location	Margam
Emission point	Main Stack
Emission point dimension (m)	1.6m
Emission point C.S.A. (m ²)	2.0106
Team leader	Robert Lethbridge
Analyst(s)	Phil Ruck / Elliot Jones
Average Ambient pressure (mb)	998
Average Ambient temperature (°C)	14.5
Instrument number	A/S545 (PG-350)
Probe length (m)	2.5m
Timer	A/S277
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	11:45:00
Test end time	15:45:00
Volumetric flow @ reference conditions (m ³ /hour)	63644.2

Reference conditions

Temperature (K)	273
Pressure (kPa)	101.3
Moisture	Dry
Oxygen (%)	6

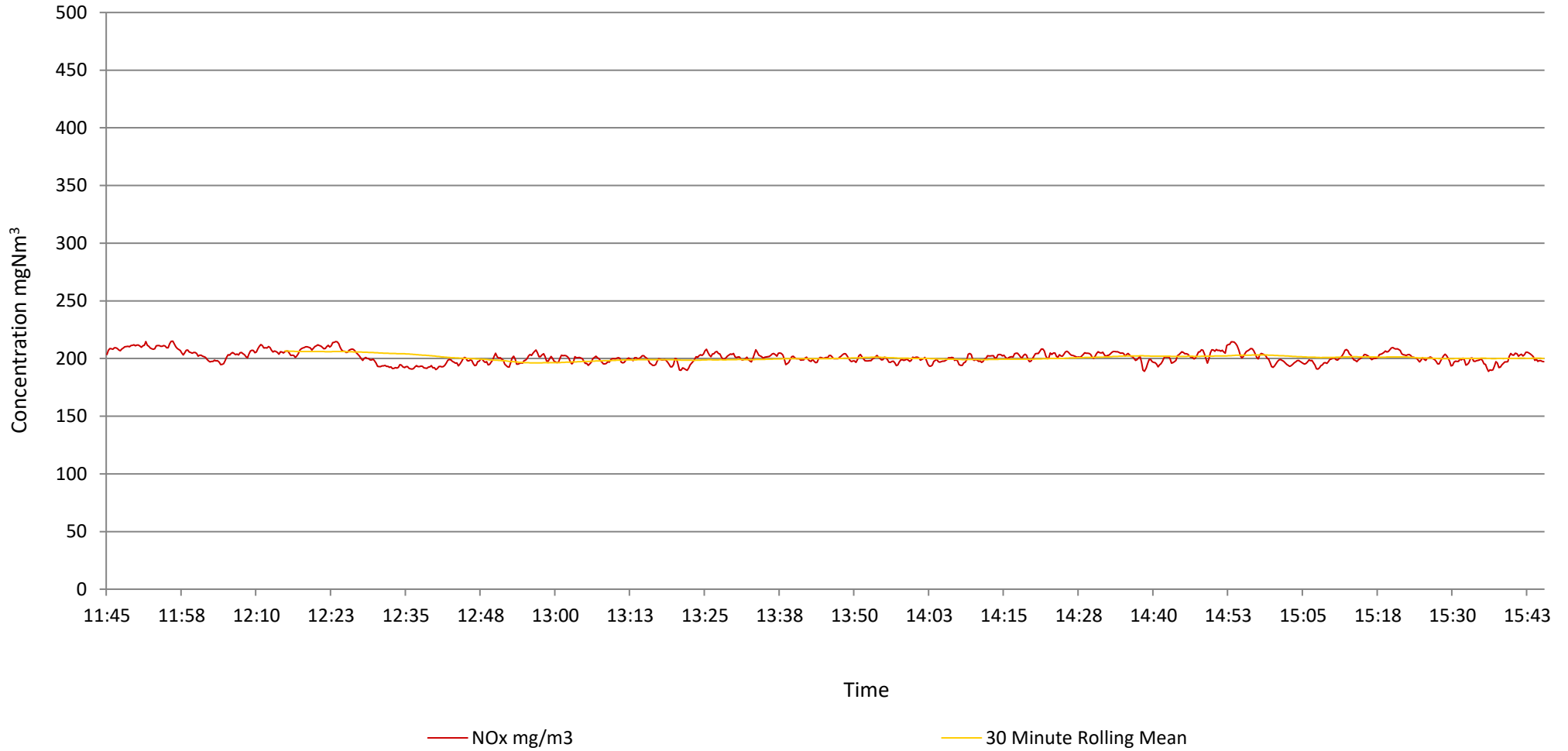
Oxides of Nitrogen (as NO₂)

Average concentration NOx (mg/m³)	201.0
Maximum concentration NOx (mg/m³)	215.1
Minimum concentration NOx (mg/m³)	188.9
Mass Emission NOx (Kg/hour)	12.79
% Uncertainty of measurement	2.3
Uncertainty Concentration	4.5

Drift corrected Combustion Gas concentrations measured on the Main Stack, at WBOC,
Margam
on the 10/4/2018
Reference No: 87308/5

Concentration	CO mg/m ³	30 Minute Rolling Mean	NOx mg/m ³	30 Minute Rolling Mean	SO2 mg/m ³	30 Minute Rolling Mean	Oxygen (% vol)
Minimum			188.9	196.2			
Maximum			215.1	206.5			
Average			201.0	200.7			

Drift corrected Combustion Gas concentrations measured on the Main Stack, at WBOC, Margam
on the 10/4/2018
Reference No: 87308/5



APPENDIX 3

(Uncertainty)

(9 Pages)



Client	Billfinger	Date	12/04/2018
Emission Point ID	Main Stack	Reference Number	87308/1

Measured Dioxin & Furan concentration (ng/m³)	0.001	Reference Oxygen (%)	6.0
ELV	N/A		

Measured Quantities	Value	Standard Uncertainty	Uncertainty as %	Symbol	
Sampled Volume (m ³)	4.9969	0.001 m ³	0.02	V _m	
Sampled gas Temperature (K)	390	1 K	0.26	T _m	
Sampled gas Pressure (kPa)	100.84	0.5 kPa	0.50	ρ _m	
Sampled gas Humidity (%)	0	1 % Vol	1	H _m	
Oxygen content (%)	7.22	0.1 % Vol	1.39	O _{2,m}	
Leak (%)	1.23		1.23	L	
Sub Con Laboratory (%)	20.00				
		Factor for Standard Conditions	0.70	f _s	
Uncertainty Components	Sensitivity Coeff	Uncertainty (in units of fs)			
T _m	0.00	0.00		$f_s = \frac{(100 - H_m) 273}{100 T_m} \cdot \frac{\rho_m}{101.3}$	
ρ _m	0.01	0.00			
H _m	0.01	0.01			
ufs		0.01	1.15		
Corrected Volume (v)	3.48			V	
	0.04	$V = V_m f_s$	1.15	uV	
Factor for O₂ Correction	1.09			f _c	
	0.08			O _{2,m}	
	0.01	$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$		u	
	0.73			ufc	
Parameter		Sensitivity Coeff			
Corrected Volume	3.48	0.00	0.00	1.15	V
Factor for O ₂ Correction	1.09	0.00	0.00	0.73	f _c
Leak	0.00	1	0.00	0.71	L
Sub Con Laboratory	0.00	1	0.00	11.55	
Combined Measurement Uncertainty (ng/m³)	0.00				
Measurement Uncertainty					
Combined Uncertainty (ng/m ³)	0.00				
Coverage Factor k	2				
Expanded uncertainty (ng/m ³)	0.00				
Expanded Uncertainty (% ELV)	N/A				
Expanded uncertainty (ng/m³)	0.0002				
Expanded uncertainty (% Value)	23.30				

Client	Bilfinger	Date	10/04/2018
Emission Point ID	Main Stack	Reference Number	87308/2

Total metals concentration (mg/m³)	0.07	Reference Oxygen (%)	6.0
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Measured Quantities	Value	Standard Uncertainty	Uncertainty as %	Symbol	
Sampled Volume (m ³)	1.2569	0.001 m ³	0.08	V _m	
Sampled gas Temperature (K)	409	2 K	0.49	T _m	
Sampled gas Pressure (kPa)	100.19	0.5 kPa	0.50	ρ _m	
Sampled gas Humidity (%)	0	1 % Vol	1	H _m	
Oxygen content (%)	7.691666667	0.1 % Vol	1.30	O _{2,m}	
Leak (%)	1.15		1.15	L	
		Factor for Standard Conditions	0.66	f _s	
Uncertainty Components	Sensitivity Coeff	Uncertainty (in units of fs)			
T _m	0.00	0.00	$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$		
ρ _m	0.01	0.00			
H _m	0.01	0.01			
ufs		0.01		1.22	
Corrected Volume (v)	0.83			V	
	0.01	$V = V_m f_s$	1.23	uV	
Factor for O₂ Correction	1.13			fc	
	0.09			O _{2,m}	
	0.01	$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$		u	
	0.76			ufc	
Parameter		Sensitivity Coeff			
Corrected Volume	0.83	0.08	0.00	1.23	V
Factor for O ₂ Correction	1.13	0.06	0.00	0.76	fc
Leak	0.00	1	0.00	0.67	L
Combined Measurement Uncertainty (mg/m³)	0.00				
Measurement Uncertainty					
Combined Uncertainty (mg/m ³)	0.00				
Coverage Factor k	2				
Expanded uncertainty (mg/m ³)	0.00				
Expanded uncertainty (mg/m³)	0.00				
Expanded uncertainty (% Value)	3.17				

Uncertainty calculation for EN 13284 Determination of low range mass concentration of dust, Manual Gravimetric Method

Main Stack

Measurement Equation

$$c = \frac{m}{V} f_c$$

Limit value (ELV)	15	mg.m ⁻³	Reference oxygen		% by volume
Measured concentration	1.32	mg.m ⁻³ (at reference conditions)			

Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv	Requirement of std		
Sampled Volume	V _m		1.25	uV _m	0.001	m ³	0.08	<=2%	
Sampled gas Temperature	T _m		406	uT _m	2	k	0.49	<=1%	
Sampled gas Pressure	p _m		100.19	up _m	0.5	kPa	0.50	<=1%	
Sampled gas Humidity	H _m		0	uH _m	1	% by volume	1.00	<=1%	
Oxygen content	O _{2,m}		7.608333333	uO _{2,m}	0.1	% by volume	1.31	<=5%	
Mass particulate	m		1.48	um	0.03	mg	1.78	0.16	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas meter									
Leak	L		0.38			%	0.38	<=2%	
Uncollected Mass (Instack filter - no rinse)	UCM		0			mg	0	<=10%	

Intermediate calculations							
Factor for std conds	fs		0.66				
uncertainty components	symbol	sensitivity coeff		u (in units of fs)			
	p _m	0.007		0.003			
	H _m	0.007		0.007			
	T _m	0.002		0.003			
	ufs			0.008			
				1.22			
Corrected volume	V		0.83	uV	0.010 m ³	$V = V_m f_s$	1.23
Factor for O2 correction	fc		1.57				
uncertainty components	symbol	sensitivity coeff		u		$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$	
	O _{2,m}	0.12		0.012			
Factor for O2 Correction	ufc		1.57		0.012		0.75

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard conditi	V	0.83 m ³	1.59	0.02 mg.m ⁻³	1.23 %
Mass	m	1.48 mg	0.90	0.02 mg.m ⁻³	1.78 %
Factor for O2 Correction	fc	1.57	0.84	0.01 mg.m ⁻³	0.75 %
Leak	L	0.00 mg.m ⁻³	1.00	0.00 mg.m ⁻³	0.22 %
Uncollected mass	UCM	0.00 mg	0.90	0.00 mg.m ⁻³	0.00 %
Combined measurement uncertainty				0.03 mg.m⁻³	

Expanded uncertainty as percentage of measured value	4.59	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	0.06	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	0.41	% ELV	

Uncertainty calculation for BS EN 1911 Determination of mass concentration of hydrogen chloride (HCl), Reference method

Main Stack

Measurement Equation

$$c = \frac{m}{V} f_c$$

Limit value (ELV)	N/A	mg.m ⁻³	Reference oxygen		% by volume
Measured concentration	0.34	mg.m ⁻³ (at reference conditions)			

Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv	Requirement of std
Sampled Volume Gas	V _m	1.250083898	uV _m	0.001 m ³	0.08		<=2%
Sampled gas Temperature	T _m	133	uT _m	2 k	2.00		<2.5 k
Sampled gas Pressure	ρ _m	100.1920261	uρ _m	0.5 kPa	0.50		<=1%
Sampled gas Humidity	H _m	0	uH _m	1 % by volume	1.00		<=1%
Oxygen content	O _{2,m}	7.608333333	uO _{2,m}	0.1 % by volume	1.31		<=5%
Concentration in impinger	C	0.665	uC	0.03325 mg/l	5.00		<5%
Impinger solution volume	VS	0.798	uVS	0.001 l	0.13		<1%
Mass HCl	m	0.54552876	um	0.03 mg	5.00	#VALUE!	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas meter							
Leak	L	0.384615385		%	0.38		<=2%

Intermediate calculations				
Factor for std cond	fs	2.03		
uncertainty components	symbol	sensitivity coeff	u (in units of fs)	
	ρ _m	0.020	0.010	
	H _m	0.020	0.020	
	T _m	0.015	0.030	
	ufs		0.038	1.87
Corrected volume	V	2.53	uV	0.047 m ³
				$V = V_m f_s$ 1.87
Factor for O2 correction	fc	1.57		
uncertainty components	symbol	sensitivity coeff	u	
	O _{2,m}	0.12	0.012	
Factor for O2 Correction	ufc	1.57		0.75
				$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard cond)	V	2.53 m ³	0.13	0.01 mg.m ⁻³	1.87 %
Mass	m	0.55 mg	0.62	0.02 mg.m ⁻³	5.00 %
Factor for O2 Correction	fc	1.57	0.21	0.00 mg.m ⁻³	0.75 %
Leak	L	0.00 mg.m ⁻³	1.00	0.00 mg.m ⁻³	0.22 %
Combined uncertainty				0.02 mg.m⁻³	

Expanded uncertainty as percentage of measured value	10.79	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	0.04	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	N/A	% ELV	

Uncertainty Budget for Carbon monoxide

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Client	WBOC	Date	10/04/2018
Emission Point ID	Main Stack	Reference Number	87308/5

Measured CO concentration (mg/m³)	114.94	Calibration Value (mg/m³)	125.88
ELV	250	Scale used (mg/m³)	250.00

<u>Performance Characteristic</u>		<u>Specification</u>	<u>Uncertainty</u>	
Response Time (seconds)	28	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	240			
Number of Readings in Measurements	960			
Standard dev Repeat @ Zero	0.21	≤±1.0% Range	u _{r0}	N/A
Standard dev Repeat @ Span	0.13	≤±2.0% Range	u _{rs}	0.00
Deviation from Linearity (±)	0.02	≤±2.0% Range	u _{fit}	0.03
Zero Drift (During Measurement)	0.40	% full scale	u _{odr}	0.33
Span Drift (During Measurement)	0.20	% full scale		
Losses in the Line (Leak)	0.10	<2% of value	u _{leak}	0.07
Sensitivity to Atmospheric Pressure	0.22	<1.5% of the certification range	u _{apres}	0.00
Sensitivity to Sample Gas Flow	0.1	<1.0% of the certification range	u _{spres}	0.00
Sensitivity to Ambient Temp @ Span	2	<3.0% of the certification range	u _{temp}	0.00
Sensitivity to Ambient Temp @ Zero	-0.2	<3.0% of the certification range		0.00
Sensitivity to Electric Voltage	-0.35	<2.0% of the certification range	u _{volt}	0.00
Cross Sensitivity (Interferents)	0.53	<4% of the certification range	u _{int}	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m ³)	0.34			
Coverage Factor k	2			
Expanded uncertainty (mg/m ³)	0.68			
Expanded uncertainty to std conditions (mg/m ³)	0.77			
Expanded Uncertainty (% ELV)	0.31			
Expanded uncertainty (mg/m³)	0.77			
Expanded uncertainty (% Value)	0.67			
Requirement in standard is for uncertainty to be < ±6% at ELV at standard conditions				

Uncertainty Budget for Sulphur dioxide

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Client	WBOC	Date	10/04/2018
Emission Point ID	Main Stack	Reference Number	87308/5

Measured SO₂ concentration (mg/m³)	2.70	Calibration Value (mg/m³)	296.30
ELV	N/A	Scale used (mg/m³)	572.00

Performance Characteristic		Specification	Uncertainty	
Response Time (seconds)	60	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	240			
Number of Readings in Measurements	960			
Standard dev Repeat @ Zero	0.16	≤±1.0% Range	u _{r0}	N/A
Standard dev Repeat @ Span	0.16	≤±2.0% Range	u _{rs}	0.01
Deviation from Linearity (±)	0.02	≤±2.0% Range	u _{fit}	0.07
Zero Drift (During Measurement)	0.42	% full scale	u _{odr}	0.25
Span Drift (During Measurement)	0.88	% full scale		
Losses in the Line (Leak)	0.77	<5% of value	u _{leak}	0.01
Sensitivity to Atmospheric Pressure	N/A	N/A	u _{apres}	N/A
Sensitivity to Sample Gas Flow	0.3	<2.0% of the certification range	u _{spres}	0.00
Sensitivity to Ambient Temp @ Span	2.4	<5.0% of the certification range	u _{temp}	0.00
Sensitivity to Ambient Temp @ Zero	2.1	<5.0% of the certification range		0.00
Sensitivity to Electric Voltage	1.00	<0.10% of the certification range	u _{volt}	0.00
Cross Sensitivity @ Reference (Interferents)	-1.82	<4% of the certification range	u _{int}	0.00
Cross Sensitivity @ Zero (Interferents)	-0.48	<4% of the certification range	u _{int}	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m ³)	0.26			
Coverage Factor k	2			
Expanded uncertainty (mg/m ³)	0.51			
Expanded uncertainty to std conditions (mg/m ³)	0.58			
Expanded Uncertainty (% ELV)	N/A			
Expanded uncertainty (mg/m³)	0.58			
Expanded uncertainty (% Value)	21.46			
Requirement in standard is for uncertainty to be < ±20% at ELV at standard conditions				

Uncertainty Budget for Oxides of nitrogen

Document Reference ANC417 Q	Issue No: 9	Page 1 of 1
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Client	WBOC	Date	10/04/2018
Emission Point ID	Main Stack	Reference Number	87308/5

Measured NOx concentration (mg/m³)	201.02	Calibration Value (mg/m³)	209.92
ELV	300	Scale used (mg/m³)	512.50

<u>Performance Characteristic</u>		<u>Specification</u>	<u>Uncertainty</u>	
Response Time (seconds)	33	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	240			
Number of Readings in Measurements	960			
Standard dev Repeat @ Zero	0.03	≤±1.0% Range	u _{r0}	N/A
Standard dev Repeat @ Span	0.06	≤±2.0% Range	u _{rs}	0.00
Deviation from Linearity (±)	0.02	≤±2.0% Range	u _{fit}	0.06
Zero Drift (During Measurement)	0.29	% full scale	u _{odr}	2.00
Span Drift (During Measurement)	3.32	% full scale		
Losses in the Line (Leak)	0.10	<2% of value	u _{leak}	0.11
Sensitivity to Atmospheric Pressure	0.1	<1.5% of the certification range	u _{apres}	0.00
Sensitivity to Sample Gas Flow	0.1	<1.0% of the certification range	u _{spres}	0.00
Sensitivity to Ambient Temp @ Span	1.53	<3.0% of the certification range	u _{temp}	0.00
Sensitivity to Ambient Temp @ Zero	0.04	<3.0% of the certification range		0.00
Sensitivity to Electric Voltage	-0.23	<2.0% of the certification range	u _{volt}	0.00
Cross Sensitivity (Interferents)	0.00	<4% of the certification range	u _{int}	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m ³)	2.01			
Coverage Factor k	2			
Expanded uncertainty (mg/m ³)	4.01			
Expanded uncertainty to std conditions (mg/m ³)	4.53			
Expanded Uncertainty (% ELV)	1.51			
Expanded uncertainty (mg/m³)	4.53			
Expanded uncertainty (% Value)	2.25			
Requirement in standard is for uncertainty to be < ±10% at ELV at standard conditions				

APPENDIX 4

(Sub-contracted laboratory results)

(12 Pages)





Test Certificate

Date 04/05/2018

Client Anchem Laboratories Limited
Unit 5A
D'Arcy Business Park
D'Arcy Way
Llandarcy
Neath
SA10 6EJ

Order No. 2018/093
Certificate No. WK18-2441
Issue No. 1

Contact Philip Ruck

Date Received 16/04/2018

Description 2 samples for dioxins & furans

Technique Subcontract

Table with 4 columns: Sample No., 986056, 87308/1 Sample, Method. Row 1: Dioxins & Furans, See attached ng, Subcontract(N)

Table with 4 columns: Sample No., 986057, 87308/1 Blank, Method. Row 1: Dioxins & Furans, See attached ng, Subcontract(N)

Tested By Subcontract Date 25/04/2018 03/05/2018

Approved By [Signature] Date 04/05/2018
Joanne Dewhurst
Operational Manager

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited
(N) Analysis is not UKAS Accredited

Concentration values (mg/m3 and ppm) are calculated on the basis of information provided by the customer.
Results stated as ml are referring to the sample volume.

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Analysis carried out on samples 'as received'
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UKAS accredited testing laboratory No. 1668

Name of Client : RPS Laboratories Salford
Address : Unit 12 Waters Edge Business Park, Modwen Rd, Salford, M5 3EZ
0

Test Certificate No: 18006456

ANALYSIS OF PCDDs and PCDFs

Job Reference: 0
Sample Identifier : 986057
Sample No: 18006456
Order No: 68264
Sample Type: Stack
Sample Condition : conforming
Instrument : Micromass Ultima NT
GC Column : DB5
Calibration File : 190418

Date of Receipt : 19/04/18
Date of Analysis : 25/04/18
Date of Report : 03/05/18

Test Method : 2002
Blank : 160418
Sample size: 1

expressed as ng /sample

Congener	Conc	TEFs	TEQ ¹	TEQ ²	DL	REC%
2378-TCDD	*	1.000	0.0014	0.0000	0.0014	100
12378-PCDD	*	0.500	0.0008	0.0000	0.0017	66
123478-HxCDD	*	0.100	0.0001	0.0000	0.0015	80
123678-HxCDD	*	0.100	0.0001	0.0000	0.0015	87
123789-HxCDD	*	0.100	0.0002	0.0000	0.0017	
1234678-HpCDD	0.00163	0.010	0.0000	0.0000	0.0016	114
OCDD	0.0127	0.001	0.0000	0.0000	0.0041	137
2378-TCDF	*	0.100	0.0001	0.0000	0.0012	89
12378-PCDF	*	0.050	0.0000	0.0000	0.0010	93
23478-PCDF	*	0.500	0.0005	0.0000	0.0011	80
123478-HxCDF	*	0.100	0.0001	0.0000	0.0007	99
123678-HxCDF	*	0.100	0.0001	0.0000	0.0007	102
234678-HxCDF	*	0.100	0.0001	0.0000	0.0007	100
123789-HxCDF	*	0.100	0.0001	0.0000	0.0011	112
1234678-HpCDF	0.000944	0.010	0.0000	0.0000	0.0008	129
1234789-HpCDF	*	0.010	0.0000	0.0000	0.0013	116
OCDF	*	0.001	0.0000	0.0000	0.0020	163
TEQ (NATO)			0.00373	0.0000385		

* Isomer Not detected
TEQ Toxic Equivalent Value
TEF Toxic Equivalent Factor
Conc Concentration
DL Detection Value
REC Recovery

TEQ¹ Concentration of Non Detected
Congeners at Detection Limit
TEQ² Concentration of Non Detected
Congeners at Zero



1668

Reported by : K Pettit
Position : Technical Manager

Signature : *Karl Pettit*

UKAS accredited testing laboratory No. 1668

Name of Client : RPS Laboratories Salford
Address : Unit 12 Waters Edge Business Park, Modwen Rd, Salford, M5 3EZ
0

Test Certificate No: 18006455

ANALYSIS OF PCDDs and PCDFs

Job Reference: 0
Sample Identifier : 986056
Sample No: 18006455
Order No: 68264
Sample Type: Stack
Sample Condition : conforming
Instrument : Micromass Ultima NT
GC Column : DB5
Calibration File : 190418

Date of Receipt : 19/04/18
Date of Analysis : 25/04/18
Date of Report : 03/05/18

Test Method : 2002
Blank : 160418
Sample size: 1

expressed as ng /sample

Congener	Conc	TEFs	TEQ ¹	TEQ ²	DL	REC%
2378-TCDD	*	1.000	0.0009	0.0000	0.0009	92
12378-PCDD	*	0.500	0.0014	0.0000	0.0027	60
123478-HxCDD	*	0.100	0.0001	0.0000	0.0008	80
123678-HxCDD	*	0.100	0.0001	0.0000	0.0008	83
123789-HxCDD	*	0.100	0.0001	0.0000	0.0009	
1234678-HpCDD	*	0.010	0.0000	0.0000	0.0013	94
OCDD	0.0145	0.001	0.0000	0.0000	0.0043	101
2378-TCDF	*	0.100	0.0001	0.0000	0.0013	81
12378-PCDF	*	0.050	0.0001	0.0000	0.0014	95
23478-PCDF	*	0.500	0.0007	0.0000	0.0015	72
123478-HxCDF	*	0.100	0.0001	0.0000	0.0012	88
123678-HxCDF	*	0.100	0.0001	0.0000	0.0011	87
234678-HxCDF	*	0.100	0.0001	0.0000	0.0011	97
123789-HxCDF	*	0.100	0.0002	0.0000	0.0016	99
1234678-HpCDF	0.00219	0.010	0.0000	0.0000	0.0010	110
1234789-HpCDF	*	0.010	0.0000	0.0000	0.0016	102
OCDF	*	0.001	0.0000	0.0000	0.0029	124
TEQ (NATO)			0.00398	0.0000364		

* Isomer Not detected
TEQ Toxic Equivalent Value
TEF Toxic Equivalent Factor
Conc Concentration
DL Detection Value
REC Recovery

TEQ¹ Concentration of Non Detected
Congeners at Detection Limit
TEQ² Concentration of Non Detected
Congeners at Zero



1668

Reported by : K Pettit
Position : Technical Manager

Signature : *Karl Pettit*



Test Certificate

Date 23/04/2018

Client
Anchem Laboratories Limited
Unit 5A
D'Arcy Business Park
D'Arcy Way
Llandarcy
Neath
SA10 6EJ

Order No. 2018/094
Certificate No. WK18-2432
Issue No. 1

Contact Philip Ruck

Date Received 16/04/2018

Description 15 filters & solutions for metals

Technique ICP Stack

<u>Parameter</u>	<u>Analysis Method</u>	<u>Accreditation</u>	<u>Method LOD</u>	<u>Uncertainty</u>
Antimony	M24	UKAS	3 µg	-
Antimony	M31-BSEN14385	UKAS	F-0.4ug :W-0.2ug :S-0.2ug/l	14.00%
Antimony	M31-BSEN14385	UKAS	F-0.4ug :W-0.2ug :S-0.2ug/l	14.00%
Arsenic	M24	UKAS	2µg	-
Arsenic	M31-BSEN14385	UKAS	F-0.2ug :W-0.3ug :S-0.3ug/l	11.00%
Arsenic	M31-BSEN14385	UKAS	F-0.2ug :W-0.3ug :S-0.3ug/l	11.00%
Cadmium	M24	UKAS	0.5 µg	-
Cadmium	M31-BSEN14385	UKAS	F-0.2ug :W-0.3ug :S-0.2ug/l	15.00%
Cadmium	M31-BSEN14385	UKAS	F-0.2ug :W-0.3ug :S-0.2ug/l	15.00%
Chromium	M24	UKAS	0.6 µg	-
Chromium	M31-BSEN14385	UKAS	F-0.3ug :W-0.3ug :S-0.1ug/l	11.00%
Chromium	M31-BSEN14385	UKAS	F-0.3ug :W-0.3ug :S-0.1ug/l	11.00%
Cobalt	M24	UKAS	0.6 µg	-
Cobalt	M31-BSEN14385	UKAS	F-0.2ug :W-0.3ug :S-0.2ug/l	10.00%
Cobalt	M31-BSEN14385	UKAS	F-0.2ug :W-0.3ug :S-0.2ug/l	10.00%
Copper	M24	UKAS	0.3 µg	-
Copper	M31-BSEN14385	UKAS	F-0.2ug :W-0.4ug :S-0.4ug/l	12.00%
Copper	M31-BSEN14385	UKAS	F-0.2ug :W-0.4ug :S-0.4ug/l	12.00%
Lead	M24	UKAS	0.5 µg	-
Lead	M31-BSEN14385	UKAS	F-0.3ug :W-0.2ug :S-0.2ug/l	13.00%
Manganese	M24	UKAS	0.3 µg	-
Manganese	M31-BSEN14385	UKAS	F-0.2ug :W-0.2ug :S-0.2ug/l	10.00%
Manganese	M31-BSEN14385	UKAS	F-0.2ug :W-0.2ug :S-0.2ug/l	10.00%
Mercury	M112-BSEN13211	UKAS	F-0.03ug SN-0.5ug/l	12.00%
Nickel	M24	UKAS	0.3 µg	-
Nickel	M31-BSEN14385	UKAS	F-0.5ug :W-0.1ug :S-0.2ug/l	10.00%
Nickel	M31-BSEN14385	UKAS	F-0.5ug :W-0.1ug :S-0.2ug/l	10.00%
Thallium	M24	UKAS	0.3 µg	-
Thallium	M31-BSEN14385	UKAS	F-0.2ug :W-0.2ug :S-0.2ug/l	14.00%
Thallium	M31-BSEN14385	UKAS	F-0.2ug :W-0.2ug :S-0.2ug/l	14.00%
Vanadium	M24	UKAS	0.3 µg	-

Vanadium	M31-BSEN14385	UKAS	F-0.2ug :W-0.2ug :S-0.1ug/l	10.00%
Vanadium	M31-BSEN14385	UKAS	F-0.2ug :W-0.2ug :S-0.1ug/l	10.00%



Test Certificate

Date 23/04/2018

Client **Anchem Laboratories Limited** Certificate No. **WK18-2432**
Issue No. **1**

Sample No.	986041	87308/2 Blank Filter	Method
Antimony	<0.4 µg		M24(U)
Arsenic	<0.2 µg		M24(U)
Cadmium	<0.2 µg		M24(U)
Chromium	0.5 µg		M24(U)
Cobalt	<0.2 µg		M24(U)
Copper	<0.2 µg		M24(U)
Lead	<0.3 µg		M24(U)
Manganese	0.3 µg		M24(U)
Nickel	<0.5 µg		M24(U)
Thallium	<0.2 µg		M24(U)
Vanadium	<0.2 µg		M24(U)
Mercury	<0.03 µg		M112-BSEN13211(U)

Sample No.	986042	87308/2 Rinsing Acid Blank	Method
Antimony	<0.2 ug/l	204 mls	M31-BSEN14385(U)
Arsenic	<0.3 ug/l		M31-BSEN14385(U)
Cadmium	<0.2 ug/l		M31-BSEN14385(U)
Chromium	0.2 ug/l		M31-BSEN14385(U)
Cobalt	<0.2 ug/l		M31-BSEN14385(U)
Copper	<0.4 ug/l		M31-BSEN14385(U)
Lead	<0.2 ug/l		M31-BSEN14385(U)
Manganese	<0.2 ug/l		M31-BSEN14385(U)
Nickel	<0.2 ug/l		M31-BSEN14385(U)
Thallium	0.3 ug/l		M31-BSEN14385(U)
Vanadium	<0.1 ug/l		M31-BSEN14385(U)
Mercury	<0.5 µg/l		M112-BSEN13211(U)



Test Certificate

Date 23/04/2018

Client Anchem Laboratories Limited

Certificate No. WK18-2432

Issue No. 1

Sample No.	986043	87308/2 Blank Absorbing Solution	Method
Antimony	<0.2 ug/l	375 mls	M31-BSEN14385(U)
Arsenic	<0.3 ug/l		M31-BSEN14385(U)
Cadmium	<0.2 ug/l		M31-BSEN14385(U)
Chromium	9 ug/l		M31-BSEN14385(U)
Cobalt	<0.2 ug/l		M31-BSEN14385(U)
Copper	0.8 ug/l		M31-BSEN14385(U)
Lead	<0.2 ug/l		M31-BSEN14385(U)
Manganese	0.5 ug/l		M31-BSEN14385(U)
Nickel	2 ug/l		M31-BSEN14385(U)
Thallium	<0.2 ug/l		M31-BSEN14385(U)
Vanadium	<0.2 ug/l		M31-BSEN14385(U)
Mercury	<0.5 µg/l		M112-BSEN13211(U)

Sample No.	986044	87308/2 Blank Permanganate Absorbing Solution	Method
Mercury	<0.5 µg/l	210 ml	M112-BSEN13211(U)

Sample No.	986045	87308/2 Filter	Method
Antimony	<0.4 µg		M24(U)
Arsenic	<0.2 µg		M24(U)
Cadmium	<0.2 µg		M24(U)
Chromium	2 µg		M24(U)
Cobalt	0.3 µg		M24(U)
Copper	0.4 µg		M24(U)
Lead	3 µg		M24(U)
Manganese	8 µg		M24(U)
Nickel	2 µg		M24(U)
Thallium	<0.2 µg		M24(U)
Vanadium	<0.2 µg		M24(U)
Mercury	<0.03 µg		M112-BSEN13211(U)



Test Certificate

Date 23/04/2018

Client Anchem Laboratories Limited

Certificate No. WK18-2432

Issue No. 1

Sample No.	986046	87308/2 Probe & Nozzle Rinse	Method
Antimony	0.3 ug		M31-BSEN14385(U)
Arsenic	3 ug		M31-BSEN14385(U)
Cadmium	<0.3 ug		M31-BSEN14385(U)
Chromium	7 ug		M31-BSEN14385(U)
Cobalt	<0.3 ug		M31-BSEN14385(U)
Copper	0.9 ug		M31-BSEN14385(U)
Lead	12 ug		M31-BSEN14385(U)
Manganese	4 ug		M31-BSEN14385(U)
Nickel	4 ug		M31-BSEN14385(U)
Thallium	<0.2 ug		M31-BSEN14385(U)
Vanadium	<0.2 ug		M31-BSEN14385(U)
Mercury	<0.03 µg		M112-BSEN13211(U)

Sample No.	986047	87308/2 Blank Probe & Nozzle Rinse	Method
Antimony	<0.2 ug		M31-BSEN14385(U)
Arsenic	<0.3 ug		M31-BSEN14385(U)
Cadmium	<0.3 ug		M31-BSEN14385(U)
Chromium	0.4 ug		M31-BSEN14385(U)
Cobalt	<0.3 ug		M31-BSEN14385(U)
Copper	<0.4 ug		M31-BSEN14385(U)
Lead	2 ug		M31-BSEN14385(U)
Manganese	<0.2 ug		M31-BSEN14385(U)
Nickel	0.4 ug		M31-BSEN14385(U)
Thallium	<0.2 ug		M31-BSEN14385(U)
Vanadium	<0.2 ug		M31-BSEN14385(U)
Mercury	<0.03 µg		M112-BSEN13211(U)



Test Certificate

Date 23/04/2018

Client Anchem Laboratories Limited

Certificate No. WK18-2432

Issue No. 1

Sample No.	986048	87308/2 Impinger 1 & 2	Method
Antimony	<0.2 ug/l	530 mls	M31-BSEN14385(U)
Arsenic	<0.3 ug/l		M31-BSEN14385(U)
Cadmium	<0.2 ug/l		M31-BSEN14385(U)
Chromium	6 ug/l		M31-BSEN14385(U)
Cobalt	0.5 ug/l		M31-BSEN14385(U)
Copper	4 ug/l		M31-BSEN14385(U)
Lead	13 ug/l		M31-BSEN14385(U)
Manganese	2 ug/l		M31-BSEN14385(U)
Nickel	34 ug/l		M31-BSEN14385(U)
Thallium	<0.2 ug/l		M31-BSEN14385(U)
Vanadium	<0.1 ug/l		M31-BSEN14385(U)
Mercury	<0.5 µg/l		M112-BSEN13211(U)

Sample No.	986049	87308/2 Impinger 1 & 2 Blank	Method
Antimony	<0.2 ug/l	500 mls	M31-BSEN14385(U)
Arsenic	<0.3 ug/l		M31-BSEN14385(U)
Cadmium	<0.2 ug/l		M31-BSEN14385(U)
Chromium	1 ug/l		M31-BSEN14385(U)
Cobalt	<0.2 ug/l		M31-BSEN14385(U)
Copper	<0.4 ug/l		M31-BSEN14385(U)
Lead	<0.2 ug/l		M31-BSEN14385(U)
Manganese	<0.2 ug/l		M31-BSEN14385(U)
Nickel	0.9 ug/l		M31-BSEN14385(U)
Thallium	<0.2 ug/l		M31-BSEN14385(U)
Vanadium	<0.1 ug/l		M31-BSEN14385(U)
Mercury	<0.5 µg/l		M112-BSEN13211(U)



Test Certificate

Date 23/04/2018

Client Anchem Laboratories Limited

Certificate No. WK18-2432

Issue No. 1

Sample No.	986050	87308/2 Impinger 3	Method
Antimony	<0.2 ug/l	290 mls	M31-BSEN14385(U)
Arsenic	<0.3 ug/l		M31-BSEN14385(U)
Cadmium	<0.2 ug/l		M31-BSEN14385(U)
Chromium	2 ug/l		M31-BSEN14385(U)
Cobalt	<0.2 ug/l		M31-BSEN14385(U)
Copper	0.4 ug/l		M31-BSEN14385(U)
Lead	<0.2 ug/l		M31-BSEN14385(U)
Manganese	0.3 ug/l		M31-BSEN14385(U)
Nickel	1 ug/l		M31-BSEN14385(U)
Thallium	<0.2 ug/l		M31-BSEN14385(U)
Vanadium	<0.1 ug/l		M31-BSEN14385(U)
Mercury	<0.5 µg/l		M112-BSEN13211(U)

Sample No.	986051	87308/2 Impinger 3 Blank	Method
Antimony	<0.2 ug/l	285 mls	M31-BSEN14385(U)
Arsenic	<0.3 ug/l		M31-BSEN14385(U)
Cadmium	<0.2 ug/l		M31-BSEN14385(U)
Chromium	2 ug/l		M31-BSEN14385(U)
Cobalt	<0.2 ug/l		M31-BSEN14385(U)
Copper	0.4 ug/l		M31-BSEN14385(U)
Lead	<0.2 ug/l		M31-BSEN14385(U)
Manganese	0.3 ug/l		M31-BSEN14385(U)
Nickel	1 ug/l		M31-BSEN14385(U)
Thallium	<0.2 ug/l		M31-BSEN14385(U)
Vanadium	<0.1 ug/l		M31-BSEN14385(U)
Mercury	<0.5 µg/l		M112-BSEN13211(U)

Sample No.	986052	87308/2 Impinger 5	Method
Mercury	0.8 µg/l	216 ml	M112-BSEN13211(U)

Sample No.	986053	87308/2 Impinger 5 Blank	Method
Mercury	<0.5 µg/l	216 ml	M112-BSEN13211(U)

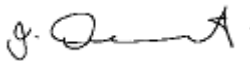


Test Certificate

Date 23/04/2018

Client	Anchem Laboratories Limited		Certificate No.	WK18-2432
			Issue No.	1
Sample No.	986054	87308/2 Impinger 6	Method	
Mercury	<0.5 µg/l	228 ml	M112-BSEN13211(U)	
Sample No.	986055	87308/2 Impinger 6 Blank	Method	
Mercury	<0.5 µg/l	222 ml	M112-BSEN13211(U)	

Tested By Calum Green Date 18/04/2018
Aimee Mollitt Date 23/04/2018

Approved By  Date 23/04/2018

Joanne Dewhurst
Operational Manager

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited
(N) Analysis is not UKAS Accredited

Concentration values (mg/m³ and ppm) are calculated on the basis of information provided by the customer.
Results stated as ml are referring to the sample volume.

Analysis carried out on samples 'as received'

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Test Certificate

Date 20/04/2018

Client Anchem Laboratories Limited
Unit 5A
D'Arcy Business Park
D'Arcy Way
Llandarcy
Neath
SA10 6EJ

Order No. 2018/092
Certificate No. WK18-2440
Issue No. 1

Contact Philip Ruck

Date Received 16/04/2018

Description 5 solutions for HCl

Technique IC Stack

Sample No.	986036	87308/4 Impinger 1 & 2 Solution	Method
Hydrochloric acid	0.66 µg/ml	558 ml	C27(U)
Sample No.	986037	87308/4 Impinger 1 & 2 Blank Solution	Method
Hydrochloric acid	<0.05 µg/ml	514 ml	C27(U)
Sample No.	986038	87308/4 Impinger 3 Solution	Method
Hydrochloric acid	<0.05 µg/ml	240 ml	C27(U)
Sample No.	986039	87308/4 Impinger 3 Blank Solution	Method
Hydrochloric acid	<0.05 µg/ml	277 ml	C27(U)
Sample No.	986040	87308/4 Absorbing Solution Blank	Method
Hydrochloric acid	<0.05 µg/ml	472 ml	C27(U)




Test Certificate

Date 20/04/2018

Client	Anchem Laboratories Limited	Certificate No.	WK18-2440
		Issue No.	1

Tested By	Adam Oseland	Date	18/04/2018
	Lora McKerracher		20/04/2018

Approved By		Date	20/04/2018
	Joanne Dewhurst Operational Manager		

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited
 (N) Analysis is not UKAS Accredited

Concentration values (mg/m³ and ppm) are calculated on the basis of information provided by the customer.
Results stated as ml are referring to the sample volume.

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Analysis carried out on samples 'as received'

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APPENDIX 5

(Instrumental analyser details)

(2 Pages)



Principle of Gas Conditioning

The sampling for oxygen, oxides of nitrogen, sulphur dioxide and carbon monoxide was carried out using a Horiba PG-350 combustion gas analyser fed via a heated sampling system comprising of a sampling probe, 20m sampling line (set at 120°C) and a PD100 permeation dryer gas conditioning system.

The sample gas enters a heated filter (approx. 100°C), separating all particles larger than 2µm. After filtration the sample gas proceeds to the permeation dryer, equipped with a temperature gradient. The installed permeation dryer is operated with dry purge gas, running in inverted direction flow. Due to the difference in partial pressure between sample and purge gas, humidity is driven out of the sample by equalization. The water is extracted from the sample gas through a semi permeable membrane and transported into an outer tube filled with the purge gas. This process does not have a distinguishable effect on the sample gas composition. The conditioned gas is then passed to the gas analyser for quantification.

Oxides of nitrogen are analysed using a standard technique called Chemiluminescence and during the sampling was set to cover the range 0-250 ppm.

Sulphur dioxide is analysed using a standard technique called Non-dispersive infra-red spectroscopy (N.D.I.R.) and was set to cover the range 0-200 ppm.

Carbon monoxide is analysed using a standard technique called Non-dispersive infra-red spectroscopy (N.D.I.R.) and was set to cover the range 0-200 ppm



Laboratory Analysis Report No. ALL54208/18/PR

Performance Characteristic	Minimum performance characteristic			
	NO _x	CO	O ₂	SO ₂
Response Time (Required)	≤200 s	≤200 s	≤200 s	≤200 s
Results	<40	<40	<30	<60
Detection Limit	± 2% Range	± 2% Range	± 0.2% relative of Range	± 2%
Results	<0.1	<0.2	<0.05	<0.15
Lack of Fit (Linearity)	± 2% Range	± 2% Range	± 0.3% volume	± 2%
Results	<2 (R ² >0.9997)	<2 (R ² >0.9999)	<2 (R ² >0.9999)	<2 (R ² >0.9996)
Zero Drift	± 2% Range/24 hours	± 2% Range/24 hours	± 0.2% Volume/24 hours	± 2%/24 hours
Results	0.03%	0.10%	0.06%	0.20%
Span Drift	± 2% Range/24 hours	± 2% Range/24 hours	± 0.2% Volume/24 hours	± 2%/24 hours
Results	0.53%	0.02%	0.16%	0.16%
Sensitivity to Atmos Pressure	± 3% Range/2 kPa	± 3% Range/2 kPa	± 3% of Range for 2 kPa	± 3%/2 kPa
Results	± 3% Range/2 kPa	± 3% Range/2 kPa	± 3% of Range for 2 kPa	± 3%/2 kPa
Sensitivity to Sample Volume/pressure	-	-	-	± 1%
Results	-	-	-	± 1%
Sensitivity to ambient temperature	± 3% Range/10 K	± 3% Range/10 K	± 0.3% Volume/10 K	± 3% Range/10 K
Results	± 3% Range/10 K	± 3% Range/10 K	± 0.3% Volume/10 K	± 3% Range/10 K
Sensitivity to Electric Voltage	± 2% Range/10 V	± 2% Range/10 V	± 0.1% Volume/10 V	± 2% Range/10 V
Results	± 2% Range/10 V	± 2% Range/10 V	± 0.1% Volume/10 V	± 2% Range/10 V
Interferents	Total ± 4% Range	Total ± 4% Range	Total ± 0.2% Volume	Total ± 4%
Results	-0.52%	-0.87%	0%	-1.82%
Converter Efficiency	≥95.0%			
Results	96.70%			
Losses & Leakage in Sampling Line and Conditioning System	± 2% of measured value	± 2% of measured value	± 2.0% relative of the measured value	± 5%
Results	<2%	<2%	<2%	<5%
Std Deviation of repeatability in Lab at zero	± 1% Range	± 1% Range	± 0.20% relative of the range	± 1%
Results	0.03%	0.21%	0.11%	0.16%
Std Deviation of repeatability in Lab at span level	± 2% Range	± 2% Range	± 0.40% relative of the range	± 2%
Results	0.06%	0.13%	0.08%	0.16%



APPENDIX 6

(Annual calibration details & analysis data retained at permanent laboratory)

