2499

EMISSIONS MONITORING SURVEY

Prepared for:

Western Bio-Energy Ltd
Longlands Lane
Margam
Port Talbot
SA13 2NR

Permit Number	**: EPR/ZP3939GL**
Variation Number	**: V005**
Installation	**: Biomass Plant**
Visit Details	**: Compliance – January 2023**
Job Number	**: P5200**
Report Number	**: R003**
Report Issue Date	**: 16th February 2023**
Survey Dates	**: 5th – 9th January 2023**

Prepared by:

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Report Issue:		**FINAL**	
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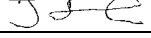
		Signature:	
Date:	8th February 2023	***Date:***	16th February 2023

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MCERTS requirements mean that comparison of results with emissions limit values is not permitted within this report.

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PART 1 - EXECUTIVE SUMMARY

1 Monitoring Objectives

Environmental Compliance Ltd (ECL) was commissioned by **Western Bio-Energy Ltd** to undertake an emission monitoring survey at their **Margam, Port Talbot** facility. This report presents the findings of the study.

The monitoring at this installation was carried out in accordance with our quotation reference **DHFB/P5200/Q001,** for compliance check monitoring of emissions to air. The substances requested for monitoring at each emissions point are listed below:

Substances to be monitored	Emission Point Identification
	Biomass Plant (Main Stack)
Particulates	• U
Velocity / Flowrate	• U
Oxides of Nitrogen (as NO_2)	• U
Sulphur Dioxide	• U
Carbon Monoxide	• U
Oxygen	• U
Total Organic Carbon (TVOC)	• U
Hydrogen Chloride	• U
Hydrogen Fluoride	• U
Dioxins / Furans	• U
Heavy Metals (Cd, Tl, Sb, As, Pb, Cr, Co, Cu, Mn, Ni & V)	• U
Mercury	• U
Nitrous Oxide (N_2O)	• U
Ammonia	• U

• Denotes the substances to be monitored.

U **Denotes UKAS accreditation is held for monitoring that substance, but does not mean that it has been claimed which will depend on whether the testing could be completed in accordance with the Standard Reference Method.**

Special Requirements: *During Normal Operation."*

1.1 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Units	Uncertainty %	Reference Conditions 273 K, 101.3 kPa	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation Claimed For Test Result	Tick if non-conforming test (see Section 2	Operating Status
Biomass Plant (Main Stack)	Volumetric Flowrate	…	48.84675	m^3/sec	4	Stack Conditions	05/01/2023	09:32 – 10:09	BS EN 16911-1:2013 & MID	UKAS / MCERTS		Normal
	Volumetric Flowrate	…	23.61437	m^3/sec	7	Dry & 6% O2	05/01/2023	09:32 – 10:09	BS EN 16911-1:2013 & MID	UKAS / MCERTS		Normal
	Particulates $	15	1.14	mg/m^3	46	Dry & 6% O2	05/01/2023	11:50 – 12:52	BS EN 13284-1:2017 & MID	UKAS / MCERTS		Normal
	Hydrogen Chloride $	…	24.02	mg/m^3	14	Dry & 6% O2	05/01/2023	11:50 – 12:52	BS EN 1911:2010	UKAS / MCERTS		Normal
	Hydrogen Fluoride $	…	0.05	mg/m^3	14	Dry & 6% O2	05/01/2023	11:50 – 12:52	PD CEN/TS 17340:2020	UKAS / MCERTS		Normal
	Ammonia $	10	8.06	mg/m^3	14	Dry & 6% O2	05/01/2023	13:30 – 14:30	BS EN ISO 21877:2019	UKAS / MCERTS		Normal
	Sulphur Dioxide $	…	20.06	mg/m^3	14	Dry & 6% O2	06/01/2023	08:30 – 12:30	BS EN 14791:2017	UKAS / MCERTS		Normal
	PCDDs & PCDFs $	…	0.0025	ng/m^3	13	Dry & 6% O2	09/01/2023	10:35 – 16:40	BS EN 1948-1:2006 & MID	UKAS / MCERTS		Normal
	Heavy Metals* $	…	0.099	mg/m^3	3	Dry & 6% O2	05/01/2023	15:00 – 16:02	BS EN 14385:2004 & MID	UKAS / MCERTS		Normal
	Cadmium / Thallium $	…	0.0013	mg/m^3	5	Dry & 6% O2	05/01/2023	15:00 – 16:02	BS EN 14385:2004 & MID	UKAS / MCERTS		Normal
	Mercury $	…	0.00044	mg/m^3	10	Dry & 6% O2	06/01/2023	13:10 – 14:12	BS EN 13211:2001	UKAS / MCERTS		Normal
	TVOC as Carbon	…	2.72	mgC/m^3	3	Dry & 6% O2	05/01/2023	13:00 – 14:00	BS EN 12619:2013	UKAS / MCERTS		Normal
	Oxides of Nitrogen (as NO_2)	300	178.73	mg/m^3	2	Dry & 6% O2	05/01/2023	14:00 – 15:00	BS EN 14792: 2017	UKAS / MCERTS		Normal
	Carbon Monoxide	250	119.10	mg/m^3	2	Dry & 6% O2	05/01/2023	14:00 – 15:00	BS EN 15058: 2017	UKAS / MCERTS		Normal
	Oxygen (Paramagnetic)	…	6.81	%	2	& Dry Gas	05/01/2023	14:00 – 15:00	BS EN 14789: 2017	UKAS / MCERTS		Normal
	Nitrous Oxide (N_2O)	…	0.53	mg/m^3	9	Dry & 6% O2	09/01/2023	14:00 – 15:00	PD CEN/TS 17337:2019	UKAS / MCERTS		Normal
	Oxygen (Zirconia Cell)	…	8.16	%	2	& Dry Gas	09/01/2023	14:00 – 15:00	BS EN 14789: 2017	UKAS / MCERTS		Normal

The volumetric flowrate shown above is that from the initial pitot traverse.
Any other flow measurements made during isokinetic sampling and/ or repeat traverses are shown later in the tables section.

(* Sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni & V)

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – January 2023**
Variation No	**: V005**	**Survey Dates**	**: 5th – 9th January 2023**
Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

Notes

The uncertainty figures presented in Table 1.1 for NO_x, CO, O_2 , N_2O & TVOC are "measurement uncertainty" figures, which do not take into account the variability of the measured sample values. The "uncertainty of measurement results" figures, which do include this contribution, are presented in the appendices of the report for these determinands.

Emission Limit Value	The emission limit value is that stated in the permit and will be expressed as a concentration or a mass emission.
Periodic Monitoring Result	The result given is expressed in the same terms and units as the emission limit value.
Uncertainty	The uncertainty associated with the quoted result is at the 95% confidence interval. The Uncertainty results **DO NOT** take into account the effect of the sample location limitations.
Reference Conditions	All results are expressed at 273 K and 101.3kPa. The oxygen and moisture corrections are stated.
Monitoring Method Reference	The method stated is in accordance with the Environment Agency Technical Guidance Note M2, or other method approved by the Environment Agency.
Accreditation for use of Method	**The details indicate the accreditation for the use of the complete monitoring method, e.g. MCERTs, UKAS. If use of the method is not accredited " NA" is stated.**
Operating Status	The details indicate the feedstock and the loading rate of the plant during monitoring.
$	Chemical Analysis on sample reagents was performed by an External Laboratory as detailed in Section 4
NU	UKAS Accreditation Held but UKAS Accreditation cannot be claimed for the test as sampling did not comply with the Standard Reference Method (SRM), see section 2 & 5
NA	**Method is NOT UKAS Accredited.**

1.2 Operating Information

Any operating information and CEMS data below has been supplied by the client.

Emission Point Reference	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results					
							Parameter	Date	Time	CEMS Results	Periodic Monitoring Results	Units
Biomass Plant	Continuous	Continuous	Wood Chip & Natural Gas	…	Bag Filters	Normal	…	…	…	NP	…	…

Notes:

Process Type	State whether the process is a continuous or batch process.
Process Duration	If a batch process, state the duration, frequency and details of the portion of the batch sampled. If continuous state "NA"
Fuel	If applicable, state the fuel type If not applicable state "NA"
Feedstock	State the feedstock type
Abatement	State the type and whether operational during monitoring. If not applicable state "NA"
Load	State the normal load, throughput or rating of the plant
CEMS Data	Enter this data for each CEM installed if it is has been provided by operator otherwise state “NP” (NOT PROVIDED)

2 Monitoring Deviations

The objective of the survey was to measure the concentrations of pollutants from the processes / locations as detailed in Section 1. This survey meets the requirements of the site's **PPC Permit Number: EPR/ZP3939GL** where UKAS and MCERTS accreditation has and could be claimed for the testing in the monitoring results table.

There were modifications to the sampling procedures (TPDs) listed in section 4, these are as follows:

The concentration of the span check gas used for FTIR sampling of N_2O has not been verified by analysis accredited to ISO 17025 with uncertainty <2%. Such analysis is not currently available. A gravimetrically prepared mixture was used instead. This deviation from the procedure has been sanctioned by the Environment Agency, until 17025 accredited gas does become available.

Due to high duct gas velocity, in order to maintain isokinetic sampling, it was necessary to use a nozzle with diameter smaller than the recommended minimum of 8mm minimum stated in BS EN 13284-1:2017. Note that there is no absolute minimum nozzle size stated in the standard, as long as the uncertainty of the nozzle area is <5%. **So this does not need to be described as a non-conforming test.**

There were substance deviations from the original and agreed emissions monitoring schedule. These are as follows:

At the request of the client, Hydrogen Fluoride was added to the scope of the sampling requirements for the visit.

There were non-conforming tests, as follows.

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of non-conformities or sample location limitations.

The following tests appeared to fail efficiency checks (>5% in final impinger): **Hydrogen Fluoride & Thallium.** For **Hydrogen Fluoride & Thallium**, the concentration in the final impinger was very low (at or below the analytical LOD / blank value, so the efficiency check is not required).

Homogeneity tests have not been completed for pollutants at the following locations: **Biomass Plant (Main Stack):** Such tests were not requested by the client.

PART 2 – SUPPORTING INFORMATION

3 SAMPLING STAFF DETAILS

Site Sampling Team

Names of Site Team	Dates on Site	MCERTS No.	LEVEL	Technical Endorsements
David Boles	5th & 9th January 2023	MM 03 215	2	TE1, TE2, TE4
Peter Brockway	5th & 6th January 2023	MM 17 1459	2	TE1, TE2, TE3, TE4
Llion Preskett Hughes	5th, 6th & 9th January 2023	MM 22 1689	Trainee	…

Report Reviewer

Name	MCERTS No.	LEVEL	Technical Endorsements
Andy Barnes	MM 03 235	2	TE1, TE2, TE3, TE4

Technical Endorsement Key:-

TE1 – **Isokinetic** Particulates, Temperature & Velocity Profiles, Oxygen.
TE2 – **Isokinetic** Extractive Pollutants:- Metals, Dioxin & Furans, PAHs, PCBs, HCl, HF.
TE3 – **Non-Isokinetic** Extractive Pollutants:- Speciated VOCs, HF, HCl, Cyanide.
TE4 – **Continuous Analysers** (Combustion Gases):- TVOC, CO, NOx, SO2.

4 SAMPLING PROTOCOLS / METHODOLOGIES

Details of the substances monitored, the standard methods used and the Environmental Compliance Limited Technical Procedures used during this survey are shown in the table below. Detailed sampling protocols are included in a separate document which will be sent with the report.

In all cases, where analysis of collected samples was required, the analysis was by a subcontract laboratory. Details of the sub-contract laboratory are shown on the analysis certificates in this report. The UKAS/MCERTs accreditation status of the analysis is also indicated on the certificates.

Any required modifications to the Technical Procedure Documents (TPDs) specified below will be detailed in section 2 of this report.

Determinand	External Reference Method	ECL Technical Procedure Number
Velocity and Flowrate	BS EN 16911-1:2013 & MID	ECL/ TPD/ 022A
Particulates (MST)	BS EN 13284-1:2017 & MID	ECL / TPD / 027
Metals (without mercury)	BS EN 14385:2004 & MID	ECL / TPD / 028
Mercury (without other metals)	BS EN 13211:2001	ECL / TPD / 030
PCDDs & PCDFs	BS EN 1948-1 to 3:2006 & MID	ECL / TPD / 031
TVOC (Signal 3030PM)	BS EN 12619: 2013	ECL / TPD / 032A
Oxygen (PG350 E)	BS EN 14789: 2017	ECL / TPD / 033D
Carbon Monoxide (PG350 E)	BS EN 15058: 2017	ECL / TPD / 033D
Oxides of Nitrogen (PG350 E)	BS EN 14792: 2017	ECL / TPD / 033D
Ammonia	BS EN ISO 21877:2019	ECL / TPD / 034
Sulphur Dioxide	BS EN 14791:2017	ECL / TPD / 039
Hydrogen Chloride.	BS EN 1911:2010	ECL / TPD / 081
Hydrogen Fluoride	PD CEN/TS 17340:2020	ECL / TPD / 081
Moisture	BS EN 14790: 2017	ECL / TPD / 082
Nitrous Oxide (N_2O) (FTIR 204M)	PD CEN/TS 17337:2019	ECL / TPD / 097
Oxygen (Protea 204M)	BS EN 14789: 2017	ECL / TPD / 097

5 SAMPLE POINT DESCRIPTIONS

The homogeneity test is applicable to combustion processes, but may also be requested by the regulator for non-combustion processes.

Homogeneity testing has not been completed at this location.

The test is not usually required for stacks with sampling plane areas of <1m^2 (below 1.13m in diameter for circular ducts).

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of non-conformities or sample location limitations.

The sample location that was monitored is detailed below:

Biomass Plant – Main Stack

The stack diameter is 1.60m and the sample platform width back from the sample ports is 3.0m.

Two sample ports are located on the stack at 90 degrees to each other and are located on the same plane.

These sample ports are located at a height of approximately 0.7m from the working sample platform.

Sampling for Particulates was carried out using an out-of-stack filter system.

Access to the sample platform was attained by means of hooped ladder accessed on the outside of the chimney.

EQUIPMENT IDs
(Pre site checklist from SSP)

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

(Completed before departure to site and when on site in full)

Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001	U010							
MST Nozzle set		335							
MST "S" Type Pitot		668							
MST Probe		149							
MST Hot Box		192							
MST Impinger Arm		337							
Barometer		352							
Site Balance		1222							
Site Check weights		1223							
		1224							
Horiba	E002	969							
Heated Probe / Filter		1191							
Chiller		1192							
MFC									
Heated Line		1186	1187						
FID	E003	211							
Heated Line		1090	1091						
Heated Probe / Filter		922							
Testo	E004								
FTIR	E005	566							
Heated Probe / Filter		1191							
Heated Line		1186	1187						
Stackmite	E006								
"L" Type Pitot									
Digital Manometer									
Stack Thermocouple		461							
Thermocouple Reader									
Nozzle Set									
Workhorse Pumps	E007								
Stack Thermocouple									
Tube Thermocouple									
Meter Thermocouple									
High Vac Gauge									
Dioxin Thermocouple		789							

Quantity of Ice Required / Used for Survey	18	Bags (2kg bags)

FIGURES

Figure 1 – TVOC

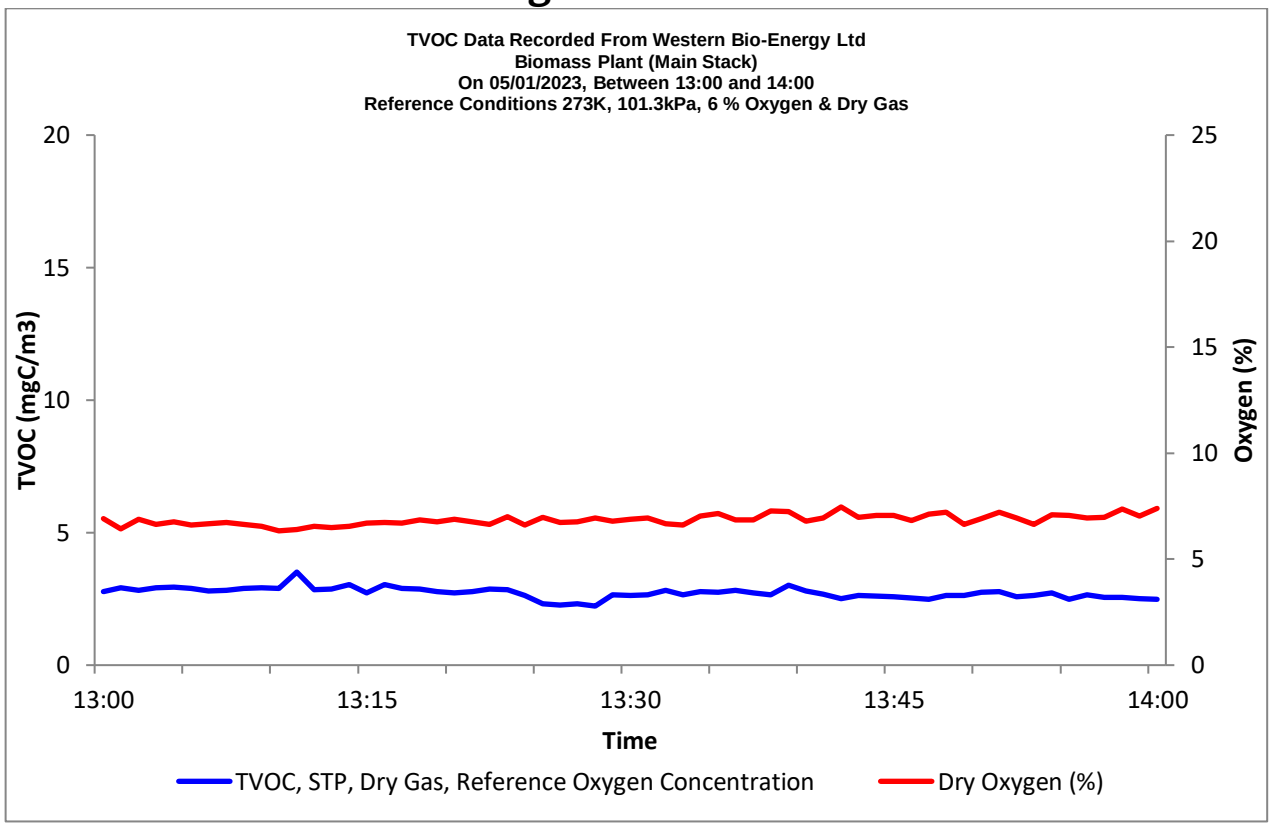


Figure 2 – NOx & CO

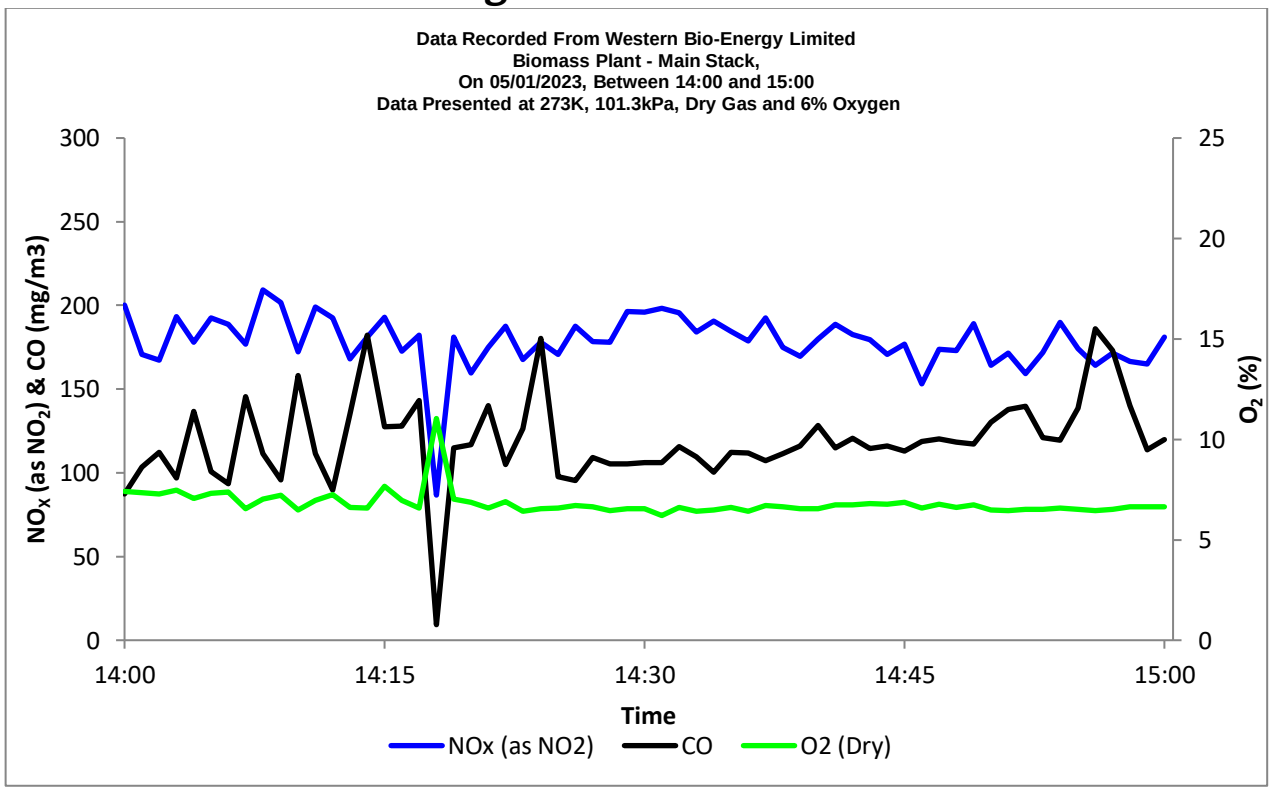
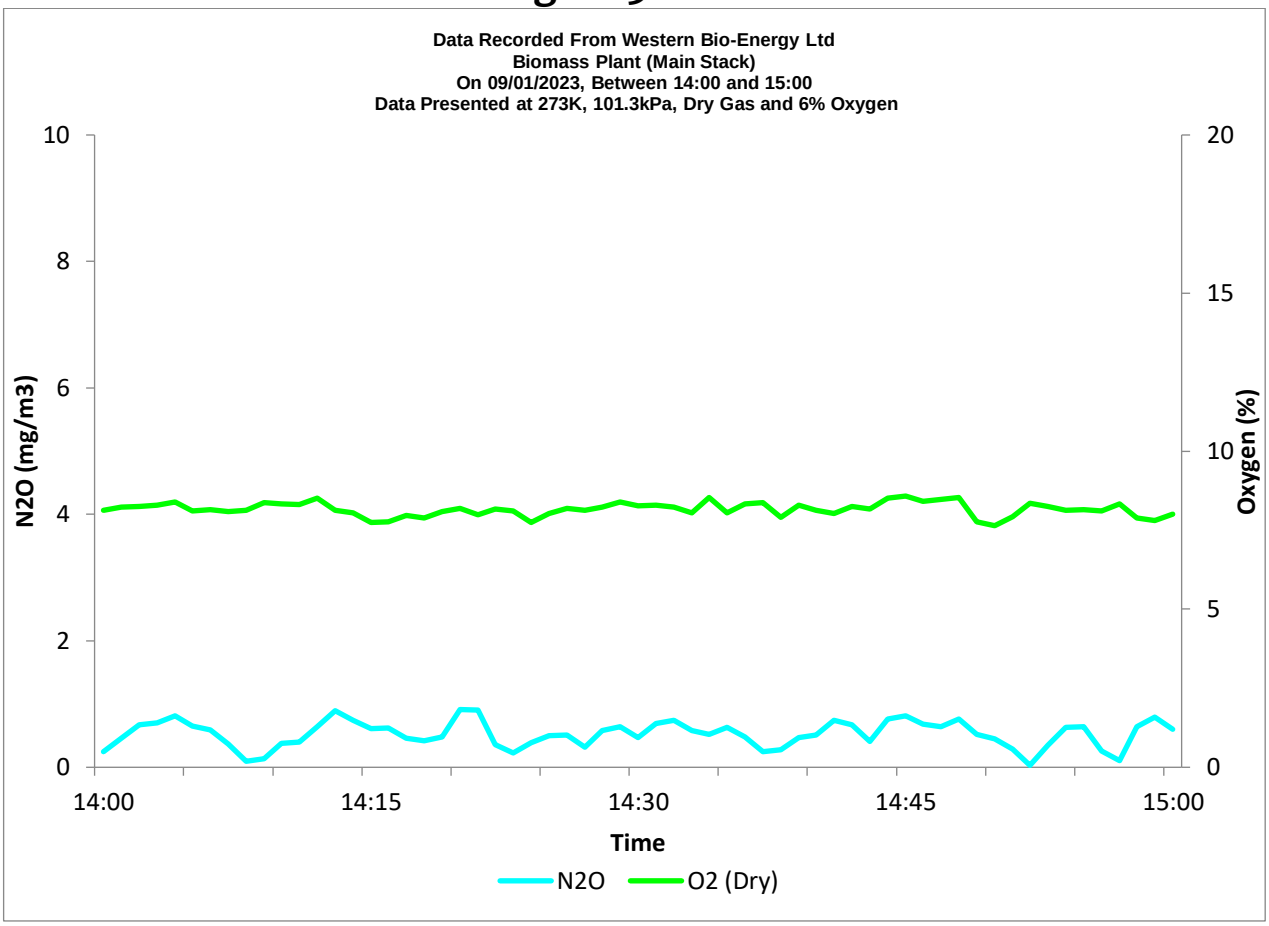


Figure 3 – N2O


Data Recorded From Western Bio-Energy Ltd
Biomass Plant (Main Stack)
On 09/01/2023, Between 14:00 and 15:00
Data Presented at 273K, 101.3kPa, Dry Gas and 6% Oxygen
N2O (mg/m3)
Oxygen (%)
0
2
4
6
8
10
0
5
10
15
20
14:00
14:15
14:30
14:45
15:00
Time
N2O
O2 (Dry)

TABLES

Table 1 – TVOC

Data Recorded from Biomass Plant (Main Stack)
Sample Period: 13:00 – 14:00 on the 5th January 2023
Volumetric Flowrate (Reference Conditions) = 23.61437 m³/sec *

	Average	Emission Rate
	mg/m³	Kg/hr
TVOC (as carbon)*	2.72	0.2312

*** Reference Conditions (273K, 101.3 kPa, 6% Oxygen & Dry Gas)**

Table 2 – Nitrous Oxide

Data Recorded from Biomass Plant (Main Stack)
Sample Period: 14:00 – 15:00 on the 9th January 2023
Volumetric Flowrate (Reference Conditions) = 23.61437 m³/sec *

	Average	Emission Rate
	mg/m³	Kg/hr
Nitrous Oxide (N_2O)	0.53	0.0451

*** Reference Conditions (273K, 101.3 kPa, 6% Oxygen & Dry Gas)**

Table 3– Combustion Gases

Data Recorded from Biomass Plant (Main Stack)
Sample Period: 14:00 – 15:00 on the 5th January 2023
Volumetric Flowrate (Reference Conditions) = 23.61437 m³/sec *

	Average	Emission Rate
	mg/m³	Kg/hr
Oxides of Nitrogen (as NO2) *	178.73	15.1941
Carbon Monoxide *	119.10	10.1249
Oxygen (%)	6.81	…

*** Reference Conditions (273K, 101.3 kPa, 6% Oxygen & Dry Gas)**

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
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Table 4 – Particulates & Hydrogen Chloride & Fluoride

Data Recorded from Main Stack - Biomass Plant

Emission Parameter	Units	TPM, HCl & HF	Blank
Stack Diameter	metres	1.60	…
Area of Sample Plane	m^2	2.011	…
Moisture Content	%	23.01	…
Oxygen Content	%	6.78	…
Stack Temperature	^oC	141	…
Gas Velocity (as Measured. Adjusted for Smooth Walls)	m/sec	23.9286	…
Gas Velocity (Reference Conditions)	m/sec*	11.5894	…
Volumetric Flowrate (as Measured)	m^3/sec	48.1114	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	23.3018	…
Dry Gas Molecular Weight	g/gmole	30.4393	
Sample Date	…	05/01/2023	…
Sample Period	…	11:50 - 12:52	…
Sample Volume (reference Conditions)	m^3*	0.980	0.980
Isokinetic Sampling Rate	%	114.77	…
Sample Reference (ECL ID)	ECL/23/	0052 & 0053	0054 & 0055
Mass of Particulate Matter Collected	mg	1.12	0.60
Concentration of Particulate Matter	mg/m^3*	**1.14**	0.61
Emission Rate of Particulate Matter	g/hr	95.91	...
Expanded Uncertainty (% Relative)	%	46	...
Emission Limit Value (ELV)	mg/m^3*	15	…
Blank Concentration as Percentage of ELV	%	…	4.08
Sample Reference (ECL ID)	ECL/23/	0058 & 0059	0060
Mass of Hydrogen Chloride Collected	mg	23.53	0.02
Concentration of Hydrogen Chloride	mg/m^3*	**24.02**	0.02
Emission Rate of Hydrogen Chloride	g/hr	2014.68	...
Expanded Uncertainty (% Relative)	%	14	...
Impinger Collection Efficiency	%	100	...
Sample Reference	ECL/23/	0058 & 0059	0060
Mass of Hydrogen Flouride Collected	mg	0.05	0.02
Concentration of Hydrogen Flouride	mg/m^3*	**0.05**	0.02
Emission Rate of Hydrogen Flouride	g/hr	4.43	...
Expanded Uncertainty (% Relative)	%	14	...
Impinger Collection Efficiency	%	68	...

***Reference Conditions (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Western Bio-Energy Ltd
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Table 5 – Ammonia

Data Recorded from Main Stack - Biomass Plant

Emission Parameter	Units	Ammonia	Blank
Stack Diameter	metres	1.60	
Area of Sample Plane	m^2	2.011	
Moisture Content	%	24.35	
Oxygen Content	%	7.01	
Stack Temperature	^oC	140	
Gas Velocity (as Measured)	m/sec	24.29	
Gas Velocity (Reference Conditions)	m/sec*	11.38	
Volumetric Flowrate (as Measured)	m^3/sec	48.85	
Volumetric Flowrate (Reference Conditions)	m^3/sec*	22.87	
Dry Gas Molecular Weight	g/gmole	30.44840953	
Sample Date	…	05/01/2023	
Sample Period	…	13:30 - 14:30	
Sample Volume (reference Conditions)	m^3*	0.770	0.770
Sample Reference (ECL ID)	ECL/23/	0062 & 0063	0064
Mass of Ammonia Collected	mg	6.21	0.05
Concentration of Ammonia	mg/m^3*	**8.06**	0.06
Emission Rate of Ammonia	kg/hr	0.66	...
Expanded Uncertainty (% Relative)	%	14	...
Emission Limit Value (ELV)	mg/m^3*	10	…
Impinger Collection Efficiency	%	99	...
Blank Concentration as Percentage of ELV	%	…	<1.00%

***Reference Conditions (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
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Table 6 – Sulphur Dioxide

Data Recorded from Main Stack - Biomass Plant

Emission Parameter	Units	Sulphur Dioxide	Blank
Stack Diameter	metres	1.60	
Area of Sample Plane	m^2	2.011	
Moisture Content	%	21.84	
Oxygen Content	%	6.55	
Stack Temperature	^oC	140	
Gas Velocity (as Measured)	m/sec	24.29	
Gas Velocity (Reference Conditions)	m/sec*	12.10	
Volumetric Flowrate (as Measured)	m^3/sec	48.85	
Volumetric Flowrate (Reference Conditions)	m^3/sec*	24.33	
Dry Gas Molecular Weight	g/gmole	30.42995243	
Sample Date	...	06/01/2023	
Sample Period	...	08:30 - 12:30	
Sample Volume (reference Conditions)	m^3*	3.333	3.333
Sample Reference	ECL/23/	0066 & 0067	0068
Mass of Sulphur Dioxide Collected	mg	66.87	0.07
Concentration of Sulphur Dioxide	mg/m^3*	**20.06**	0.02
Emission Rate of Sulphur Dioxide	kg/hr	1.76	...
Expanded Uncertainty (% Relative)	%	14	...
Impinger Collection Efficiency	%	100	...

***Reference Conditions (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Table 7 – Dioxins & Furans

Data Recorded from Biomass Plant - Stack Main Stack

Emission Parameter	Units	Chlorinated D & F
Stack Diameter	**metres**	1.6
-	**-**	-
Area of sample plane	**m^2**	2.011
Moisture Content	**%**	22.60
Moisture Expanded Uncertainty	%(Relative)	5.23
Stack Temperature	**°C**	132
Oxygen Concentration	**%**	8.17
Gas velocity (as Measured)	**m/sec**	21.7532
Gas velocity (Reference Conditions)	**m/sec***	9.6454
Volumetric Flowrate (as Measured)	**m^3/sec**	43.7375
Volumetric Flowrate (Reference	**m^3/sec***	19.3933
Sample Date	09/01/2023	
Sample Period	10:35 - 16:40	
Sample Reference	ECL/23/0046 - 0048	
Sample Volume (Reference Conditions)	**m^3 ***	4.59
Isokinetic Sampling Rate	**%**	**107.73**

Species	Sample Reference: ECL/23/0046 - 0048		Blank Reference: ECL/23/0049 - 0051	
	Conc. ng/m³*	TEQ ng/m³*	Conc. ng/m³*	TEQ ng/m³*
Chlorinated Dioxins 2,3,7,8 Isomers	**0.032**	**0.0012**	**0.0053**	**0.00014**
Total Chlorinated Dioxins Non – Targeted Isomers	**0.00**	**…**	**0.00**	**…**
Chlorinated Furans 2,3,7,8 Isomers	**0.013**	**0.0013**	**0.0040**	***0.00033***
Total Chlorinated Furans Non – Targeted Isomers	**0.00**	**…**	**0.00**	**…**
TOTAL	**…**	**0.0025**	**…**	**0.00046**
Range	**…**	**0.0023 - 0.0025**	**Blank <10% of ELV?**	**YES**
% Uncertainty	**…**	**13**		

***Reference Conditions 273K, 101.3kPa, 6% Oxygen, Dry Gas. NB: For each congener, where the blank concentration exceeds or equals the measured concentration, the blank value has been substituted. Refer to the table of individual congeners for more detailed information.**

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Table 7b – Dioxins & Furans

Data Recorded from Biomass Plant - Stack Main Stack on the 09/01/23, 10:35 - 16:40

Species	Blank Reference: ECL/23/0049 - 0051 TEQ ng/m³*	EEC Toxic Equivalent Factor (TEF)	Sample Ref.: ECL/23/0046 - 0048		WHO Humans & Mammals (TEF)	Humans & Mammals TEQ ng/m³*	WHO Fish (TEF)	Fish TEQ ng/m³*	WHO Birds (TEF)	Birds TEQ ng/m³*
			Concentration ng/m³*	TEQ ng/m³*						
Chlorinated Dioxins - 2,3,7,8 Isomers										
2,3,7,8 - TCDD	0.000031	1	*0.00011*	*0.00011*	1	*0.00011*	1	*0.00011*	1	*0.00011*
1,2,3,7,8 - PCDD	0.000048	0.5	**0.00084**	**0.00042**	1	**0.00084**	1	**0.00084**	1	**0.00084**
1,2,3,4,7,8 - HxCDD	0.000006	0.1	**0.0012**	**0.00012**	0.1	**0.00012**	0.5	**0.00061**	0.05	**0.000061**
1,2,3,6,7,8 - HxCDD	0.000020	0.1	**0.0026**	**0.00026**	0.1	**0.00026**	0.01	**0.000026**	0.01	**0.000026**
1,2,3,7,8,9 - HxCDD	0.000016	0.1	**0.0015**	**0.00015**	0.1	**0.00015**	0.01	**0.000015**	0.1	**0.00015**
1,2,3,4,6,7,8 - HpCDD	0.000014	0.01	**0.012**	**0.00012**	0.01	**0.00012**	0.001	**0.000012**	0.001	**0.000012**
OCDD	0.000003	0.001	**0.013**	**0.000013**	0.0001	**0.000001**	0	**…**	0	**…**
Total Chlorinated Dioxins - Non - Targeted Isomers										
TCDD	…	0	0.000000	…	0	…	0	…	0	…
PCDD	…	0	0.000000	…	0	…	0	…	0	…
HxCDD	…	0	0.000000	…	0	…	0	…	0	…
HpCDD	…	0	0.000000	…	0	…	0	…	0	…
Chlorinated Furans - 2,3,7,8 Isomers										
2,3,7,8 - TCDF	0.000019	0.1	**0.0022**	**0.00022**	0.1	**0.00022**	0.05	**0.00011**	1	**0.0022**
1,2,3,7,8 - PCDF	0.000015	0.05	**0.00090**	**0.000045**	0.05	**0.000045**	0.05	**0.000045**	0.1	**0.000090**
2,3,4,7,8 - PCDF	0.00017	0.5	**0.0012**	**0.00061**	0.5	**0.00061**	0.5	**0.00061**	1	**0.0012**
1,2,3,4,7,8 - HxCDF	0.000005	0.1	**0.0010**	**0.00010**	0.1	**0.00010**	0.1	**0.00010**	0.1	**0.00010**
1,2,3,6,7,8 - HxCDF	0.000046	0.1	**0.0012**	**0.00012**	0.1	**0.00012**	0.1	**0.00012**	0.1	**0.00012**
2,3,4,6,7,8 - HxCDF	0.000055	0.1	**0.0011**	**0.00011**	0.1	**0.00011**	0.1	**0.00011**	0.1	**0.00011**
1,2,3,7,8,9 - HxCDF	0.000004	0.1	*0.000078*	*0.000008*	0.1	*0.000008*	0.1	*0.000008*	0.1	*0.000008*
1,2,3,4,6,7,8 - HpCDF	0.000015	0.01	**0.0038**	**0.000038**	0.01	**0.000038**	0.01	**0.000038**	0.01	**0.000038**
1,2,3,4,7,8,9 - HpCDF	0.000002	0.01	**0.00047**	**0.000005**	0.01	**0.000005**	0.01	**0.000005**	0.01	**0.000005**
OCDF	0.000000	0.001	**0.0010**	**0.000001**	0.0001	**0.000000**	0.0001	**0.000000**	0.0001	**0.000000**
Total Chlorinated Furans - Non - Targeted Isomers										
TCDF	…	0	0.000000	…	0	…	0	…	0	…
PCDF	…	0	0.000000	…	0	…	0	…	0	…
HxCDF	…	0	0.000000	…	0	…	0	…	0	…
HpCDF	…	0	0.000000	…	0	…	0	…	0	…
TOTAL	**0.00046**	**…**	**…**	**0.0025**	**…**	**0.0029**	**…**	**0.0028**	**…**	**0.0051**
Range	**…**	**…**	**…**	**0.0023 - 0.0025**	**…**	**0.0027 - 0.0029**	**…**	**0.0026 - 0.0028**	**…**	**0.005 - 0.0051**
% Uncertainty	**…**	**…**	**…**	**13**	**…**	**17**	**…**	**18**	**…**	**18**

***Reference Conditions 273K, 101.3kPa, 6% Oxygen, Dry Gas. NB: For each congener, where the blank concentration exceeds or equals the measured concentration, the blank value has been substituted.This is presented as shaded cells. Where the Limit of Detection applies, concentrations are presented in italics.**

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Table 8 – Heavy Metals

Sampling Location: Biomass Plant Main Stack

Test Heavy Metals					
Stack Profile:	Circular	Units	Gas velocity (as Measured. Adjusted for Smooth Walls):	24.0213	m/sec
Diameter:	1.60	m	Gas velocity (Reference Conditions):	11.8048	m/sec *
			Volumetric Flowrate (as Measured):	48.2977	m^3/sec
Area of sample plane:	2.011	m^2	Volumetric Flowrate (Reference Conditions):	23.7350	m^3/sec *
Moisture Content:	22.58	%	Sample Date:	05/01/2023	
Stack Temperature:	141	°C	Sample Period:	15:00 - 16:02	
Barometric Pressure:	1018	mbar	Sample Volume:	0.953	m^3
Measured Oxygen:	6.66	%	Isokinetic Rate (95% < ISOKx > 115%):	109.64	%

***Reference Conditions: (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Trace Element	Symbol	Mass (mg)			ECL/23/0 - 0 Concentration (mg/m^3)*			Emission Rate (g/hr)*	Uncertainty (%)	ECL/23/0 - 0 Blank	
		Particulate Phase	Vapour Phase	Total Element Phase	Particulate Phase	Vapour Phase	Total Element Phase		Total Element Phase	Mass (mg)	Conc. (mg/m^3)
Antimony	Sb	0.013	0.0013	0.014	0.013	0.0014	**0.015**	**1.25**	14	0.00069	0.00072
Arsenic	As	0.0021	0.0047	0.0068	0.0022	0.0050	**0.0072**	**0.61**	10	0.00063	0.00066
Cadmium	Cd	0.00050	0.00019	0.00069	0.00052	0.00020	**0.00072**	**0.062**	10	0.00059	0.00062
Chromium	Cr	0.012	0.011	0.023	0.012	0.012	**0.024**	**2.08**	9	0.0046	0.0048
Cobalt	Co	0.00050	0.00019	0.00069	0.00052	0.00020	**0.00072**	**0.062**	10	0.00059	0.00062
Copper	Cu	0.0022	0.011	0.014	0.0023	0.012	**0.014**	**1.23**	10	0.00077	0.00081
Lead	Pb	0.0033	0.0062	0.0095	0.0035	0.0065	**0.010**	**0.86**	12	0.00069	0.00072
Manganese	Mn	0.0058	0.0010	0.0068	0.0061	0.0011	**0.0072**	**0.61**	14	0.0015	0.0016
Nickel	Ni	0.017	0.0013	0.018	0.018	0.0013	**0.019**	**1.63**	12	0.0056	0.0059
Thallium	Tl	0.00040	0.00019	0.00059	0.00042	0.00020	**0.00062**	**0.053**	12	0.00049	0.00051
Vanadium	V	0.0014	0.000094	0.0015	0.0015	0.000099	**0.0016**	**0.13**	12	0.00044	0.00047
Cadmium & Thallium		0.00090	0.00038	0.0013	0.00094	0.00040	**0.0013**	**0.11**	5	0.0011	0.0011
Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel & Vanadium		0.057	0.038	0.094	0.060	0.040	**0.099**	**8.46**	3	0.016	0.016

Efficiency Failure

No ELV Entered!

No ELV Entered!

Note: Uncertainty for each metals group is based on the summation in quadrature of the individual standard uncertainties (in mg/m^3) of each contributing metal. Combined standard uncertainty of each group is converted to 95% confidence (multiplication by k = 2) before being expressed as a percentage of the combined group concentration.

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Table 8b – Heavy Metals Efficiencies

Metals groups have been selected. Efficiencies will only be displayed for individual elements if the group total concentration is greater than 30% of the associated ELV.

Recovery in the final impinger must be <10% of the total combined element mass (i.e. filter, probe rinse & impingers) to pass - ONLY if the element makes up >1% of the total mass of all metals collected

Trace Element	Symbol	Final Impinger (%)	<10%?	<1% of Total?
Antimony	Sb	0.48	PASS	NO
Arsenic	As	1.45	PASS	NO
Cadmium	Cd	9.59	PASS	NO
Chromium	Cr	0.28	PASS	NO
Cobalt	Co	9.59	N/A	YES
Copper	Cu	0.96	PASS	NO
Lead	Pb	0.69	PASS	NO
Manganese	Mn	0.96	PASS	NO
Nickel	Ni	0.55	PASS	NO
Thallium	Tl	11.22	FAIL	NO
Vanadium	V	2.21	PASS	NO

Combined Groups	ELV mg/m^3	Result <30% ELV?
Cadmium & Thallium	0	NO
Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel & Vanadium	0	NO

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Table 9 – Mercury

Sampling Location: Biomass Plant Main Stack

Test Mercury					
Stack Profile:	Circular	Units	Gas velocity (as Measured. Adjusted for Smooth Walls):	24.1513	m/sec
Diameter:	1.60	m	Gas velocity (Reference Conditions):	11.7466	m/sec *
			Volumetric Flowrate (as Measured):	48.5590	m^3/sec
Area of sample plane:	2.011	m^2	Volumetric Flowrate (Reference Conditions):	23.6180	m^3/sec *
Moisture Content:	23.65	%	Sample Date:	06/01/2023	
Stack Temperature:	140	°C	Sample Period:	13:10 - 14:12	
Barometric Pressure:	1014	mbar	Sample Volume:	0.903	m^3
Measured Oxygen:	6.60	%	Isokinetic Rate (95% < ISOKx > 115%):	104.40	%

***Reference Conditions: (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Trace Element	Symbol	Mass (mg)			ECL/23/0 - 0 Concentration (mg/m^3)*			Emission Rate (g/hr)*	Uncertainty (%)	ECL/23/0 - 0 Blank	
		Particulate Phase	Vapour Phase	Total Element Phase	Particulate Phase	Vapour Phase	Total Element Phase		Total Element Phase	Mass (mg)	Conc. (mg/m^3)
Mercury	Hg	0.00011	0.00029	0.00040	0.00012	0.00032	**0.00044**	**0.037**	10	0.00029	0.00032

No ELV Entered!

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Table 9b – Mercury Efficiencies

Groups have been selected. Efficiencies will only be displayed for mercury if the concentration is greater than 30% of the associated ELV.

Recovery in the final impinger must be <5% of the total combined element mass in both impingers to pass - ONLY if the final impinger has a concentration greated than 2µg/m^3

Trace Element	Symbol	Final Impinger (%)	<5%?	Final Impinger <2 µg/m^3?
Mercury	Hg	N/A	N/A	YES

Combined Groups	ELV mg/m^3	Result <30% ELV?
Mercury	0	NO

VELOCITY TRAVERSE PROFILES

Environmental Compliance Limited

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Environmental Compliance Limited	Traverse Data Profoma	Date of Measurement	05/01/2023

Company	Western Bio-Energy Limited	Stack Diameter Port A (mm)	1600	Average Stack Diameter (mm)	1600	Pitot tube coefficient	0.84
Site	Margam	Stack Diameter Port B (mm)	1600	Port Length (mm)	210	Pitot Id	668
Location	Biomass Plant	Duct Length Port A (mm)		Average Duct Length (mm) L		Stack Thermocouple ID	461
Stack	Main Stack	Duct Length Port B (mm)		Duct width (mm) B		Stack Temp Reader ID	987
Job No	P5200	Duct Length Port C (mm)		Barometric Pressure. (mb)	1018	Manometer ID	989
Operators	PB, DB & LPH	Duct Length Port D (mm)		Ave Static Press. (mm $H_2$0)	16.90	Barometer ID	352

Pre - Traverse Checks Carried Out	Time	Pass/ Fail
Pre - Traverse PITOT Visual Inspection	09:32:00	Pass
Pre - Traverse PITOT Leak Check	09:34:00	Pass

Smooth Walls

Static Pressure Readings (mm H_2O)			
Port A	Port B	Port C	Port D
16.80	17.00		

Port/ Point	Distance to Point (mm)	Time	Temperature Readings (°C) 1	2	3	(ΔP) Pitot Readings (mm H_2O) 1	2	3	Average Temp. (°C)	Average (ΔP) (mm H_2O)	Swirl Test ° From Reference
A1	70	09:37:00	142.0	142.0	142.0	40.00	40.00	38.00	142.0	39.33	10
A2	234	09:39:00	142.0	142.0	141.0	38.00	38.00	38.00	141.7	38.00	10
A3	473	09:41:00	141.0	141.0	141.0	36.00	38.00	36.00	141.0	36.67	10
A4	1127	09:43:00	141.0	140.0	141.0	36.00	36.00	36.00	140.7	36.00	10
A5	1366	09:45:00	141.0	141.0	142.0	34.00	34.00	32.00	141.3	33.33	10
A6	1530	09:47:00	142.0	142.0	142.0	32.00	32.00	32.00	142.0	32.00	10
B1	70	09:50:00	140.0	140.0	140.0	38.00	38.00	38.00	140.0	38.00	10
B2	234	09:52:00	141.0	141.0	141.0	38.00	38.00	38.00	141.0	38.00	10
B3	473	09:54:00	141.0	141.0	141.0	36.00	36.00	34.00	141.0	35.33	10
B4	1127	09:56:00	140.0	139.0	139.0	34.00	36.00	34.00	139.3	34.67	10
B5	1366	09:58:00	139.0	139.0	140.0	32.00	32.00	32.00	139.3	32.00	10
B6	1530	10:00:00	140.0	141.0	141.0	30.00	30.00	30.00	140.7	30.00	10
Blockage Check @ A1 (L-Type Pitot Only)									1690.0	423.3	Total
			Mean			Mean			142.0	39.3	Max
			Difference <5% from Initial ?			Difference <5% from Initial ?			139.3	30.0	Min
									140.8	35.3	Average

Stagnation Check (S-type Pitot Only)	Time	Reading
Static Pressure Via Positive Leg (mm H_2O)	10:03:00	17.00
Static Pressure Via Negative Leg (mm H_2O)	10:05:00	16.80
Difference (Pa) < 1 mm $H_2$0 ?		-0.20

Post - Traverse Checks Carried Out	Time	Pass/ Fail
Post - Traverse PITOT Visual Inspection	10:07:00	Pass
Post - Traverse PITOT Leak Check	10:09:00	Pass

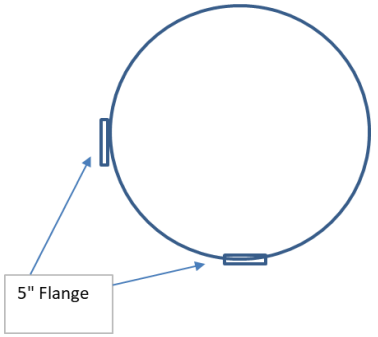
Average temp (K)	413.833

Suitability of Sampling Position	Actual Stack Conditions
Highest:lowest flow pressure ratio < 9:1?	1.33:1
Maximum deviation of flow from axis <15° ?	10
X-sectional area for stacks= πr2	2.01 m^2
X-sectional area for ducts = L x B	m^2
Suitability of Position for Sampling	OK

Stack Moisture	23.01	%	Gas Velocity (as Measured) Adjusted for Smooth Walls	24.29438	m/sec
Measured Oxygen	6.81	%	Gas Velocity (Reference Conditions) Adjusted for Smooth Walls	11.74482	m/sec*
Measured Carbon Dioxide	13.55	%	Volumetric Flowrate (as Measured) Adjusted for Smooth Walls	48.84675	m^3/sec
Dry Gas Molecular Weight	30.44040	g/g mole	Volumetric Flowrate (Ref Cond) Adjusted for Smooth Walls	23.61437	m^3/sec*

*Reference Conditions: 273K, 101.3kPa, 6% Oxygen, Dry Gas NOTE: Velocity / volume flowrate calculations exclude contributions from the measurement point(s) where swirl >15°

Diagram/ Description of Cross Section of Stack/Duct



Notes
Including expected or actual deviations from procedures / non-conformities

Compliance With Positional Requirements?

Height of sample ports from Platform	0.70m
Number of sample ports	2
Width of platform (port back to handrail)	3.0m

Nearest downstream disturbance	Exit	15m
Nearest upstream disturbance	Bend	>5m

Disturbances are classed as bends, fans or diameter variations

FIELD CALIBRATION AND SAMPLING DATA

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

TVOC Calibration Site Log

TVOC - FIELD DATA SHEET

Client	Western Bio-Energy Ltd			Barometric Pressure mb	1018		
Site	Margam			Barometer ID	ECL/ID/ 352		
Date	05/01/2023			Analyser ID	ECL/ID/ 211		
Location	Biomass Plant			Sonimix/ MFC ID	ECL/ID/ N/A		
Stack ID	Main Stack			Heated Line/ Controller ID	ECL/ID/1090 1091		
Stack Temp °C	140			Heated Line Set Temp °C	180	YES	
Ambient Temp (sampling)	1= 11	2= 12	3= 12	Heated Line Length	20	m	
Ambient Temp (sampling)	4=	5=	6=	Heated Probe Filter ID	ECL/ID/ 1190		
Job No	P5200			Heated Filter Set Temp °C	180	YES	
Operators	DB/ PB / LPH			Logger ID	922		

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)
Zero Gas (Synthetic Air)	Gas/ 2806	…	…
Hydrogen / Helium	Gas/ 2761	…	…
Propane (In Air)	Gas/ 2687	30.11ppm	0.3ppm

	Analyser Range	Span Gas value used
Propane	40ppm	30.11 ppm

Analyser Range should be not less than the expected peak emissions.

Span Gas Values should be **either** *approximately the half-hourly ELV* **OR** ***50%*** *to* ***90%*** *of the Selected Analyser Range.*

	Direct Calibration (Rear of Analyser)					
	Zero Cal		Span Gas Cal		Zero Check	
	Start Time	End Time	Start Time	End Time	Start Time	End Time
ZERO /SPAN/ ZERO	12:09	12:12	12:14	12:17	12:19	12:22

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

Pre-Cal Ambient Temp °C		PRE System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
		Start Time	End Time	Start Time	End Time
11	11				
ZERO / SPAN		12:28	12:31	12:33	12:36

Response Time SYSTEM Span Gas Cal		
Start Time	90% Time	less than 200s (Y/N)
12:32:15	12:32:30	Y

	Start Time	End Time	Location	Production Details
Sample Period	12:45	14:15	Main Stack	Normal
Sample Period				
Sample Period				
Sample Period				
Sample Period				
Sample Period				

Post-Cal Ambient Temp °C		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
		Start Time	End Time	Start Time	End Time
12	12				
ZERO / SPAN		14:19	14:22	14:24	14:26

Process Details / Comments

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

TVOC Calibration Summary – 05/01/2023

		TVOC ppm
Analyser Range		40
Repeatability at Zero		0.8
Span Gas Concentration Applied		30.11
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	30.1
	Zero	-0.01
Difference (Zero)		0.0051
<2×Repeatability @ Zero?		YES
Pre Test (System)	Zero	0.03
	Span	30.1
Difference (Zero)		0.0339
<2% Relative to Direct Span		YES
Difference (Span)		0.0166
<2% Relative to Direct Span		YES
Post Test (System)	Zero	0.15
	Span	30.4
Difference (Zero)		0.1190
Zero Drift <2% of Applied Span?		YES
Difference (Span)		0.3169
Span Drift <2% of Applied Span?		YES
Zero and Span Drift <5% of Applied Span?		YES

Western Bio-Energy Ltd			Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL		Visit Details	: Compliance – January 2023
Variation No	: V005		Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200	: R003	Report Issue Date	: 16th February 2023

Horiba Calibration Summary – 05/01/2023 (NO_x, CO & O_2)

	Horiba PG 350 E Ranges:		
	NO as NO_2	CO	O_2
	512.5	625	25
Units	mg/m^3	mg/m^3	%Vol
	Zero Values (Direct)		
Mean Initial Direct Zero	0.17	-0.01	-0.02
Mean Confirmation Direct Zero	0.22	0.33	-0.03
Difference in Direct Zero	0.05	0.34	0.01
Repeatability at Zero	4.10	2.50	0.20
<2 x Repeatability at Zero?	YES	YES	YES
	Pre Zero Values (System)		
Mean Pre Test Zero	0.47	0.23	0.03
% of Measurement Range?	0.09%	0.04%	0.12%
Detection Limit (LOD)	0.38	0.12	0.20
	Applied Span:		
	NO	CO	O_2
Actual Applied Span Concentration	317.96	382.63	14.99
	Pre Test System Zero Values		
Mean Pre Test System Zero	0.47	0.23	0.03
Difference ≤ ± 2% of Span Value?	0.15%	0.06%	0.20%
	Post Test Direct Zero Values		
Mean Post Test Direct Zero	0.17	0.42	-0.03
% of Certified Range?	0.03%	0.07%	-0.12%
Zero Drift ≤ ± 5% of Applied Span?	0.00%	0.11%	0.05%
	Pre Test System Span Values		
Mean Pre Test System Span	315.10	381.57	15.00
Difference ≤ ± 2% of Span Value ?	0.90%	0.28%	0.07%
	Post Test Direct Span Values		
Mean Post Test Direct Span	316.79	383.20	15.04
Span Drift ≤ ± 5% Span Value?	0.37%	0.15%	0.34%

Western Bio-Energy Ltd			Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL		Visit Details	: Compliance – January 2023
Variation No	: V005		Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200	: R003	Report Issue Date	: 16th February 2023

FTIR Calibration Summary – 09/01/2023
(N_2O & O_2)

	)4M FTIR Certified	
	N_2O	O_2
Upper Limit of Certified Range	39	20.9
Units	mg/m^3	% Vol
	e System Zero Valu	
Mean Pre Test System Zero	0.04	0.02
% of Certified Range? (Maximum Allowed 2%)	0.10%	0.11%
	e Direct Zero Valu	
Mean Pre Test Direct Zero	-0.05	0.00
% of Certified Range? (Maximum Allowed 2%)	-0.12%	0.00%
Detection Limit (LOD)	0.10	0.20
LOD as % of Range (Maximum Allowed 2%)	0.25	0.96
	st System Zero Val	
Mean Post Test System Zero	-0.05	0.00
% of Certified Range?	-0.14%	-0.01%
Zero Drift ≤ ± 5% of Applied Span?	0.01%	0.01%
	Applied Span:	
	N_2O	O_2
Actual Applied Span Concentration	36.65	14.99
	Direct Span Values	
Mean Span Direct to Analyser	36.48	14.99
Deviation ≤ ± 5% Applied Concentration?	0.47%	0.00%
	e System Span Valu	
Mean Pre Test System Span	36.46	15.08
Losses Due to Sampling System ≤ 2% ?	0.04%	0.61%
	st System Span Val	
Mean Post Test System Span	36.37	15.04
Span Drift ≤ ± 5% Pre Span?	0.24%	0.35%

Western Bio-Energy Ltd			Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL		Visit Details	: Compliance – January 2023
Variation No	: V005		Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200	: R003	Report Issue Date	: 16th February 2023

Oxygen Calibration Summary
06/01/2023

	Horiba PG 350 E Ranges:
	O_2
	25
Units	%Vol
	Zero Values (Direct)
Mean Initial Direct Zero	-0.02
Mean Confirmation Direct Zero	-0.03
Difference in Direct Zero	0.01
Repeatability at Zero	0.20
<2 x Repeatability at Zero?	YES
	Pre Zero Values (System)
Mean Pre Test Zero	0.03
% of Measurement Range?	0.12%
Detection Limit (LOD)	0.20
	Applied Span:
	O_2
Actual Applied Span Concentration	14.99
	Pre Test System Zero Values
Mean Pre Test System Zero	0.03
Difference ≤ ± 2% of Span Value?	0.20%
	Post Test Direct Zero Values
Mean Post Test Direct Zero	-0.12
% of Certified Range?	-0.48%
Zero Drift ≤ ± 5% of Applied Span?	0.65%
	Pre Test System Span Values
Mean Pre Test System Span	15.00
Difference ≤ ± 2% of Span Value ?	0.07%
	Post Test Direct Span Values
Mean Post Test Direct Span	14.98
Span Drift ≤ ± 5% Span Value?	0.05%

Environmental Compliance Limited

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – January 2023**
Variation No	**: V005**	**Survey Dates**	**: 5th – 9th January 2023**
Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

Particulates & Hydrogen Chloride & Fluoride

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	05/01/2023

ECL/TPD/	027 & 081	Time taken to change Ports?	2	Start Time	11:50	End Time	12:52
				Test Duration	60 mins		

Client	Western Bio-Energy Limited	Stack Profile	Circular	Console id	U010	Barometer id	352
Site	Margam	Stack Area (m^2)	2.01	Pump id	U010	Nozzle Id	335
Location	Biomass Plant	Barometric Pressure (mb)	1018	Probe id	149	Nozzle size	5.09
Stack ID	Main Stack	Static Pres. (mm H_20)	16.9	DGM Yd	0.9979	Filter Id	249657 4043
Test No.	TPM, HCl & HF	Pitot coefficient	0.84	ΔH@	47.22	Pitot ID	668
Job No	P5200	Probe Heater Setting (°C)	160	Impinger Id	337	Hot Box ID	192
ECL Site Staff	PB, DB & LPH	Hot Box Setting (°C)	160	Balance Id	1222		

IF SAMPLING FOR PARTICULATES NO LEAK CHECKS ARE ALLOWED AFTER SAMPLING HAS STARTED (NOT EVEN IF TRAIN IS BROKEN DOWN)
FOR OTHER SAMPLING (WITHOUT PARTICULATES) LEAK CHECKS ARE ALLOWED AFTER SAMPLING HAS STARTED (BUT ARE NOT MANDATORY)

Silica <50% Spent at End of Test?	YES

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	2712243.0						
Final Volume	2713346.8						
Total Volume	1103.8	0.0	0.0	0.0	0.0	0.0	1103.8

Original K Factor Settings	
Meter Temp.	20
Stack Temp	140
%Moisture	20.00

Leak Check	First	Second	Third	Fourth	Fifth
Leak rate l/min	0.2				
Vaccum "Hg	11				
Time of Check	11:48				
Set Rate l/min	20				
Leak <2%?	YES				

Dry O_2 (Atmospheric)	6.78	K factor	0.9
Dry Carbon Dioxide %	13.55	Reference Oxygen Percentage	6

Smooth Walls

Traverse Point	A1	A2	A3	A4	A5	A6	B1	B2	Total
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (mm H20)	36.00	34.00	34.00	32.00	32.00	30.00	38.00	38.00	34.25
K factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
ΔH (Orifice)	32.40	30.60	30.60	28.80	28.80	27.00	34.20	34.20	30.83
Meter (Tm in)	18.00	19.00	19.00	19.00	20.00	20.00	20.00	21.00	19.50
Meter (Tm out)	18.00	19.00	19.00	19.00	20.00	20.00	20.00	21.00	19.50
Stack Temp (Ts)	142.00	143.00	141.00	140.00	141.00	142.00	142.00	140.00	141.38
Impinger T Outlet	7.00	7.00	7.00	8.00	8.00	8.00	9.00	9.00	7.88
Vaccum (" Hg)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

Traverse Point	B3	B4	B5	B6					Total
Time/Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔP (mm H20)	36.00	34.00	34.00	32.00					34.00
K factor	0.90	0.90	0.90	0.90					
ΔH (Orifice)	32.40	30.60	30.60	28.80					30.60
Meter (Tm in)	21.00	21.00	22.00	22.00					21.50
Meter (Tm out)	21.00	21.00	22.00	22.00					21.50
Stack Temp (Ts)	140.00	139.00	139.00	140.00					139.50
Impinger T Outlet	10.00	10.00	11.00	11.00					10.50
Vaccum (" Hg)	10.00	10.00	10.00	10.00					10.00

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

	Impinger 1	Impinger 2	Impinger3	Impinger 4	Impinger 5	Impinger 6	Impinger 7	Impinger 8
	Di H2O	Di H2O	Di H2O	Empty	Silica			
SOL/	4803	4803	4803	...	...			
Start Weight (g)	633.1	625.1	613.5	500.5	956.2			
End Weight (g)	780.2	695.8	626.3	504.5	969.8			
Total weight (g)	147.1	70.7	12.8	4	13.6	0	0	0

Total (g)	248.20

Rinse Solutions used	
Solution	SOL NO
DI Water	4803
Acetone	4748

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

Additional Moisture Weighings

Item Name	Start Weight (g)	End Weight (g)	Total weight (g)
			0
			0
			0
			0
			0
			0
			0
			0

PRE-Sample PITOT **Visual Inspection**	
Time	11:44
Pass ? (Y/N)	Y

PRE-Sample PITOT **Leak Check**	
Time	11:46
Pass ? (Y/N)	Y

Post-Sample Blockage Check (L-type)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	

POST-Sample PITOT **Visual Inspection**	
Time	12:54
Pass ? (Y/N)	Y

POST-Sample PITOT **Leak Check**	
Time	12:56
Pass ? (Y/N)	Y

Ammonia

Environmental Compliance Limited	NON ISOKINETIC SAMPLING PROFORMA	Date of Measurement	05/01/2023

If moisture was not measured see detailed notes below.

ECL/TPD/	034	Time taken to change Ports?	0	Start Time	13:30	End Time	14:30
				Test Duration	60 mins		

Client	Western Bio-Energy Limited	Stack Profile	Circular	Console id	U010	Barometer id	352
Site	Margam	Stack Area (m^2)	2.01	Pump id	U010	Nozzle Id	n/a
Location	Biomass Plant	Barometric Pressure (mb)	1017	Probe id	149	Nozzle size	n/a
Stack ID	Main Stack	Static Pres. (mm H_20)	16.9	DGM Yd	0.9979	Filter Id	UW QMA
Test No.	Ammonia	Pitot coefficient	n/a	ΔH@	47.22	Pitot ID	n/a
Job No	P5200	Probe Heater Setting (°C)	150	Impinger Id	337	Hot Box ID	192
ECL Site Staff	PB, DB & LPH	Hot Box Setting (°C)	150	Balance Id	1222		

For all parameters a leak check is OPTIONAL at the end of the test.
(and when moving between sample ports if any disconnections are required).

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	2714900.2						
Final Volume	2715788.2						
Total Volume	888.0	0.0	0.0	0.0	0.0	0.0	888.0

Required Sample Flowrate l/min	Suggested ΔH Entered Below
3	1
6	3
10	10
15	25
25	50
Initial ΔH	25

Leak Check	First	Second	Third	Fourth	Fifth
Leak rate l/min	0.2				
Vaccum "Hg	7				
Time of Check	13:28				
Set Rate l/min	15				
Leak <2%?	YES				

Dry O_2 (Atmospheric)	7.01		
Dry Carbon Dioxide %	13.55	Reference Oxygen Percentage	6
Dry Carbon Monoxide ppm	81.17		

Traverse Point	A3	A3	A3	A3	A3	A3			Total
Time/Point (mins)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60			
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	25.00	25.00	25.00	25.00	25.00	25.00			25.00
Meter (Tm in)	21.00	21.00	22.00	22.00	22.00	22.00			21.67
Meter (Tm out)	21.00	21.00	22.00	22.00	22.00	22.00			21.67
Stack Temp (Ts)	139.00	139.00	140.00	141.00	140.00	142.00			140.17
Impinger T Outlet	8.00	8.00	8.00	9.00	9.00	10.00			8.67
Vaccum (" Hg)	5.00	5.00	5.00	5.00	5.00	5.00			5.00

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

	Impinger 1	Impinger 2	Impinger3	Impinger 4	Impinger 5	Impinger 6	Impinger 7	Impinger 8
	0.1N H2SO4	0.1N H2SO4	0.1N H2SO4	Empty	Silica			
SOL/	4805	4805	4805	...	...			
Start Weight (g)	658.9	636.9	615.2	503.8	969.8			
End Weight (g)	830.9	666	618.3	504.7	978.4			
Total weight (g)	172	29.1	3.1	0.9	8.6	0	0	0

Total (g)	213.70

Silica <50% used at End of Test? Y/N	YES

Rinse Solutions used	
Solution	SOL NO
DI Water	4803
Acetone	4748

Additional Moisture Weighings

Item Name	Start Weight (g)	End Weight (g)	Total weight (g)
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

Sulphur Dioxide

Environmental Compliance Limited	NON ISOKINETIC SAMPLING PROFORMA	Date of Measurement	06/01/2023
ECL/TPD/	039	Time taken to change Ports?	0
Start Time	08:30	End Time	12:30
Test Duration	240 mins		

Client	Western Bio-Energy Limited	Stack Profile	Circular	Console id	U010	Barometer id	352
Site	Margam	Stack Area (m^2)	2.01	Pump id	U010	Nozzle Id	n/a
Location	Biomass Plant	Barometric Pressure (mb)	1014	Probe id	149	Nozzle size	n/a
Stack ID	Main Stack	Static Pres. (mm H_20)	16.9	DGM Yd	0.9979	Filter Id	UW QMA
Test No.	Sulphur Dioxide	Pitot coefficient	n/a	ΔH@	47.22	Pitot ID	n/a
Job No	P5200	Probe Heater Setting (^oC)	160	Impinger Id	337	Hot Box ID	192
ECL Site Staff	PB & LPH	Hot Box Setting (^oC)	160	Balance Id	1222		

For all parameters a leak check is OPTIONAL at the end of the test.
(and when moving between sample ports if any disconnections are required).

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	2720654.2						
Final Volume	2724366.4						
Total Volume	3712.2	0.0	0.0	0.0	0.0	0.0	3712.2
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	8						
Time of Check	08:28						
Set Rate l/min	15						
Leak <2%?	YES						

Required Sample Flowrate l/min	Suggested ΔH Entered Below
3	1
6	3
10	10
15	25
25	50
Initial ΔH	15

Dry O_2 (Atmospheric)	6.55	Reference Oxygen Percentage	6
Dry Carbon Dioxide %	13.55		
Dry Carbon Monoxide ppm	101.48		

Traverse Point	A3	A3	A3	A3	A3	A3	A3	A3	Total
Time/Point (mins)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Meter (Tm in)	14.00	15.00	16.00	17.00	18.00	19.00	19.00	20.00	17.25
Meter (Tm out)	14.00	15.00	16.00	17.00	18.00	19.00	19.00	20.00	17.25
Stack Temp (Ts)	142.00	141.00	141.00	138.00	140.00	141.00	141.00	138.00	140.25
Impinger T Outlet	6.00	7.00	9.00	9.00	9.00	10.00	10.00	11.00	8.88
Vaccum (" Hg)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Traverse Point	A3	A3	A3	A3	A3	A3	A3	A3	Total
Time/Point(mins)	80 - 90	90 - 100	100 - 110	110 - 120	120 - 130	130 - 140	140 - 150	150 - 160	
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Meter (Tm in)	20.00	20.00	21.00	21.00	21.00	21.00	21.00	21.00	20.75
Meter (Tm out)	20.00	20.00	21.00	21.00	21.00	21.00	21.00	21.00	20.75
Stack Temp (Ts)	140.00	140.00	138.00	142.00	142.00	141.00	140.00	138.00	140.13
Impinger T Outlet	12.00	13.00	8.00	8.00	9.00	9.00	10.00	10.00	9.88
Vaccum (" Hg)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Traverse Point	A3	A3	A3	A3	A3	A3	A3	A3	Total
Time/Point(mins)	160 - 170	170 - 180	180 - 190	190 - 200	200 - 210	210 - 220	220 - 230	230 - 240	
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Meter (Tm in)	21.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	21.88
Meter (Tm out)	21.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	21.88
Stack Temp (Ts)	140.00	138.00	138.00	142.00	139.00	138.00	142.00	139.00	139.50
Impinger T Outlet	11.00	12.00	13.00	13.00	13.00	14.00	14.00	14.00	13.00
Vaccum (" Hg)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Impinger 1	3% H2O2	
SOL/	4804	
Start Weight (g)	636.9	
End Weight (g)	850.9	
Total weight (g)	214	
Impinger 2	3% H2O2	
SOL/	4804	
Start Weight (g)	659.3	
End Weight (g)	971.3	
Total weight (g)	312	
Impinger3	3% H2O2	
SOL/	4804	
Start Weight (g)	644.5	
End Weight (g)	876.3	
Total weight (g)	231.8	
Impinger 4	Empty	
SOL/	...	
Start Weight (g)	503.5	
End Weight (g)	506	
Total weight (g)	2.5	
Impinger 5	Silica	
SOL/	...	
Start Weight (g)	989	
End Weight (g)	1005.3	
Total weight (g)	16.3	
Impinger 6		
SOL/		
Start Weight (g)		
End Weight (g)		
Total weight (g)	0	
Impinger 7		
SOL/		
Start Weight (g)		
End Weight (g)		
Total weight (g)	0	
Impinger 8		
SOL/		
Start Weight (g)		
End Weight (g)		
Total weight (g)	0	
Total (g)	776.60	
Silica <50% used at End of Test? Y/N	YES	

Rinse Solutions used	
Solution	SOL NO
DI Water	4803
Acetone	4748

If moisture was not measured see detailed notes below.

Additional Moisture Weighings

Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

Dioxins & Furans

	DIOXIN & FURANS DATA SAMPLING PROFORMA	Date of Measurement	09/01/2023
ECL/TPD/	031	Time taken to change Ports?	5
Start Time	10:35	End Time	16:40
Sample Time (mins)	360		

Client	Western Bio-Energy Limited	Stack Profile	Circular	Console ID	U010	Barometer ID	352
Site	Margam	Stack Area (m^2)	2.011	Pump ID	U010	Nozzle ID	335
Location	Biomass Plant	Barometric Pressure (mb)	1004	Probe ID	149	Nozzle size	5.09
Stack ID	Main Stack	Static Pres. (mm H_20)	16.9	DGM Yd	0.9979	Filter ID	GFA
Test No.	Chlorinated D & F	Pitot coefficient	0.84	DH@	47.22	Pitot ID	668
Job No	P5200	Probe Heater Setting (°C)	120	Impinger ID	337	Hot Box ID	192
Operators	DB + LPH	Hot Box Setting (°C)	120	Balance ID	1222	XAD Therm ID	789

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	2728406.0	2731232.0					
Final Volume	2734137.8	2731244.8					
Total Volume	5731.8	12.8	0.0	0.0	0.0	0.0	5719.0
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.1	0.1	0.2				
Vaccum "Hg	-14	-12	-12				
Time of Check	10:30	13:38	16:43				
Set Rate l/min	20	15.7	15.92				
Leak <4%?	YES	YES	YES				

Original K Factor Settings	
Meter Temp.	20
Stack Temp	140
%Moisture	20.00
Silica <50% Spent at End of Test?	Yes
K factor	0.9
Reference Oxygen Percentage	6

Smooth Walls

Dry O_2 (Atmospheric)	8.17
Dry Carbon Dioxide %	13.55

Leak check ALWAYS needs to be performed when moving between sample ports.
Leak check IS ALWAYS required on completion of the sample.

Traverse Point	A1	A1	A2	A2	A3	A3	A4	A4	Total
Time/Point(mins)	0 - 15	15 - 30	30 - 45	45 - 60	60 - 75	75 - 90	90 - 105	105 - 120	
DP (mm H20)	26.0	26.0	28.0	28.0	32.0	34.0	30.0	30.0	29.3
K factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
DH (Orifice)	23.40	23.40	25.20	25.20	28.80	30.60	27.00	27.00	26.3
Meter (Tm in)	11.60	12.80	14.70	15.00	15.10	15.30	15.20	15.50	14.4
Meter (Tm out)	11.60	12.80	14.70	15.00	15.10	15.00	15.20	15.50	14.4
Stack Temp (Ts)	133.20	133.20	133.60	133.00	134.00	134.00	133.20	132.40	133.3
Impinger T Outlet	7.00	7.40	9.40	9.40	10.20	9.30	9.40	10.30	9.1
Vaccum (" Hg)	7.00	7.00	7.00	7.00	7.00	8.00	8.00	8.00	7.4
XAD Temperature (°C)	5.00	6.00	7.00	7.00	8.00	5.00	5.00	6.00	6.1
Traverse Point	A5	A5	A6	A6	B1	B1	B2	B2	Total
Time/Point(mins)	120 - 135	135 - 150	150 - 165	165 - 180	180 - 195	195 - 210	210 - 225	225 - 240	
DP (mm H20)	26.0	30.0	26.0	26.0	26.0	26.0	30.0	26.0	27.0
K factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
DH (Orifice)	23.40	27.00	23.40	23.40	23.40	23.40	27.00	23.40	24.3
Meter (Tm in)	15.9	15.7	15.6	15.6	15.6	15.8	15.9	16.0	15.8
Meter (Tm out)	15.9	15.7	15.6	15.6	15.6	15.8	15.9	16.0	15.8
Stack Temp (Ts)	131.4	131.1	130.0	130.2	130.3	130.4	130.6	130.7	130.6
Impinger T Outlet	11.0	9.5	9.8	10.2	8.1	9.8	10.6	10.7	10.0
Vaccum (" Hg)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
XAD Temperature (°C)	6.00	6.00	7.00	7.00	7.00	8.00	8.00	9.00	7.3
Traverse Point	B3	B3	B4	B4	B5	B5	B6	B6	Total
Time/Point(mins)	240 - 255	255 - 270	270 - 285	285 - 300	300 - 315	315 - 330	330 - 345	345 - 360	
DP (mm H20)	30.0	30.0	32.0	26.0	25.8	32.0	30.0	30.0	29.5
K factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
DH (Orifice)	27.00	27.00	28.80	23.40	23.22	28.80	27.00	27.00	26.5
Meter (Tm in)	16.0	16.1	16.1	16.2	16.2	16.3	16.3	16.3	16.2
Meter (Tm out)	16.0	16.1	16.1	16.2	16.2	16.3	16.3	16.3	16.2
Stack Temp (Ts)	130.9	131.1	130.7	130.9	131.2	130.8	130.9	130.7	130.9
Impinger T Outlet	10.9	11.0	11.0	11.1	11.4	11.8	12.2	12.8	11.5
Vaccum (" Hg)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
XAD Temperature (°C)	9.00	9.00	9.00	10.00	10.00	11.00	11.00	11.00	10.0
Traverse Point									Total
Time/Point(mins)									
DP (mm H20)									
K factor									
DH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									
XAD Temperature (°C)									

Impinger 1	XAD
TRAP ID	732
Start Weight (g)	223.6
End Weight (g)	227.8
Total weight (g)	4.2
Impinger 2	Condenser
Start Weight (g)	370.5
End Weight (g)	1209.4
Total weight (g)	838.9
Impinger3	Empty
Start Weight (g)	523.6
End Weight (g)	824.6
Total weight (g)	301
Impinger 4	Empty
Start Weight (g)	598.9
End Weight (g)	660.6
Total weight (g)	61.7
Impinger 5	Silica
Start Weight (g)	712.6
End Weight (g)	765.9
Total weight (g)	53.3
Impinger 6	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 7	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 8	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Total (g)	1259.1

Rinse Solutions used	
Solution	SOL NO
DCM	4749
Acetone	4795
Toluene	4750

Additional Moisture Weighings

Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

PRE-Sample PITOT Visual Inspection	
Time	10:31
Pass ? (Y/N)	Y

PRE-Sample PITOT Leak Check	
Time	10:33
Pass ? (Y/N)	Y

Post-Sample Blockage Check (L-type)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	

POST-Sample PITOT Visual Inspection	
Time	16:45
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	16:47
Pass ? (Y/N)	Y

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Heavy Metals

METALS DATA SAMPLING PROFORMA | Date of Measurement: 05/01/2023

ECL/TPD/: 028 | Time taken to change Ports?: 2 | Start Time: 15:00 | Test Duration: 60 mins | End Time: 16:02

Client	Western Bio-Energy Limited	Stack Profile	Circular	Console id	U010	Barometer id	352
Site	Margam	Stack Area (m^2)	2.01	Pump id	U010	Nozzle Id	335
Location	Biomass Plant	Barometric Pressure (mb)	1018	Probe id	149	Nozzle size	5.09
Stack ID	Main Stack	Static Pres. (mm $H^2$0)	16.9	DGM Yd	0.9979	Filter Id	UW QMA
Test No.	Heavy Metals	Pitot coefficient	0.84	ΔH@	47.22	Pitot ID	668
Job No	P5200	Probe Heater Setting (°C)	180	Impinger Id	337	Hot Box ID	192
ECL Site Staff	PB, DB & LPH	Hot Box Setting (°C)	180	Balance Id	1222		

Rinse Solutions used

Solution	SOL NO
5% HNO3	4800

NB: Leak Check - Record Actual leak rate or '0' but not 'less than' values

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	2717228.0						
Final Volume	2718300.2						
Total Volume	1072.2	0.0	0.0	0.0	0.0	0.0	1072.2
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	12						
Time of Check	14:58						
Set Rate l/min	20						
Leak <2%?	YES						

Smooth Walls

Dry O_2 ☐ A(tmospheric) 6.66
Dry Carbon Dioxide % 13.55

Leak checks DO NOT NEED to be performed (BUT ARE ALLOWED) at the end of the test or when moving between sample ports, EVEN when disconnections are made.

Original K Factor Settings

Meter Temp.	20
Stack Temp	140
%Moisture	20.00
Silica <50% Spent at End of Test?	YES
K factor	0.9
Reference Oxygen Percentage	6

Traverse Point	A1	A2	A3	A4	A5	A6	B1	B2	Total
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (mm H20)	36.00	36.00	34.00	34.00	32.00	32.00	38.00	36.00	34.8
K factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
ΔH (Orifice)	32.40	32.40	30.60	30.60	28.80	28.80	34.20	32.40	31.3
Meter (Tm in)	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.0
Meter (Tm out)	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.0
Stack Temp (Ts)	140.00	141.00	142.00	142.00	142.00	141.00	141.00	141.00	141.3
Impinger T Outlet	7.00	7.00	7.00	7.00	8.00	8.00	8.00	8.00	7.5
Vaccum (" Hg)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10

Traverse Point	B3	B4	B5	B6					Total
Time/Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔP (mm H20)	36.00	34.00	34.00	32.00					34.0
K factor	0.90	0.90	0.90	0.90					
ΔH (Orifice)	32.40	30.60	30.60	28.80					30.6
Meter (Tm in)	22.00	23.00	23.00	23.00					22.8
Meter (Tm out)	22.00	23.00	23.00	23.00					22.8
Stack Temp (Ts)	140.00	140.00	139.00	139.00					139.5
Impinger T Outlet	9.00	9.00	9.00	9.00					9.0
Vaccum (" Hg)	10.00	10.00	10.00	10.00					10

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

	HNO3 / H2O2
Impinger 1	
SOL/	4799
Start Weight (g)	671.2
End Weight (g)	841.5
Total weight (g)	170.3
Impinger 2	
SOL/	4799
Start Weight (g)	662.9
End Weight (g)	709
Total weight (g)	46.1
Impinger3	
SOL/	4799
Start Weight (g)	614.7
End Weight (g)	621.6
Total weight (g)	6.9
Impinger 4	Empty
SOL/	...
Start Weight (g)	504.1
End Weight (g)	505.2
Total weight (g)	1.1
Impinger 5	Silica
SOL/	...
Start Weight (g)	978.4
End Weight (g)	987.7
Total weight (g)	9.3
Impinger 6	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 7	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Total (g)	233.7

Pitot Quality Control Checks

PRE-Sample PITOT Visual Inspection	
Time	14:54
Pass ? (Y/N)	Y
PRE-Sample PITOT Leak Check	
Time	14:56
Pass ? (Y/N)	Y
Post-Sample Blockage Check (L-Type ONLY)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	
POST-Sample PITOT Visual Inspection	
Time	16:04
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	16:06
Pass ? (Y/N)	Y

Additional Moisture Weighings

Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0

Mercury

METALS DATA SAMPLING PROFORMA | Date of Measurement: 06/01/2023

ECL/TPD/: 030 | Time taken to change Ports?: 2 | Start Time: 13:10 | Test Duration: 60 mins | End Time: 14:12

Client	Western Bio-Energy Limited	Stack Profile	Circular	Console id	U010	Barometer id	352
Site	Margam	Stack Area (m^2)	2.01	Pump id	U010	Nozzle Id	335
Location	Biomass Plant	Barometric Pressure (mb)	1014	Probe id	149	Nozzle size	5.09
Stack ID	Main Stack	Static Pres. (mm $H^2$0)	16.9	DGM Yd	0.9979	Filter Id	UW QMA
Test No.	Mercury	Pitot coefficient	0.84	ΔH@	47.22	Pitot ID	668
Job No	P5200	Probe Heater Setting (°C)	180	Impinger Id	337	Hot Box ID	192
ECL Site Staff	PB & LPH	Hot Box Setting (°C)	180	Balance Id	1222		

Rinse Solutions used

Solution	SOL NO
5% HNO3	4800

NB: Leak Check - Record Actual leak rate or '0' but not 'less than' values

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	2725942.4						
Final Volume	2726956.8						
Total Volume	1014.4	0.0	0.0	0.0	0.0	0.0	1014.4
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	12						
Time of Check	13:08						
Set Rate l/min	20						
Leak <2%?	YES						

Smooth Walls

Dry O_2 ☐ A(tmospheric) 6.60
Dry Carbon Dioxide % 13.55

Leak checks DO NOT NEED to be performed (BUT ARE ALLOWED) at the end of the test or when moving between sample ports, EVEN when disconnections are made.

Original K Factor Settings

Meter Temp.	20
Stack Temp	140
%Moisture	20.00
Silica <50% Spent at End of Test?	YES
K factor	0.9
Reference Oxygen Percentage	6

Traverse Point	A1	A2	A3	A4	A5	A6	B1	B2	Total
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (mm H20)	36.00	34.00	34.00	34.00	32.00	32.00	38.00	38.00	34.8
K factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
ΔH (Orifice)	32.40	30.60	30.60	30.60	28.80	28.80	34.20	34.20	31.3
Meter (Tm in)	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.0
Meter (Tm out)	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.0
Stack Temp (Ts)	138.00	138.00	139.00	140.00	140.00	140.00	141.00	140.00	139.5
Impinger T Outlet	7.00	7.00	7.00	7.00	8.00	8.00	8.00	8.00	7.5
Vaccum (" Hg)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10

Traverse Point	B3	B4	B5	B6					Total
Time/Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔP (mm H20)	36.00	36.00	34.00	32.00					34.5
K factor	0.90	0.90	0.90	0.90					
ΔH (Orifice)	32.40	32.40	30.60	28.80					31.1
Meter (Tm in)	22.00	22.00	22.00	22.00					22.0
Meter (Tm out)	22.00	22.00	22.00	22.00					22.0
Stack Temp (Ts)	139.00	139.00	140.00	140.00					139.5
Impinger T Outlet	8.00	9.00	9.00	9.00					8.8
Vaccum (" Hg)	10.00	10.00	10.00	10.00					10

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

	K2Cr2O7 / 20 % HNO3
Impinger 1	
SOL/	4802
Start Weight (g)	677.7
End Weight (g)	846.1
Total weight (g)	168.4
Impinger 2	
SOL/	4802
Start Weight (g)	585.6
End Weight (g)	628.5
Total weight (g)	42.9
Impinger3	Empty
SOL/	
Start Weight (g)	485.9
End Weight (g)	495.2
Total weight (g)	9.3
Impinger 4	Silica
SOL/	
Start Weight (g)	1005.3
End Weight (g)	1018.7
Total weight (g)	13.4
Impinger 5	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 6	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 7	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Total (g)	234.0

Pitot Quality Control Checks

PRE-Sample PITOT Visual Inspection	
Time	13:04
Pass ? (Y/N)	Y
PRE-Sample PITOT Leak Check	
Time	13:06
Pass ? (Y/N)	Y
Post-Sample Blockage Check (L-Type ONLY)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	
POST-Sample PITOT Visual Inspection	
Time	14:19
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	14:21
Pass ? (Y/N)	Y

Additional Moisture Weighings

Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0
Item Name		
Start Weight (g)		
End Weight (g)		
Total weight (g)		0

LABORATORY ANALYSIS RESULTS

Laboratory analysis for Particulates, Hydrogen Chloride, Hydrogen Fluoride, ammonia, Sulphur Dioxide & Heavy Metals, Mercury was subcontracted to RPS laboratories, a UKAS Accredited Testing Laboratory, Number 0605.

RPS DO/ DO NOT hold UKAS & MCERTS accreditation for this analysis.

As required by the MCERTS Performance Standard for Organisations, the analysis results are shown below.

Laboratory analysis for Dioxins& Furans was subcontracted to Marchwood, a UKAS Accredited Testing Laboratory, Number 1668.

Marchwood DO hold UKAS & MCERTS accreditation for this analysis.

As required by the MCERTS Performance Standard for Organisations, the analysis results are shown below.

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Results Summary

Report No.: 23-00403-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Customer Sample No	ECL/23/0052	ECL/23/0053	ECL/23/0054	ECL/23/0055	ECL/23/0056	ECL/23/0057
RPS Sample No	155254	155255	155256	155257	155258	155259
Sample Matrix	FILTER	SOLUTION	FILTER	SOLUTION	FILTER	SOLUTION
Sampling Date	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023

Determinand	CAS No	Codes	SOP	RL	Units						
particulates		UM	D9	0.04	mg	0.52		S/C		S/C	
particulates		UM	D9	0.5	mg		0.6		< 0.5		< 0.5

Comments

Report No.: 23-00403-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

RPS Sample Number	Customer Number	Sample Comments
155256	ECL/23/0054	<0.1 mg
155258	ECL/23/0056	<0.1 mg

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Results Summary

Report No.: 23-00404-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Customer Sample No	ECL/23/0058	ECL/23/0059	ECL/23/0060	ECL/23/0061	ECL/23/0062	ECL/23/0063	ECL/23/0064	ECL/23/0065	ECL/23/0066	ECL/23/0067	ECL/23/0068
RPS Sample No	155260	155261	155262	155263	155264	155265	155266	155267	155268	155269	155270
Sample Matrix	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION	SOLUTION
Sampling Date	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	06/01/2023	06/01/2023	06/01/2023

Determinand	CAS No	Codes	SOP	RL	Units											
volume of sample supplied		U	N/A	n/a	ml	706	328	390	426	812	346	478	506	1050	491	365
ammonia	7664-41-7	UM	A6	0.1	ug/mL					7.6	< 0.1	< 0.1	< 0.1			
hydrogen chloride	7647-01-0	UM	C27	0.05	ug/mL	33.3	< 0.05	< 0.05	< 0.05							
sulphur dioxide	7446-09-5	UM	C27	0.05	ug/mL									63.6	0.19	0.19
hydrogen fluoride	7664-39-3	UM	C27	0.05	ug/mL	< 0.05	< 0.05	< 0.05	< 0.05							

Results Summary

Report No.: 23-00404-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Customer Sample No	ECL/23/0069
RPS Sample No	155271
Sample Matrix	SOLUTION
Sampling Date	06/01/2023

Determinand	CAS No	Codes	SOP	RL	Units	
volume of sample supplied		U	N/A	n/a	ml	376
ammonia	7664-41-7	UM	A6	0.1	ug/mL	
hydrogen chloride	7647-01-0	UM	C27	0.05	ug/mL	
sulphur dioxide	7446-09-5	UM	C27	0.05	ug/mL	0.18
hydrogen fluoride	7664-39-3	UM	C27	0.05	ug/mL	

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Results Summary

Report No.: 23-00405-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Customer Sample No	ECL/23/0070	ECL/23/0071	ECL/23/0072	ECL/23/0073	ECL/23/0074	ECL/23/0075	ECL/23/0076	ECL/23/0077	ECL/23/0078	ECL/23/0079	ECL/23/0080
RPS Sample No	155272	155273	155274	155275	155276	155277	155278	155279	155280	155281	155282
Sample Matrix	FILTER	SOLUTION	SOLUTION	SOLUTION	FILTER	SOLUTION	SOLUTION	SOLUTION	FILTER	SOLUTION	SOLUTION
Sampling Date	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	06/01/2023	06/01/2023	06/01/2023

Determinand	CAS No	Codes	SOP	RL	Units											
volume of sample supplied		U	N/A	n/a	ml		136	611	330		179	280	155		157	361
arsenic	7440-38-2	UM	M31	0.2	ug	1.8				< 0.2						
cadmium	7440-43-9	UM	M31	0.2	ug	< 0.2				< 0.2						
cobalt	7440-48-4	UM	M31	0.2	ug	< 0.2				< 0.2						
chromium	7440-47-3	UM	M31	0.3	ug	2.2				2.0						
copper	7440-50-8	UM	M31	0.2	ug	0.3				< 0.2						
manganese	7439-96-5	UM	M31	0.2	ug	1.5				1.2						
nickel	7440-02-0	UM	M31	0.5	ug	5.5				5.4						
lead	7439-92-1	UM	M31	0.3	ug	1.1				0.4						
antimony	7440-36-0	UM	M31	0.4	ug	12.4				< 0.4						
thallium	7440-28-0	UM	M31	0.2	ug	< 0.2				< 0.2						
vanadium	7440-62-2	UM	M31	0.2	ug	< 0.2				< 0.2						
arsenic	7440-38-2	UM	M31	0.3	ug		< 0.3				< 0.3					
cadmium	7440-43-9	UM	M31	0.3	ug		< 0.3				< 0.3					
cobalt	7440-48-4	UM	M31	0.3	ug		< 0.3				< 0.3					
chromium	7440-47-3	UM	M31	0.3	ug		9.7				2.5					
copper	7440-50-8	UM	M31	0.4	ug		1.9				< 0.4					
manganese	7439-96-5	UM	M31	0.2	ug		4.3				< 0.2					
nickel	7440-02-0	UM	M31	0.1	ug		11.4				< 0.1					
lead	7439-92-1	UM	M31	0.2	ug		2.2				< 0.2					
antimony	7440-36-0	UM	M31	0.2	ug		< 0.2				< 0.2					
thallium	7440-28-0	UM	M31	0.2	ug		< 0.2				< 0.2					
vanadium	7440-62-2	UM	M31	0.2	ug		1.2				< 0.2					
arsenic	7440-38-2	UM	M31	0.3	ug/L			7.6	< 0.3			< 0.3	< 0.3			
cadmium	7440-43-9	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2			
cobalt	7440-48-4	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2			
chromium	7440-47-3	UM	M31	0.2	ug/L			18.4	< 0.2			< 0.2	0.2			
copper	7440-50-8	UM	M31	0.4	ug/L			18.6	< 0.4			< 0.4	< 0.4			
manganese	7439-96-5	UM	M31	0.2	ug/L			1.6	< 0.2			< 0.2	< 0.2			
nickel	7440-02-0	UM	M31	0.3	ug/L			1.9	< 0.3			< 0.3	< 0.3			
lead	7439-92-1	UM	M31	0.2	ug/L			10.1	< 0.2			< 0.2	< 0.2			
antimony	7440-36-0	UM	M31	0.2	ug/L			2.0	< 0.2			< 0.2	< 0.2			
thallium	7440-28-0	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2			

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Results Summary

Report No.: 23-00405-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Customer Sample No	ECL/23/0070	ECL/23/0071	ECL/23/0072	ECL/23/0073	ECL/23/0074	ECL/23/0075	ECL/23/0076	ECL/23/0077	ECL/23/0078	ECL/23/0079	ECL/23/0080
RPS Sample No	155272	155273	155274	155275	155276	155277	155278	155279	155280	155281	155282
Sample Matrix	FILTER	SOLUTION	SOLUTION	SOLUTION	FILTER	SOLUTION	SOLUTION	SOLUTION	FILTER	SOLUTION	SOLUTION
Sampling Date	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	05/01/2023	06/01/2023	06/01/2023	06/01/2023

Determinand	CAS No	Codes	SOP	RL	Units											
vanadium	7440-62-2	UM	M31	0.1	ug/L			< 0.1	< 0.1			< 0.1	< 0.1			
mercury	7439-97-6	UM	M112	0.03	ug									< 0.03		
mercury	7439-97-6	UM	M112	0.5	ug/l											< 0.5
mercury	7439-97-6	UM	M112	0.5	ug/l										< 0.50	

Results Summary

Report No.: 23-00405-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Customer Sample No	ECL/23/0081	ECL/23/0082	ECL/23/0083	ECL/23/0084	ECL/23/0085
RPS Sample No	155283	155284	155285	155286	155287
Sample Matrix	SOLUTION	FILTER	SOLUTION	SOLUTION	SOLUTION
Sampling Date	06/01/2023	06/01/2023	06/01/2023	06/01/2023	06/01/2023

Determinand	CAS No	Codes	SOP	RL	Units					
vanadium	7440-62-2	UM	M31	0.1	ug/L					
mercury	7439-97-6	UM	M112	0.03	ug		< 0.03			
mercury	7439-97-6	UM	M112	0.5	ug/l	< 0.5			< 0.5	< 0.5
mercury	7439-97-6	UM	M112	0.5	ug/l			< 0.50		

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Results Summary

Report No.: 23-00405-1

Customer Reference: 2023 Stack Preferential Rates

Customer Order No: E0232 P5200

Determinand	CAS No	Codes	SOP	RL	Units	Customer Sample No	ECL/23/0081	ECL/23/0082	ECL/23/0083	ECL/23/0084	ECL/23/0085
						RPS Sample No	155283	155284	155285	155286	155287
						Sample Matrix	SOLUTION	FILTER	SOLUTION	SOLUTION	SOLUTION
						Sampling Date	06/01/2023	06/01/2023	06/01/2023	06/01/2023	06/01/2023
volume of sample supplied		U	N/A	n/a	ml		212		152	250	114
arsenic	7440-38-2	UM	M31	0.2	ug						
cadmium	7440-43-9	UM	M31	0.2	ug						
cobalt	7440-48-4	UM	M31	0.2	ug						
chromium	7440-47-3	UM	M31	0.3	ug						
copper	7440-50-8	UM	M31	0.2	ug						
manganese	7439-96-5	UM	M31	0.2	ug						
nickel	7440-02-0	UM	M31	0.5	ug						
lead	7439-92-1	UM	M31	0.3	ug						
antimony	7440-36-0	UM	M31	0.4	ug						
thallium	7440-28-0	UM	M31	0.2	ug						
vanadium	7440-62-2	UM	M31	0.2	ug						
arsenic	7440-38-2	UM	M31	0.3	ug						
cadmium	7440-43-9	UM	M31	0.3	ug						
cobalt	7440-48-4	UM	M31	0.3	ug						
chromium	7440-47-3	UM	M31	0.3	ug						
copper	7440-50-8	UM	M31	0.4	ug						
manganese	7439-96-5	UM	M31	0.2	ug						
nickel	7440-02-0	UM	M31	0.1	ug						
lead	7439-92-1	UM	M31	0.2	ug						
antimony	7440-36-0	UM	M31	0.2	ug						
thallium	7440-28-0	UM	M31	0.2	ug						
vanadium	7440-62-2	UM	M31	0.2	ug						
arsenic	7440-38-2	UM	M31	0.3	ug/L						
cadmium	7440-43-9	UM	M31	0.2	ug/L						
cobalt	7440-48-4	UM	M31	0.2	ug/L						
chromium	7440-47-3	UM	M31	0.2	ug/L						
copper	7440-50-8	UM	M31	0.4	ug/L						
manganese	7439-96-5	UM	M31	0.2	ug/L						
nickel	7440-02-0	UM	M31	0.3	ug/L						
lead	7439-92-1	UM	M31	0.2	ug/L						
antimony	7440-36-0	UM	M31	0.2	ug/L						
thallium	7440-28-0	UM	M31	0.2	ug/L						

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

CERTIFICATE OF ANALYSIS

MSSL reference: 23-48763

Report date: 26-01-2023

Customer: Environmental Compliance Ltd
Unit 1G,
Main Avenue,
Treforest Industrial Estate,
Pontypridd,
CF37 5BF

Customer contact(s): -

Customer reference: P5200
Customer PO: E0233
Customer sampling date: 09-01-2023
Date received: 13-01-2023

Analysis started: 19-01-2023
Analysis complete: 23-01-2023
Conforming: YES

Accreditation Key:
Y : ISO/IEC 17025 M : MCERTS
N : Non Accredited (S) : Subcontracted

Notes:

Reported by: Lesley Jeffery
Position: Scientist

Approved by: Giuseppe Reitano
Position: Technical Laboratory Manager
For/on behalf of Marchwood Scientific Services Ltd

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t: 02380 786979 w: www.cawood.co.uk/marchwood
Marchwood, 371 Millbrook Road West, Southampton SO15 0HW
www.cawood.co.uk

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

270166 Dioxin Results Summary

Sample Type : Stack
MSS Sample Ref : 270166
Customer Sample Ref : ECL/23/0046 -ECL/23/0048
Sample Condition : Conforming
Test Method : 2002b

Dioxins/ Furans

Analysis	Accreditation	Lower Bound	Upper Bound
I-TEQ	M	0.0107	0.0113

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

270166 Dioxin Results

Sample Type : Stack
MSS Sample Ref : 270166
Customer Sample Ref : ECL/23/0046 -ECL/23/0048
Sample Condition : Conforming
Test Method : 2002b

Congener	LOD	Detected	Lower Bound	Upper Bound	Recovery	Sampling Recovery	UKAS
Dioxins/Furans	**ng/Sample**	**ng/Sample**	**ng/Sample**	**ng/Sample**	**%**	**%**	
2378-TCDD	0.00051	< 0.00051	0.0000	0.00051	103		M
12378-PeCDD	0.00120	0.00384	0.00192	0.00192	84		M
123478-HxCDD	0.00096	0.00564	0.00056	0.00056	81		M
123678-HxCDD	0.00096	0.0121	0.00121	0.00121	89		M
123789-HxCDD	0.00091	0.00671	0.00067	0.00067			M
1234678-HpCDD	0.00049	0.0557	0.00056	0.00056	84		M
OCDD	0.00053	0.0615	0.00006	0.00006	78		M
Dioxins Total			**0.00498**	**0.00549**			M
2378-TCDF	0.00116	0.0103	0.00103	0.00103	89		M
12378-PeCDF	0.00087	0.00412	0.00021	0.00021		105	M
23478-PeCDF	0.00085	0.00556	0.00278	0.00278	86		M
123478-HxCDF	0.00042	0.00466	0.00047	0.00047	85		M
123678-HxCDF	0.00043	0.00546	0.00055	0.00055	89		M
234678-HxCDF	0.00037	0.00523	0.00052	0.00052	91		M
123789-HxCDF	0.00036	< 0.00036	0.0000	0.00004		90	M
1234678-HpCDF	0.00025	0.0174	0.00017	0.00017	85		M
1234789-HpCDF	0.00029	0.00216	0.00002	0.00002		102	M
OCDF	0.00025	0.00469	0.00000	0.00000	72		M
Furans Total			**0.00575**	**0.00579**			M
Dioxin/Furan Total			**0.0107**	**0.0113**			M

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

270167 Dioxin Results Summary

Sample Type : Stack
MSS Sample Ref : 270167
Customer Sample Ref : ECL/23/0049 -ECL/23/0051
Sample Condition : Conforming
Test Method : 2002b

Dioxins/ Furans

Analysis	Accreditation	Lower Bound	Upper Bound
I-TEQ	M	0.00170	0.00213

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

270167 Dioxin Results

Sample Type : Stack
MSS Sample Ref : 270167
Customer Sample Ref : ECL/23/0049 -ECL/23/0051
Sample Condition : Conforming
Test Method : 2002b

Congener	LOD	Detected	Lower Bound	Upper Bound	Recovery	Sampling Recovery	UKAS
Dioxins/Furans	**ng/Sample**	**ng/Sample**	**ng/Sample**	**ng/Sample**	**%**	**%**	
2378-TCDD	0.00014	< 0.00014	0.0000	0.00014	100		M
12378-PeCDD	0.00044	< 0.00044	0.0000	0.00022	87		M
123478-HxCDD	0.00026	< 0.00026	0.0000	0.00003	82		M
123678-HxCDD	0.00027	0.00090	0.00009	0.00009	79		M
123789-HxCDD	0.00026	0.00073	0.00007	0.00007			M
1234678-HpCDD	0.00028	0.00644	0.00006	0.00006	77		M
OCDD	0.00041	0.0155	0.00002	0.00002	75		M
Dioxins Total			**0.00024**	**0.00063**			M
2378-TCDF	0.00036	0.00085	0.00008	0.00008	88		M
12378-PeCDF	0.00029	0.00141	0.00007	0.00007		108	M
23478-PeCDF	0.00028	0.00152	0.00076	0.00076	84		M
123478-HxCDF	0.00022	< 0.00022	0.0000	0.00002	79		M
123678-HxCDF	0.00021	0.00210	0.00021	0.00021	80		M
234678-HxCDF	0.00020	0.00252	0.00025	0.00025	82		M
123789-HxCDF	0.00019	< 0.00019	0.0000	0.00002		91	M
1234678-HpCDF	0.00019	0.00695	0.00007	0.00007	77		M
1234789-HpCDF	0.00022	0.00084	0.00001	0.00001		103	M
OCDF	0.00020	0.00197	0.00000	0.00000	68		M
Furans Total			**0.00146**	**0.00150**			M
Dioxin/Furan Total			**0.00170**	**0.00213**			M

UNCERTAINTY CALCULATIONS

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

TVOC Measurement Uncertainty

Main Stack - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges TVOC 0 - 15 mgC/m^3
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.73
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.35
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	1.61
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	0.11
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.30
Interferents[1]	u_i	Rectangular (Divisor = √3)	4.39
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	0.84

Note:

$$when\ \left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the certified range
2 Expressed as maximum drift per 24hr period as percentage of the certified range
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m^3 / %Vol taking account of an additional uncertainty of 2% for gas blending
7 Expressed as a percentage of the certified range

Main Stack - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.24
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.0096
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.013
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	0.48
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	0.79
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	1.58
Applied Span Concentration			48.39
Measured Span Concentration, STP Dry Gas			48.53
Expanded measurement uncertainty as % of Applied Span			3 %

* Signal 3030 FID

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – January 2023**
Variation No	**: V005**	**Survey Dates**	**: 5th – 9th January 2023**
Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

TVOC Uncertainty of Measurement Results

Main Stack - TVOC - Uncertainty of Measurement Results - Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range O_2 0 - 25 %Vol	Min Certified Range TVOC 0 - 15 mgC/m³
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.13	0.73
Span drift[2]	$u_{d,s}$			0.029	0.35
Losses / leakage in the sample system[4]	u_{loss}			1.00	0.055
Temperature dependant span drift[5]	u_t			0.070	0.30
Interferents[1]	u_i			0.56	4.39
Effect of Voltage Fluctuation[7]	u_v			...	1.80
Effect of Oxygen Synergism[7]	u_{syn}			...	

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})(x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	O_2 0 - 25 %Vol	TVOC 0 - 15 mgC/m³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.019	0.064
Span drift	$u_{d,s}$			0.0041	0.031
Temperature dependant span drift	u_t			0.0051	0.013
Interferents	u_i			0.081	0.38
Effect of Voltage Fluctuation (See Note)	u_v			...	0.16

Main Stack - TVOC - Uncertainty of Measurement Results - Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	O_2 0 - 25 %Vol	TVOC 0 - 15 mgC/m³
Losses / leakage in the sample system	u_{loss}	05/01/23 13:00 - 14:00	0.069	0.0015
Standard Error of Measured Value	u_{SE}	05/01/23 13:00 - 14:00	0.032	0.019
Uncertainty due to Moisture Correction[6]	u_{H2O}	05/01/23 13:00 - 14:00	0.27	0.081

Effect on Uncertainty Caused by Oxygen

$$uCorr^{n}_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \text{ x Uncertainty of } O_2 \text{ Meas} = 0.03$$

$$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.0609$$

$$uf_{O_2} = \frac{uCorr^{n}_{O_2}}{f_{O_2}} x100 = 2.56 \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Main Stack - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	O_2 0 - 25 %Vol	*TVOC 0 - 15 mgC/m³
Measured Concentration	05/01/23 13:00 - 14:00	6.85	2.72
Expanded Uncertainty as Percentage of Measured Concentration		8 %	29 %

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{syn}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the applied span concentration
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of moisture is taken from the manual extract test calculations.
7 Expressed as a percentage of the certified range
8 Where no uncertainty is presented above, the uncertainty is >100%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Combustion Gases (NO_x, CO & O_2) Measurement Uncertainty

Measurement Uncertainty Calculations Part 1

Horiba PG 350 E Performance Characteristics	Standard Uncertainty (% of Range)	Distributiuon	Minimum Certified Range (R_i) NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.75	0.61	0.10
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.094	0.056	0.0057
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	0.76	1.18	0.094
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	2.13	1.41	0.041
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.051	0.057	0.014
Interferents[1]	u_i	Rectangular (Divisor = √3)	0.52	0.87	0.010
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	5.51	6.63	0.15
Effect of Voltage Fluctuation[7]	u_v	Rectangular (Divisor = √3)	0.40	0.50	0.020
Effect of Sample Gas Flow/ Pressure[7]	u_{sg}	Rectangular (Divisor = √3)	0.10	0.10	0.10

Note:

$$when\ \left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
7 Expressed as a percentage of the certified range

Measurement Uncertainty Calculations Part 2

Horiba PG 350 E Performance Characteristics	Uncertainty	Value of Standard Uncertainty	NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.58	0.26	0.014
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.073	0.024	0.00082
Repeatability Standard Deviation (span	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.76	1.18	0.094
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	1.65	0.61	0.0059
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.020	0.012	0.0010
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.40	0.38	0.0014
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	3.18	3.83	0.087
Effect of Voltage Fluctuation [7]	u_v	$u(x_i) = \frac{u_v \times R_i}{\sqrt{3}} =$	0.23	0.29	0.012
Effect of Sample Gas Flow / Pressure [7]	u_{sg}	$u(x_i) = \frac{usg \times R_i}{\sqrt{3}} =$	0.058	0.058	0.058
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2} + u2v + u2sg$	3.74	4.09	0.14
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	7.47	8.17	0.28
Applied Span Concentration			317.96	382.63	14.99
Measured Span Concentration, STP Dry Gas			315.67	382.31	15.02
Expanded measurement uncertainty as % of Applied Span			2%	2%	2%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
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Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Combustion Gases (NO_x, CO & O_2) Uncertainty of Measurement Results

Uncertainty of Measurement Results - Calculations Part 1

Horiba PG 350 E Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Minimum Certified Range (R_i) NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.75	0.61	0.10
Span drift[2]	$u_{d,s}$			0.094	0.056	0.0057
Losses / leakage in the sample system[4]	u_{loss}			2.13	1.41	0.04
Temperature dependant span drift[5]	u_t			0.051	0.057	0.014
Interferents[1]	u_i			0.52	0.87	0.010
Effect of Voltage Fluctuation[7]	u_v			0.40	0.50	0.020
Sample Gas Pressure/ Flow[7]	u_{sg}			0.10	0.10	0.10

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,\max} - x_{i,adj})^2 + (x_{i,\min} - x_{i,adj})(x_{i,\max} - x_{i,adj}) + (x_{i,\min} - x_{i,adj})^2}{3}}$, when $|(x_{i,\max} - x_{i,adj})| = |(x_{i,\min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Horiba PG 350 E Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.58	0.26	0.014
Span drift	$u_{d,s}$			0.073	0.024	0.00082
Temperature dependant span drift	u_t			0.020	0.012	0.0010
Interferents	u_i			0.40	0.38	0.0014
Effect of Voltage Fluctuation[7]	u_v			0.31	0.22	0.0029
Sample Gas Pressure/ Flow[7]	u_{sg}			0.077	0.043	0.014

Uncertainty of Measurement Results - Calculations Part 2

Horiba PG 350 E Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Losses / leakage in the sample system	u_{loss}	05/01/23 14:00 - 15:00	3.80	1.67	0.003
Standard Error of Measured Value	u_{SE}	05/01/23 14:00 - 15:00	2.04	3.14	0.081

Effect on Uncertainty Caused by Oxygen $uCorr^{n}_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} x\,Uncertainty\ of\ O_2\ Measurement =$ 0.027

$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} =$ 2.1871 $uf_{O_2} = \frac{uCorr^{n}_{O_2}}{f_{O_2}} x100 =$ 1.24 %

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Uncertainty of Measurement Results - Calculations Part 3

Horiba PG 350 E Uncertainty	Date & Time	NOx (as NO2) 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Measured Concentration	05/01/23 14:00 - 15:00	178.73	119.10	6.81
Expanded Uncertainty as Percentage of Measured Concentration		5%	6%	3%

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{sg}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of Moisture is taken as the standard error of the time averaged value used to correct to Dry Conditions
7 If no value for uncertainty is presented above, the uncertainty is considered to be >100%

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Combustion Gases (N_2O & O_2) Measurement Uncertainty

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Measurement Uncertainty Calculations Part 1

Protir 204M FTIR Performance Characteristics	Standard Uncertainty	Distributiuon	imum Certified Range N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.67	0.19
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.57	0.029
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	0.87	0.13
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	0.48	0.44
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.30	0.13
Interferents[1]	u_i	Rectangular (Divisor = √3)	5.16	0.10
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	1.04	0.15

Note:

$$when\ \left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
7 Not Available

Measurement Uncertainty Calculations Part 2

Protir 204M FTIR Performance Characteristics	Uncertainty	Value of Standard Uncertainty	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.15	0.023
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.13	0.0034
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.87	0.13
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.089	0.036
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_i}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.10	0.024
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	1.16	0.012
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	0.60	0.087
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	1.59	0.16
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	3.18	0.32
Applied Span Concentration			36.65	14.99
Measured Span Concentration, STP Dry Gas			36.42	15.06
Expanded measurement uncertainty as % of Applied Span			9%	2%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Combustion Gases (N_2O & O_2) Uncertainty of Measurement Results

Uncertainty of Measurement Results - Calculations Part 1

Protir 204M FTIR Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Minimum Certified Range (R_i) N_2O 0 - 39 mg/m³	Minimum Certified Range (R_i) O_2 0 - 21 %Vol
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.67	0.19
Span drift[2]	$u_{d,s}$			0.57	0.029
Losses / leakage in the sample system[4]	u_{loss}			0.48	0.44
Temperature dependant span drift[5]	u_t			0.30	0.13

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,\max} - x_{i,adj})^2 + (x_{i,\min} - x_{i,adj})(x_{i,\max} - x_{i,adj}) + (x_{i,\min} - x_{i,adj})^2}{3}}$, when $\left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Protir 204M FTIR Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.15	0.023
Span drift	$u_{d,s}$			0.13	0.0034
Temperature dependant span drift	u_t			0.089	0.021
Interferents	u_i			1.16	0.012

Uncertainty of Measurement Results - Calculations Part 2

Protir 204M FTIR Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Losses / leakage in the sample system	u_{loss}	09/01/23 14:00 - 15:00	0.0025	0.036
Standard Error of Measured Value	u_{SE}	09/01/23 14:00 - 15:00	0.018	0.021
Uncertainty due to Moisture Correction[6]	u_{H2O}	09/01/23 14:00 - 15:00	0.015	0.24

Effect on Uncertainty Caused by Oxygen $uCorr^n_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})x(20.9\% - O_{2,measured})} x\, Uncertainty\ of\ O_2\ Measurement =$ 0.025

$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} =$ 2.3570 $uf_{o_2} = \frac{uCorr^n_{o_2}}{f_{o_2}} x100 =$ 1.07 %

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Uncertainty of Measurement Results - Calculations Part 3

Protir 204M FTIR Uncertainty	Date & Time	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Measured Concentration	09/01/23 14:00 - 15:00	0.53	8.16
Expanded Uncertainty as Percentage of Measured Concentration		>100%	6%
$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_i^2 + u_t^2 + u_{ref}^2 + u_v^2 + u_{syn}^2}$			

Combined Standard Uncertainty $U_{Exp} = 2 \times u_c$

Expanded uncertainty (at 95% confidence)

1 Expressed as a percentage of the certified range
2 Expressed as percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of moisture is taken from the manual extract test calculations.
7 Not available
8 If no value for uncertainty is presented above, the uncertainty is considered to be >100%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
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Particulates & Hydrogen Chloride & Fluoride Uncertainty

Site: Margam
Location: Main Stack

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	LAB Method Uncert (%) K=2 Solution mg	Standard Uncertainty Filter mg	Standard Uncertainty Solution mg	Combined Uncertainty mg
			TPM, HCl & HF					
Particulates	0.52	0.60	1.12	0.10	0.50	0.0500	0.25	0.25
Hydrogen Chloride	…	23.53	23.53	…	3.06	…	1.53	1.53
Hydrogen Flouride	…	0.0517	0.0517	…	0.00672	…	0.00336	0.00336
…	…	…	…	…	…	…	…	…

	TPM, HCl & HF			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.10	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	1.00	…		…	…	
Meter Temperature (T_m)	293.17	k	uT_m	1.5	k	
Average Differential Pressure (ΔH)	30.75	mmH_2O	uΔH	0.25	mmH_2O	
Barometric Pressure (ρ_b)	763.56	mmHg	up_b	3.8	mmHg	
ΔH + ρs (ρ_m)	102.10	kPa		…	…	
Oxygen content ($O_{2,m}$)	6.78	% by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.0792		% by volume
Moisture Content (H_2O)	23.01	% by volume	uH_2O	0.61		% by volume

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. i =uV_m, uT_m etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

TPM, HCl & HF:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1.00$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_s) & measured temperature of dry gas uncertainty component ($uT_{m\ Dry}$)

TPM, HCl & HF:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.936$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.94	0.94	0.0000899	0.0000225
up_b	0.94	0.93	0.00122	0.00459
uT_m	0.94	0.93	0.00319	0.00479
H_2O	…	…	…	…

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00597$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

TPM, HCl & HF:

$$V_{std} = V_{measured} \times f_s = \quad 1.034$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	1.04	1.03	1.10	0.00659
Effect of uV_m	1.03	1.03	0.94	0.000936

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.00732$$

Uncertainty of Oxygen Correction Factor (%):-

TPM, HCl & HF:

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.06$$

$$uCorr^{n}{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.0269$$

$$uf_{o_2} = \frac{uCorr^{n}{}_{o_2}}{f_{o_2}} x 100 \quad 2.55\ \%$$

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R003

Installation Name : Biomass Plant
Visit Details : Compliance – January 2023
Survey Dates : 5th – 9th January 2023
Report Issue Date : 16th February 2023

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	TPM, HCl & HF:			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
Particulates	1.40	0.88	1.02	0.26
Hydrogen Chloride	25.59	22.46	1.02	1.56
Hydrogen Flouride	0.0562	0.0494	1.02	0.00343
Ammonia	…	…	…	…

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	TPM, HCl & HF:
	uL mg/Nm^3
Particulates	0.0132
Hydrogen Chloride	0.28
Hydrogen Flouride	0.000610
Ammonia	…

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	TPM, HCl & HF:			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
Particulates	1.15	1.14	1.11	0.00811
Hydrogen Chloride	24.20	23.86	23.25	0.17
Hydrogen Flouride	0.0532	0.0524	0.0511	0.000374
Ammonia	…	…	…	…

Measurement Uncertainty of Determinand (excluding correction for oxygen)

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	TPM, HCl & HF:				
	Measurement Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration	Uncertainty as Percentage of ELV
Particulates	0.26	0.52	1.14	45.61	3.48
Hydrogen Chloride	1.60	3.19	24.03	13.28	
Hydrogen Flouride	0.00351	0.00701	0.0528	13.28	
Ammonia	…	…	…	…	

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	TPM, HCl & HF:		
	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (*Ucombined*)
Particulates	45.61	2.55	45.68
Hydrogen Chloride	13.28	2.55	13.52
Hydrogen Flouride	13.28	2.55	13.52
Ammonia	…	…	…

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – January 2023**
Variation No	**: V005**	**Survey Dates**	**: 5th – 9th January 2023**
Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

Ammoina Uncertainty

Site: Margam
Location: Main Stack

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	Solution mg	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
				Ammonia				
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
Ammonia	...	6.21	6.21	...	0.81	...	0.40	0.40
				...				
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	Ammonia			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	0.89	**m^3**	**uV_m**	0.001	**m^3**	
Meter Correction Factor (Yd)	1.00	**...**		...	**...**	
Meter Temperature (T_m)	294.67	**k**	**uT_m**	1.5	**k**	
Average Differential Pressure (ΔH)	25.00	**mmH_2O**	**uΔH**	0.25	**mmH_2O**	
Barometric Pressure (ρ_b)	762.81	**mmHg**	**up$_b$**	3.8	**mmHg**	
ΔH + ρs (ρ_m)	101.94	**kPa**		...	**...**	
Oxygen content ($O_{2,m}$)	7.01	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$	0.0772		**% by volume**
Moisture Content (H_2O)	24.35	**% by volume**	**uH_2O**	0.65		**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. i =uV$_m$, uT$_m$ etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

Ammonia:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1.00$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up$_s$) & measured temperature of dry gas uncertainty component (uT$_{m\ Dry}$)

Ammonia:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.930$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.93	0.93	0.0000894	0.0000224
up$_b$	0.93	0.93	0.00122	0.00456
uT$_m$	0.93	0.93	0.00316	0.00474
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00587$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV$_{std}$) & volume uncertainty component (uV$_m$)

Ammonia:

$$V_{std} = V_{measured} \times f_s = \quad 0.826$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV$_{std}$	0.83	0.82	0.89	0.00521
Effect of uV$_m$	0.83	0.83	0.93	0.000930

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.00471$$

Uncertainty of Oxygen Correction Factor (%):-

Ammonia:

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.07$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} \; x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.0278$$

$$uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 2.59\ \%$$

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	Ammonia: Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uM mg/Nm³
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Ammonia	8.58	7.54	1.30	0.52

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	Ammonia: uL mg/Nm³
…	…
…	…
…	…
Ammonia	0.0931

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	Ammonia: Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uVstp mg/Nm³
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Ammonia	8.11	8.01	9.76	0.0459

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	Ammonia: Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Ammonia	0.53	1.07	8.06	13.25

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corrn Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (Ucombined)
…	…	…	…
…	…	…	…
…	…	…	…
Ammonia	13.25	2.59	13.50

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Sulhpur Dioixde Uncertainty

Site: Margam
Location: Main Stack

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	LAB Method Uncert (%) K=2 Solution mg	Standard Uncertainty Filter mg	Standard Uncertainty Solution mg	Combined Uncertainty mg
			Sulphur Dioxide					
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
Sulphur Dioxide	...	66.87	66.87	...	8.69	...	4.35	4.35
...	...	...	...	...	...	...	...	...
				...				
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	Sulphur Dioxide			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	3.71	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	1.00	...		...	...	
Meter Temperature (T_m)	292.96	k	uT_m	1.5	k	
Average Differential Pressure (ΔH)	15.00	mmH_2O	uΔH	0.25	mmH_2O	
Barometric Pressure (ρ_b)	760.56	mmHg	up_b	3.8	mmHg	
ΔH + ρs (ρ_m)	101.55	kPa		...	...	
Oxygen content ($O_{2,m}$)	6.55	% by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.0293		% by volume
Moisture Content (H_2O)	21.84	% by volume	uH_2O	0.57		% by volume

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. i =uV_m, uT_m etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

Sulphur Dioxide :

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1.00$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_s) & measured temperature of dry gas uncertainty component ($uT_{m\ Dry}$)

Sulphur Dioxide :

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.932$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.93	0.93	0.0000900	0.0000225
up_b	0.94	0.93	0.00122	0.00459
uT_m	0.94	0.93	0.00318	0.00477
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00595$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

Sulphur Dioxide :

$$V_{std} = V_{measured} \times f_s = \quad 3.460$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	3.48	3.44	3.71	0.0221
Effect of uV_m	3.46	3.46	0.93	0.000932

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0820$$

Uncertainty of Oxygen Correction Factor (%):-

Sulphur Dioxide :

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.04$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} \; x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.0260$$

$$uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 2.51\ \%$$

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – January 2023**
Variation No	**: V005**	**Survey Dates**	**: 5th – 9th January 2023**
Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	Sulphur Dioxide :			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
…	…	…	…	…
…	…	…	…	…
Sulphur Dioxide	21.37	18.76	0.30	1.30
…	…	…	…	…

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	Sulphur Dioxide :
	uL mg/Nm^3
…	…
…	…
Sulphur Dioxide	0.23
…	…

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	Sulphur Dioxide :			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
…	…	…	…	…
…	…	…	…	…
Sulphur Dioxide	20.56	19.60	5.80	0.48
…	…	…	…	…

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	Sulphur Dioxide :			
	Combined Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration
…	…	…	…	…
…	…	…	…	…
Sulphur Dioxide	1.41	2.82	20.07	14.03
…	…	…	…	…

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corrn Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (Ucombined)
…	…	…	…
…	…	…	…
Sulphur Dioxide	14.03	2.51	14.25
…	…	…	…

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – January 2023**
Variation No	**: V005**	**Survey Dates**	**: 5th – 9th January 2023**
Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

Dioxins & Furans & PCBs Uncertainty

Site: Margam
Location: Main Stack

Dioxin	Recovered Mass ng	LOD ng	LAB Method Uncert (%) K=2 %age	as Mass (ng)	Standard Uncertainty Symbol	ng
2,3,7,8 - TCDD	0.000510	0.000140	50	0.000255	**u2,3,7,8 - TCDD**	0.000128
1,2,3,7,8 - PCDD	0.00384	0.000440	50	0.00192	**u1,2,3,7,8 - PCDD**	0.000960
1,2,3,4,7,8 - HxCDD	0.00564	0.000260	30	0.00169	**u1,2,3,4,7,8 - HxCDD**	0.000846
1,2,3,6,7,8 - HxCDD	0.0121	0.000270	30	0.00363	**u1,2,3,6,7,8 - HxCDD**	0.00182
1,2,3,7,8,9 - HxCDD	0.00671	0.000260	30	0.00201	**u1,2,3,7,8,9 - HxCDD**	0.00101
1,2,3,4,6,7,8 - HpCDD	0.0557	0.000280	30	0.0167	**u1,2,3,4,6,7,8 - HpCDD**	0.00836
OCDD	0.0615	0.000410	30	0.0185	**uOCDD**	0.00923
2,3,7,8 - TCDF	0.0103	0.000360	30	0.00309	**u2,3,7,8 - TCDF**	0.00155
1,2,3,7,8 - PCDF	0.00412	0.000290	30	0.00124	**u1,2,3,7,8 - PCDF**	0.000618
2,3,4,7,8 - PCDF	0.00556	0.000280	30	0.00167	**u2,3,4,7,8 - PCDF**	0.000834
1,2,3,4,7,8 - HxCDF	0.00466	0.000220	30	0.00140	**u1,2,3,4,7,8 - HxCDF**	0.000699
1,2,3,6,7,8 - HxCDF	0.00546	0.000210	30	0.00164	**u1,2,3,6,7,8 - HxCDF**	0.000819
2,3,4,6,7,8 - HxCDF	0.00523	0.000200	30	0.00157	**u2,3,4,6,7,8 - HxCDF**	0.000785
1,2,3,7,8,9 - HxCDF	0.000360	0.000190	50	0.000180	**u1,2,3,7,8,9 - HxCDF**	0.0000900
1,2,3,4,6,7,8 - HpCDF	0.0174	0.000190	30	0.00522	**u1,2,3,4,6,7,8 - HpCDF**	0.00261
1,2,3,4,7,8,9 - HpCDF	0.00216	0.000220	50	0.00108	**u1,2,3,4,7,8,9 - HpCDF**	0.000540
OCDF	0.00469	0.000200	30	0.00141	**uOCDF**	0.000704

	Measured Values			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	5.719	**m^3**		**uV_m**	0.001	**m^3**
Meter Correction Factor (Yd)	0.998	**...**			...	**...**
Meter Temperature (T_m)	288.444	**k**		**uTm**	1.5	**k**
Average Differential Pressure (ΔH)	25.718	**mmH_2O**		**uDH**	0.25	**mmH_2O**
Barometric Pressure (ρ_b)	753.059	**mmHg**		**$u\rho_b$**	3.8	**mmHg**
ΔH + ρs (ρ_m)	100.652	**kPa**			...	**...**
Oxygen content ($O_{2,m}$)	8.168	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$		0.04	**% by volume**
Moisture Content (H_2O)	22.602	**% by volume**		**uH_2O**	0.59	**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using:

$$C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔ H), measured stack pressure uncertainty component (up_s) & measured temperature of dry gas

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.938$$

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.938	0.938	0.0000914	0.0000228
$u\rho_b$	0.943	0.934	0.00124	0.00466
uT_m	0.943	0.933	0.00325	0.00488
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00618$$

Uncertainty in volume @ reference conditions due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

$$V_{std} = V_{measured} \times f_s = \quad 5.366$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty m^3
Effect of uV_{std}	5.401	5.330	5.719	0.0353
Effect of uV_m	5.366	5.365	0.938	0.000938

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.2020$$

Uncertainty of oxygen correction factor (ufO_2)

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.169 \qquad uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} x\, Uncertainty\ of\ O_2\ Measurement =$$

$$\therefore uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 2.83\ \%$$

Western Bio-Energy Ltd | **Installation Name** : Biomass Plant
Permit No : EPR/ZP3939GL | **Visit Details** : Compliance – January 2023
Variation No : V005 | **Survey Dates** : 5th – 9th January 2023
Report Ref : P5200 : R003 | **Report Issue Date** : 16th February 2023

Uncertainty in final dioxin measurement @ reference conditions due to mass uncertainty component (uM)

Dioxin	Maximum ng/Nm³	Minimum ng/Nm³	Sensitivity	uM ng/Nm³
2,3,7,8 - TCDD	0.000139	0.0000833	0.218	0.0000278
1,2,3,7,8 - PCDD	0.00105	0.000627	0.218	0.000209
1,2,3,4,7,8 - HxCDD	0.00141	0.00104	0.218	0.000184
1,2,3,6,7,8 - HxCDD	0.00303	0.00224	0.218	0.000395
1,2,3,7,8,9 - HxCDD	0.00168	0.00124	0.218	0.000219
1,2,3,4,6,7,8 - HpCDD	0.0140	0.0103	0.218	0.00182
OCDD	0.0154	0.0114	0.218	0.00201
2,3,7,8 - TCDF	0.00258	0.00191	0.218	0.000337
1,2,3,7,8 - PCDF	0.00103	0.000763	0.218	0.000135
2,3,4,7,8 - PCDF	0.00139	0.00103	0.218	0.000182
1,2,3,4,7,8 - HxCDF	0.00117	0.000863	0.218	0.000152
1,2,3,6,7,8 - HxCDF	0.00137	0.00101	0.218	0.000178
2,3,4,6,7,8 - HxCDF	0.00131	0.000969	0.218	0.000171
1,2,3,7,8,9 - HxCDF	0.0000980	0.0000588	0.218	0.0000196
1,2,3,4,6,7,8 - HpCDF	0.00436	0.00322	0.218	0.000569
1,2,3,4,7,8,9 - HpCDF	0.000588	0.000353	0.218	0.000118
OCDF	0.00118	0.000869	0.218	0.000153

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss in the sample system (uL)

Dioxin	uL ng/Nm³
2,3,7,8 - TCDD	1.283E-06
1,2,3,7,8 - PCDD	9.660E-06
1,2,3,4,7,8 - HxCDD	0.0000142
1,2,3,6,7,8 - HxCDD	0.0000304
1,2,3,7,8,9 - HxCDD	0.0000169
1,2,3,4,6,7,8 - HpCDD	0.000140
OCDD	0.000155
2,3,7,8 - TCDF	0.0000259
1,2,3,7,8 - PCDF	0.0000104
2,3,4,7,8 - PCDF	0.0000140
1,2,3,4,7,8 - HxCDF	0.0000117
1,2,3,6,7,8 - HxCDF	0.0000137
2,3,4,6,7,8 - HxCDF	0.0000132
1,2,3,7,8,9 - HxCDF	9.056E-07
1,2,3,4,6,7,8 - HpCDF	0.0000438
1,2,3,4,7,8,9 - HpCDF	5.434E-06
OCDF	0.0000118

Uncertainty in final measurement @ Reference Conditions due to uVstp

Dioxin	Maximum ng/Nm³	Minimum ng/Nm³	Sensitivity	uVstp mg/Nm³
2,3,7,8 - TCDD	0.000115	0.000107	0.0000207	4.190E-06
1,2,3,7,8 - PCDD	0.000869	0.000806	0.000156	0.0000315
1,2,3,4,7,8 - HxCDD	0.00128	0.00118	0.000229	0.0000463
1,2,3,6,7,8 - HxCDD	0.00274	0.00254	0.000492	0.0000994
1,2,3,7,8,9 - HxCDD	0.00152	0.00141	0.000273	0.0000551
1,2,3,4,6,7,8 - HpCDD	0.0126	0.0117	0.00226	0.000458
OCDD	0.0139	0.0129	0.00250	0.000505
2,3,7,8 - TCDF	0.00233	0.00216	0.000419	0.0000846
1,2,3,7,8 - PCDF	0.000933	0.000865	0.000168	0.0000338
2,3,4,7,8 - PCDF	0.00126	0.00117	0.000226	0.0000457
1,2,3,4,7,8 - HxCDF	0.00105	0.000978	0.000189	0.0000383
1,2,3,6,7,8 - HxCDF	0.00124	0.00115	0.000222	0.0000449
2,3,4,6,7,8 - HxCDF	0.00118	0.00110	0.000213	0.0000430
1,2,3,7,8,9 - HxCDF	0.0000815	0.0000756	0.0000146	2.957E-06
1,2,3,4,6,7,8 - HpCDF	0.00394	0.00365	0.000708	0.000143
1,2,3,4,7,8,9 - HpCDF	0.000489	0.000454	0.0000878	0.0000177
OCDF	0.00106	0.000985	0.000191	0.0000385

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Dioxin	Combined Uncertainty ng/Nm³	Expanded Uncertainty ng/Nm³	Measured Concentration ng/Nm³	% of Measured Concentration
2,3,7,8 - TCDD	0.0000281	0.0000562	0.000111	50.618
1,2,3,7,8 - PCDD	0.000212	0.000423	0.000837	50.618
1,2,3,4,7,8 - HxCDD	0.000191	0.000381	0.00123	31.019
1,2,3,6,7,8 - HxCDD	0.000409	0.000818	0.00264	31.019
1,2,3,7,8,9 - HxCDD	0.000227	0.000453	0.00146	31.019
1,2,3,4,6,7,8 - HpCDD	0.00188	0.00376	0.0121	31.019
OCDD	0.00208	0.00416	0.0134	31.019
2,3,7,8 - TCDF	0.000348	0.000696	0.00224	31.019
1,2,3,7,8 - PCDF	0.000139	0.000278	0.000898	31.019
2,3,4,7,8 - PCDF	0.000188	0.000376	0.00121	31.019
1,2,3,4,7,8 - HxCDF	0.000157	0.000315	0.00102	31.019
1,2,3,6,7,8 - HxCDF	0.000184	0.000369	0.00119	31.019
2,3,4,6,7,8 - HxCDF	0.000177	0.000353	0.00114	31.019
1,2,3,7,8,9 - HxCDF	0.0000199	0.0000397	0.0000784	50.618
1,2,3,4,6,7,8 - HpCDF	0.000588	0.00118	0.00379	31.019
1,2,3,4,7,8,9 - HpCDF	0.000119	0.000238	0.000471	50.618
OCDF	0.000158	0.000317	0.00102	31.019
		Total (ng/Nm³)	0.045	13.2

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Dioxin	% of Measured Concentration	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor ($Ucombined$)	New Combined Uncertainty ng/Nm³
2,3,7,8 - TCDD	50.618	2.830	50.697	0.0000281
1,2,3,7,8 - PCDD	50.618	2.830	50.697	0.000212
1,2,3,4,7,8 - HxCDD	31.019	2.830	31.148	0.000191
1,2,3,6,7,8 - HxCDD	31.019	2.830	31.148	0.000409
1,2,3,7,8,9 - HxCDD	31.019	2.830	31.148	0.000227
1,2,3,4,6,7,8 - HpCDD	31.019	2.830	31.148	0.00188
OCDD	31.019	2.830	31.148	0.00208
2,3,7,8 - TCDF	31.019	2.830	31.148	0.000348
1,2,3,7,8 - PCDF	31.019	2.830	31.148	0.000139
2,3,4,7,8 - PCDF	31.019	2.830	31.148	0.000188
1,2,3,4,7,8 - HxCDF	31.019	2.830	31.148	0.000158
1,2,3,6,7,8 - HxCDF	31.019	2.830	31.148	0.000185
2,3,4,6,7,8 - HxCDF	31.019	2.830	31.148	0.000177
1,2,3,7,8,9 - HxCDF	50.618	2.830	50.697	0.0000199
1,2,3,4,6,7,8 - HpCDF	31.019	2.830	31.148	0.000589
1,2,3,4,7,8,9 - HpCDF	50.618	2.830	50.697	0.000119
OCDF	31.019	2.830	31.148	0.000159

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Uncertainty - Adjusted for TEQ / TEF

Dioxin	TEQ ng/m³*	Uncertainty ng/Nm³	Conc ng/Nm³	WHO Humans & Mammals (TEF)	Uncertainty ng/Nm³	Conc ng/Nm³	WHO Fish (TEF)	Uncertainty ng/Nm³	Conc ng/Nm³	WHO Birds (TEF)	Uncertainty ng/Nm³	Conc ng/Nm³
2,3,7,8 - TCDD	1	0.0000563	0.000111	1	0.0000563	0.000111	1	0.0000563	0.000111	1	0.0000563	0.000111
1,2,3,7,8 - PCDD	0.5	0.000212	0.000418	1	0.000424	0.000837	1	0.000424	0.000837	1	0.000424	0.000837
1,2,3,4,7,8 - HxCDD	0.1	0.0000382	0.000123	0.1	0.0000382	0.000123	0.5	0.000191	0.000614	0.05	0.0000191	0.0000614
1,2,3,6,7,8 - HxCDD	0.1	0.0000819	0.000264	0.1	0.0000819	0.000264	0.01	8.188E-06	0.0000264	0.01	8.188E-06	0.0000264
1,2,3,7,8,9 - HxCDD	0.1	0.0000454	0.000146	0.1	0.0000454	0.000146	0.01	4.540E-06	0.0000146	0.1	0.0000454	0.000146
1,2,3,4,6,7,8 - HpCDD	0.01	0.0000377	0.000121	0.01	0.0000377	0.000121	0.001	3.769E-06	0.0000121	0.001	3.769E-06	0.0000121
OCDD	0.001	4.161E-06	0.0000134	0.0001	4.161E-07	1.340E-06	...	...	...	...	...	...
2,3,7,8 - TCDF	0.1	0.0000697	0.000224	0.1	0.0000697	0.000224	0.05	0.0000348	0.000112	1	0.000697	0.00224
1,2,3,7,8 - PCDF	0.05	0.0000139	0.0000449	0.05	0.0000139	0.0000449	0.05	0.0000139	0.0000449	0.1	0.0000279	0.0000898
2,3,4,7,8 - PCDF	0.5	0.000188	0.000606	0.5	0.000188	0.000606	0.5	0.000188	0.000606	1	0.000376	0.00121
1,2,3,4,7,8 - HxCDF	0.1	0.0000315	0.000102	0.1	0.0000315	0.000102	0.1	0.0000315	0.000102	0.1	0.0000315	0.000102
1,2,3,6,7,8 - HxCDF	0.1	0.0000369	0.000119	0.1	0.0000369	0.000119	0.1	0.0000369	0.000119	0.1	0.0000369	0.000119
2,3,4,6,7,8 - HxCDF	0.1	0.0000354	0.000114	0.1	0.0000354	0.000114	0.1	0.0000354	0.000114	0.1	0.0000354	0.000114
1,2,3,7,8,9 - HxCDF	0.1	3.973E-06	7.843E-06	0.1	3.973E-06	7.843E-06	0.1	3.973E-06	7.843E-06	0.1	3.973E-06	7.843E-06
1,2,3,4,6,7,8 - HpCDF	0.01	0.0000118	0.0000379	0.01	0.0000118	0.0000379	0.01	0.0000118	0.0000379	0.01	0.0000118	0.0000379
1,2,3,4,7,8,9 - HpCDF	0.01	2.384E-06	4.706E-06	0.01	2.384E-06	4.706E-06	0.01	2.384E-06	4.706E-06	0.01	2.384E-06	4.706E-06
OCDF	0.001	3.174E-07	1.022E-06	0.0001	3.174E-08	1.022E-07	0.0001	3.174E-08	1.022E-07	0.0001	3.174E-08	1.022E-07
TOTAL	...	0.000	0.002	...	0.000	0.003	...	0.001	0.003	...	0.001	0.005
% Uncertainty	...	...	13.118	...	...	17.063	...	...	18.450	...	...	17.6

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
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Report Ref	**: P5200 : R003**	**Report Issue Date**	**: 16th February 2023**

Heavy Metals Uncertainty

Site: Margam
Location: Main Stack

$$u_{phase(mg/m^3)} = \frac{u_{method} \times Mass_{\mu g}}{200000} \qquad u_{mass} = \sqrt{\sum (u_{particulate})^2 + (u_{vapour})^2}$$

Metal	Particulate	Vapour	LAB Method Uncert (%) K=2		Standard Uncertainty Particulate Phase	Standard Uncertainty Vapour Phase	Combined Standard Uncertainty of Measured	
	mg	mg	Particulate Phase	Vapour Phase	mg/m³	mg/m³	Symbol	mg/m³
Antimony	12.600	1.288	15	16	0.000945	0.000103	uMSb	0.000951
Arsenic	2.100	4.743	11	12	0.000116	0.000285	uMAs	0.000307
Cadmium	0.500	0.188	12	10	0.0000300	9.410E-06	uMCd	0.0000314
Chromium	11.900	11.308	12	10	0.000714	0.000565	uMCr	0.000911
Cobalt	0.500	0.188	12	10	0.0000300	9.410E-06	uMCo	0.0000314
Copper	2.200	11.497	12	10	0.000132	0.000575	uMCu	0.000590
Lead	3.300	6.237	13	16	0.000215	0.000499	uMPb	0.000543
Manganese	5.800	1.044	16	10	0.000464	0.0000522	uMMn	0.000467
Nickel	16.900	1.260	12	9	0.00101	0.0000567	uMNi	0.00102
Thallium	0.400	0.188	14	14	0.0000280	0.0000132	uMTl	0.0000309
Vanadium	1.400	0.0941	12	9	0.0000840	4.235E-06	uMV	0.0000841

				Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.072	**m³**		**uV_m**	0.001	**m³**
Meter Correction Factor (Yd)	0.998	**...**			...	**...**
Meter Temperature (T_m)	295.25	**k**		**uTm**	1.5	**k**
Average Differential Pressure (ΔH)	31.05	**mmH₂O**		**uDH**	0.25	**mmH₂O**
Barometric Pressure (ρ_b)	763.56	**mmHg**		**up$_s$**	3.8	**mmHg**
ΔH + ρs (ρ_m)	102.10	**kPa**			...	**...**
Oxygen content ($O_{2,m}$)	6.66	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$		0.03	**% by volume**
Moisture Content (H_2O)	22.58	**% by volume**		**uH_2O**	0.60	**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using:

$$C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up$_s$) & measured

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.930$$

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.930	0.930	0.0000893	0.0000223
up$_s$	0.934	0.925	0.00121	0.00455
uT_m	0.935	0.925	0.00315	0.00472
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00584$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

$$V_{std} = V_{measured} \times f_s = \quad 0.997$$

	Maximum m³	Minimum m³	Sensitivity	Standard Uncertainty m³
Effect of uV_{std}	1.003	0.991	1.072	0.00627
Effect of uV_m	0.998	0.996	0.930	0.000930

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.00677$$

Uncertainty of oxygen correction factor (uf_{O2})

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = \quad 0.70$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured}) x (20.9\% - O_{2,measured})} x Uncertainty\ of\ O_2\ Measurement = \quad 0.03$$

$$\therefore uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 3.81\ \%$$

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Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Metal	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
Antimony	0.0103	0.00902	0.697	0.000663
Arsenic	0.00499	0.00456	0.697	0.000214
Cadmium	0.000502	0.000458	0.697	0.0000219
Chromium	0.0168	0.0156	0.697	0.000635
Cobalt	0.000502	0.000458	0.697	0.0000219
Copper	0.00996	0.00914	0.697	0.000411
Lead	0.00703	0.00627	0.697	0.000379
Manganese	0.00510	0.00445	0.697	0.000326
Nickel	0.0134	0.0120	0.697	0.000708
Thallium	0.000432	0.000389	0.697	0.0000216
Vanadium	0.00110	0.000983	0.697	0.0000587

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system

Metal	uL mg/Nm^3
Antimony	0.000112
Arsenic	0.0000551
Cadmium	5.543E-06
Chromium	0.000187
Cobalt	5.543E-06
Copper	0.000110
Lead	0.0000768
Manganese	0.0000551
Nickel	0.000146
Thallium	4.737E-06
Vanadium	0.0000120

Uncertainty in final measurement @ Reference Conditions due to uVstp

Metal	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
Antimony	0.00975	0.00962	0.00972	0.0000658
Arsenic	0.00481	0.00474	0.00479	0.0000324
Cadmium	0.000483	0.000477	0.000482	3.262E-06
Chromium	0.0163	0.0161	0.0162	0.000110
Cobalt	0.000483	0.000477	0.000482	3.262E-06
Copper	0.00962	0.00949	0.00958	0.0000649
Lead	0.00670	0.00661	0.00667	0.0000452
Manganese	0.00481	0.00474	0.00479	0.0000324
Nickel	0.0128	0.0126	0.0127	0.0000861
Thallium	0.000413	0.000407	0.000412	2.788E-06
Vanadium	0.00105	0.00104	0.00105	7.081E-06

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Metal	Combined Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration
Antimony	0.000676	0.00135	0.00969	13.949
Arsenic	0.000224	0.000447	0.00477	9.368
Cadmium	0.0000229	0.0000457	0.000480	9.522
Chromium	0.000671	0.00134	0.0162	8.293
Cobalt	0.0000229	0.0000457	0.000480	9.522
Copper	0.000431	0.000862	0.00955	9.019
Lead	0.000389	0.000778	0.00665	11.701
Manganese	0.000332	0.000664	0.00477	13.906
Nickel	0.000728	0.00146	0.0127	11.501
Thallium	0.0000223	0.0000445	0.000410	10.858
Vanadium	0.0000603	0.000121	0.00104	11.573

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Metal	% of Measured Concentration	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor ($Ucombined$)	New Combined Uncertainty mg/Nm^3
Antimony	13.949	3.810	14.460	0.000700
Arsenic	9.368	3.810	10.113	0.000241
Cadmium	9.522	3.810	10.256	0.000025
Chromium	8.293	3.810	9.127	0.000739
Cobalt	9.522	3.810	10.256	0.000025
Copper	9.019	3.810	9.791	0.000468
Lead	11.701	3.810	12.305	0.000409
Manganese	13.906	3.810	14.419	0.000344
Nickel	11.501	3.810	12.116	0.000767
Thallium	10.858	3.810	11.507	0.000024
Vanadium	11.573	3.810	12.184	0.000063

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Note: Uncertainty for each metals group is based on the summation in quadrature of the individual standard uncertainties (in mg/m3) of each contributing metal. Combined standard uncertainty of each group is converted to 95% confidence (multiplication by k = 2) before being expressed as a percentage of the combined group concentration.

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Mercury Uncertainty

Site: Margam
Location: Main Stack

$$u_{phase(mg/m^3)} = \frac{u_{method} \times Mass_{\mu g}}{200000} \qquad u_{mass} = \sqrt{\sum (u_{particulate})^2 + (u_{vapour})^2}$$

Metal	Particulate	Vapour	LAB Method Uncert (%) K=2		Standard Uncertainty Particulate Phase	Standard Uncertainty Vapour Phase	Combined Standard Uncertainty of Measured	
	mg	mg	Particulate Phase	Vapour Phase	mg/m³	mg/m³	Symbol	mg/m³
Mercury	0.109	0.287	10	12	5.425E-06	0.0000172	uMHg	0.0000180

			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.014	**m³**	**uV_m**	0.001	**m³**
Meter Correction Factor (Yd)	0.998	**...**		...	**...**
Meter Temperature (T_m)	295.00	**k**	**uTm**	1.5	**k**
Average Differential Pressure (ΔH)	31.20	**mmH_2O**	**uDH**	0.25	**mmH_2O**
Barometric Pressure (ρ_b)	760.56	**mmHg**	**up$_s$**	3.8	**mmHg**
ΔH + ρs (ρ_m)	101.71	**kPa**		...	**...**
Oxygen content ($O_{2,m}$)	6.60	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$	0.02	**% by volume**
Moisture Content (H_2O)	23.65	**% by volume**	**uH_2O**	0.63	**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using:

$$C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up$_s$) & measured

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.927$$

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.927	0.927	0.0000893	0.0000223
up$_s$	0.932	0.922	0.00122	0.00456
uT_m	0.932	0.922	0.00314	0.00471
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00584$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

$$V_{std} = V_{measured} \times f_s = \quad 0.940$$

	Maximum m³	Minimum m³	Sensitivity	Standard Uncertainty m³
Effect of uV_{std}	0.946	0.934	1.014	0.00592
Effect of uV_m	0.941	0.939	0.927	0.000927

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.00607$$

Uncertainty of oxygen correction factor (uf_{O2})

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 0.69$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} \; x \; Uncertainty\ of\ O_2\ Measurement = \quad 0.03$$

$$\therefore uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 3.79\ \%$$

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Metal	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
Mercury	0.000304	0.000277	0.736	0.0000133

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system

Metal	uL mg/Nm^3
Mercury	3.357E-06

Uncertainty in final measurement @ Reference Conditions due to uVstp

Metal	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
Mercury	0.000293	0.000289	0.000309	1.876E-06

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Metal	Combined Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration
Mercury	0.0000138	0.0000276	0.000291	9.503

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Metal	% of Measured Concentration	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (*Ucombined*)	New Combined Uncertainty mg/Nm^3
Mercury	9.503	3.790	10.231	0.000015

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Note: Uncertainty for each metals group is based on the summation in quadrature of the individual standard uncertainties (in mg/m3) of each contributing metal. Combined standard uncertainty of each group is converted to 95% confidence (multiplication by k = 2) before being expressed as a percentage of the combined group concentration.

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – January 2023
Variation No	: V005	Survey Dates	: 5th – 9th January 2023
Report Ref	: P5200 : R003	Report Issue Date	: 16th February 2023

Stack Reference Main Stack

Measurement Uncertainty Calculations - Velocity at Stack Conditions

Contribution From	Standard u/c (mm H_2O)	
Pitot Calibration Uncertainty Contribution	0.176	A
Manometer Calibration Uncertainty Contribution	0.176	B
Variation in Actual Pitot reading at sample points	0.42	C
Combined u/c (mm H_2O) =	**Combined u/c (mm H_2O)**	
SQRT $(A/\sqrt{3})^2 + (B/\sqrt{3})^2 + (C/\sqrt{3})^2$	0.28	
Expanded Uncertainty of Flow Measurements (mm H_2O)	**0.56**	
	Standard u/c (K)	
Temperature Calibration (K)	2.07	D
Variation in Actual Temp reading at sample points	0.25	E
Combined u/c of Temp (K)	**Combined u/c (K)**	
SQRT $((D/\sqrt{3^2}) + (E/\sqrt{3})^2)$	1.20	
Expanded Uncertainty of Temp Measurements (K)	**2.41**	
Measured Average Velocity (m/s) at Stack Conds	24.42	
Maximum Average Velocity (m/s) at Stack Conds	24.68	
Standard Uncertainty Velocity at Stack Conditions (%)	1.08	
Expanded Uncertainty Velocity (at Stack Conditions)	**2.17 (%)**	

Measurement Uncertainty Calculations - Flowrate at Stack Conditions

Contribution From	Standard u/c (m^2)	
Area (m2)	0.02011	
Measured Average Flowrate (m^3/s) at Stack Conds	49.09	
Maximum Average Flowrate (m^3/s) at Stack Conds	50.12	
Standard Uncertainty Flowrate (m^3/s) at Stack Conditions (%)	2.10	
Expanded Uncertainty Flowrate (m^3/s) at Stack Conditions	**4.19 (%)**	

Measurement Uncertainty Calculations - Flowrate at STP & Wet Gas

Contribution From	Standard u/c (%)	
Temperature Calibration (K)	0.5	
Barometer Calibration	0.5	
Measured Average Flowrate (m^3/s) at STP Wet	32.55	
Maximum Average Flowrate (m^3/s) at STP Wet	33.34	
Standard Uncertainty Flowrate (m^3/s) at STP Wet	2.43	
Expanded Uncertainty Flowrate (m^3/s) at STP Wet	**4.86 (%)**	

Measurement Uncertainty Calculations - Flowrate at STP & Dry Gas

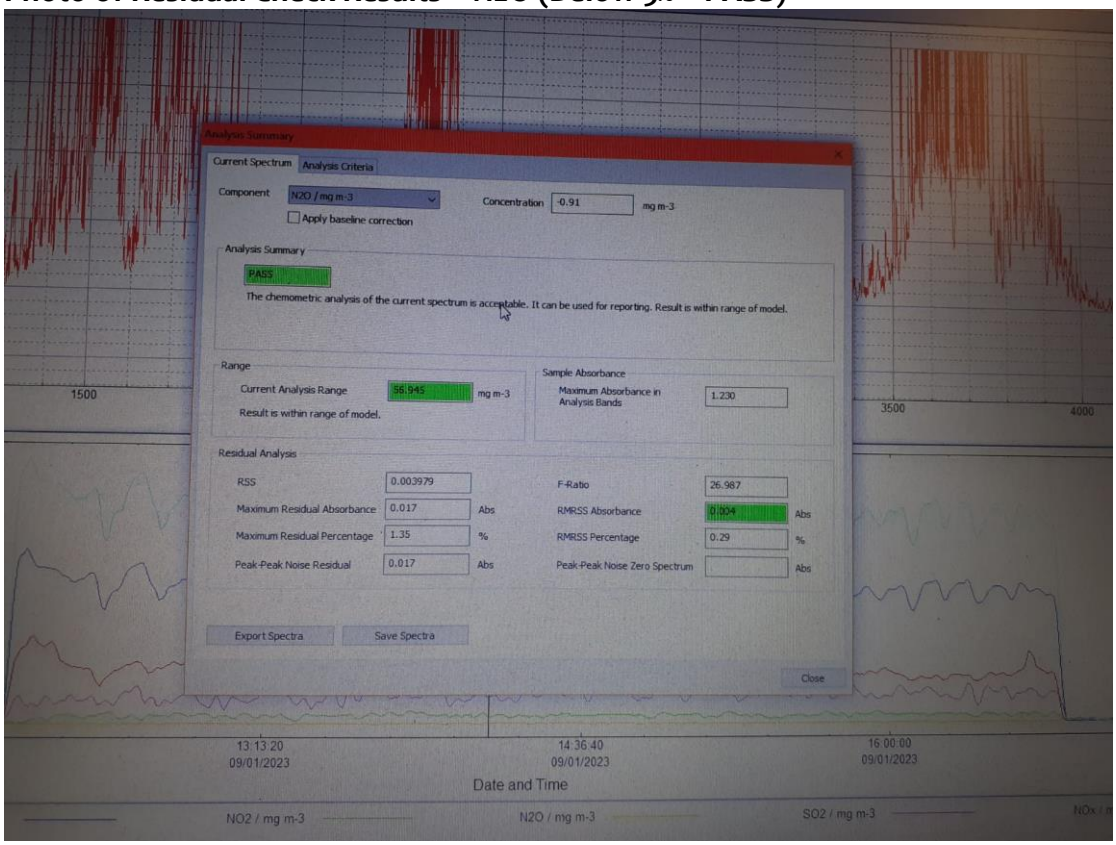
Contribution From	Standard u/c (%)	
Moisture Uncertainty (% v/v)	0.31	
Measured Average Flowrate (m^3/s) at STP Dry	25.06	
Maximum Average Flowrate (m^3/s) at STP Dry	25.77	
Standard Uncertainty Flowrate (m^3/s) at STP Dry	2.84	
Expanded Uncertainty Flowrate (m^3/s) at STP Dry	**5.67 (%)**	

Measurement Uncertainty Calculations - Flowrate at STP, Dry Gas & Ref Oxygen

Contribution From	Standard u/c (%)	
Oxygen Uncertainty (% v/v)	0.068	
Measured Average Flowrate (m^3/s) at STP Dry & Ref Oxygen	23.70	
Maximum Average Flowrate (m^3/s) at STP Dry & Ref Oxygen	24.49	
Standard Uncertainty Flowrate (m^3/s) at STP Dry & Ref Oxygen	3.33	
Expanded Uncertainty Flowrate (m^3/s) at STP Dry & Ref O_2	**6.66 (%)**	

RESULTS OF FTIR DAILY SPECTRAL RESIDUALS CHECKS

Photo of Residual Check Results – N2O (Below 5% = PASS)



FTIR SUMMARY OF ANALYTICAL BANDS

SUMMARY OF ANALYTICAL BANDS – PROTEA FTIR 204M

Gas Species	Primary Method Band / cm^{-1}	Secondary Method Band / cm^{-1}	Tertiary Method Band / cm^{-1}
H_2O	3319.374 – 3404.709		
CO_2	2043.693 – 2091.905 902.523 – 997.018		
CO	2132.885 – 2201.345	2021.034 – 2201.345	2021.034 – 2201.345
NO	1872.060 – 1905.326	2012.838 – 1851.329 (sub-set of smaller bands in this region)	3388.317 – 3404.709 1905.326 - 1872.060
NO_2	1548.077 – 1677.284	1605.931 - 1583.754; 2810.741 – 3160.276	2810.259 – 2936.091
N_2O	2113.600 – 2223.041	2528.703 – 2651.160 2113.600 – 2223.041	
SO_2	1295.448 – 1414.531	3388.317 – 3404.709 1342.695 – 1360.052 1019.195 – 1233.737	2810.259 – 2936.091
NH_3	899.148 – 969.055		
HCl	2587.521 – 2884.023	2587.521 – 2884.023	