20 MAY 2013

EMISSIONS MONITORING SURVEY

Prepared for:

Bryn Posteg Landfill Site.
Llanidloes
Powys
SY18 6JJ

Permit Number	**: EPR/BU7766IC**
Variation Number	**: V004**
Installation	**: Landfill Flare**
Visit Details	**: Annual Compliance**
Job Number	**: P1560**
Report Number	**: R001**
Report Issue Date	**: 30th January 2013**
Survey Dates	**: 17th – 19th December 2012**

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UKAS TESTING 2499

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PART 1 - EXECUTIVE SUMMARY

1 Monitoring Objectives

Environmental Compliance Ltd (ECL) was commissioned by **Bryn Posteg Landfill Site** to undertake an emission monitoring survey at their **Llanidloes**. This report presents the findings of the study.

The monitoring at this installation was carried out in accordance with our quotation reference **mdw/P1560/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
	Landfill Flare Stack
Oxides of Nitrogen (as NO_2)	• U
Sulphur Dioxide	• U
Carbon Monoxide	• U
Carbon Dioxide	• U
Oxygen	• U
Total Organic Carbon (TOC)	• U
Hydrogen Chloride	• U
Dioxins / Furans	• U
Non Methane VOC	• 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: *"Normal Operation – Engine Not Running."*

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 for use of Method	Tick if non-conforming test (see Sections 2 & 5)	Operating Status
Flare Stack	Dioxin & Furans $	...	0.035	ng/m³	24	Dry & 3% O_2	18/12/2012	13:30 – 17:30	BS EN 1948	UKAS / MCERTS	✓	Normal (Engine Not Running)
	TOCs as Carbon	10	4.65	mg/m³	8		19/12/2012	12:05 – 13:05	BS EN 12619	UKAS / MCERTS		
	Oxides of Nitrogen (as NO_2)	150	37.8	mg/m³	2		18/12/2012	14:00 – 16:59	BS EN 14792: 2005	UKAS / MCERTS		
	Carbon Monoxide	50	35.9	mg/m³	3				BS EN 15058: 2006	UKAS / MCERTS		
	Sulphur Dioxide	...	58.4	mg/m³	2				EA TGN M21:V1.1 Jan 2010 (AM for BS EN 14791)	UKAS / MCERTS		
	Carbon Dioxide	...	6.75	%	4	Dry Gas			ISO 12039	UKAS / MCERTS		
	Oxygen	...	13.56	%	3	Dry Gas			BS EN 14789: 2005	UKAS / MCERTS		
	Hydrogen Chloride $	...	8.54	mg/m³	13	Dry & 3% O_2	19/12/2012	10:13 – 11:13	BS EN 1911	UKAS / MCERTS	✓	
	Non Methane VOC $	5	4.57	mg/m³	89		19/12/2012	12:05 – 13:05	BS EN 13649	NU	✓	

Notes

For CO & NO_x, the permit requires data to be reported as hourly averages.
The average figure presented for these parameters in Table 1.1, as well as for CO_2, SO_2 & O_2, is the maximum hourly average result during the 3hr sample period.
All other hourly averages are presented in the tables section in the appendices of this report.

The uncertainty figures presented in Table 1.1 for NO_x, CO, SO_2, CO_2, O_2 & TOC 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

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
Flare Stack	Continuous	n/a	Gas	Landfill Gas	None	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/BU7766IC** where UKAS and MCERTS accreditation has and could be claimed for the testing in the monitoring results table.

There was one modification to the sampling procedures (TPDs) listed in section 4. This was as follows:-

Non Methane VOC – ECL/TPD/84 is specifically for the monitoring of dry ambient gas. Testing of the flare stack required the modification of the TPD, to cool and dry the sample gas prior to passing it through the capture media (sorbent tube).

There was one substance deviation from the original and agreed emissions monitoring schedule:

Dioxins – Due to limited plant operation only 4 hours of sampling could be undertaken, rather than 6 hours as quoted.

Non-conforming tests are as follows:-

Due to the nature of the process and the limited access it was not possible to fully traverse the duct. All isokinetic sampling for **HCl & Dioxins** was undertaken at a single representative point, near the centre of the duct. Furthermore, the velocity was measured at a single point in the duct and was near to the lower limit of detection.

UKAS accreditation is not possible for the laboratory analysis stage of the **Non-Methane VOC** method.

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

Homogeneity tests have not been completed for pollutants at the flare stack and were not requested by client. Due to access limitations, it would not be safe to carry out such tests.

PART 2 – SUPPORTING INFORMATION

3 SAMPLING STAFF DETAILS

Site Sampling Team

Names of Site Team	Dates on Site	MCERTS No.	LEVEL	Technical Endorsements
Jonathan Litterick	17th – 19th December 2012	MM 03 236	2	TE1, TE2, TE3, TE4
Matthew Broughton		MM 12 1196	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):- TOCs, CO, NOx, SO2.

4 SAMPLING PROTOCOLS / METHODOLOGIES

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

Combustion Gases (NO_x, SO_2, CO, O_2 & CO_2)

Measurements of combustion gases were carried out using an MCERTS Certified Horiba PG 250 portable stack analyser. Continuous monitoring of emissions was undertaken over each test period recording minute averaged data (one measurement every 60 seconds). The measurement techniques for each determinand are as follows:

Determinand	Technique	SRM
• NO_x	Chemiluminescence	BS EN 14792: 2005
• SO_2	Non dispersive infrared	EA TGN M21
• CO	Non-dispersive infrared	BS EN 15058: 2006
• O_2	Galvanic / Zirconia	BS EN 14789: 2005
• CO_2	Non-dispersive infrared	ISO 12039

The analyser was set up with reference to the manufacturers operator handbook and the in-house technical procedure **ECL/TPD/033c**. The analyser was calibrated on site using certified gases which are traceable to ISO 17025. (with uncertainty <2%). Zero measurements were performed using Nitrogen. The analyser was calibrated directly into the sample inlet and then checked through the entire sampling system (including sampling probe, heated & unheated gas transport lines and gas drying/ conditioning system).

Data is presented graphically in the Figures Section, and the minute averaged data is given in the Tables Section.

Pressure, Temperature and Velocity

Testing was carried out using a sampling system in accordance with **BS EN 13284-1 & MID** and In-house technical procedure **ECL/TPD/022.**

Temperature was recorded using a thermocouple and digital temperature reader.

Velocity and pressure were recorded using an "L" type pitot and digital manometer, data being recorded in Pascals.

TOCs as Carbon

Testing was carried out using an MCERTS Certified Signal 3030PM FID and heated gas sample line, with reference to the manufacturer's operation handbook **BS EN 12619** and in-house technical procedure **ECL/TPD/032**.

The analyser was calibrated on site using certified propane span gases which are traceable to ISO 17025 standard. (with uncertainty <2%). Zero measurements were performed using Nitrogen. The analyser was calibrated directly into the sample inlet and then checked through the entire sampling system (including sampling probe and heated gas transport lines). Data was corrected by molecular weight to TOCs as total carbon.

Data was recorded as minute averages over each test period. The data is presented in the Figures Section and the minute averaged data is detailed in the Tables Section.

The date of the last control gas mixture test on the FID was April 2012.

Hydrogen Chloride

Testing was carried out isokinetically, using a Universal Stack Sampling system in accordance with **BS EN 1911** and In-house technical procedure **ECL/TPD/036**. Non-isokinetic sampling can only take place if there are no droplets present in the stack gas.

In this method the stack gases are filtered to remove particulate matter then the gases are passed through a series of impingers. The first two or three impingers each containing 100ml of De-ionised Water and finally through an impinger containing a measured quantity of silica gel.

The impingers containing the de-ionised water are analysed for concentrations of Hydrogen Chloride by IC (Ion Chromatography).

Scientific Analysis Laboratories Ltd (SAL) who are situated in Manchester carried out the analysis of the samples. **SAL** are UKAS accredited for this analysis. In addition to the survey samples, appropriate field blanks and efficiency checks are submitted as part of the technical procedure.

Dioxins & Furans - (Filter / Condenser Method)

Determination of **Dioxins & Furans** was carried out using a Universal Stack Sampling system in accordance with **BS EN 1948-1** and In-house technical procedure **ECL/TPD/031**.

In this method the stack gases are sampled via a heated titanium probe and are then filtered (110mm out-stack, heated quartz or GFA filter) to remove particulate matter. The filtered gases are then passed through a cooling condenser and spiked XAD absorber, a verification absorption stage is not used. The gases the pass through a condensate flask and a series of silica gel filled impingers.

The gases are cooled via the condenser where the cooled gases and condensate percolate through the XAD absorber accumulate in the condensate flask before being dried by the silica impingers.

Scientific Analysis Laboratories Ltd (SAL) who are situated in Manchester carried out the analysis of the samples. **SAL** are UKAS accredited for this analysis. In addition to the survey samples, appropriate field blanks are submitted as part of the technical procedure.

Prior to every sampling campaign, the sample train glassware (upstream of the silica impingers) is rinsed with solvents and then muffled at 450 °C for three hours, before being carefully capped for transport to site. If any of the glassware is re-used on site (for further samples) additional rinses of the glassware are taken prior to the re-use and kept for analysis in case of high results being obtained for the following sample.

The sorbent trap is filled with approx 70g of Amberlite XAD-2 resin, it is spiked with 0.4ng of 1,2,3,7,8-PeCDF & 1,2,3,7,8,9-HxCDF and 0.8ng of 1,2,3,4,7,8,9-HpCDF.

Water Vapour

Testing was carried out using a Universal Stack Sampling system in accordance with **BS EN 14790** and In-house technical procedure **ECL/TPD/082**.

In this method the stack gases are filtered (in-stack unheated filter or out-stack heated filter) to remove particulate matter. The gases are then passed through a **heated probe** and then to a cooled moisture trapping unit. All unheated parts of the sample train (outside the sample port) which come into contact with stack gas are weighed pre and post sampling in order to determine the weight gain.

After each test, a visual inspection of the last impinger is made to confirm that at least 50% of the silica gel column has not changed colour. This indicates satisfactory collection of water vapour.

Speciated VOC (Non-Methane VOC)

Non-continuous sampling for **Speciated VOC (Non-Methane VOC)** was carried out in based on **BS EN 13649** and In-house technical procedure **ECL/TPD/084.** In this method a metered volume of stack gas is extracted through a standard charcoal sorbent tube.

Scientific Analysis Laboratories Ltd (SAL) who are situated in Manchester carried out the analysis of the samples. **SAL** are **NOT UKAS** accredited for this analysis. In addition to the survey samples, appropriate field blanks and efficiency checks are submitted as part of the technical procedure.

Due to restrictions set out in BS EN 13649, MCERTS/UKAS accreditation can only be claimed when the target parameters are organic compounds, the sorbent tube used is a standard charcoal tube and when laboratory analysis is UKAS accredited and carried out by GC. If other tubes are used, or if analysis is by other means than GC, then usually only UKAS accreditation can be claimed, as long as the laboratory analysis is UKAS accredited. (MCERTS accreditation may still be claimed if prior approval is given for the modifications by the Environment Agency – details will be given in section 2 of this report).

Laboratory analysis **cannot** be UKAS accredited for "non-methane VOC", "Total VOC" or "TOP 10 compounds".

For the subcontract laboratory to claim UKAS accreditation for analysis, the internal recovery of a spiking compound (desorption efficiency from tube) needs to be above 80%. If it falls below 80% this will be noted on the analysis certificate.

5 SAMPLE POINT DESCRIPTION

The homogeneity test is applicable to combustion processes. This includes but is not restricted to, those regulated under the Waste Incineration Directive (**WID**) and the Large Combustion Plant Directive (**LCPD**).

Homogeneity testing has not been completed at this location.

The sample location that was monitored is detailed below:-

Flare Stack

The stack diameter is 2.3m and sampling was performed using one of the four ports located close to the exit of the stack.

As a result of the sampling point being located in close proximity to the exit of the stack the sampling location does not currently meet the requirements detailed in *Technical Guidance Note (Monitoring) M1"Sampling requirements for stack-emission monitoring" Environment Agency, January 2007, Version 4.1,* and BS EN 13284-1.

Also, due to health and safety considerations, the flare was turned off in order to set up equipment and then turned back on again after the probe had been inserted into the stack and the monitoring team had descended from the sampling platform.

Due to the restricted access to the platform, all isokinetic samples were taken at a single point near to the centre of the duct, as they could not be taken from the designated number of sample points.

Access to the stack was gained by means of a temporary ladder secured to the side of temporary scaffolding complete with an in date scafftag.

A 240V power supply was available inside the engine room building directly below the sampling location.

EQUIPMENT IDs
(Pre site checklist from SSP)

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

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	009							
MST Nozzle set		873							
MST "S" Type Pitot									
MST Probe									
MST Hot Box		134							
MST Impinger Arm		659	323						
Barometer		351							
Site Balance		368							
Site Check weights		598	599						
Horiba	E002	511							
Heated Probe									
Chiller		270							
Sonimix									
Heated Line		852	853						
FID	E003	269							
Heated Line		432	433						
Testo	E004								
FTIR	E005								
Heated Probe									
Heated Line									
Stackmite	E006								
"L" Type Pitot		488							
Digital Manometer		356							
Stack Thermocouple		466							
Thermocouple Reader		370							
Nozzle Set									
Workhorse Pumps	E007								
Low Flow Pumps									

Quantity of Ice Required / Used for Survey	10	Bags (2kg bags)

FIGURES

Figure 1

TOC Continuous Emissions Data recorded from Bryn Posteg Landfill Flare between 12:05 and 13:05, on 19/12/2012. Reference Conditions (273K, 101.3kPa, 3% Oxygen & Dry Gas)

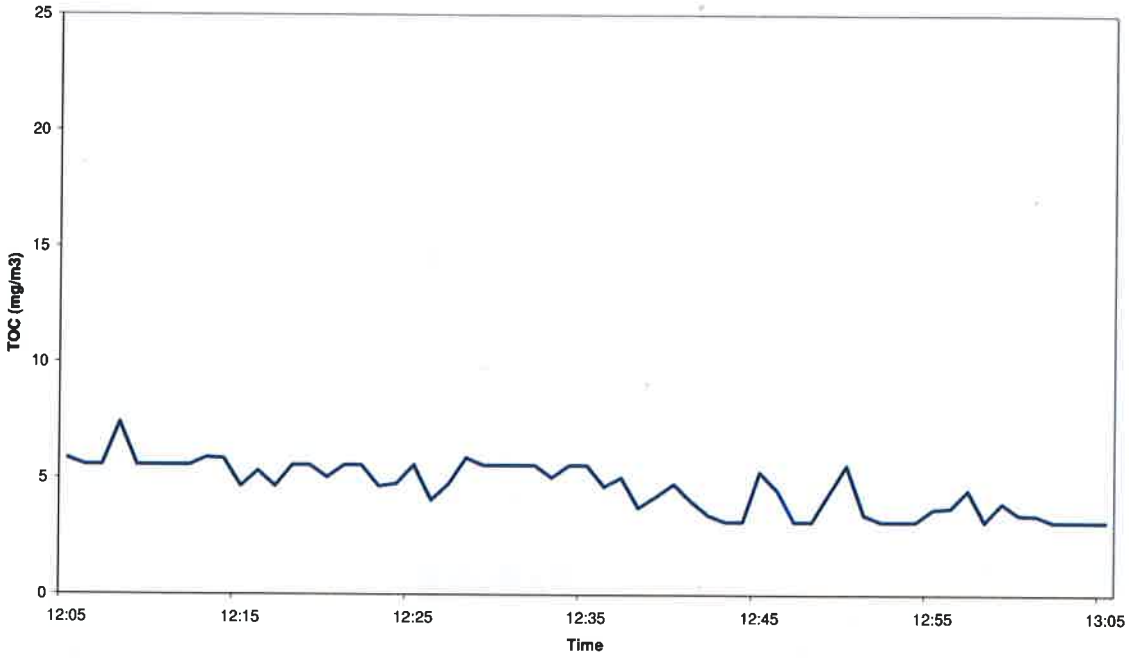
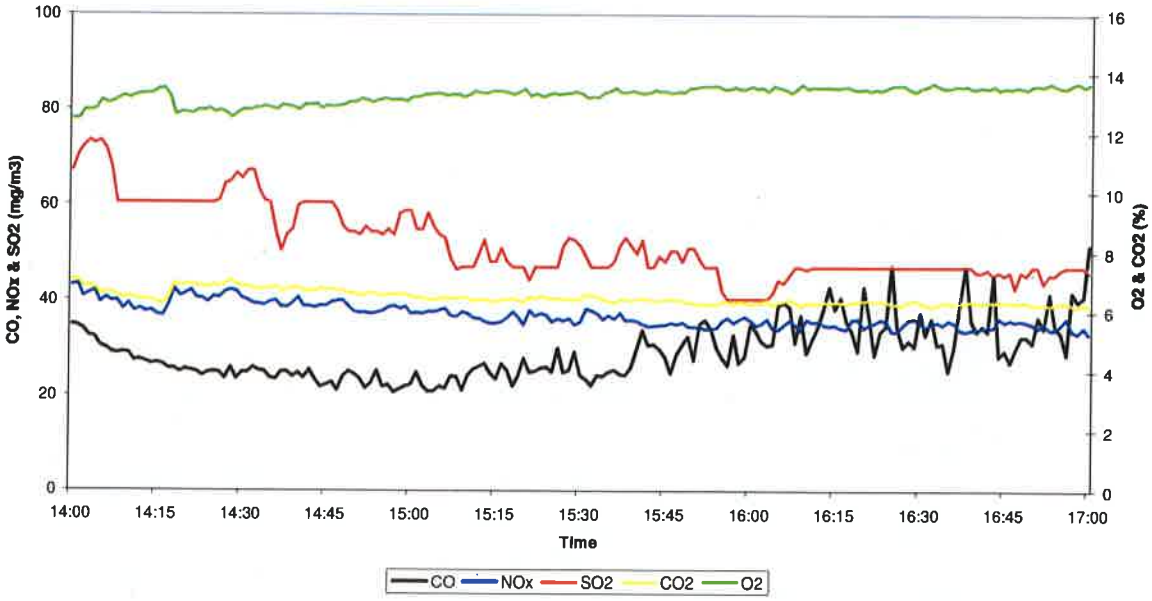


Figure 2

Combustion Gases Continuous Emissions Data recorded from Bryn Posteg Landfill Flare between 14:00 and 16:59, on 18/12/2012. Reference Conditions (273K, 101.3kPa, 3% Oxygen & Dry Gas)



TABLES

Table 1 - TOC

Data Recorded from Bryn Posteg Landfill Flare

Sample Period: 12:05 – 13:05 on the 19th December 2012

Volumetric Flowrate (Reference Conditions) = 2.90 m^3/sec *

	Average	Emission Rate
	mg/m^3	Kg/hr
TOCs (as carbon)*	4.65	0.049

* Reference Conditions (273K, 101.3 kPa, 3% Oxygen & Dry Gas)

Table 2 – Carbon Monoxide

Data Recorded from Bryn Posteg Landfill Flare

Sample Period: 14:00 – 16:59 on the 18th December 2012

Volumetric Flowrate (Reference Conditions) = 2.90 m^3/sec *

	Average	Emission Rate
Carbon Monoxide*	mg/m^3	Kg/hr
14:00 – 14:59	24.5	0.256
15:00 – 15:59	26.7	0.279
16:00 – 16:59	35.9	0.375

* Reference Conditions (273K, 101.3 kPa, 3% Oxygen & Dry Gas)

Table 3 – Oxides of Nitrogen (as NO_2)

Data Recorded from Bryn Posteg Landfill Flare

Sample Period: 14:00 – 16:59 on the 18th December 2012

Volumetric Flowrate (Reference Conditions) = 2.90 m^3/sec *

	Average	Emission Rate
Oxides of Nitrogen*	mg/m^3	Kg/hr
14:00 – 14:59	37.8	0.395
15:00 – 15:59	36.5	0.381
16:00 – 16:59	36.2	0.378

*** Reference Conditions (273K, 101.3 kPa, 3% Oxygen & Dry Gas)**

Table 4 – Sulphur Dioxide

Data Recorded from Bryn Posteg Landfill Flare

Sample Period: 14:00 – 16:59 on the 18th December 2012

Volumetric Flowrate (Reference Conditions) = 2.90 m^3/sec *

	Average	Emission Rate
Sulphur Dioxide*	mg/m^3	Kg/hr
14:00 – 14:59	58.4	0.610
15:00 – 15:59	49.6	0.622
16:00 – 16:59	47.7	0.498

*** Reference Conditions (273K, 101.3 kPa, 3% Oxygen & Dry Gas)**

Table 5 – Carbon Dioxide

Data Recorded from Bryn Posteg Landfill Flare

Sample Period: 14:00 – 16:59 on the 18th December 2012

	Average	Emission Rate
Carbon Dioxide*	% (v/v)	Kg/hr
14:00 – 14:59	6.75	...
15:00 – 15:59	6.44	...
16:00 – 16:59	6.33	...

* Reference Conditions (273K, 101.3k & Dry Gas)

Table 6 – Oxygen

Data Recorded from Bryn Posteg Landfill Flare

Sample Period: 14:00 – 16:59 on the 18th December 2012

	Average	Emission Rate
Oxygen*	% (v/v)	Kg/hr
14:00 – 14:59	12.96	...
15:00 – 15:59	13.39	...
16:00 – 16:59	13.56	...

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

Table 7 – Hydrogen Chloride

Data Recorded from Flare - Landfill

Emission Parameter	Units	HCl	Blank
Stack Diameter	metres	2.30	...
Area of Sample Plane	m^2	4.155	...
Moisture Content	%	10.17	...
Oxygen Content	%	13.31	...
Stack Temperature	°C	959	...
Gas Velocity (as Measured)	m/sec	8.70	...
Gas Velocity (Reference Conditions)	m/sec*	0.70	...
Volumetric Flowrate (as Measured)	m^3/sec	36.15	...
Volumetric Flowrate (Reference Conditions)	m^3/sec*	2.911	...
Sample Date	...	19/12/2012	...
Sample Period	...	10:13 - 11:13	...
Sample Volume (reference Conditions)	m^{3*}	0.325	0.325
Isokinetic Sampling Rate	%	112.24	...
Sample Reference (ECL ID)	ECL/12/	7532-33	7534
Mass of Hydrogen Chloride Collected	mg	2.78	0.02
Concentration of Hydrogen Chloride	mg/m^{3*}	8.54	0.06
Emission Rate of Hydrogen Chloride	g/hr	89.43	...
Expanded Uncertainty (% Relative)	%	13	...

*Reference Conditions (273K, 101.3kPa, 3% Oxygen, Dry Gas)

Table 8 – Non Methane VOC

Bryn Posteg
Llanidloes Flare

Emission Parameter	Units	Value
Stack Diameter	mm	2300
Area of Sample Plane	m^2	4.155
Moisture Content	%	10.51
Expanded Uncertainty of Moisture (%Relative)	%	13.40
Measured Oxygen (Dry)	%v/vol	13.31
Meter Temperature	°C	9.50
StackTemperature	°C	953.67
Sample Date	...	19/12/2012
Sample Period	...	12:05 - 13:05
Sample Volume (as Measured)	m^3	0.23
Sample Volume (reference Conditions)	m^{3*}	0.22

Sample Tube Results		NM VOC		Blank
Sample Reference ECL/13/7537	Units	Concentration*	Uncertainty	Concentration
Concentration of NM VOC	mg/m^3	4.57	88.49%	0.042

*Reference Conditions: 273 K, 101.3 kPa, 3%Oxygen & Dry Gas

Table 9 – Dioxin

Data Recorded from Landfill - Stack Flare

Emission Parameter	Units	Test DIOXIN
Stack Diameter	metres	2.3
-	-	-
Area of sample plane	m^2	4.155
Moisture Content	%	10.45
Moisture Expanded Uncertainty	%(Relative)	5.32
Stack Temperature	°C	890
Oxygen Concentration	%	13.31
Gas velocity (as Measured)	m/sec	8.31
Gas velocity (Reference Conditions)	m/sec*	0.71
Volumetric Flowrate (as Measured)	m^3/sec	34.51
Volumetric Flowrate (Reference	m^3/sec*	2.96
Sample Date	18/12/2012	
Sample Period	13:30 - 17:30	
Sample Reference	ECL/12/7525-7528	
Sample Volume (Reference Conditions)	m^3 *	1.32
Isokinetic Sampling Rate	%	112.33

Species	Sample Reference: ECL/12/7525-7528		Blank Reference: ECL/12/7529-7531	
	Conc. ng/m^3*	TEQ ng/m^3*	Conc. ng/m^3*	TEQ ng/m^3*
Dioxins 2,3,7,8 Isomers	0.17	0.020	0.073	0.012
Total Dioxins Non – Targeted	0.00	...	0.00	...
Furans 2,3,7,8 Isomers	0.13	0.015	0.030	*0.0032*
Total Furans Non – Targeted	0.00	...	0.00	...
TOTAL	...	0.035	...	0.015
Range	...	0.022 - 0.035	...	...
% Uncertainty	...	24	...	...

*Reference Conditions 273K, 101.3kPa, 3% Oxygen, Dry Gas

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Table 10 – Dioxins

Data Recorded from Landfill - Stack Flare on the 18/12/12, 13:30 - 17:30

Species	Blank Reference: ECL/12/7529-7531 TEQ ng/m³*	EEC Toxic Equivalent Factor (TEF)	Sample Ref.: ECL/12/7525-7528 Concentration ng/m³*	Sample Ref.: ECL/12/7525-7528 TEQ ng/m³*	WHO Humans & Mammals (TEF)	Humans & Mammals TEQ ng/m³*	WHO Fish (TEF)	Fish TEQ ng/m³*	WHO Birds (TEF)	Birds TEQ ng/m³*
Dioxins - 2,3,7,8 Isomers										
2,3,7,8 - TCDD	0.0014	1	**0.0050**	**0.0050**	1	**0.0050**	1	**0.0050**	1	**0.0050**
1,2,3,7,8 - PeCDD	0.0099	0.5	*0.027*	*0.014*	1	*0.027*	1	*0.027*	1	*0.027*
1,2,3,4,7,8 - HxCDD	0.00017	0.1	**0.0041**	**0.00041**	0.1	**0.00041**	0.5	**0.0021**	0.05	**0.00021**
1,2,3,6,7,8 - HxCDD	0.00020	0.1	**0.0046**	**0.00046**	0.1	**0.00046**	0.01	**0.000046**	0.01	**0.000046**
1,2,3,7,8,9 - HxCDD	0.00020	0.1	**0.0038**	**0.00038**	0.1	**0.00038**	0.01	**0.000038**	0.1	**0.00038**
1,2,3,4,6,7,8 - HpCDD	0.000056	0.01	**0.017**	**0.00017**	0.01	**0.00017**	0.001	**0.000017**	0.001	**0.000017**
OCDD	0.000040	0.001	**0.11**	**0.00011**	0.0001	**0.000011**	0	...	0	...
Total Dioxins - Non - Targeted Isomers										
TCDD	...	0	0.000000	...	0	...	0	...	0	...
PeCDD	...	0	0.000000	...	0	...	0	...	0	...
HxCDD	...	0	0.000000	...	0	...	0	...	0	...
HpCDD	...	0	0.000000	...	0	...	0	...	0	...
Furans - 2,3,7,8 Isomers										
2,3,7,8 - TCDF	0.00027	0.1	**0.024**	**0.0024**	0.1	**0.0024**	0.05	**0.0012**	1	**0.024**
1,2,3,7,8 - PeCDF	0.00012	0.05	**0.031**	**0.0016**	0.05	**0.0016**	0.05	**0.0016**	0.1	**0.0031**
2,3,4,7,8 - PeCDF	0.0019	0.5	**0.014**	**0.0072**	0.5	**0.0072**	0.5	**0.0072**	1	**0.014**
1,2,3,4,7,8 - HxCDF	0.00017	0.1	**0.014**	**0.0014**	0.1	**0.0014**	0.1	**0.0014**	0.1	**0.0014**
1,2,3,6,7,8 - HxCDF	0.00020	0.1	**0.011**	**0.0011**	0.1	**0.0011**	0.1	**0.0011**	0.1	**0.0011**
2,3,4,6,7,8 - HxCDF	0.00029	0.1	**0.0099**	**0.00099**	0.1	**0.00099**	0.1	**0.00099**	0.1	**0.00099**
1,2,3,7,8,9 - HxCDF	0.00022	0.1	**0.0024**	**0.00024**	0.1	**0.00024**	0.1	**0.00024**	0.1	**0.00024**
1,2,3,4,6,7,8 - HpCDF	0.000036	0.01	**0.014**	**0.00014**	0.01	**0.00014**	0.01	**0.00014**	0.01	**0.00014**
1,2,3,4,7,8,9 - HpCDF	0.000036	0.01	*0.0024*	*0.000024*	0.01	*0.000024*	0.01	*0.000024*	0.01	*0.000024*
OCDF	0.000005	0.001	**0.011**	**0.000011**	0.0001	**0.000001**	0.0001	**0.000001**	0.0001	**0.000001**
Total Furans - Non - Targeted Isomers										
TCDF	...	0	0.000000	...	0	...	0	...	0	...
PeCDF	...	0	0.000000	...	0	...	0	...	0	...
HxCDF	...	0	0.000000	...	0	...	0	...	0	...
HpCDF	...	0	0.000000	...	0	...	0	...	0	...
TOTAL	**0.015**	...	...	**0.035**	...	**0.049**	...	**0.048**	...	**0.079**
Range	...	...	...	**0.022 - 0.035**	...	**0.021 - 0.049**	...	**0.021 - 0.048**	...	**0.051 - 0.079**
% Uncertainty	...	...	...	**23.7**	...	**29.8**	...	**30.1**	...	**25.4**

***Reference Conditions 273K, 101.3kPa, 3% Oxygen, Dry Gas**

VELOCITY TRAVERSE PROFILES

Environmental Compliance Limited

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Combustion Gases

Formula ref			CO ppm	CO2 %	NO ppm	O2 %	SO2 ppm	
	Analyser Range		500	25	500	25	3000	
	Repeatability at Zero		2.5	0.125	2.5	0.125	15	
A	Span Gas Concentration Applied		201.1	5.041	262.5	15.008	1017	
B	Zero Gas Concentration Applied		0	0	0	0	0	
	Direct Cal	Zero	0.413	0.010	0.013	0.009	0.448	
		Span	201.179	5.056	264.134	15.171	1019.729	
		Zero	0.653	0.010	0.014	0.066	16.319	
	Difference (Zero)		1.0661111	0	0.000556	0.074389	16.76778	
	<2×Repeatability @ Zero?		YES	YES	YES	YES	YES	
C	Pre Test	Zero	0.085	0.010	0.013	0.008	3.350	
D		Span	199.738	5.027	264.198	15.074	1011.333	
	Difference (Zero)		0.7377778	0	0.000556	0.073389	12.96944	
Drift	<2×Repeatability @ Zero?		YES	YES	YES	YES	YES	If Red CONTACT QM
Correction	Difference (Span)		1.4418661	0.029889	0.06425	0.09775	8.395833	
	<2% Relative		YES	YES	YES	YES	YES	If Red CONTACT QM
F	Post Test	Zero	3.0138889	0.052361	1.077778	0.173611	3.361111	
G		Span	198.45167	4.9615	257.42	15.02033	1011.3	
	Difference (Zero)		2.9288889	0.042361	1.064444	0.165778	0.011111	
	<2% of Span Value		YES	YES	YES	YES	YES	If Red apply Drift
	Difference (Span)		1.2858335	0.065	6.777914	0.053166	0.033333	
	<2% of Span Value		YES	YES	NO	YES	YES	If Red apply Drift
	Drift <5%?		YES	YES	YES	YES	YES	If Red CONTACT QM

TOC

		TOC ppm		
Analyser Range		40		
Repeatability at Zero		0.4		
Span Gas Concentration Applied		10.06		
Zero Gas Concentration Applied		0		
Direct Cal	Zero	0.00		
	Span	10.06		
	Zero	0.56		
Difference (Zero)		0.560436118		
<2×Repeatability @ Zero?		YES		
Pre Test	Zero	0.20		
	Span	9.82		
Difference (Zero)		0.36109788		
<5% (2% for O_2) Relative to Direct Span		YES		If Red CONTACT QM
Difference (Span)		0.239015131		
<5% (2% for O_2) Relative to Direct Span		YES		If Red CONTACT QM
Post Test	Zero	0.17		
	Span	9.92		
Difference (Zero)		0.026		
<2% of Analyser Range		YES		If Red apply Drift
Difference (Span)		0.095		
<2% of Analyser Range		YES		If Red apply Drift
Drift <5% of Analyser Range?		YES		If Red CONTACT QM

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Non Methane VOC

Environmental Compliance Limited — SAMPLE TUBE DATA SAMPLING PROFORMA

Client	Bryn Posteg	Circular / Rectangular / Ellipse		Barometer ID	351	Date of Test	19/12/2012
Site	Llanddoes	Stack Diameter (mm)	2300	Balance ID	368	Sample Start Time	12:05
Location	Landfill Site			Pump ID	u009	Sample End Time	13:05
Stack ID	Flare	Stack Area (m^2)	4.155	Meter ID	u009	Duration	60
Test No.	NM VOC	Barometric Pressure (mb)	998	DGM Yd or mlcount	1.0151	Measured O2	13.31
Job No	P1560	Heated Line ID	---	tube condensation free for entire sample (y/n)	N	O2 Uncertainty %Vol	2.50
ECL Site Staff	JL & MB	Impinger ID	659				

	Sample	Leak 1	Time (start/ end) (minimum 1 minute)	Leak 2	Time (start/ end) (minimum 1 minute)	Total
Start Volume	1674343.0	1674343.0	12:02:00	1674573.0	13:13:00	
Final Volume	1674573.0	1674343.0	12:03:00	1674573.0	13:14:00	
Total Volume	230.0	0.0		0.0		230.0

Time Point	0 to 10	10 to 20	20 to 30	30 to 40
Heated Line Temp °C	---	---	---	---
Tube Temp °C	9	9	8	8
Stack Temp °C	956	951	954	954
Meter Temp In °C	10	10	10	10
Meter Temp Out °C	10	10	10	10

Time Point	40 to 50	50 to 60		
Heated Line Temp °C	---	---		
Tube Temp °C	8	8		
Stack Temp °C	946	941		
Meter Temp In °C	9	9		
Meter Temp Out °C	9	8		

Time Point				
Heated Line Temp °C				
Tube Temp °C				
Stack Temp °C				
Meter Temp In °C				
Meter Temp Out °C				

Impinger 1	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 2	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger3	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Silica	(IF USED)
<50% Spent at end?	YES
Start Weight (g)	0
End Weight (g)	20
Total weight (g)	20
Total	20

Dioxins

DIOXIN & FURANS DATA SAMPLING PROFORMA — Date of Measurement: 19/12/2012

ECUTR: 31 — Time taken to change Ports? 0 — Start Time 12:30 — End Time 17:30 — Sample Time (mins) 240

Client	Bryn Posteg	Stack Profile	Circular	Console ID	U009	Barometer ID	351
Site	Llanddoes	Stack Area (m²)	4.155	Pump ID	U009	Nozzle ID	573
Location	Landfill	Barometric Pressure (mb)	998	Probe ID	H Temp	Nozzle dia	12.05
Stack ID	Flare	Static Pres. (mmH2O)	0	DGM Vd	1.0151	Filter ID	OF
Test No.	DIOXIN	Pitot coefficient	1	O+Q	30.09	Pitot ID	498
Job No	P1560	Probe Heater Setting (°C)	---	Impinger ID	659	Hot Box ID	134
Operators	JL/MB	Hot Box Setting (°C)	120	Balance ID	368		

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	1670014.0						
Final Volume	1670239.0						
Total Volume	225.0	0.0	0.0	0.0	0.0	0.0	225.0

Original K Factor Settings	
Meter Temp.	20
Stack Temp.	1000
%Moisture	5.00

Leak Check	First	Second	Third	Fourth	Fifth				
Rate l/min	0				0	Measured O_2 (Atmospheric)	13.31	K factor	15.2
Vacuum "Hg	-10				-10	Measured Carbon Dioxide %	6.80	Reference Oxygen Percentage	3
Time of Check	10:15				17:28	Measured Carbon Monoxide ppm	10		

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	Total
Time/Point (mins)	0 - 15	15 - 30	30 - 45	45 - 60	60 - 75	75 - 90	90 - 105	105 - 120	
DP (mmHg)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K factor	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	
DH (litres)	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.2
Meter (litres)	25.0	25.0	25.0	24.0	24.0	24.0	21.0	20.0	23.5
Meter (litres)	25.0	25.0	25.0	24.0	24.0	24.0	21.0	20.0	23.5
Stack Temp (°K)	933.0	933.0	932.0	933.0	933.0	935.0	933.0	933.0	933.0
Impinger T (°C)	13.0	15.0	15.0	15.0	15.0	15.0	14.0	14.0	15.1
Vacuum "Hg	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	Total
Time/Point (mins)	120 - 135	135 - 150	150 - 165	165 - 180	180 - 195	195 - 210	210 - 225	225 - 240	
DP (mmHg)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K factor	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	
DH (litres)	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.2
Meter (litres)	19.0	19.0	18.0	17.0	15.0	15.0	15.0	15.0	16.4
Meter (litres)	19.0	19.0	18.0	17.0	15.0	15.0	15.0	15.0	16.4
Stack Temp (°K)	893.0	874.0	867.0	865.0	864.0	861.0	862.0	863.0	864.5
Impinger T (°C)	8.0	8.0	9.0	10.0	9.0	8.0	10.0	8.0	8.9
Vacuum "Hg	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.5

Traverse Point									Total
Time/Point (mins)									
DP (mmHg)									
K factor									
DH (litres)									
Meter (litres)									
Meter (litres)									
Stack Temp (°K)									
Impinger T (°C)									
Vacuum "Hg									

Traverse Point									Total
Time/Point (mins)									
DP (mmHg)									
K factor									
DH (litres)									
Meter (litres)									
Meter (litres)									
Stack Temp (°K)									
Impinger T (°C)									
Vacuum "Hg									

Impinger 1	XAD	Additional Moisture Weighings	
Start Weight (g)		Item/Name	
End Weight (g)	377.2	Start Weight (g)	
Total weight (g)	385.4	End Weight (g)	
	8.2	Total weight (g)	0
Impinger 2	Condenser	Item/Name	
Start Weight (g)	389.1	Start Weight (g)	
End Weight (g)	406.8	End Weight (g)	
Total weight (g)	347.7	Total weight (g)	0
Impinger3	Empty	Item/Name	
Start Weight (g)		Start Weight (g)	
End Weight (g)		End Weight (g)	
Total weight (g)	0	Total weight (g)	0
Impinger 4	Empty	Item/Name	
Start Weight (g)	461.1	Start Weight (g)	
End Weight (g)	462	End Weight (g)	
Total weight (g)	1.0	Total weight (g)	0
Impinger 5	Silica	Item/Name	
Start Weight (g)	727.1	Start Weight (g)	
End Weight (g)	727.1	End Weight (g)	
Total weight (g)	30	Total weight (g)	0
Impinger 6		Item/Name	
Start Weight (g)		Start Weight (g)	
End Weight (g)		End Weight (g)	
Total weight (g)	0	Total weight (g)	0
Impinger 7		Item/Name	
Start Weight (g)		Start Weight (g)	
End Weight (g)		End Weight (g)	
Total weight (g)	0	Total weight (g)	0
Impinger 8		Item/Name	
Start Weight (g)		Start Weight (g)	
End Weight (g)		End Weight (g)	
Total weight (g)	0	Total weight (g)	0
Total (g)	28.8	Item/Name	
		Start Weight (g)	
		End Weight (g)	
		Total weight (g)	0

Rinse Solutions Used	
Solution	DCM, HCl
DCM	1993
Acetone	1994
Toluene	1995

Environmental Compliance Limited

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Environmental Compliance Limited	Traverse Data Profoma	Date of Measurement	17/12/2012

Company	Bryn Posteg	Stack Diameter (mm)	2300	Pitot tube coefficient	1
Site	Llanidloes	Port Length (mm)	90	Pitot Id	488
Location	Land Fill Site	Duct Length (mm) A		Stack Thermocouple ID	466
Stack	Flare	Duct width (mm) B		Stack Temp Reader ID	370
Job No	P1560	Barometric Pressure. (mb)	969	Manometer ID	356
Operators	JL & MB	Static Pressure. (mm H_2O)	1	Barometer ID	351

	Distance to Point (mm)	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test ° From Reference	Port	Temp. (°C)	(ΔP) (Pa)	Swirl Test ° From Reference
	1000	A1	950.0	10.0	0				
Total			950				0		
Max			950	10.0			0	0.0	
Min			950	10.0			0	0.0	
Average			950.0	10.0					

Average temp (K)	1223

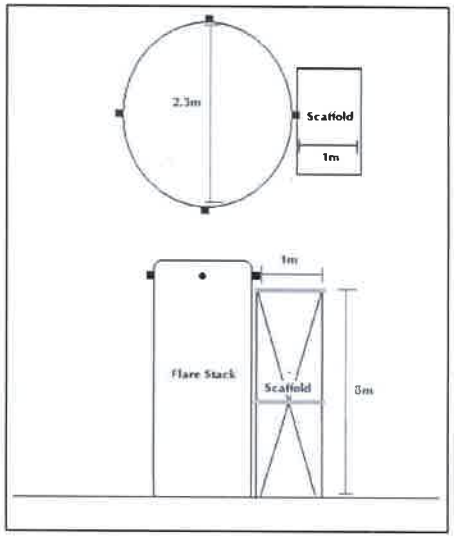
Suitability of Sampling Position	Actual Stack Conditons
Permitted highest:lowest flow pressure ratio =9:1	1:1
Average deviation of flow from axis <15°	OK
X-sectional area for stacks= πr^2	4.15 m^2
X-sectional area for ducts = L x B	0.000 m^2
Suitabilty of Position for Sampling	OK

Stack Moisture	10.2	%
Measured Oxygen	13.31	%
Measured Carbon Dioxide	6.75	%
Dry Gas Molecular Weight	29.6124	g/g mole

Gas Velocity (as Measured)	8.59	m/sec
Gas Velocity (Reference Conditions)	0.70	m/sec*
Volumetric Flowrate (as Measured)	35.69	m^3/sec
Volumetric Flowrate (Reference Conditions)	2.90	m^3/sec*

*Reference Conditions: 273K, 101.3kPa, 3% Oxygen, Dry Gas

Diagram/ Description of Cross Section of Stack/Duct



Compliance With Positional Requirements?

Height of sample ports from Platform	0.5m
Number of sample ports	4
Width of platform (port back to handrail)	0.8m

Nearest downstream disturbance	Exit	0.5m
Nearest upstream disturbance	Flare	5m

Disturbances are classed as bends, fans or diameter variations

FIELD CALIBRATION AND SAMPLING DATA

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Hydrogen Chloride

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	19/12/2012

ECL/TPD	30	Time taken to change Ports	8

Start Time	10:13	End Time	11:13
		Test Duration	60 mins

Client	Bryn Posteg Landfill Site	Stack Profile		Circular	Console id	U009	Barometer id	351
Site	Llanilloes	Stack Area (m^2)		4.15	Pump id	U009	Nozzle id	873
Location	Landfill	Barometric Pressure (mb)		966	Probe id	HI TEMP	Nozzle size	12.05
Stack ID	Flare	Static Pres. (mm H^2O)		0	DGM Yd	1.0131	Filter id	-
Test No.	HCl	Pitot coefficient		1	ΔH@	30.96	Pitot ID	498
Job No	P1560	Probe Heater Setting (°C)			Impinger id	859	Hot Box ID	134
ECL Site Staff	JL/MB	Hot Box Setting (°C)		150	Balance id	309		

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	1873450.0						
Final Volume	1874355.0						
Total Volume	905.0	0.0	0.0	0.0	0.0	0.0	905.0

Original K Factor Settings	
Meter Temp.	20
Stack Temp	1000
%Moisture	5.00

Leak Check	First	Second	Third	Fourth	Fifth	Measured O_2 (_ Atmospheric)	13.31	K factor	15.2
Rate l/min	0				0	Measured Carbon Dioxide %		Reference Oxygen Percentage	3
Vacuum "Hg	-10				-10	Measured Carbon Monoxide ppm			
Time of Check	09:18				11:15				

Traverse Point	CP	CP	CP	CP	CP	CP	CP	CP	Total
Time Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔH (mm H20)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K factor	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	
ΔH (Orifice)	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20
Meter (Tm in)	6.00	6.00	7.00	7.00	8.00	8.00	8.00	7.00	6.88
Meter (Tm out)	6.00	6.00	7.00	7.00	8.00	8.00	8.00	7.00	6.88
Stack Temp (Ts)	930.00	944.00	957.00	956.00	954.00	959.00	960.00	958.00	957.13
Impinger T Outlet	6.00	6.00	6.00	7.00	7.00	7.00	8.00	8.00	6.38
Vaccum (" Hg)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Traverse Point	CP	CP	CP	CP					Total
Time Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔH (mm H20)	1.00	1.00	1.00	1.00					1.00
K factor	15.20	15.20	15.20	15.20					
ΔH (Orifice)	15.20	15.20	15.20	15.20					15.20
Meter (Tm in)	7.00	7.00	8.00	8.00					7.00
Meter (Tm out)	7.00	7.00	8.00	8.00					7.00
Stack Temp (Ts)	960.00	961.00	964.00	965.00					962.50
Impinger T Outlet	6.00	6.00	6.00	6.00					5.50
Vaccum (" Hg)	1.00	1.00	1.00	1.00					1.00

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

Impinger 1	H_2O		
SOL/	2052		
Start Weight (g)	652		
End Weight (g)	719.8		
Total weight (g)	67.8		
Impinger 2	H_2O		
SOL/	3053		
Start Weight (g)	664		
End Weight (g)	666.7		
Total weight (g)	2.7		
Impinger3	H_2O		
SOL/	3052		
Start Weight (g)	703.5		
End Weight (g)	706.4		
Total weight (g)	2.9		
Impinger 4	Empty		
SOL/			
Start Weight (g)	482.4		
End Weight (g)	483.8		
Total weight (g)	1.4		
Impinger 5	Silica		
SOL/			
Start Weight (g)	757.1		
End Weight (g)	761.5		
Total weight (g)	4.4		
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)	89.30		

Rinse Solutions Used	
Solution	SOL NO
DI Water	1994
Acetone	2057

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

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.

LABORATORY ANALYSIS RESULTS

Bryn Posteg Landfill Site		Installation Name	: Landfill Flare
Permit No	: EPR/BU7766IC	Visit Details	: Annual Compliance
Variation No	: V004	Survey Dates	: 17th – 19th December 2012
Report Ref	: P1560 : R001	Report Issue Date	: 30th January 2013

Dioxins

Scientific Analysis Laboratories Ltd

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

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M16 9FE
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Fax : 0161 874 2404

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Report Number: 309928-1

Date of Report: 15-Jan-2013

Customer: Environmental Compliance Ltd
Building 26
Bay 6
First Avenue
Pensnett Trading Estate
Kingswinford
DY6 7TB

Customer Contact: Mr Jonathon Litterick

Customer Job Reference: P1560
Customer Purchase Order: E0956
Date Job Received at SAL: 24-Dec-2012
Date Analysis Started: 30-Dec-2012
Date Analysis Completed: 15-Jan-2013

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING 1549

Report checked and authorised by :
Kayleigh McCann
Project Manager

Issued by :
Kayleigh McCann
Project Manager

Validity unknown
Digitally signed by Kayleigh McCann
Date: 2013.01.15 18:07 GMT
Reason: Issued
Location: SAL

Bryn Posteg Landfill Site		Installation Name	: Landfill Flare
Permit No	: EPR/BU7766IC	Visit Details	: Annual Compliance
Variation No	: V004	Survey Dates	: 17th – 19th December 2012
Report Ref	: P1560 : R001	Report Issue Date	: 30th January 2013

Summary Of Results

Composite (Filt, Trap, Wash)

Dioxins and Dioxin-like PCBs

				ITEQ Toxic Equivalents ng	
SAL Reference	Customer Sample Reference	Analysis	Symbol	Lower Bound	Upper Bound
309926 005	Combined ECL/12/7527 + ECL/12/7526 + ECL/12/7525 + ECL/12/7528	Dioxins and Furans (BS EN 1948:06)	U	0.028	0.046
309926 009	Combined ECL/12/7529 + ECL/12/7531 + ECL/12/7530	Dioxins and Furans (BS EN 1948:06)	U	0.00053	0.020
309926 013	Combined METHOD BLANK TRAP + METHOD BLANK FILTER + METHOD BLANK WASH	Dioxins and Furans (BS EN 1948:06)	U	0.0	0.0064

Sampling Recoveries

SAL Reference	Customer Sample Reference	Determinand	Sampling Recovery %
309926 005	Combined ECL/12/7527 + ECL/12/7526 + ECL/12/7525 + ECL/12/7528	1,2,3,7,8-PeCDF	107
		1,2,3,7,8,9-HxCDF	100
		1,2,3,4,7,8,9-HpCDF	97
309926 009	Combined ECL/12/7529 + ECL/12/7531 + ECL/12/7530	1,2,3,7,8-PeCDF	101
		1,2,3,7,8,9-HxCDF	121
		1,2,3,4,7,8,9-HpCDF	122

Composite (Filt, Trap, Wash)

Customer Sample Reference : Combined ECL/12/7527 + ECL/12/7526 + ECL/12/7525 + ECL/12/7528

SAL Sample Reference : 309928 005

Dioxins and Furans (BS EN 1948:06)

Technique : GC/MS (HR)

Determinand	Symbol	LOD ng	Result ng	Internal Recovery %	ITEQ Toxic Equivalents ng Lower Bound	ITEQ Toxic Equivalents ng Upper Bound
2,3,7,8-TCDD	U	0.0015	0.0066	103	0.0066	0.0066
1,2,3,7,8-PeCDD	U	0.036	<0.036	90	0.0	0.018
1,2,3,4,7,8-HxCDD	U	0.0012	0.0054	130	0.00054	0.00054
1,2,3,6,7,8-HxCDD	U	0.0016	0.0061	96	0.00061	0.00061
1,2,3,7,8,9-HxCDD	U	0.0018	0.0050		0.00050	0.00050
1,2,3,4,6,7,8-HpCDD	U	0.0027	0.023	90	0.00023	0.00023
OCDD	U	0.0053	0.14	56	0.00014	0.00014
				Dioxins Totals :	0.0086	0.027
2,3,7,8-TCDF	U	0.0014	0.032	109	0.0032	0.0032
1,2,3,7,8-PeCDF	U	0.0020	0.041		0.0021	0.0021
2,3,4,7,8-PeCDF	U	0.0028	0.070	74	0.0095	0.0095
1,2,3,4,7,8-HxCDF	U	0.0013	0.048	120	0.0018	0.0018
1,2,3,6,7,8-HxCDF	U	0.0015	0.044	111	0.0014	0.0014
2,3,4,6,7,8-HxCDF	U	0.0014	0.043	104	0.0013	0.0013
1,2,3,7,8,9-HxCDF	U	0.0023	0.0032		0.00032	0.00032
1,2,3,4,6,7,8-HpCDF	U	0.0031	0.019	95	0.00019	0.00019
1,2,3,4,7,8,9-HpCDF	U	0.0031	<0.0031		0.0	0.00003
OCDF	U	0.0059	0.015	51	0.00001	0.00001
				Furans Totals :	0.020	0.020
				Totals :	0.028	0.046

Composite (Filt, Trap, Wash)

Customer Sample Reference : Combined ECL/12/7529 + ECL/12/7531 + ECL/12/7530

SAL Sample Reference : 309928 009

Dioxins and Furans (BS EN 1948:06)

Technique : GC/MS (HR)

Determinand	Symbol	LOD ng	Result ng	Internal Recovery %	ITEQ Toxic Equivalents ng Lower Bound	ITEQ Toxic Equivalents ng Upper Bound
2,3,7,8-TCDD	U	0.0019	<0.0019	77	0.0	0.0019
1,2,3,7,8-PeCDD	U	0.026	<0.026	72	0.0	0.013
1,2,3,4,7,8-HxCDD	U	0.0022	<0.0022	124	0.0	0.00022
1,2,3,6,7,8-HxCDD	U	0.0026	<0.0026	94	0.0	0.00026
1,2,3,7,8,9-HxCDD	U	0.0026	<0.0026		0.0	0.00026
1,2,3,4,6,7,8-HpCDD	U	0.0031	0.0074	78	0.00007	0.00007
OCDD	U	0.0087	0.053	45	0.00005	0.00005
				Dioxins Totals :	0.00013	0.016
2,3,7,8-TCDF	U	0.0017	0.0035	88	0.00035	0.00035
1,2,3,7,8-PeCDF	U	0.0032	<0.0032		0.0	0.00016
2,3,4,7,8-PeCDF	U	0.0049	<0.0049	81	0.0	0.0024
1,2,3,4,7,8-HxCDF	U	0.0022	<0.0022	124	0.0	0.00022
1,2,3,6,7,8-HxCDF	U	0.0026	<0.0026	93	0.0	0.00026
2,3,4,6,7,8-HxCDF	U	0.0038	<0.0038	84	0.0	0.00038
1,2,3,7,8,9-HxCDF	U	0.0029	<0.0029		0.0	0.00029
1,2,3,4,6,7,8-HpCDF	U	0.0047	0.0047	86	0.00005	0.00005
1,2,3,4,7,8,9-HpCDF	U	0.0047	<0.0047		0.0	0.00005
OCDF	U	0.0059	0.0086	51	0.00001	0.00001
				Furans Totals :	0.00040	0.0042
				Totals :	0.00053	0.020

Composite (Filt, Trap, Wash)

Customer Sample Reference : Combined METHOD BLANK TRAP + METHOD BLANK FILTER + METHOD BLANK WASH

SAL Sample Reference : 309928 013

Dioxins and Furans (BS EN 1948:06)

Technique : GC/MS (HR)

Determinand	Symbol	LOD ng	Result ng	Internal Recovery %	ITEQ Toxic Equivalents ng Lower Bound	ITEQ Toxic Equivalents ng Upper Bound
2,3,7,8-TCDD	U	0.0020	<0.0020	68	0.0	0.0020
1,2,3,7,8-PeCDD	U	0.0021	<0.0021	70	0.0	0.0010
1,2,3,4,7,8-HxCDD	U	0.0021	<0.0021	71	0.0	0.00021
1,2,3,6,7,8-HxCDD	U	0.0021	<0.0021	72	0.0	0.00021
1,2,3,7,8,9-HxCDD	U	0.0021	<0.0021		0.0	0.00021
1,2,3,4,6,7,8-HpCDD	U	0.0038	<0.0038	63	0.0	0.00004
OCDD	U	0.0072	<0.0072	42	0.0	0.00001
				Dioxins Totals :	0.0	0.0037
2,3,7,8-TCDF	U	0.0024	<0.0024	83	0.0	0.00024
1,2,3,7,8-PeCDF	U	0.0024	<0.0024		0.0	0.00012
2,3,4,7,8-PeCDF	U	0.0024	<0.0024	81	0.0	0.0012
1,2,3,4,7,8-HxCDF	U	0.0021	<0.0021	70	0.0	0.00021
1,2,3,6,7,8-HxCDF	U	0.0023	<0.0023	85	0.0	0.00023
2,3,4,6,7,8-HxCDF	U	0.0022	<0.0022	85	0.0	0.00022
1,2,3,7,8,9-HxCDF	U	0.0035	<0.0035		0.0	0.00035
1,2,3,4,6,7,8-HpCDF	U	0.0048	<0.0048	83	0.0	0.00005
1,2,3,4,7,8,9-HpCDF	U	0.0048	<0.0048		0.0	0.00005
OCDF	U	0.0069	<0.0069	43	0.0	0.00001
				Furans Totals :	0.0	0.0027
				Totals :	0.0	0.0064

Bryn Posteg Landfill Site		Installation Name	: Landfill Flare
Permit No	: EPR/BU7766IC	Visit Details	: Annual Compliance
Variation No	: V004	Survey Dates	: 17th – 19th December 2012
Report Ref	: P1560 : R001	Report Issue Date	: 30th January 2013

Index to symbols used in 309928-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

Bryn Posteg Landfill Site		**Installation Name**	**: Landfill Flare**
Permit No	**: EPR/BU7766IC**	**Visit Details**	**: Annual Compliance**
Variation No	**: V004**	**Survey Dates**	**: 17th – 19th December 2012**
Report Ref	**: P1560 : R001**	**Report Issue Date**	**: 30th January 2013**

Non Methane VOC & Hydrogen Chloride

SAL

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

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Certificate of Analysis

Report Number: 309929-1

Date of Report: 07-Jan-2013

Customer: Environmental Compliance Ltd
Unit G1
Main Avenue
Treforest Industrial Estate
Pontypridd
CF37 5YL.

Customer Contact: Mr Andrew Barnes

Customer Job Reference: P1560
Customer Purchase Order: E0956
Date Job Received at SAL: 24-Dec-2012
Date Analysis Started: 28-Dec-2012
Date Analysis Completed: 07-Jan-2013

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING 1549

Report checked and authorised by :
Kayleigh McCann
Project Manager

Issued by :
Kayleigh McCann
Project Manager

Validity unknown
Digitally signed by Kayleigh McCann
Date: 2013.01.17 12:32 GMT
Reason: Issue
Location: SAL

SAL Reference: 309929
Customer Reference: P1560

Impinger(DI water) Analysed as Impinger(DI water)
Miscellaneous

				SAL Reference	309929 001	309929 002	309929 003
				Customer Sample Reference	ECL/12/7632	ECL/12/7633	ECL/12/7634
				Test Sample	AR	AR	AR
Determinand	Method	LOD	Units	Symbol			
Hydrogen Chloride	IC	0.05	mg/l	U	(13) 7.1	(13) <0.05	(13) <0.05
Volume	Vol	1	ml	U	380	140	380

SAL Reference: 309929
Customer Reference: P1560

Tube (Charcoal 226-09) Analysed as Tube (Charcoal 226-09)
Miscellaneous

				SAL Reference	309929 004	309929 005	309929 006	309929 007
				Customer Sample Reference	ECL/12/7635	ECL/12/7636	ECL/12/7637	ECL/12/7638
				Test Sample	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol				
Volatile Organic Compounds (Total)	GC/MS	2	µg	N	4480	13	428	9

Index to symbols used in 309929-1

Value	Description
AR	As Received
13	Results have been blank corrected.
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

UNCERTAINTY CALCULATIONS

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Combustion Gases
Uncertainty of Measurements

Uncertainty Calculations Part 1

Horiba PG250 Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Minimum Certified Range (R) NO 0-125 mg/m³	SO_2 0-460 mg/m³	CO 0-95 mg/m³	O_2 0-25 %Vol	CO_2 0-20 %Vol
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.40	0.80	0.40	0.13	0.60
Span drift[2]	u_{dx}			0.27	0.27	0.29	0.029	0.24
Losses / leakage in the sample system[4]	u_{lsm}			1.00	1.00	1.00	1.00	1.00
Temperature dependant span drift[3]	u_t			0.18	0.15	0.050	0.070	0.040

Notes:

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

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 PG250 Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	NO 0-125 mg/m³	SO_2 0-460 mg/m³	CO 0-95 mg/m³	O_2 0-25 %Vol	CO_2 0-20 %Vol
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.29	2.12	0.22	0.019	0.069
Span drift	u_{dx}			0.20	0.72	0.16	0.0041	0.028
Temperature dependant span drift	u_t			0.34	1.05	0.073	0.027	0.0092
Interferents	u_i			0.87	3.98	1.59	0.081	–

Uncertainty Calculations Part 2

Horiba PG250 Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	NO 0-125 mg/m³	SO_2 0-460 mg/m³	CO 0-95 mg/m³	O_2 0-25 %Vol	CO_2 0-20 %Vol
Losses / leakage in the sample system	u_{lsm}	18/12/12 14:00 - 14:59	0.38	0.58	0.24	0.13	0.057
		18/12/12 15:00 - 15:59	0.37	0.50	0.27	0.13	0.064
		18/12/12 16:00 - 16:59	0.36	0.48	0.36	0.14	0.063
Standard Error of Measured Value	u_{SE}	18/12/12 14:00 - 14:59	0.086	0.30	0.16	0.030	0.024
		18/12/12 15:00 - 15:59	0.063	0.22	0.20	0.013	0.0095
		18/12/12 16:00 - 16:59	0.047	0.11	0.27	0.0086	0.0068
Uncertainty due to Oxygen Correction[6]	u_{Oxy}	18/12/12 14:00 - 14:59	0.14	0.22	0.093		
		18/12/12 15:00 - 15:59	0.065	0.088	0.047		
		18/12/12 16:00 - 16:59	0.042	0.056	0.042		

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 Calculations Part 3

Horiba PG250 Uncertainty	Date & Time	NO 0-125 mg/m³	SO_2 0-460 mg/m³	CO 0-95 mg/m³	O_2 0-25 %Vol	CO_2 0-20 %Vol
Measured Concentration	18/12/12 14:00 - 14:59	37.81	58.39	24.47	12.96	6.75
Expanded Uncertainty as Percentage of Measured Concentration		5.7%	16.2%	13.5%	2.5%	3.1%
Measured Concentration	18/12/12 15:00 - 15:59	36.54	49.56	26.66	13.39	6.44
Expanded Uncertainty as Percentage of Measured Concentration		5.6%	19.1%	12.4%	2.4%	3.1%
Measured Concentration	18/12/12 16:00 - 16:59	35.15	47.68	35.68	13.56	6.33
Expanded Uncertainty as Percentage of Measured Concentration		5.9%	19.6%	9.3%	2.4%	3.1%

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{dx}^2 + u_t^2 + u_{lsm}^2 + u_i^2 + u_{SE}^2 + u_{Oxy}^2}$

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

1 Expressed as a percentage of the analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Where the uncertainty of Oxygen is taken as the standard error of the time averaged value used to correct to Reference Oxygen
7 Where the uncertainty of Moisture is taken as the standard error of the time averaged value used to correct to Dry Conditions

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Combustion Gases Measurement Uncertainty

Horiba PG 250 Performance Characteristics	Standard Uncertainty	Distribution	Minimum Certified Range (R)				
			NO 0 - 125 mg/m³	SO_2 0 - 460 mg/m³	CO 0 - 95 mg/m³	O_2 0 - 25 %Vol	CO_2 0 - 20 %Vol
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.40	0.60	0.40	0.13	0.60
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.27	0.27	0.29	0.029	0.24
Repeatability Standard Deviation (span)	u_r	Normal (Divisor = 1)	0.17	5.43	0.29	0.038	0.010
Losses / leakage in the sample system[3]	u_{loss}	Rectangular (Divisor = √3)	2.00	2.00	2.00	2.00	2.00
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.18	0.15	0.050	0.070	0.040
Interferents[1]	u_i	Rectangular (Divisor = √3)	1.20	1.50	2.90	0.56	...
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	5.39	29.06	2.51	0.076	0.038

Note:

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

1 Expressed as a percentage of the analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement, dry gas
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol

Horiba PG 250 Performance Characteristics	Uncertainty	Value of Standard Uncertainty	NO 0 - 125 mg/m³	SO_2 0 - 460 mg/m³	CO 0 - 95 mg/m³	O_2 0 - 25 %Vol	CO_2 0 - 20 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.29	2.12	0.22	0.019	0.07
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.20	0.72	0.16	0.0041	0.0280
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.17	5.43	0.29	0.038	0.01
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	1.99	26.92	2.50	0.16	0.06
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R \times \sqrt{\frac{(x_{i,max}-x_{adj})^2+(x_{i,min}-x_{adj})(x_{i,max}-x_{adj})+(x_{i,min}-x_{adj})^2}{3}}$	0.13	0.40	0.027	0.010	0.005
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.67	3.98	1.59	0.081	...
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	3.11	16.78	1.45	0.044	0.02
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	3.81	32.51	3.32	0.19	0.10
Expanded measurement uncertainty (at 95%confidence)		$U_{EXP} = 2 \times u_c$	7.63	65.02	6.64	0.38	0.20
Applied Span Concentration			539.06	2905.71	251.38	15.01	5.04
Measured Span Concentration, STP Dry Gas			205.49	2913.51	251.47	15.17	5.06
Expanded measurement uncertainty as %of Applied Span			1.4%	2.2%	2.6%	2.5%	3.9%

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

TOC
Uncertainty of Measurements

Uncertainty Calculations Part 1

Protir 204M FTIR & Signal 3030 FID Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Minimum Certified Range (R) O_2 0-21 %Vol	Minimum Certified Range (R) *TOC 0-15 mgC/m³
Lack of fit(1)	u_{lof}	Rectangular	$\sqrt{3}$	1.80	0.40
Span drift(2)	$u_{d,s}$			0.029	0.35
Losses / leakage in the sample system(4)	u_{loss}			1.00	1.00
Temperature dependant span drift(5)	u_t			0.30	0.30
Effect of Voltage Fluctuation(7)	u_v			---	1.80

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), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Protir 204M FTIR & Signal 3030 FID Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	O_2 0-21 %Vol	*TOC 0-15 mgC/m³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.22	0.035
Span drift	$u_{d,s}$			0.0034	0.031
Temperature dependant span drift	u_t			0.00	0.00
Interferents	u_i			0.37	0.38
Effect of Voltage Fluctuation (See Note)	u_v			---	0.16

Uncertainty Calculations Part 2

Protir 204M FTIR & Signal 3030 FID Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	O_2 0-21 %Vol	*TOC 0-15 mgC/m³
Losses / leakage in the sample system	u_{loss}	19/12/12 12:05 - 13:05	0.13	0.046
Standard Error of Measured Value	u_{SE}	19/12/12 12:05 - 13:05	1.15E-15	0.052
Uncertainty due to Oxygen Correction(6)	u_{Oxy}	19/12/12 12:05 - 13:05		4.44E-16
Uncertainty due to Moisture Correction(6)	u_{H2O}	19/12/12 12:05 - 13:05	0.74	0.26

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 Calculations Part 3

Protir 204M FTIR & Signal 3030 FID Uncertainty	Date & Time	O_2 0-21 %Vol	*TOC 0-15 mgC/m³
Measured Concentration	19/12/12 12:05 - 13:05	13.31	4.65
Expanded Uncertainty as Percentage of Measured Concentration		13.1%	21.2%

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_t^2 + u_{loss}^2 + u_i^2 + u_v^2 + u_{SE}^2 + u_{Oxy}^2 + u_{H2O}^2}$

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

1 Expressed as a percentage of the analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Where the uncertainty of Oxygen is taken as the standard error of the time averaged value used to correct to Reference Oxygen
7 Where the uncertainty of Moisture is taken from the manual extractive test calculations

TOC
Measurement Uncertainty

Signal 3030 FID Performance Characteristics	Standard Uncertainty	Distribution	Minimum Certified Range (R) *TOC 0 - 15 mgC/m³
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.40
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.35
Repeatability Standard Deviation (span)	u_r	Normal (Divisor = 1)	0.20
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	2.00
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)	0.23
Effect of Voltage Fluctuation[7]	u_v	Rectangular (Divisor = √3)	1.80
Effect of Oxygen Synergism[7]	u_{syn}	Rectangular (Divisor = √3)	4.60

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 analyser range
2 Expressed as maximum drift per 24hr period
3 Expressed in units of final measurement, dry gas
4 Expressed as a percentage of the final measured value
5 Per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol
7 Applies to TOC analyser (*Signal 3030 FID) only

Signal 3030 FID Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TOC 0 - 15 mgC/m³
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.03
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	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.20
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.18
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.000
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	0.13
Effect of Voltage Fluctuation (See Note 7)	u_v	$u(x_i) = \frac{u_v \times R_i}{\sqrt{3}} =$	0.16
Effect of Oxygen Synergism (See Note 7)	u_{syn}	$u(x_i) = \frac{u_{syn} \times R_i}{\sqrt{3}} =$	0.40
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	0.65
Expanded measurement uncertainty (at 95%confidence)		$U_{EXP} = 2 \times u_c$	1.30
Applied Span Concentration			16.17
Measured Span Concentration, STP Dry Gas			15.94
Expanded measurement uncertainty as %of Applied Span			8.0%

* Signal 3030 FID

Bryn Posteg Landfill Site		Installation Name	: Landfill Flare
Permit No	: EPR/BU7766IC	Visit Details	: Annual Compliance
Variation No	: V004	Survey Dates	: 17th – 19th December 2012
Report Ref	: P1560 : R001	Report Issue Date	: 30th January 2013

Dioxins

Site: Llanidloes
Location: Flare

Dioxin	Recovered Mass ng	LOD ng	LAB Method Uncert (%) K=2 %age	as Mass (ng)	Standard Uncertainty Symbol	ng
2,3,7,8 - TCDD	0.00660	0.00190	50	0.00330	u2,3,7,8 - TCDD	0.00165
1,2,3,7,8 - PeCDD	0.0360	0.0260	50	0.0180	u1,2,3,7,8 - PeCDD	0.0090
1,2,3,4,7,8 - HxCDD	0.00540	0.00220	50	0.00270	u1,2,3,4,7,8 - HxCDD	0.0014
1,2,3,6,7,8 - HxCDD	0.00610	0.00260	50	0.00305	u1,2,3,6,7,8 - HxCDD	0.0015
1,2,3,7,8,9 - HxCDD	0.00500	0.00260	50	0.00250	u1,2,3,7,8,9 - HxCDD	0.0013
1,2,3,4,6,7,8 - HpCDD	0.0230	0.00740	50	0.0115	u1,2,3,4,6,7,8 - HpCDD	0.006
OCDD	0.140	0.0530	50	0.0700	uOCDD	0.035
2,3,7,8 - TCDF	0.0320	0.00350	50	0.0160	u2,3,7,8 - TCDF	0.0080
1,2,3,7,8 - PeCDF	0.0410	0.00320	30	0.0123	u1,2,3,7,8 - PeCDF	0.0062
2,3,4,7,8 - PeCDF	0.0190	0.00490	50	0.00950	u2,3,4,7,8 - PeCDF	0.0048
1,2,3,4,7,8 - HxCDF	0.0180	0.00220	50	0.00900	u1,2,3,4,7,8 - HxCDF	0.0045
1,2,3,6,7,8 - HxCDF	0.0140	0.00260	50	0.00700	u1,2,3,6,7,8 - HxCDF	0.0035
2,3,4,6,7,8 - HxCDF	0.0130	0.00380	50	0.00650	u2,3,4,6,7,8 - HxCDF	0.003
1,2,3,7,8,9 - HxCDF	0.00320	0.00290	50	0.00160	u1,2,3,7,8,9 - HxCDF	0.0008
1,2,3,4,6,7,8 - HpCDF	0.0190	0.00470	50	0.00950	u1,2,3,4,6,7,8 - HpCDF	0.005
1,2,3,4,7,8,9 - HpCDF	0.00310	0.00470	50	0.00155	u1,2,3,4,7,8,9 - HpCDF	0.0008
OCDF	0.0150	0.00660	50	0.00750	uOCDF	0.004

	Measured Values			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	3.399	m^3		uV_m	0.001	m^3
Meter Correction Factor (Yd)	1.015	...			...	...
Meter Temperature (T_m)	292.938	k		uTm	1.5	k
Average Differential Pressure (ΔH)	15.200	mmH_2O		uDH	0.25	mmH_2O
Barometric Pressure (ρ_b)	726.807	mmHg		$u\rho_b$	3.8	mmHg
$\Delta H + \rho s$ (ρ_m)	97.049	kPa			...	...
Oxygen content ($O_{2,m}$)	13.307	% by volume	$uO_{2,m} = \sigma/\sqrt{n}$		0.02	% by volume
Moisture Content (H_2O)	10.450	% by volume		uH_2O	0.28	% by volume

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

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

($u\Delta H$), measured stack pressure uncertainty component (up_s) & measured temperature of dry gas uncertainty component ($uT_{m\ Dry}$)

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.906$$

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
$u\Delta H$	0.906	0.906	0.0000915	0.0000229
up_b	0.911	0.901	0.00124	0.00467
uT_m	0.911	0.901	0.00309	0.00464
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00590$$

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

$$V_{std} = V_{measured} \times f_s = \quad 3.080$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty m^3
Effect of uV_{std}	3.100	3.060	3.399	0.0201
Effect of uV_m	3.081	3.079	0.906	0.000906

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0682$$

Uncertainty of correction factor to reference oxygen due to measured oxygen uncertainty component (uf_{O2})

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = \quad 1.300$$

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	1.304	1.296	0.169	0.00374

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	0.00348	0.00209	0.422	0.000696
1,2,3,7,8 - PeCDD	0.0190	0.0114	0.422	0.00380
1,2,3,4,7,8 - HxCDD	0.00285	0.00171	0.422	0.000570
1,2,3,6,7,8 - HxCDD	0.00322	0.00193	0.422	0.000644
1,2,3,7,8,9 - HxCDD	0.00264	0.00158	0.422	0.000528
1,2,3,4,6,7,8 - HpCDD	0.0121	0.00728	0.422	0.00243
OCDD	0.0739	0.0443	0.422	0.0148
2,3,7,8 - TCDF	0.0169	0.0101	0.422	0.00338
1,2,3,7,8 - PeCDF	0.0199	0.0147	0.422	0.00260
2,3,4,7,8 - PeCDF	0.0100	0.00601	0.422	0.00200
1,2,3,4,7,8 - HxCDF	0.00950	0.00570	0.422	0.00190
1,2,3,6,7,8 - HxCDF	0.00739	0.00443	0.422	0.00148
2,3,4,6,7,8 - HxCDF	0.00686	0.00412	0.422	0.00137
1,2,3,7,8,9 - HxCDF	0.00169	0.00101	0.422	0.000338
1,2,3,4,6,7,8 - HpCDF	0.0100	0.00601	0.422	0.00200
1,2,3,4,7,8,9 - HpCDF	0.00164	0.000981	0.422	0.000327
OCDF	0.00791	0.00475	0.422	0.00158

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

Dioxin	uL ng/Nm³
2,3,7,8 - TCDD	0.0000322
1,2,3,7,8 - PeCDD	0.000175
1,2,3,4,7,8 - HxCDD	0.0000263
1,2,3,6,7,8 - HxCDD	0.0000297
1,2,3,7,8,9 - HxCDD	0.0000244
1,2,3,4,6,7,8 - HpCDD	0.000112
OCDD	0.000682
2,3,7,8 - TCDF	0.000156
1,2,3,7,8 - PeCDF	0.000200
2,3,4,7,8 - PeCDF	0.0000926
1,2,3,4,7,8 - HxCDF	0.0000877
1,2,3,6,7,8 - HxCDF	0.0000682
2,3,4,6,7,8 - HxCDF	0.0000634
1,2,3,7,8,9 - HxCDF	0.0000156
1,2,3,4,6,7,8 - HpCDF	0.0000926
1,2,3,4,7,8,9 - HpCDF	0.0000151
OCDF	0.0000731

Uncertainty in final measurement @ reference conditions due to oxygen correction uncertainty component (uf_{Oxy})

Dioxin	Maximum ng/Nm³	Minimum ng/Nm³	Sensitivity	uf_{Oxy} ng/Nm³
2,3,7,8 - TCDD	0.00279	0.00278	0.00214	8.005E-06
1,2,3,7,8 - PeCDD	0.0152	0.0152	0.0117	0.0000437
1,2,3,4,7,8 - HxCDD	0.00229	0.00227	0.00175	6.549E-06
1,2,3,6,7,8 - HxCDD	0.00258	0.00257	0.00198	7.398E-06
1,2,3,7,8,9 - HxCDD	0.00212	0.00210	0.00162	6.064E-06
1,2,3,4,6,7,8 - HpCDD	0.00974	0.00968	0.00747	0.0000279
OCDD	0.0593	0.0589	0.0455	0.000170
2,3,7,8 - TCDF	0.0135	0.0135	0.0104	0.0000388
1,2,3,7,8 - PeCDF	0.0174	0.0173	0.0133	0.0000497
2,3,4,7,8 - PeCDF	0.00804	0.00800	0.00617	0.0000230
1,2,3,4,7,8 - HxCDF	0.00762	0.00758	0.00584	0.0000218
1,2,3,6,7,8 - HxCDF	0.00593	0.00589	0.00455	0.0000170
2,3,4,6,7,8 - HxCDF	0.00550	0.00547	0.00422	0.0000158
1,2,3,7,8,9 - HxCDF	0.00135	0.00135	0.00104	3.881E-06
1,2,3,4,6,7,8 - HpCDF	0.00804	0.00800	0.00617	0.0000230
1,2,3,4,7,8,9 - HpCDF	0.00131	0.00130	0.00101	3.760E-06
OCDF	0.00635	0.00631	0.00487	0.0000182

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	0.00285	0.00273	0.000905	0.0000617
1,2,3,7,8 - PeCDD	0.0155	0.0149	0.00494	0.000337
1,2,3,4,7,8 - HxCDD	0.00233	0.00223	0.000740	0.0000505
1,2,3,6,7,8 - HxCDD	0.00263	0.00252	0.000838	0.0000571
1,2,3,7,8,9 - HxCDD	0.00216	0.00206	0.000686	0.0000468
1,2,3,4,6,7,8 - HpCDD	0.00993	0.00950	0.00315	0.000215
OCDD	0.0604	0.0578	0.0192	0.00131
2,3,7,8 - TCDF	0.0138	0.0132	0.00439	0.000299
1,2,3,7,8 - PeCDF	0.0177	0.0169	0.00562	0.000383
2,3,4,7,8 - PeCDF	0.00820	0.00785	0.00261	0.000178
1,2,3,4,7,8 - HxCDF	0.00777	0.00743	0.00247	0.000168
1,2,3,6,7,8 - HxCDF	0.00604	0.00578	0.00192	0.000131
2,3,4,6,7,8 - HxCDF	0.00561	0.00537	0.00178	0.000122
1,2,3,7,8,9 - HxCDF	0.00138	0.00132	0.000439	0.0000299
1,2,3,4,6,7,8 - HpCDF	0.00820	0.00785	0.00261	0.000178
1,2,3,4,7,8,9 - HpCDF	0.00134	0.00128	0.000425	0.0000290
OCDF	0.00647	0.00619	0.00206	0.000140

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

Dioxin	Combined Uncertainty ng/Nm³	Expanded Uncertainty ng/Nm³	Measured Concentration ng/Nm³	% of Measured Concentration
2,3,7,8 - TCDD	0.000700	0.00140	0.00279	50.3
1,2,3,7,8 - PeCDD	0.00382	0.00764	0.0152	50.3
1,2,3,4,7,8 - HxCDD	0.000573	0.00115	0.00226	50.3
1,2,3,6,7,8 - HxCDD	0.000647	0.00129	0.00257	50.3
1,2,3,7,8,9 - HxCDD	0.000530	0.00106	0.00211	50.3
1,2,3,4,6,7,8 - HpCDD	0.00244	0.00488	0.00971	50.3
OCDD	0.0148	0.0297	0.0591	50.3
2,3,7,8 - TCDF	0.00339	0.00679	0.0135	50.3
1,2,3,7,8 - PeCDF	0.00263	0.00526	0.0173	30.4
2,3,4,7,8 - PeCDF	0.00201	0.00403	0.00802	50.3
1,2,3,4,7,8 - HxCDF	0.00191	0.00382	0.00760	50.3
1,2,3,6,7,8 - HxCDF	0.00148	0.00297	0.00591	50.3
2,3,4,6,7,8 - HxCDF	0.00138	0.00276	0.00549	50.3
1,2,3,7,8,9 - HxCDF	0.000339	0.000679	0.00135	50.3
1,2,3,4,6,7,8 - HpCDF	0.00201	0.00403	0.00802	50.3
1,2,3,4,7,8,9 - HpCDF	0.000329	0.000658	0.00131	50.3
OCDF	0.00159	0.00318	0.00633	50.3
		Total (ng/Nm³)	0.169	19.8

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

Uncertainty - Adjusted for TEQ / TEF

Dioxin	TEQ ngm^{3*}	Uncertainty ng/Nm^3	Conc ng/Nm^3	WHO Humans & Mammals (TEF)	Uncertainty ng/Nm^3	Conc ng/Nm^3	WHO Fish (TEF)	Uncertainty ng/Nm^3	Conc ng/Nm^3	WHO Birds (TEF)	Uncertainty ng/Nm^3	Conc ng/Nm^3
2,3,7,8 - TCDD	1	0.00140	0.00279	1	0.00140	0.00279	1	0.00140	0.00279	1	0.00140	0.00279
1,2,3,7,8 - PeCDD	0.5	0.00382	0.00760	1	0.00764	0.0152	1	0.00764	0.0152	1	0.00764	0.0152
1,2,3,4,7,8 - HxCDD	0.1	0.000115	0.000228	0.1	0.000115	0.000228	0.5	0.000573	0.00114	0.05	0.0000573	0.000114
1,2,3,6,7,8 - HxCDD	0.1	0.000129	0.000257	0.1	0.000129	0.000257	0.01	0.0000129	0.0000257	0.01	0.0000129	0.0000257
1,2,3,7,8,9 - HxCDD	0.1	0.000106	0.000211	0.1	0.000106	0.000211	0.01	0.0000106	0.0000211	0.1	0.000106	0.000211
1,2,3,4,6,7,8 - HpCDD	0.01	0.0000488	0.0000971	0.01	0.0000488	0.0000971	0.001	4.878E-06	9.707E-06	0.001	4.878E-06	9.707E-06
OCDD	0.001	0.0000297	0.0000591	0.0001	2.969E-06	5.909E-06	---	---	---	---	---	---
2,3,7,8 - TCDF	0.1	0.000679	0.00135	0.1	0.000679	0.00135	0.05	0.000339	0.000675	1	0.00679	0.0135
1,2,3,7,8 - PeCDF	0.05	0.000263	0.000865	0.05	0.000263	0.000865	0.05	0.000263	0.000865	0.1	0.000526	0.00173
2,3,4,7,8 - PeCDF	0.5	0.00201	0.00401	0.5	0.00201	0.00401	0.5	0.00201	0.00401	1	0.00403	0.00802
1,2,3,4,7,8 - HxCDF	0.1	0.000382	0.000760	0.1	0.000382	0.000760	0.1	0.000382	0.000760	0.1	0.000382	0.000760
1,2,3,6,7,8 - HxCDF	0.1	0.000297	0.000591	0.1	0.000297	0.000591	0.1	0.000297	0.000591	0.1	0.000297	0.000591
2,3,4,6,7,8 - HxCDF	0.1	0.000276	0.000549	0.1	0.000276	0.000549	0.1	0.000276	0.000549	0.1	0.000276	0.000549
1,2,3,7,8,9 - HxCDF	0.1	0.0000679	0.000135	0.1	0.0000679	0.000135	0.1	0.0000679	0.000135	0.1	0.0000679	0.000135
1,2,3,4,6,7,8 - HpCDF	0.01	0.0000403	0.0000802	0.01	0.0000403	0.0000802	0.01	0.0000403	0.0000802	0.01	0.0000403	0.0000802
1,2,3,4,7,8,9 - HpCDF	0.01	6.575E-06	0.0000131	0.01	6.575E-06	0.0000131	0.01	6.575E-06	0.0000131	0.01	6.575E-06	0.0000131
OCDF	0.0001	3.181E-06	6.331E-06	0.0001	3.181E-07	6.331E-07	0.0001	3.181E-07	6.331E-07	0.0001	3.181E-07	6.331E-07
TOTAL	---	0.00464	0.0196	---	0.00908	0.0271	---	0.00807	0.0269	---	0.0111	0.0437
% Uncertainty	---	---	23.7	---	---	29.8	---	---	30.1	---	---	25.4

Uncertainty - Adjusted for TEF

PCB	WHO Humans & Mammals (TEF)	Uncertainty ng/Nm^3	Conc ng/Nm^3	WHO Fish (TEF)	Uncertainty ng/Nm^3	Conc ng/Nm^3	WHO Birds (TEF)	Uncertainty ng/Nm^3	Conc ng/Nm^3
	0.0001			0.000005			0.0001		
	0.0005			0.000005			0.0001		
	0.0001			0.000005			0.00001		
	0.0001			0.000005			0.00001		
	0.1			0.005			0.1		
	0.0005			0.000005			0.0001		
	0.0005			0.000005			0.0001		
	0.00001			0.000005			0.00001		
	0.01			0.00005			0.001		
	0.0001			0.000005			0.00001		
	0.0001			0.0001			0.05		
	0.0001			0.0005			0.1		
TOTAL	---	0.00	0.00	---	0.00	0.00	---	0.00	0.00
% Uncertainty	---	---	0.0	---	---	0.0	---	---	0.0

Bryn Posteg Landfill Site		Installation Name	: Landfill Flare
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Hydrogen Chloride

Site: Llanidloes
Location: Flare

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

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
HCl								
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	...	2.78	2.78	...	0.36	...	0.18	0.18
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...								
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	HCl	...			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	0.81	0.00	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	1.02	0.00	...		...	...	
Meter Temperature (T_m)	279.92	0.00	k	uT_m	1.5	k	
Average Differential Pressure (ΔH)	15.20	0.00	mmH_2O	$u\Delta H$	0.25	mmH_2O	
Barometric Pressure (p_b)	724.56	0.00	mmHg	up_b	3.8	mmHg	
$\Delta H + ps$ (p_m)	96.75	0.00	kPa		...	...	
Oxygen content ($O_{2,m}$)	13.31	0.00	% by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.0221	0.00	% by volume
Moisture Content (H_2O)	10.17	0.00	% by volume	uH_2O	0.32	0.00	% 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:

HCl:

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

...:

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

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

HCl:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.945$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.95	0.95	0.0000958	0.0000239
up_b	0.95	0.94	0.00130	0.00488
uT_m	0.95	0.94	0.00338	0.00507
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = 0.00672$$

...:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.000$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	...	...	...	...
up_b	...	...	...	...
uT_m	...	...	...	...
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = 0.00$$

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

HCl:

$$V_{std} = V_{measured} \times f_s = 0.761$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	0.77	0.76	0.80	0.00541
Effect of uV_m	0.76	0.76	0.95	0.000945

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00445$$

...:

$$V_{std} = V_{measured} \times f_s = 0.000$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	...	...	...	...
Effect of uV_m	...	...	...	...

Combined Standard Uncertainty

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

Uncertainty of correction factor to reference oxygen due to measured oxygen uncertainty component (uf_{O2})

HCl:

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 2.34$$

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	1.30	1.30	0.17	0.00374

...:

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.00$$

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	...	...	...	...

Environmental Compliance Limited

Bryn Posteg Landfill Site
Permit No : EPR/BU7766IC
Variation No : V004
Report Ref : P1560 : R001

Installation Name : Landfill Flare
Visit Details : Annual Compliance
Survey Dates : 17th – 19th December 2012
Report Issue Date : 30th January 2013

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

Determinand	HCl:				...:			
	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uM mg/Nm³	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uM mg/Nm³
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	9.09	7.98	3.07	0.55	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

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

Determinand	HCl:	...:
	uL mg/Nm³	uL mg/Nm³
...	...	...
Hydrogen Chloride	0.0986	...
...	...	...
...	...	...

Uncertainty in final measurement @ reference conditions due to oxygen correction uncertainty component (uf_{Oxy})

Determinand	HCl:				...:			
	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uf_{Oxy} mg/Nm³	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uf_{Oxy} mg/Nm³
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	8.55	8.52	3.65	0.0136	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	HCl:				...:			
	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uVstp mg/Nm³	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uVstp mg/Nm³
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	8.59	8.49	11.22	0.0499	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

Combined Uncertainty

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

Determinand	HCl:				...:			
	Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration	Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	0.57	1.13	8.54	13.26	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

Bryn Posteg Landfill Site		Installation Name	: Landfill Flare
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Non Methane VOC

Site: Bryn Posteg, Llanidloes
Location: Landfill Site, Stack ID:Flare

				Standard Uncertainty @ 95%		
Sampled Volume	V_m	0.23000	m^3	uV_m	0.000	m^3
Meter Correction Factor or ml/count	Yd	1.0151	...	...	...	...
Meter Temperature	T_m	282.50	k	uT_m	1.5	k
Barometric Pressure	p_b	966.00	mBar		10.0	mBar
Oxygen content	$O_{2,m}$	13.31	%Vol	$uO_{2,m}$	2.50	%Vol
Moisture	H_2O	10.51	%Vol	uH_2O	1.41	%Vol

Tubes					
Determinand	Recovered Mass		Standard Uncertainty		
NM VOC	420.00	µg	uM	21.00	µg

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:

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

Uncertainty in correction factor to STP due to measured barometric pressure uncertainty component (upb), measured temperature of dry gas uncertainty component (uT_m) & measured moisture (uH_2O)

$$f_s = \frac{273}{T_m} \times \frac{p}{101.3} = 0.92$$

	Maximum	Minimum	Sensitivity	ufstp
up_b	0.47	0.46	0.000485	0.00485
uT_m	0.93	0.92	0.00326	0.00489
uH_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{uP_b}{(P_b/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = 0.00640$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uVstd) & volume uncertainty component (uVm)

$$V_{std} = V_{measured} \times f_s = 0.22$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty m^3
Effect of uf_s	0.22	0.21	0.23	0.00149
Effect of uV_m	0.22	0.22	0.94	9.355E-06

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uf_s}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.0502$$

Uncertainty of correction factor to reference oxygen due to measured oxygen uncertainty component (uf_{O2}) & Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 2.34$$

	Maximum	Minimum	Sensitivity	Standard Uncertainty
uf_{o_2}	3.47	1.77	0.34	0.85

$$uL = \frac{Conc \times \frac{2}{100}}{\sqrt{3}}$$

	Tubes uL mg/Nm³	Condensate uL mg/Nm³
NM VOC	0.0528	...

$$Conc = \frac{M_{Recovered}}{V_m \times f_t \times f_{O_2}}$$

Uncertainty in final measurement @ Reference Conditions due to $uM_{Recovered}$

Charcoal Tube Results	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	Standard Uncertainty mg/Nm³
NM VOC	4.80	4.34	10.88	0.23

Condensate Results	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	Standard Uncertainty mg/Nm³
NM VOC				

Uncertainty in final measurement @ Reference Conditions due to uV_{STD}

Charcoal Tube Results	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	Standard Uncertainty mg/Nm³
NM VOC	5.96	3.70	22.46	1.13

Uncertainty in final measurement @ Reference Conditions due to uf_{O_2}

Charcoal Tube Results	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	Standard Uncertainty mg/Nm³
NM VOC	6.23	2.91	1.95	1.66

Combined Uncertainty

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

Charcoal Tubes: Determinand	Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
NM VOC	2.02	4.04	4.57	88.5%