Intended for
Cambrian Pet Food Limited

Date
September 2019

CAMBRIAN PET FOODS LIMITED
POINT SOURCE EMISSIONS

RAMBOLL

CAMBRIAN PET FOODS LIMITED
POINT SOURCE EMISSIONS

Project No.	**1700001923**
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01	10/09/2019	KH	KH	KH	First issue to client

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APPENDICES

Installation name		Cambrian Pet Foods Limited		
Point source emissions to air				
Emission point reference and location	Source	Parameter	Quantity Unit	Unit
A1- Chimney stack	Gas-fired boiler	Oxides of Nitrogen	100	Mg/Nm^3
A2 – Chimney Stack	Gas-fired boiler	Oxides of Nitrogen	100	Mg/Nm^3
Point source emissions to water (other than sewers)				
Emission point reference and location	Source	Parameter	Quantity Unit	Unit
S1	ETP	pH	6 - 8.5	-
		Temperature	29	°C
		BOD	40	Mg/l
		Phosphate (as P)	35	Mg/l
		Ammoniacal Nitrogen (as N)	30	Mg/l
Point source emissions to sewers, effluent treatment plants or other transfers off site				
Emission point reference and location	Source	Parameter	Quantity Unit	Unit
N/A				
Point source emissions to land				
Emission point reference and location	Source	Parameter	Quantity Unit	Unit
N/A				

1.1 Emissions to air

In the table above, air emission point A1 represents the existing emissions to air arising from the current Cochran boiler. The proposed site developments plan to relocate the existing boiler to a new boiler house, to be constructed at the east of the site, along with a newly acquired back-up boiler. Air emission point A2 represents the common stack that shall be used for both boilers in the proposed new boiler house. The new boiler is to be used as a backup boiler only, and will be operational for less than 500 hours per year (on average, over a rolling 5 year period); therefore, only one boiler shall be operational at any one time, and emission point A1 shall no longer be used.

Emissions to air were monitored by Exova Catalyst in November 2018, and NOx emissions were shown to be within the 100 mg/Nm3 limit, and therefore compliant with the requirements of the Medium Combustion Plant Directive. The Exova report has been provided as Appendix 1.

Air modelling of the impacts of the new and existing boilers was undertaken by Ramboll in August 2019 (PNN-00206_Air Quality Modelling Report).

1.2 Emissions to water

An assessment of the impacts of the discharge of treated trade effluent to surface water quality was carried out by Ramboll (PNN-00206_Cambrian Water Quality Assessment). Ramboll contacted Welsh Water on behalf of Cambrian to discuss the potential to discharge excess effluent to sewer, should effluent volumes exceed the current consent level of 1,000m3 per day to surface water. The response from Welsh Water, provided at Appendix 2, advised that the existing sewer network and infrastructure would require substantial upgrades and investment to accept effluent from the site, and that this would not be possible at the current time.

APPENDIX 1
EXOVA AIR MONITORING REPORT

Exova Catalyst, Unit 11, Aspen Close, Swindon, SN2 8AJ
E: paul.martin@exova.com
Your Exova Catalyst Contact: Paul Martin (07827 332 630)

Stack Emissions Testing Report Commissioned by
Cambrian Pet Food

Installation Name & Address
Cambrian Pet Food
Tywi Valley Food Park
The Creamery
Llangadog
SA19 9LY

Stack Reference
Boiler

Dates of the Monitoring Campaign
9th November 2018

Job Reference Number
CSW-3410

Report Written by
Ed Powell Team Leader MCERTS Level 2 MM 05 621 TE1 TE2 TE3 TE4

Report Approved by
Martin Futter Team Leader MCERTS Level 2 MM 03 216 TE1 TE2 TE3 TE4

Report Date
23rd November 2018

Version
Version 1

Signature of Report Approver


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Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Cambrian Pet Food, Llangadog
Boiler
9th November 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Cambrian Pet Food to carry out stack emissions testing on the Boiler at Llangadog.

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values (ELVs) as specified in the Site's Permit.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$, Sulphur Dioxide, Nitrogen Monoxide, Oxides of Nitrogen (as NO_2), Carbon Monoxide

Executive Summary

MONITORING RESULTS

Cambrian Pet Food, Llangadog
Boiler
9th November 2018

where MU = Measurement Uncertainty associated with the Result

		Concentration				Mass Emission			
Parameter	**Units**	**Result**		**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	1.29		2.22	-	g/hr	3.2	6.0	-
PM_{10} [1]	mg/m³	0.17		0.34	-	g/hr	0.4	0.9	-
$PM_{2.5}$ [1]	mg/m³	0.17		0.33	-	g/hr	0.4	0.9	-
Sulphur Dioxide [1]	mg/m³	0.55		0.05	-	g/hr	1.3	1.1	-
Nitrogen Monoxide [1]	mg/m³	59.2		2.9	-	g/hr	148.6	118.5	-
Oxides of Nitrogen (as NO_2) [1]	mg/m³	88.9		4.4	-	g/hr	223.2	178.0	-
Carbon Monoxide [1]	mg/m³	3		0.68	-	g/hr	8.5	6.9	-
Carbon Dioxide	% v/v	Dry	8.5	0.2					
Oxygen	% v/v	Dry	6.0	0.2					
Water Vapour	% v/v	5.5		0.28					
Stack Gas Temperature	°C	149							
Stack Gas Velocity	m/s	3.7		2.9					
Volumetric Flow Rate (ACTUAL)	m³/hr	4423		3520					
Volumetric Flow Rate (REF) [1]	m³/hr	2511		1999					

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

[1] Reference Conditions (REF) are: 273K, 101.3kPa, dry gas, 5% oxygen.

Executive Summary

MONITORING DATE(S) & TIMES

Cambrian Pet Food, Llangadog
Boiler
9th November 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	1.3	g/hr	3.2	09/11/2018	10:35 - 11:35	60
PM_{10}	R1	mg/m³	0.17	g/hr	0.4	09/11/2018	11:39 - 12:39	60
$PM_{2.5}$	R1	mg/m³	0.17	g/hr	0.4	09/11/2018	11:39 - 12:39	60
Sulphur Dioxide	R1	mg/m³	0.55	g/hr	1.3	09/11/2018	10:35 - 11:35	60
Oxides of Nitrogen (as NO_2)	R1	mg/m³	88.9	g/hr	223.2	09/11/2018	10:35 - 11:35	60
Carbon Monoxide	R1	mg/m³	3.4	g/hr	8.5	09/11/2018	10:35 - 12:40	125
Carbon Dioxide	R1	% v/v	8.5			09/11/2018	10:35 - 12:40	125
Oxygen	R1	% v/v	6.0			09/11/2018	10:35 - 12:40	125
Nitrogen Monoxide	R1	mg/m³	59.2	g/hr	148.6	09/11/2018	11:40 - 12:40	60
Oxygen	R1	% v/v	5.9			09/11/2018	11:40 - 12:40	60
Velocity Traverse	R1					09/11/2018	09:45 - 10:00	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Cambrian Pet Food, Llangadog
Boiler
9th November 2018

Standard Operating Conditions

Parameter	Value
Process Status	Operational
Capacity (of 100%) and Tonnes / Hour	70% load
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Gas
Abatement System	N/A
Abatement System Running Status	Operational
Fuel	Gas
Plume Appearance	No visible plume

MONITORING & ANALYTICAL METHODS

Cambrian Pet Food, Llangadog
Boiler
9th November 2018

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.21 mg/m³
PM_{10}	US EPA M201A	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	No	0.17 mg/m³
$PM_{2.5}$	US EPA M201A	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	No	0.17 mg/m³
Sulphur Dioxide	EN 14791	CAT-TP-09	Yes	CAT	CAT-AP-01	IC	Yes	CAT	Yes	0.024 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Nitrogen Monoxide	EN 14792	CAT-TP-39	Yes	CAT	Chemiluminescence by Horiba PG-350E				Yes	0.25 mg/m³
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-39	Yes	CAT	Chemiluminescence by Horiba PG-350E				Yes	0.39 mg/m³
Carbon Monoxide	EN 15058	CAT-TP-39	Yes	CAT	NDIR by Horiba PG-350E				Yes	0.46 mg/m³
Carbon Dioxide	ISO 12039	CAT-TP-39	Yes	CAT	NDIR by Horiba PG-350E				Yes	0.4 %
Oxygen	EN 14789	CAT-TP-39	Yes	CAT	Dry Paramagnetic Cell by Horiba PG-350E				Yes	0.04 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.8 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Sulphur Dioxide	1	The absorption efficiency was less than the required 95%.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.65
Width	m	-
Area	m²	0.33
Port Depth	cm	12
Orientation of Duct	-	Vertical
Number of Ports	-	1
Sample Port Size	-	4" BSP

Location of Sampling Platform

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

Platform Details

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

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

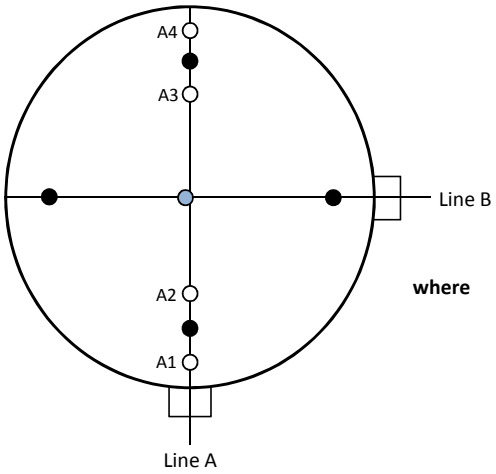
EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	9.8	> 5 Pa	Yes
Mean Velocity	m/s	4.12	-	-
Lowest Gas Velocity	m/s	4.12	-	-
Highest Gas Velocity	m/s	4.12	-	-
Ratio of Above	: 1	1.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	0.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

SAMPLE POINTS



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

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Ed Powell	MCERTS Level 2	MM 05 621	TE1 TE2 TE3 TE4
Technician	Jonny Guy	MCERTS Level 1	MM 16 1388	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.40
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.011
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.011
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.101
Heated Probe (2)	CAT 5.102
Heated Probe (3)	CAT 5.103
S-Pitot (1)	CAT 21P.76
S-Pitot (2)	CAT 21S.17
L-Pitot	-
Site Balance	CAT 17.8
500g / 1Kg Check Weights	CAT 17.8
Last Impinger Arm	-
Callipers	CAT 23.9
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-350E	CAT 39.1
SELECT Horiba Model (2)	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
JCT JCC P1 Cooler	CAT 4.46
SELECT FTIR	-
Gasmet Sampling System	-
Bernath 3006 FID	-
Ankersmid APP100	CAT 12.1
Mass Flow Controller (10L)	CAT 6.30
Mass Flow Controller (2L)	CAT 6.31
Mass View (10L/m)	-
Mass View (2L/m)	-
Easylogger EN-EL-12 Bit	-
SELECT Logger 2	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (500)	-
Digital Manometer (1000)	CAT 3.116
Digital Temperature Meter	CAT 3.121
Stopwatch	-
Barometer	-
Stack Thermocouple (0.5m)	CAT 4.576
Stack Thermocouple (1.0m)	CAT 4.882
Stack Thermocouple (1.5)	CAT 4.923
Stack Thermocouple	CAT 4.947
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	CAT 20.23
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.24
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	CAT INPUT
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.99

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	US EPA M201A	CAT-TP-18
$PM_{2.5}$	US EPA M201A	CAT-TP-18
Sulphur Dioxide	EN 14791	CAT-TP-09
Water Vapour	EN 14790	CAT-TP-05
Nitrogen Monoxide	EN 14792	CAT-TP-39
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-39
Carbon Monoxide	EN 15058	CAT-TP-39
Carbon Dioxide	ISO 12039	CAT-TP-39
Oxygen	EN 14789	CAT-TP-39
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.65
Stack Width, W	m	-
Stack Area, A	m^2	0.33
Average Stack Gas Temperature, T_a	°C	151.0
Average Stack Gas Pressure	mmH_2O	1.0
Average Stack Static Pressure, P_{static}	kPa	-0.030
Average Barometric Pressure, P_b	kPa	101.0
Average Pitot Tube Calibration Coefficient, C_p	-	0.85

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2	-	8.49	8.03	0.0849	44.01	1.9635	0.16679
O_2	-	6.02	5.69	0.0602	32.00	1.4277	0.08600
N_2	-	85.48	80.81	0.8548	28.01	1.2498	1.06839
Moisture (H_2O)	-	-	5.47	0.0547	18.02	0.8037	0.04396

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.321
Wet Density (STP), P_{STW}	kg/m³	1.293
Dry Density (Actual), P_{Actual}	kg/m³	0.848
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	0.830

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	151.0	0.0
Total Pressure	kPa	101.0	101.3
Moisture	%	5.47	0.00
Oxygen (Dry)	%	6.0	5.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	4928
Gas Volumetric Flowrate (STP, Wet)	m³/hr	3162
Gas Volumetric Flowrate (STP, Dry)	m³/hr	2989
Gas Volumetric Flowrate REF [1]	m³/hr	2798

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	09/11/2018
Time of Survey	-	09:45 - 10:00
Atmospheric Pressure	kPa	101.0
Average Stack Static Pressure	Pa	-30
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with Liquid Incline Manometer	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.85
Number of Lines Available	-	1
Number of Lines Used	-	1

Sampling Line A

Traverse Point	Depth m	ΔP mmH_2O	Temp °C	Wet Density kg/m^3	Velocity m/s	Swirl °
STATIC (Units: Pa)		*-30.0*				
Mean		**1.0**	**151.0**	**0.830**	**4.12**	
1	0.04	1.0	151.0	0.830	4.12	0.0
2	0.16	1.0	151.0	0.830	4.12	0.0
3	0.49	1.0	151.0	0.830	4.12	0.0
4	0.61	1.0	151.0	0.830	4.12	0.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.621	Pa
- Resolution	u(res)	0.52154	
- Calibration	u(cal)	0.010	
- Drift	u(drift)	1.096	
- Lack of Fit	u(fit)	0.001	
- Overall corrections to dynamic measurements	u(Cf)	1.628	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00005	-
- $\varphi O_2,w$	-	5.694	
- $\varphi CO_2,w$	-	8.030	
- Oxygen, dry	u(ϕO_2,d)	0.184	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.260	
- Water Vapour	u(ϕH_2O)	0.279	
- Oxygen, wet	u(ϕO_2,w)	0.175	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.247	
Standard uncertainty associated with the stack temperature	u(Tc)	2.163	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.700	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.621	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00447	-
Standard uncertainty associated with the local velocities	u(vi)	3.344	Pa
Standard uncertainty associated with the mean velocity	u(v)	1.672	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	3.277	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	79.46	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	3921.7	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.16488	
- $u^2(qV,w)$	-	4003477	
- $u(qV,w)$	-	2000.9	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	79.59	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	1.29		1.29
Uncertainty	±mg/m³	2.22		2.22
Mass Emission	g/hr	3.2		3.2
Uncertainty	±g/hr	6.0		6.0

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	5.71		5.71
Uncertainty	±% v/v	0.29		0.29

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	1.29		1.29

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, A3 & A4	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	756.8	
Stack static pressure, P_{static}	mmH_2O	-3.1	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	756.5	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	37.2	
Total mass collected in impingers (silica trap)	g	6.2	
Total mass of liquid collected, V_{lc}	g	43.4	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0541	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.9457	
Gas meter correction factor, Y_d	-	1.0370	
Average dry gas meter temperature, T_m	°C	26.6	
Average pressure drop across orifice, ΔH	mmH_2O	27.9	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.8922	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0571	
B_{wo} as a percentage	% v/v	5.71	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	5.71	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9463	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	5.90	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	6.24	
% oxygen reference condition, $REF\%O_2$	% v/v	5.00	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	1.06	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	1.08	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	0.8933	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	0.8232	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	8.20	
O_2	% v/v	6.24	
Total	% v/v	14.44	
N_2	% v/v	85.56	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.56	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.90	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.85	
Average of velocity heads, ΔP_{avg}	mmH_2O	0.80	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	0.89	
Average stack gas temperature, T_s	°C	154.3	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)}(P_s))$	m/s	3.72	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.33	
$Q_a = (60)(A_s)(V_s)$	m^3/min	74.0	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	47.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	44.4	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	44.4	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	40.9	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	12.01	
Nozzle area, A_n	mm^2	113.30	
Total sampling time, q	min	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	98.2	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	10:35 - 11:35
Sampling Dates	-	09/11/2018
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	0.8232
Filter I.D. Number	-	47-54437
Start Filter Mass	g	0.14732
End Filter Mass	g	0.14713
Total Mass on Filter	g	-0.00019
Probe Rinse I.D. Number	-	PR-47-54437
Start Probe Rinse Mass	g	2.60625
End Probe Rinse Mass	g	2.60717
Total Mass in Probe Rinse	g	0.00092
Total Mass Collected	mg	0.73
Calculated Concentration	mg/m^3	0.88
Balance Uncertainty / LOD	mg/m^3	0.21

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	09/11/2018
Average Volume Sampled (REF)	m^3	0.8232
Filter I.D. Number	-	47-54433
Start Filter Mass	g	0.14677
End Filter Mass	g	0.14703
Total Mass on Filter	g	0.00026
Probe Rinse I.D. Number	-	PR-47-54433
Start Probe Rinse Mass	g	2.84154
End Probe Rinse Mass	g	2.84234
Total Mass in Probe Rinse	g	0.00080
Total Mass Collected	mg	1.06
Calculated Concentration	mg/m^3	1.29
Balance Uncertainty / LOD	mg/m^3	0.21

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	16.3
Pre-Sampling Leak Rate	l/min	0.24
Post-Sampling Leak Rate	l/min	0.16
Allowable Leak Rate	l/min	0.33
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.1
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	98.2
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Weighing Uncertainty Criteria	Units	Run 1
Overall Weighing Uncertainty	± mg	0.32
Overall Weighing Uncertainty	± mg/m³	0.39
ELV [Daily ELV for IED]	mg/m³	N/A
Allowable Weighing Uncertainty	mg/m³	N/A
Weighing Uncertainty Acceptable	-	N/A

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	156

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	18.0
Pre-Sampling Leak Rate	l/min	0.13
Post-Sampling Leak Rate	l/min	0.24
Allowable Leak Rate	l/min	0.36
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number	
	1	
One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to the minimum required by the Standard	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	0.9457	uV_m	m^3	0.0189
Sampled Gas Temperature	T_m	299.6	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	100.9	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	0.98	uL	%	-
Mass of Particulate	m	0.73	um	mg	0.17
Uncollected Mass	UCM	1.06	uUCM	mg	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.98	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	0.8922	1.45
Leak	L	mg/m^3	0.007	1.00
Mass of Particulate	L_r	mg	0.727	1.78
Uncollected Mass	UCM	mg	0.61	1.78

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.032
Leak	mg/m^3	0.0073
Mass of Particulate	mg/m^3	0.3022
Uncollected Mass	mg/m^3	1.0913

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	1.08
Stack Gas O_2 Content	% v/v	6.24
MU for O_2 Correction	-	0.04
Overall MU For O_2 Measurement	%	3.39

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	1.13
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	2.22
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	2.22
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	2.22
Reported Uncertainty	mg/m^3	2.22
Expanded uncertainty (95% confidence), without Oxygen Correction	%	171.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	171.9
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	171.9
Reported Uncertainty	%	171.9

PM_{10}: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.17		0.17
Uncertainty	±mg/m³	0.34		0.34
Mass Emission	g/hr	0.4		0.4
Uncertainty	±g/hr	0.9		0.9

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	5.22		5.22
Uncertainty	±% v/v	0.26		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.17		0.17

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	US EPA M201A	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	756.8	
Stack static pressure, P_{static}	mmH_2O	-3.1	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	756.5	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	74.0	
Total mass collected in impingers (silica trap)	g	15.0	
Total mass of liquid collected, V_{lc}	g	89.0	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1109	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	2.1300	
Gas meter correction factor, Y_d	-	1.0370	
Average dry gas meter temperature, T_m	°C	28.9	
Average pressure drop across orifice, ΔH	mmH_2O	117.1	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.0115	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0522	
B_{wo} as a percentage	% v/v	5.22	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	5.22	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.1224	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	5.60	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	5.92	
% oxygen reference condition, $REF\%O_2$	% v/v	5.00	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	1.04	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	1.06	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	2.0429	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	1.8954	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	8.50	
O_2	% v/v	5.92	
Total	% v/v	14.42	
N_2	% v/v	85.58	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.60	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.99	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.85	
Average stack gas temperature, T_s	°C	143.7	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	3.69	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.33	
$Q_a = (60)(A_s)(V_s)$	m^3/min	73.4	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	47.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	45.4	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	46.1	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	42.8	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	17.00	
Nozzle area, A_n	mm^2	227.01	
Total sampling time, q	min	60	
Velocity at nozzle, V_n	m/s	3.98	
$\%I = V_n / V_{spt} \times 100$	%	108.0	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:39 - 12:39
Sampling Dates	-	09/11/2018
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	1.8954
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)		
Filter I.D. Number (2nd Stage)	-	PM2-01971
Start Filter Mass (2nd Stage)	g	0.12527
End Filter Mass (2nd Stage)	g	0.12535
Total Mass	g	0.00008
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)		
Filter I.D. Number (3rd Stage)	-	PM3-01971
Start Filter Mass (3rd Stage)	g	0.14404
End Filter Mass (3rd Stage)	g	0.14405
Total Mass	g	0.00001
Total Mass Collected	mg	0.09
Calculated Concentration	mg/m^3	0.05
Balance Uncertainty / LOD	mg/m^3	0.17

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	09/11/2018
Average Volume Sampled (REF)	m^3	1.8954
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)		
Filter I.D. Number (2nd Stage)	-	PM2-01939
Start Filter Mass (2nd Stage)	g	0.12528
End Filter Mass (2nd Stage)	g	0.12525
Total Mass	g	-0.00003
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)		
Filter I.D. Number (3rd Stage)	-	PM3-01939
Start Filter Mass (3rd Stage)	g	0.14691
End Filter Mass (3rd Stage)	g	0.14689
Total Mass	g	-0.00002
Total Mass Collected	mg	-0.05
Calculated Concentration	mg/m^3	-0.03
Balance Uncertainty / LOD	mg/m^3	0.17

PM_{10}: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Expected Sampling Rate	l/min	35.0
Pre-Sampling Leak Rate	l/min	0.25
Allowable Leak Rate	l/min	0.70
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.0
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	108.0
Allowable Isokinetic Range	%	90 - 130
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	155

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Cut Size	Units	Run 1
D_{50} Cut Size	µm	10.04
Allowable D_{50} Cut Size	µm	9 - 11
D_{50} Cut Size Acceptable	-	Yes

PM_{10}: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	35.0
Pre-Sampling Leak Rate	l/min	0.13
Allowable Leak Rate	l/min	0.70
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Method Deviations

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

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	2.1300	uV_m	m^3	0.0426
Sampled Gas Temperature	T_m	301.9	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	100.9	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	0.71	uL	%	-
Mass of Particulate	m	0.33	um	mg	0.33
Uncollected Mass	UCM	-0.05	uUCM	mg	-
Particulate Sizing	PS	10.00	uPS	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.66	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.71	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.00	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	2.0115	0.09
Leak	L	mg/m^3	0.001	1.00
Mass of Particulate	L_r	mg	0.326	0.53
Uncollected Mass	UCM	mg	-0.03	0.53
Particulate Sizing	PS	mg	0.01	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.004
Leak	mg/m^3	0.0007
Mass of Particulate	mg/m^3	0.1718
Uncollected Mass	mg/m^3	-0.0152
Particulate Sizing	mg/m^3	0.0099

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	1.06
Stack Gas O_2 Content	% v/v	5.92
MU for O_2 Correction	-	0.04
Overall MU For O_2 Measurement	%	3.32

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.17
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.34
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	0.34
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.34
Reported Uncertainty	mg/m^3	0.34
Expanded uncertainty (95% confidence), without Oxygen Correction	%	197.2
Expanded uncertainty (95% confidence), with Oxygen Correction	%	197.2
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	197.2
Reported Uncertainty	%	197.2

$PM_{2.5}$: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.17		0.17
Uncertainty	±mg/m³	0.33		0.33
Mass Emission	g/hr	0.4		0.4
Uncertainty	±g/hr	0.9		0.9

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	5.22		5.22
Uncertainty	±% v/v	0.26		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.17		0.17

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	US EPA M201A	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	756.8	
Stack static pressure, P_{static}	mmH_2O	-3.1	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	756.5	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	74.0	
Total mass collected in impingers (silica trap)	g	15.0	
Total mass of liquid collected, V_{lc}	g	89.0	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1109	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	2.1300	
Gas meter correction factor, Y_d	-	1.0370	
Average dry gas meter temperature, T_m	°C	28.9	
Average pressure drop across orifice, ΔH	mmH_2O	117.1	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.0115	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0522	
B_{wo} as a percentage	% v/v	5.22	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	5.22	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.1224	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	5.60	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	5.92	
% oxygen reference condition, $REF\%O_2$	% v/v	5.00	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	1.04	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	1.06	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	2.0429	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	1.8954	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	8.50	
O_2	% v/v	5.92	
Total	% v/v	14.42	
N_2	% v/v	85.58	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.60	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.99	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.85	
Average stack gas temperature, T_s	°C	143.7	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	3.69	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.33	
$Q_a = (60)(A_s)(V_s)$	m^3/min	73.4	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	47.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	45.4	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	46.1	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	42.8	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	17.00	
Nozzle area, A_n	mm^2	227.01	
Total sampling time, q	min	60	
Velocity at nozzle, V_n	m/s	3.98	
$\%I = V_n / V_{spt} \times 100$	%	108.0	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:39 - 12:39
Sampling Dates	-	09/11/2018
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	1.8954
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)		
Filter I.D. Number (3rd Stage)	-	PM3-01971
Start Filter Mass (3rd Stage)	g	0.14404
End Filter Mass (3rd Stage)	g	0.14405
Total Mass	g	0.00001
Total Mass Collected	mg	0.01
Calculated Concentration	mg/m^3	0.01
Balance Uncertainty / LOD	mg/m^3	0.17

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	09/11/2018
Average Volume Sampled (REF)	m^3	1.8954
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)		
Filter I.D. Number (3rd Stage)	-	PM3-01939
Start Filter Mass (3rd Stage)	g	0.14691
End Filter Mass (3rd Stage)	g	0.14689
Total Mass	g	-0.00002
Total Mass Collected	mg	-0.02
Calculated Concentration	mg/m^3	-0.01
Balance Uncertainty / LOD	mg/m^3	0.17

$PM_{2.5}$: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Expected Sampling Rate	l/min	35.0
Pre-Sampling Leak Rate	l/min	0.25
Allowable Leak Rate	l/min	0.70
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.0
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	108.0
Allowable Isokinetic Range	%	90 - 130
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	155

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Cut Size	Units	Run 1
D_{50} Cut Size	µm	2.51
Allowable D_{50} Cut Size	µm	2.25 - 2.75
D_{50} Cut Size Acceptable	-	Yes

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	35.0
Pre-Sampling Leak Rate	l/min	0.13
Allowable Leak Rate	l/min	0.70
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Method Deviations

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

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	2.1300	uV_m	m^3	0.0426
Sampled Gas Temperature	T_m	301.9	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	100.9	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	0.71	uL	%	-
Mass of Particulate	m	0.32	um	mg	0.32
Uncollected Mass	UCM	-0.02	uUCM	mg	-
Particulate Sizing	PS	10.00	uPS	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.66	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.71	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.00	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	2.0115	0.08
Leak	L	mg/m^3	0.001	1.00
Mass of Particulate	L_r	mg	0.320	0.53
Uncollected Mass	UCM	mg	-0.01	0.53
Particulate Sizing	PS	mg	0.01	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.004
Leak	mg/m^3	0.0007
Mass of Particulate	mg/m^3	0.1688
Uncollected Mass	mg/m^3	-0.0061
Particulate Sizing	mg/m^3	0.0097

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	1.06
Stack Gas O_2 Content	% v/v	5.92
MU for O_2 Correction	-	0.04
Overall MU For O_2 Measurement	%	3.32

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.17
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.33
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	0.33
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.33
Reported Uncertainty	mg/m^3	0.33
Expanded uncertainty (95% confidence)	%	196.5
Expanded uncertainty (95% confidence), with Oxygen Correction	%	196.5
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	196.5
Reported Uncertainty	%	196.5

SULPHUR DIOXIDE: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.55		0.55
Uncertainty	±mg/m³	0.05		0.05
Mass Emission	g/hr	1.3		1.3
Uncertainty	±g/hr	1.1		1.1

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	5.71		5.71
Uncertainty	±% v/v	0.29		0.29

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.14		0.14

General Sampling Information

Parameter	Value	
Standard	EN 14791	
Technical Procedure	CAT-TP-09	
Name of Analytical Laboratory	CAT	
Analytical Laboratory's Procedure	CAT-AP-01	
ISO 17025 Accredited Analysis?	Yes	
Date of Sample Analysis	16/11/2018	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Polyethylene	
Absorption Solution	0.3% Hydrogen Peroxide	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, A3 & A4	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

SULPHUR DIOXIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	756.8	
Stack static pressure, P_{static}	mmH_2O	-3.1	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	756.5	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	37.2	
Total mass collected in impingers (silica trap)	g	6.2	
Total mass of liquid collected, V_{lc}	g	43.4	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0541	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.9457	
Gas meter correction factor, Y_d	-	1.0370	
Average dry gas meter temperature, T_m	°C	26.6	
Average pressure drop across orifice, ΔH	mmH_2O	27.9	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.8922	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0571	
B_{wo} as a percentage	% v/v	5.71	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	5.71	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9463	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	5.90	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	6.24	
% oxygen reference condition, $REF\%O_2$	% v/v	5.00	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	1.06	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	1.08	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	0.8933	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	0.8232	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	8.20	
O_2	% v/v	6.24	
Total	% v/v	14.44	
N_2	% v/v	85.56	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.56	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.90	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.85	
Average of velocity heads, ΔP_{avg}	mmH_2O	0.80	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	0.89	
Average stack gas temperature, T_s	°C	154.3	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	3.72	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.33	
$Q_a = (60)(A_s)(V_s)$	m^3/min	74.0	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	47.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	44.4	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	44.4	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	40.9	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	12.01	
Nozzle area, A_n	mm^2	113.30	
Total sampling time, q	min	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	98.2	

SULPHUR DIOXIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	10:35 - 11:35
Sampling Dates	-	09/11/2018
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	0.8232
Laboratory Result for Front Impingers	µg/ml	1.34
Laboratory Result for Back Impinger	µg/ml	0.61
Volume in Front Impingers	ml	280.0
Volume in Back Impinger	ml	121.6
Mass in Front Impingers	µg	375.2
Mass in Back Impinger	µg	74.2
Total Mass Collected	µg	449.4
Calculated Concentration	mg/m^3	0.55

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	09/11/2018
Average Volume Sampled (REF)	m^3	0.8232
Laboratory Result for Impingers	µg/ml	0.38
Volume in Impingers	ml	310.3
Total Mass Collected	µg	117.9
Calculated Concentration	mg/m^3	0.14

SULPHUR DIOXIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	16.3
Pre-Sampling Leak Rate	l/min	0.24
Post-Sampling Leak Rate	l/min	0.16
Allowable Leak Rate	l/min	0.33
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	83.5
Allowable Absorption Efficiency	%	95
Absorption Efficiency Acceptable	-	No

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.1
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	98.2
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	154

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

SULPHUR DIOXIDE: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	18.0
Pre-Sampling Leak Rate	l/min	0.13
Post-Sampling Leak Rate	l/min	0.24
Allowable Leak Rate	l/min	0.36
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
The absorption efficiency was less than the required 95%.	x	

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	0.9457	uV_m	m^3	0.0189
Sampled Gas Temperature	T_m	299.6	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	100.9	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	0.98	uL	%	-
Laboratory Result	L_r	2.90	uL_r	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.98	≤2%
Laboratory Result	%	2.90	No Requirement

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	0.8922	0.61
Leak	L	mg/m^3	0.003	1.00
Laboratory Result	L_r	mg/m^3	0.016	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.014
Leak	mg/m^3	0.0031
Laboratory Result	mg/m^3	0.0158

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	1.08
Stack Gas O_2 Content	% v/v	6.24
MU for O_2 Correction	-	0.04
Overall MU For O_2 Measurement	%	3.39

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.02
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.04
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	0.05
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.05
Reported Uncertainty	mg/m^3	0.05
Expanded uncertainty (95% confidence), without Oxygen Correction	%	7.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	8.3
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	10.0
Reported Uncertainty	%	10.0

NITROGEN MONOXIDE: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m³	59.19	59.19
Uncertainty	±mg/m³	2.88	2.88
Mass Emission	g/hr	148.6	148.6
Uncertainty	±g/hr	118.5	118.5

General Sampling Information

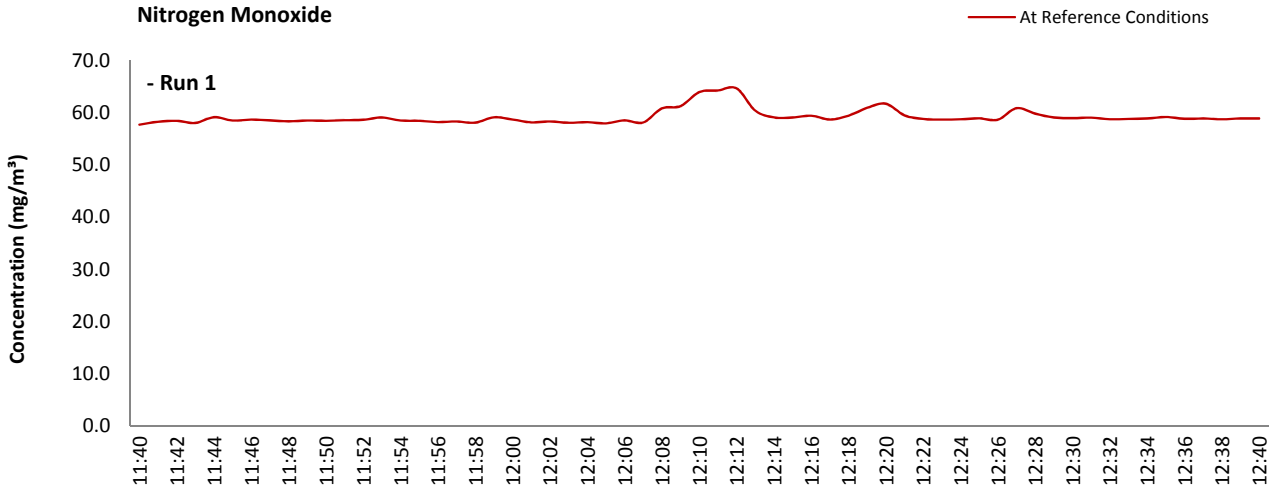
Parameter	Value	
Standard	EN 14792	
Technical Procedure	CAT-TP-39	
Probe Material	Titanium	
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	12.0084	
Span Gas Expiry Date	06/05/2019	
Span Gas Start Pressure (bar)	140	
Gas Cylinder Concentration (ppm)	390.3	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	Middle	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

NITROGEN MONOXIDE: DATA TREND

Graphical Trend of Data



NITROGEN MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:40 - 12:40
Sampling Dates	-	09/11/2018
Instrument Range	ppm	250
Span Gas Value	ppm	200.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.7
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero at Analyser (Pre)	ppm	0.00
	Zero at Analyser (Post)	ppm	0.00
	Zero Drift	ppm	0.00
CAL 2	Zero at Analyser (Pre)	ppm	
	Zero at Analyser (Post)	ppm	
	Zero Drift	ppm	
CAL 3	Zero at Analyser (Pre)	ppm	
	Zero at Analyser (Post)	ppm	
	Zero Drift	ppm	
	Allowable Zero Drift	± ppm	10.00
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span at Analyser (Pre)	ppm	200.00
	Span at Analyser (Post)	ppm	206.20
	Span Drift	ppm	6.20
CAL 2	Span at Analyser (Pre)	ppm	
	Span at Analyser (Post)	ppm	
	Span Drift	ppm	
CAL 3	Span at Analyser (Pre)	ppm	
	Span at Analyser (Post)	ppm	
	Span Drift	ppm	
	Allowable Span Drift	± ppm	10.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	29 / 27

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

NITROGEN MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	-	mg/m³ (REF)
TGN M2 Allowable MU	10.0	%
Measured concentration	55.77	mg/m³ (STP, dry)
Range Used	250.0	ppm
Range Used [A]	334.6	mg/m³
Cal gas conc.	200.0	ppm
Conversion	1.34	ppm to mg/m³
MCERTS Range [B]	134.0	mg/m³
Lower of [A] or [B]	134.0	mg/m³
Cal gas conc.	267.7	mg/m³

Performance characteristics	RUN 1	Units
Response time	31	seconds
Number of readings in measurement	60	-
Repeatability at zero	0.00	% full scale
Repeatability at span level	0.10	% full scale
Deviation from linearity	0.20	% of value
Zero drift	0.00	% full scale
Span drift	0.00	% full scale
Volume or pressure flow dependence	0.10	% of full scale
Atmospheric pressure dependence	0.10	% of value/kPa
Ambient temperature dependence	0.04	% full scale/10K
Combined interference	0.63	% range
Dependence on voltage	-0.23	% full scale/10V
Losses in the line (leak)	0.00	% of value
Uncertainty of calibration gas blending	1.40	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	mg/m³
Standard deviation of repeatability at span level	0.01	mg/m³
Lack of fit	0.15	mg/m³
Drift	0.00	mg/m³
Volume or pressure flow dependence	0.00	mg/m³
Atmospheric pressure dependence	0.04	mg/m³
Ambient temperature dependence	0.01	mg/m³
Combined interference (from MCERTS Certificate)	0.49	mg/m³
Dependence on voltage	-0.03	mg/m³
Losses in the line (leak)	0.00	mg/m³
Uncertainty of calibration gas blending	0.45	mg/m³
Uncertainty of calibration gas	0.64	mg/m³

Measurement uncertainty		Result	RUN 1	Units
Combined uncertainty			55.77	mg/m³
Expanded uncertainty	k =	1.96	1.06	mg/m³
Uncertainty corrected to std conds. (O_2)			2.07	mg/m³
			2.20	mg/m³ (REF)

	RUN 1	Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.72	% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A	% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**	-

	RUN 1	Units
Expanded uncertainty (with O_2) - at 95% Confidence	4.87	% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A	% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**	-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

OXIDES OF NITROGEN (as NO_2): RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	88.9		88.9
Uncertainty	±mg/m³	4.4		4.4
Mass Emission	g/hr	223.2		223.2
Uncertainty	±g/hr	178.0		178.0

General Sampling Information

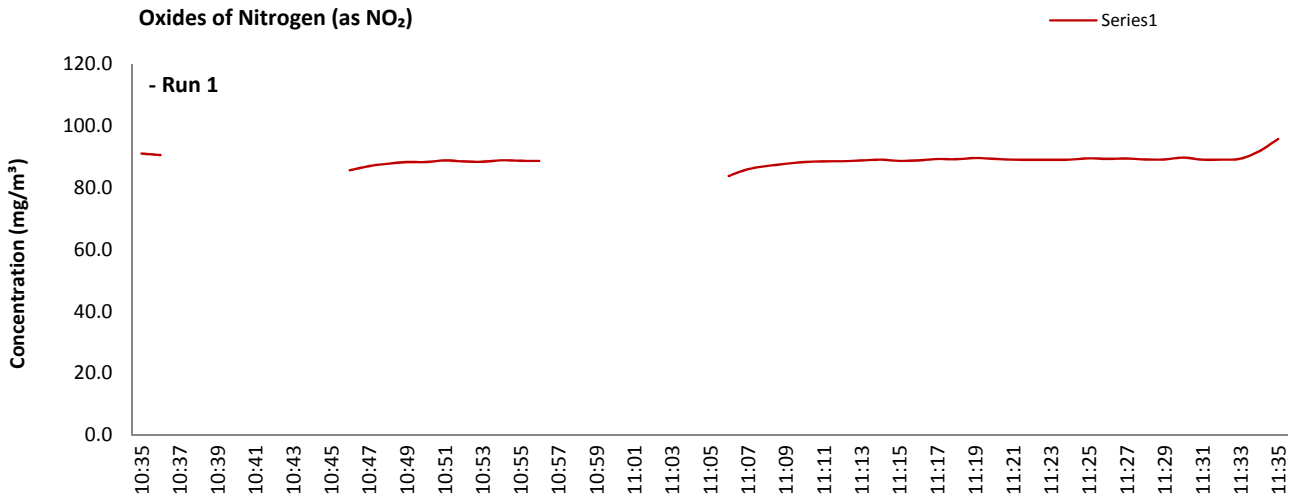
Parameter	Value	
Standard	EN 14792	
Technical Procedure	CAT-TP-39	
Probe Material	Titanium	
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Date & Result of Last Converter Check	25/10/2018 - 95.2%	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	12.0084	
Span Gas Expiry Date	06/05/2019	
Span Gas Start Pressure (bar)	140	
Gas Cylinder Concentration (ppm)	390.3	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	Middle	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

OXIDES OF NITROGEN (as NO_2): DATA TREND

Graphical Trend of Data



OXIDES OF NITROGEN (as NO_2): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	10:35 - 11:35
Sampling Dates	-	09/11/2018
Instrument Range	ppm	250
Span Gas Value	ppm	200.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.7
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero at Analyser (Pre)	ppm	0.00
	Zero at Analyser (Post)	ppm	0.00
	Zero Drift	ppm	0.00
CAL 2	Zero at Analyser (Pre)	ppm	
	Zero at Analyser (Post)	ppm	
	Zero Drift	ppm	
CAL 3	Zero at Analyser (Pre)	ppm	
	Zero at Analyser (Post)	ppm	
	Zero Drift	ppm	
	Allowable Zero Drift	± ppm	10.00
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span at Analyser (Pre)	ppm	200.00
	Span at Analyser (Post)	ppm	206.20
	Span Drift	ppm	6.20
CAL 2	Span at Analyser (Pre)	ppm	
	Span at Analyser (Post)	ppm	
	Span Drift	ppm	
CAL 3	Span at Analyser (Pre)	ppm	
	Span at Analyser (Post)	ppm	
	Span Drift	ppm	
	Allowable Span Drift	± ppm	10.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	29 / 27

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

OXIDES OF NITROGEN (as NO_2): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
TGN M2 Allowable MU	10.0		%
Measured concentration	83.27		mg/m³ (STP, dry)
Ratio NO / NO_2	5		%
Range Used	250.0		ppm
Range Used [A]	513.1		mg/m³
Cal gas conc.	200.0		ppm
Conversion	2.05		ppm to mg/m³
MCERTS Range [B]	205.0		mg/m³
Lower of [A] or [B]	205.0		mg/m³
Cal gas conc.	410.5		mg/m³

Performance characteristics	RUN 1		Units
Response time	31		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.00		% full scale
Repeatability at span level	0.10		% full scale
Deviation from linearity	0.20		% of value
Zero drift	0.00		% full scale
Span drift	0.00		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.10		% of value/kPa
Ambient temperature dependence	0.04		% full scale/10K
Combined interference	0.63		% range
Dependence on voltage	-0.23		% full scale/10V
Converter efficiency	95.2		%
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.01		mg/m³
Lack of fit	0.24		mg/m³
Drift	0.00		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.06		mg/m³
Ambient temperature dependence	0.01		mg/m³
Combined interference (from MCERTS Certificate)	0.75		mg/m³
Dependence on voltage	-0.03		mg/m³
Converter efficiency	0.12		mg/m³
Losses in the line (leak)	0.00		mg/m³
Uncertainty of calibration gas blending	0.67		mg/m³
Uncertainty of calibration gas	0.96		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	83.27		mg/m³
Combined uncertainty			1.60		mg/m³
Expanded uncertainty	k =	1.96	3.14		mg/m³
Uncertainty corrected to std conds. (O_2)			3.35		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.77		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	4.90		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

CARBON MONOXIDE: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	3.37		3.37
Uncertainty	±mg/m³	0.68		0.68
Mass Emission	g/hr	8.5		8.5
Uncertainty	±g/hr	6.9		6.9

General Sampling Information

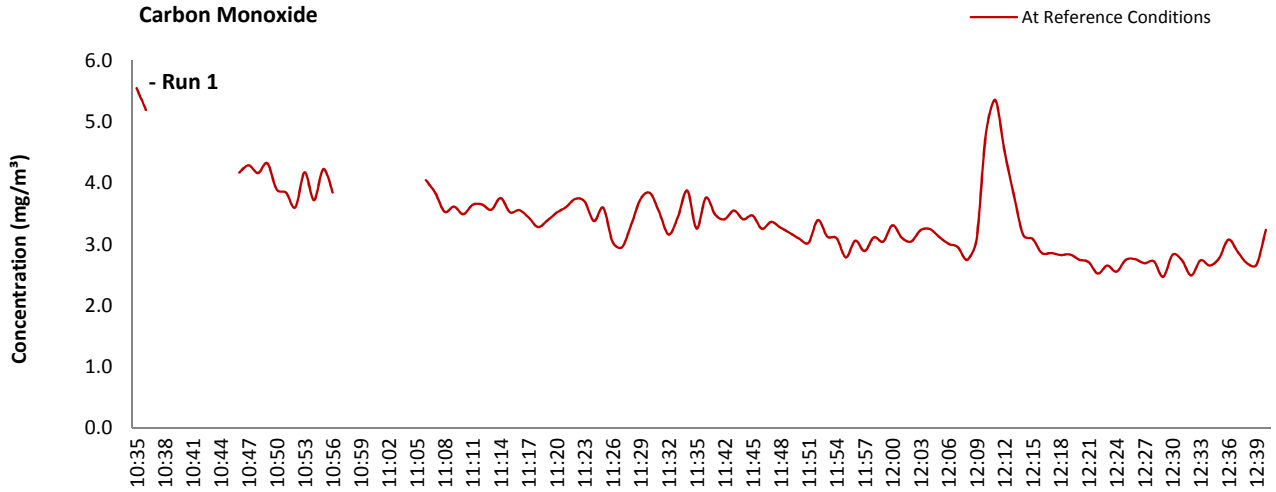
Parameter	Value	
Standard	EN 15058	
Technical Procedure	CAT-TP-39	
Probe Material	Titanium	
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Monoxide	
Span Gas Reference Number	12.0084	
Span Gas Expiry Date	06/05/2019	
Span Gas Start Pressure (bar)	140	
Gas Cylinder Concentration (ppm)	407.7	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	Middle	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% oxygen.

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	10:35 - 12:40
Sampling Dates	-	09/11/2018
Instrument Range	ppm	200
Span Gas Value	ppm	160.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.7
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero at Analyser (Pre)	ppm	0.00
	Zero at Analyser (Post)	ppm	0.10
	Zero Drift	ppm	0.10
CAL 2	Zero at Analyser (Pre)	ppm	
	Zero at Analyser (Post)	ppm	
	Zero Drift	ppm	
CAL 3	Zero at Analyser (Pre)	ppm	
	Zero at Analyser (Post)	ppm	
	Zero Drift	ppm	
	Allowable Zero Drift	± ppm	8.00
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span at Analyser (Pre)	ppm	160.00
	Span at Analyser (Post)	ppm	157.30
	Span Drift	ppm	-2.70
CAL 2	Span at Analyser (Pre)	ppm	
	Span at Analyser (Post)	ppm	
	Span Drift	ppm	
CAL 3	Span at Analyser (Pre)	ppm	
	Span at Analyser (Post)	ppm	
	Span Drift	ppm	
	Allowable Span Drift	± ppm	8.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	29 / 27

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
TGN M2 Allowable MU	6.0		%
Measured concentration	3.15		mg/m³ (STP, dry)
Range Used	200.0		ppm
Range Used [A]	249.8		mg/m³
Cal gas conc.	160.0		ppm
Conversion	1.25		ppm to mg/m³
MCERTS Range [B]	75.0		mg/m³
Lower of [A] or [B]	75.0		mg/m³
Cal gas conc.	199.9		mg/m³

Performance characteristics	RUN 1		Units
Response time	28		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.10		% full scale
Repeatability at span level	0.20		% full scale
Deviation from linearity	0.20		% of value
Zero drift	0.06		% full scale
Span drift	-1.69		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.22		% of value/kPa
Ambient temperature dependence	-0.20		% full scale/10K
Combined interference	-0.48		% range
Dependence on voltage	-0.35		% full scale/10V
Losses in the line (leak)	1.81		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.03		mg/m³
Lack of fit	0.09		mg/m³
Drift	0.04		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.05		mg/m³
Ambient temperature dependence	-0.03		mg/m³
Combined interference (from MCERTS Certificate)	-0.21		mg/m³
Dependence on voltage	-0.04		mg/m³
Losses in the line (leak)	0.03		mg/m³
Uncertainty of calibration gas blending	0.03		mg/m³
Uncertainty of calibration gas	0.04		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	3.15		mg/m³
Combined uncertainty			0.32		mg/m³
Expanded uncertainty	k =	1.96	0.63		mg/m³
Uncertainty corrected to std conds. (O_2)			0.67		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	20.05		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	20.29		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <6% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 6% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

CARBON DIOXIDE: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

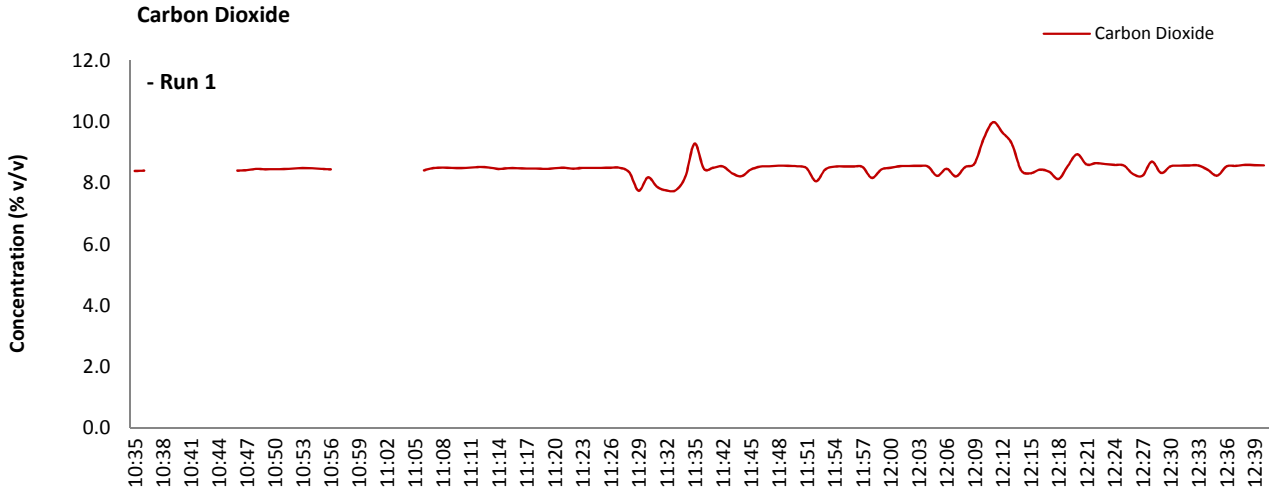
Parameter	Units	Run 1		Mean
Concentration	% v/v	8.49		8.49
Uncertainty	±% v/v	0.23		0.23

General Sampling Information

Parameter	Value	
Standard	ISO 12039	
Technical Procedure	CAT-TP-39	
Probe Material	Titanium	
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Dioxide	
Span Gas Reference Number	6.0043	
Span Gas Expiry Date	09/05/2023	
Span Gas Start Pressure (bar)	20	
Gas Cylinder Concentration (% v/v)	16.03	
Span Gas Uncertainty (%)	2.00	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	Middle	

CARBON DIOXIDE: DATA TREND

Graphical Trend of Data



CARBON DIOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	10:35 - 12:40
Sampling Dates	-	09/11/2018
Instrument Range	% v/v	20
Span Gas Value	% v/v	16.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.7
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero Down Sampling Line (Pre)	% v/v	0.02
	Zero Down Sampling Line (Post)	% v/v	0.04
	Zero Drift	% v/v	0.02
CAL 2	Zero Down Sampling Line (Pre)	% v/v	
	Zero Down Sampling Line (Post)	% v/v	
	Zero Drift	% v/v	
CAL 3	Zero Down Sampling Line (Pre)	% v/v	
	Zero Down Sampling Line (Post)	% v/v	
	Zero Drift	% v/v	
	Allowable Zero Drift	± % v/v	0.80
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span Down Sampling Line (Pre)	% v/v	16.03
	Span Down Sampling Line (Post)	% v/v	16.00
	Span Drift	% v/v	-0.03
CAL 2	Span Down Sampling Line (Pre)	% v/v	
	Span Down Sampling Line (Post)	% v/v	
	Span Drift	% v/v	
CAL 3	Span Down Sampling Line (Pre)	% v/v	
	Span Down Sampling Line (Post)	% v/v	
	Span Drift	% v/v	
	Allowable Span Drift	± % v/v	0.80
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	29 / 27

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

CARBON DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	25.0		%
Measured concentration	8.49		%vol
Range Used	20.0		%vol
Cal gas conc.	16.0		%vol

Performance characteristics	RUN 1		Units
Response time	29		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.00		% full scale
Repeatability at span level	0.10		% full scale
Deviation from linearity	0.10		% of value
Zero drift	0.12		% full scale
Span drift	-0.19		% full scale
Volume or pressure flow dependence	0.10		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	-0.20		% full scale/10K
Combined interference	0.00		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.01		%vol
Lack of fit	0.01		%vol
Drift	0.00		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	-0.03		%vol
Combined interference (from MCERTS Certificate)	0.00		%vol
Dependence on voltage	0.05		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.10		%vol

			RUN 1		Units
Measurement uncertainty		**Result**	8.49		%vol
Combined uncertainty			0.11		%vol
Expanded uncertainty	k =	1.96	0.23		%vol

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.65		% of Value

OXYGEN: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

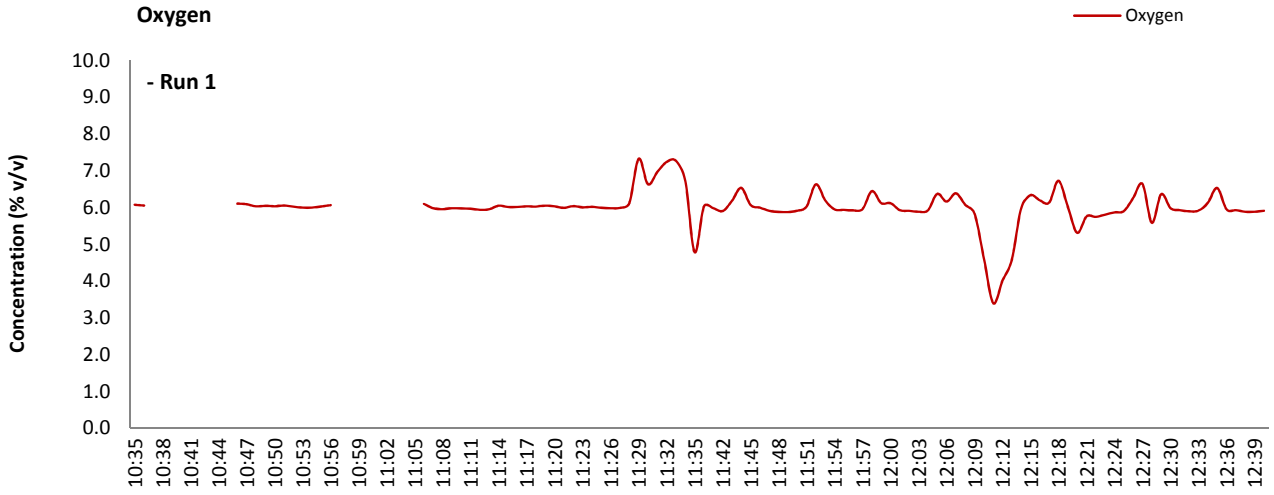
Parameter	Units	Run 1	Run 2		Mean
Concentration	% v/v	6.0	5.9		6.0
Uncertainty	±% v/v	0.2	0.2		0.2

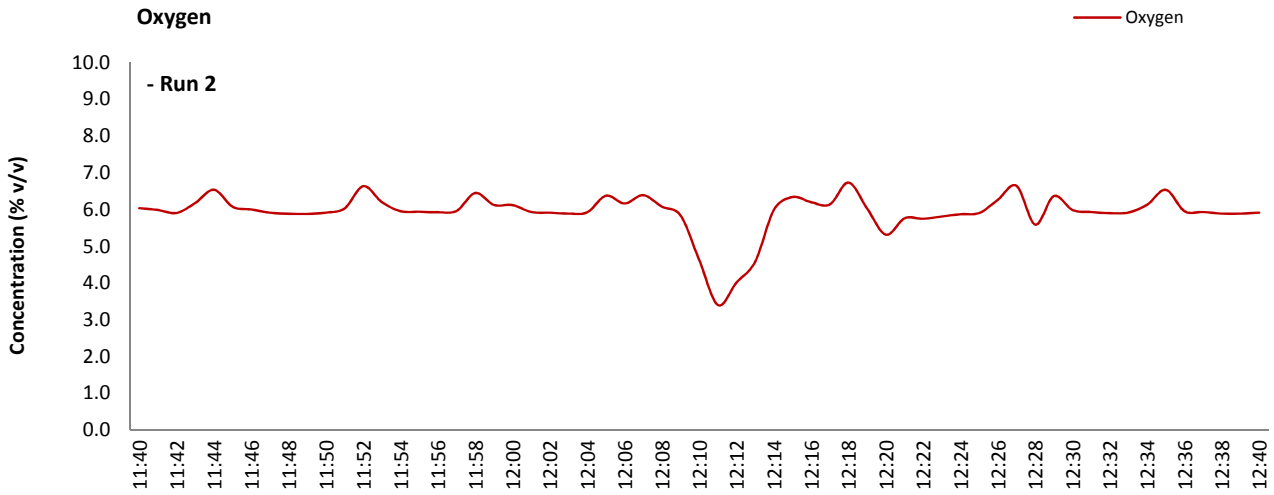
General Sampling Information

Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-39	
Probe Material	Titanium	
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	11.0316	
Span Gas Expiry Date	23/11/2022	
Span Gas Start Pressure (bar)	150	
Gas Cylinder Concentration (% v/v)	21.4	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	Middle	

OXYGEN: DATA TREND

Graphical Trend of Data





OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2
Sampling Times	-	10:35 - 12:40	11:40 - 12:40
Sampling Dates	-	09/11/2018	09/11/2018
Instrument Range	% v/v	25	25
Span Gas Value	% v/v	5.0	5.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2
Average Temperature	°C	2.7	2.7
Allowable Temperature	< °C	4.0	4.0
Temperature Acceptable	-	Yes	Yes

	Zero Drift	Units	Run 1	Run 2
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00
CAL 1	Zero at Analyser (Post)	% v/v	-0.15	-0.15
CAL 1	Zero Drift	% v/v	-0.15	-0.15
CAL 2	Zero at Analyser (Pre)	% v/v		
CAL 2	Zero at Analyser (Post)	% v/v		
CAL 2	Zero Drift	% v/v		
CAL 3	Zero at Analyser (Pre)	% v/v		
CAL 3	Zero at Analyser (Post)	% v/v		
CAL 3	Zero Drift	% v/v		
	Allowable Zero Drift	± % v/v	0.25	0.25
	Zero Drift Acceptable	-	Yes	Yes

	Span Drift	Units	Run 1	Run 2
CAL 1	Span at Analyser (Pre)	% v/v	4.93	4.85
CAL 1	Span at Analyser (Post)	% v/v	4.78	4.78
CAL 1	Span Drift	% v/v	-0.15	-0.15
CAL 2	Span at Analyser (Pre)	% v/v		
CAL 2	Span at Analyser (Post)	% v/v		
CAL 2	Span Drift	% v/v		
CAL 3	Span at Analyser (Pre)	% v/v		
CAL 3	Span at Analyser (Post)	% v/v		
CAL 3	Span Drift	% v/v		
	Allowable Span Drift	± % v/v	0.25	0.25
	Span Drift Acceptable	-	Yes	Yes

Test Conditions	Units	Run 1	Run 2
Run Ambient Temperature Range	°C	29 / 27	29 / 27

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	2	
There are no deviations associated with the sampling employed.	x	x	

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2		Units
Limit value	N/A	N/A		%vol
TGN M2 Allowable MU	6.0	6.0		%
Measured concentration	6.01	5.92		%vol
Range Used	25.0	25.0		%vol
Cal gas conc.	21.4	21.4		%vol

Performance characteristics	RUN 1	RUN 2		Units
Response time	41	41		seconds
Number of readings in measurement	60	60		-
Repeatability at zero	0.02	0.02		% full scale
Repeatability at span level	0.02	0.02		% full scale
Deviation from linearity	0.10	0.10		% of value
Zero drift	0.00	0.00		% full scale
Span drift	0.00	0.00		% full scale
Volume or pressure flow dependence	0.10	0.10		% of full scale
Atmospheric pressure dependence	0.19	0.19		% of value/kPa
Ambient temperature dependence	-0.21	-0.21		% full scale/10K
Combined interference	0.00	0.00		% range
Dependence on voltage	0.02	0.02		% full scale/10V
Losses in the line (leak)	1.60	1.60		% of value
Uncertainty of calibration gas	2.00	2.00		% of value

Performance characteristic	RUN 1	RUN 2		Units
Standard deviation of repeatability at zero	use rep at span	use rep at span		%vol
Standard deviation of repeatability at span level	0.00	0.00		%vol
Lack of fit	0.01	0.01		%vol
Drift	0.00	0.00		%vol
Volume or pressure flow dependence	0.00	0.00		%vol
Atmospheric pressure dependence	0.01	0.01		%vol
Ambient temperature dependence	-0.03	-0.03		%vol
Combined interference (from MCERTS Certificate)	0.00	0.00		%vol
Dependence on voltage	0.00	0.00		%vol
Losses in the line (leak)	0.06	0.05		%vol
Uncertainty of calibration gas	0.07	0.07		%vol

			RUN 1	RUN 2		Units
Measurement uncertainty		**Result**	6.01	5.92		%vol
Combined uncertainty			0.10	0.09		%vol
Expanded uncertainty	k =	1.96	0.19	0.19		%vol

	RUN 1	RUN 2		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.13	3.14		% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**		-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

APPENDIX 2
EMAIL FROM WELSH WATER

From: Jenkins Rob
Sent: 01 August 2019 15:28
To: Hughes Mike C <Mike.Hughes@dwrcymru.com>
Subject: RE: Trade effluent

Hi Mike
I am assuming that this would be proposed to connect into the Llangadog sewerage system which would take it to Llangadog STW.

Network
I note the sewers are 150mm in the vicinity of the premises applying for the TEC which may not be adequate to accommodate the proposed flow. The flows from this area of the town are pumped to Llangadog STW via Albion SPS which has a maximum pumped flow of 18l/sec which may be unable to accommodate the 820m3/d (9.5l/sec) from the proposed TEA.

STW
The STW has a dry weather flow limit of 427m3/d and the flow data for the site is showing it is currently achieving slightly under 400m3/d. An increase of 820m3/d would obviously exceed this allowance and would drive a review of the permit limits which would in turn tighten the limits currently in effect. The existing STW processes would not able to meet any tighter permit limits and hydraulically we would not be able to accommodate this volume through the existing assets. The STW is designed for a maximum hydraulic load of 687.9m3/d.

There is some available biological headroom at the STW and the sample data supplied shows that the effluent quality is almost to our permit standard. Total loading at 30mg/l BOD would be around 25kg BOD/day which is an equivalent population of about 400. This would be an approximate 30% increase on the current population served by the works which would constitute a significant increase in load.

Conclusion
We would not currently be able to accept this discharge mainly on the basis of the volume as it would significantly exceed our current DWF permit by approximately 200% driving a pro-rata tightening on our sanitary permit limits. In order for the STW to accept this discharge then the STW would require significant capital investment to meet a potentially tightened permit. DCWW does not have any immediate (next 10 years) plans to invest in this asset other than for maintenance purposes. Network upgrades would also be required.

Regards
Rob