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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
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Report Approved by
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23rd November 2018

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TITLE PAGE

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Executive Summary

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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, PM₁₀, PM_{2.5}, Sulphur Dioxide, Nitrogen Monoxide, Oxides of Nitrogen (as NO₂), Carbon Monoxide

Executive Summary

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MONITORING RESULTS

Cambrian Pet Food, Llangadog

Boiler

9th November 2018

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter ¹	mg/m ³	1.29	2.22	-	g/hr	3.2	6.0	-
PM ₁₀ ¹	mg/m ³	0.17	0.34	-	g/hr	0.4	0.9	-
PM _{2.5} ¹	mg/m ³	0.17	0.33	-	g/hr	0.4	0.9	-
Sulphur Dioxide ¹	mg/m ³	0.55	0.05	-	g/hr	1.3	1.1	-
Nitrogen Monoxide ¹	mg/m ³	59.2	2.9	-	g/hr	148.6	118.5	-
Oxides of Nitrogen (as NO ₂) ¹	mg/m ³	88.9	4.4	-	g/hr	223.2	178.0	-
Carbon Monoxide ¹	mg/m ³	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)	m ³ /hr	4423	3520					
Volumetric Flow Rate (REF)	m ³ /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.

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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.

Executive Summary

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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

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MONITORING & ANALYTICAL METHODS

Cambrian Pet Food, Llangadog

Boiler

9th November 2018

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.21 mg/m ³
PM ₁₀	US EPA M201A	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	No	0.17 mg/m ³
PM _{2.5}	US EPA M201A	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	No	0.17 mg/m ³
Sulphur Dioxide	EN 14791	CAT-TP-09	Yes	CAT	CAT-AP-01	IC	Yes	CAT	Yes	0.024 mg/m ³
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/m ³
Oxides of Nitrogen (as NO ₂)	EN 14792	CAT-TP-39	Yes	CAT	Chemiluminescence by Horiba PG-350E				Yes	0.39 mg/m ³
Carbon Monoxide	EN 15058	CAT-TP-39	Yes	CAT	NDIR by Horiba PG-350E				Yes	0.46 mg/m ³
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
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SUMMARY OF SAMPLING DEVIATIONS

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

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SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.65
Width	m	-
Area	m ²	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.

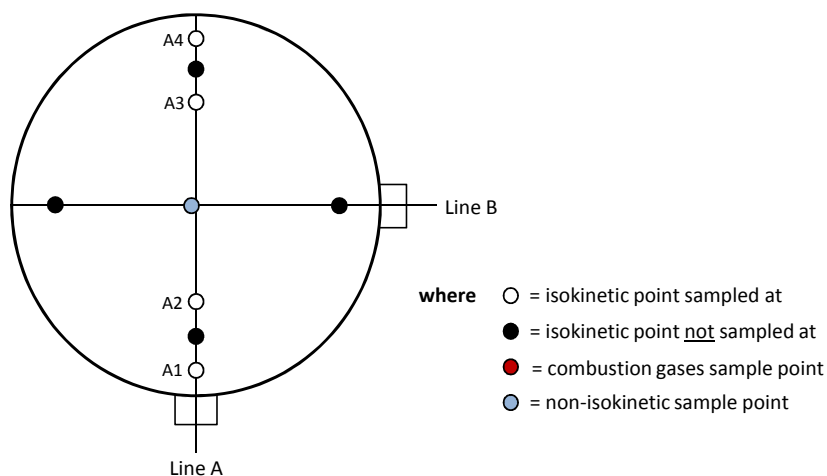
Sampling Plane Validation Criteria (from EN 15259)

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

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SAMPLE POINTS



APPENDICES

APPENDIX CONTENTS

APPENDIX 1 - Stack Emissions Monitoring Personnel, List of Equipment & Methods and Technical Procedures Used

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

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		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.40	Horiba PG-350E	CAT 39.1	Digital Manometer (500)	-
Control Box DGM (2)	-	SELECT Horiba Model (2)	-	Digital Manometer (1000)	CAT 3.116
Box Thermocouples (1)	CAT 3.011	Servomex 4900	-	Digital Temperature Meter	CAT 3.121
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	-
Umbilical (1)	CAT 3.011	ABB AO2020-URAS26	-	Barometer	-
Umbilical (2)	-	Servomex 5200MP	-	Stack Thermocouple (0.5m)	CAT 4.576
Oven Box (1)	-	JCT JCC P1 Cooler	CAT 4.46	Stack Thermocouple (1.0m)	CAT 4.882
Oven Box (2)	-	SELECT FTIR	-	Stack Thermocouple (1.5)	CAT 4.923
Heated Probe (1)	CAT 5.101	Gasmet Sampling System	-	Stack Thermocouple	CAT 4.947
Heated Probe (2)	CAT 5.102	Bernath 3006 FID	-	1m Heated Line (2)	-
Heated Probe (3)	CAT 5.103	Ankersmid APP100	CAT 12.1	1m Heated Line (3)	-
S-Pitot (1)	CAT 21P.76	Mass Flow Controller (10L)	CAT 6.30	5m Heated Line (1)	CAT 20.23
S-Pitot (2)	CAT 21S.17	Mass Flow Controller (2L)	CAT 6.31	15m Heated Line (1)	-
L-Pitot	-	Mass View (10L/m)	-	20m Heated Line (1)	CAT 20.24
Site Balance	CAT 17.8	Mass View (2L/m)	-	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.8	Easylogger EN-EL-12 Bit	-	Dual Channel Heater Controller	-
Last Impinger Arm	-	SELECT Logger 2	-	Single Channel Heater Controller	CAT INPUT
Callipers	CAT 23.9	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	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 ₂ O	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/m ³ p	Conc kg/m ³ 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 ₂ O)	-	-	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/m ³	1.321
Wet Density (STP), P _{STW}	kg/m ³	1.293
Dry Density (Actual), P _{Actual}	kg/m ³	0.848
Average Wet Density (Actual), P _{ActualW}	kg/m ³	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)

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

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

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)	m ³ /hr	4928
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	3162
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	2989
Gas Volumetric Flowrate REF ¹	m ³ /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 ₂ O	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	$u(\Delta p_i)$	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	$u(C_f)$	1.628	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00005	-
- $\phi O_2, w$	-	5.694	
- $\phi CO_2, w$	-	8.030	
- Oxygen, dry	$u(\phi O_2, d)$	0.184	
- Carbon Dioxide, dry	$u(\phi CO_2, d)$	0.260	
- Water Vapour	$u(\phi H_2O)$	0.279	
- Oxygen, wet	$u(\phi O_2, w)$	0.175	
- Carbon Dioxide, wet	$u(\phi CO_2, w)$	0.247	
Standard uncertainty associated with the stack temperature	$u(T_c)$	2.163	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.700	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.621	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00447	-
Standard uncertainty associated with the local velocities	$u(v_i)$	3.344	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	1.672	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	3.277	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	79.46	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV, w)$	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	$U_{c,rel}(qV, w)$	79.59	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m ³	1.29		1.29
Uncertainty	±mg/m ³	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/m ³	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 ₂ O	-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 ₂ O	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, R_{wv}	% 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 ₂ O	0.80	
Average square root of velocity heads, $\sqrt{\Delta P}$	√mmH ₂ O	0.89	
Average stack gas temperature, T_s	°C	154.3	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(V_{T_s + 273})) / (V(M_s)(P_s))$	m/s	3.72	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} ($Q_{stw@O_2}$), Dry@O_{2REF} ($Q_{std@O_2}$)			
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	
$Q_{stw@O_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m ³ /min	44.4	
$Q_{std@O_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	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

(PAGE 1 OF 2)

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/m ³	0.39	
ELV [Daily ELV for IED]	mg/m ³	N/A	
Allowable Weighing Uncertainty	mg/m ³	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

(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	

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

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	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

Measured Quantities	Value		Standard uncertainty		
	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	p _m	100.9	up _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	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
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	%	-	-

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	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

Measured Quantities	Uncertainty in Result	
	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

Measured Quantities	Oxygen Correction Part of MU Budget	
	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

PM₁₀: RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	0.17	0.17
Uncertainty	±mg/m ³	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/m ³	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.

PM₁₀: 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 ₂ O	-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 ₂ O	117.1	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/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, R _{wv}	% 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%O₂} & V_{mstw@X%O₂}			
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_{stwO₂}), Dry@O_{2REF} (Q_{stdO₂})			
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 _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s) + 273) / (O _{2REFw})	m ³ /min	46.1	
Q _{stdO₂} = ((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} x 100	%	108.0	

PM₁₀: 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 (PM₁₀ 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 (PM₁₀ 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	

PM₁₀: QUALITY ASSURANCE

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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	

PM₁₀: 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	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

PM₁₀: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	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	p _m	100.9	uρ _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			Requirement of Standard
Measured Quantities	Units	Run 1	
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/m ³	0.17		0.17
Uncertainty	±mg/m ³	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/m ³	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 ₂ O	-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 ₂ O	117.1	
V _{mstd} = ((0.3592)(V _m)(P _b + (ΔH/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, R _{wv}	% 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%O₂} & V_{mstw@X%O₂}			
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_{stwO₂}), Dry@O_{2REF} (Q_{stdO₂})			
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 _{stwO₂} = ((Q _a)(P _s)(C _f)) / ((T _s) + 273) / (O _{2REFw})	m ³ /min	46.1	
Q _{stdO₂} = ((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} x 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

(PAGE 1 OF 2)

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

PM_{2.5}: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	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	p _m	100.9	uρ _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	%	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
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	-

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	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

Measured Quantities	Uncertainty in Result	
	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

Measured Quantities	Oxygen Correction Part of MU Budget	
	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/m ³	0.55	0.55
Uncertainty	±mg/m ³	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/m ³	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
Number of Sampling Points Used	4 / 4
Sample Point I.D.'s	A1, A2, A3 & A4

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

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 ₂ O	-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 ₂ O	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, R_{wv}	% 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 ₂ O	0.80	
Average square root of velocity heads, $\sqrt{\Delta P}$	√mmH ₂ O	0.89	
Average stack gas temperature, T_s	°C	154.3	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(V_{T_s + 273})) / (V(M_s)(P_s))$	m/s	3.72	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} ($Q_{stw@O_2}$), Dry@O_{2REF} ($Q_{std@O_2}$)			
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	
$Q_{stw@O_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m ³ /min	44.4	
$Q_{std@O_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	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

(PAGE 1 OF 2)

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

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	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	p_m	100.9	up_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	%	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
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

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	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

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

Measured Quantities	Oxygen Correction Part of MU Budget	
	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/m ³		59.19		59.19
Uncertainty	±mg/m ³		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
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	Middle

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

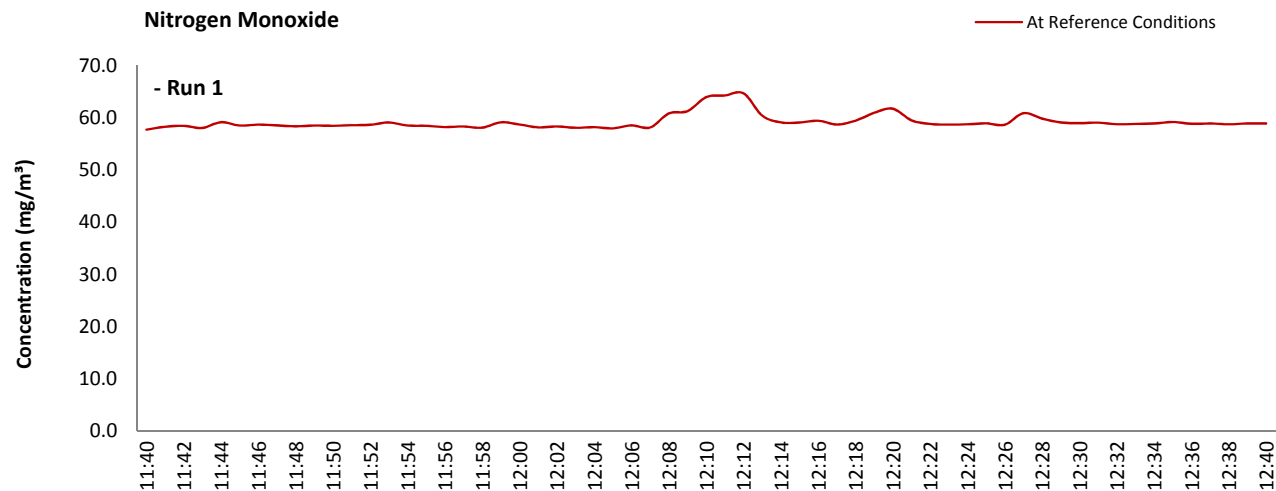
FORMAT: Number Used / Number Required

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

NITROGEN MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics		RUN 1		Units
Limit value		-		mg/m ³ (REF)
TGN M2 Allowable MU		10.0		%
Measured concentration		55.77		mg/m ³ (STP, dry)
Range Used		250.0		ppm
Range Used [A]		334.6		mg/m ³
Cal gas conc.		200.0		ppm
Conversion		1.34		ppm to mg/m ³
MCERTS Range [B]		134.0		mg/m ³
Lower of [A] or [B]		134.0		mg/m ³
Cal gas conc.		267.7		mg/m ³

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/m ³
Standard deviation of repeatability at span level		0.01		mg/m ³
Lack of fit		0.15		mg/m ³
Drift		0.00		mg/m ³
Volume or pressure flow dependence		0.00		mg/m ³
Atmospheric pressure dependence		0.04		mg/m ³
Ambient temperature dependence		0.01		mg/m ³
Combined interference (from MCERTS Certificate)		0.49		mg/m ³
Dependence on voltage		-0.03		mg/m ³
Losses in the line (leak)		0.00		mg/m ³
Uncertainty of calibration gas blending		0.45		mg/m ³
Uncertainty of calibration gas		0.64		mg/m ³

Measurement uncertainty	Result	RUN 1		Units
Combined uncertainty		55.77		mg/m ³
Expanded uncertainty	k = 1.96	1.06		mg/m ³
Expanded uncertainty		2.07		mg/m ³
Uncertainty corrected to std conds. (O ₂)		2.20		mg/m ³ (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 Q_c correction is applied less than 10% + the uncertainty associated with the O₂ correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

OXIDES OF NITROGEN (as NO₂): RESULTS SUMMARY

Cambrian Pet Food, Llangadog
Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	88.9	88.9
Uncertainty	±mg/m ³	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
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	Middle

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

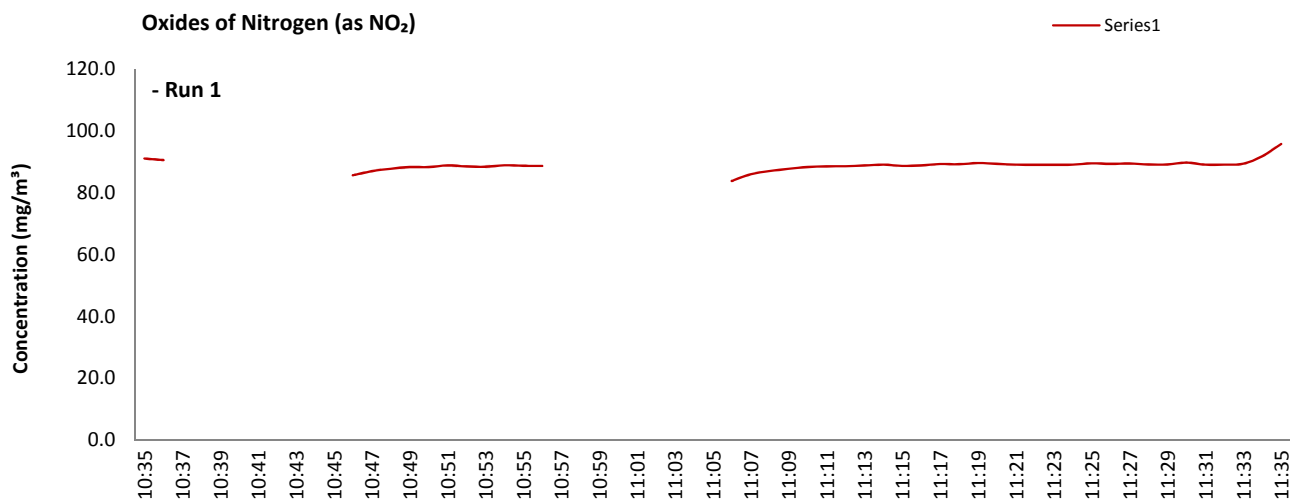
FORMAT: Number Used / Number Required

Reference Conditions

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

OXIDES OF NITROGEN (as NO₂): DATA TREND

Graphical Trend of Data



OXIDES OF NITROGEN (as NO₂): 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	Run Number
(x = deviation applies to the associated run)	1
There are no deviations associated with the sampling employed.	x

OXIDES OF NITROGEN (as NO₂): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	-	mg/m ³ (REF)
TGN M2 Allowable MU	10.0	%
Measured concentration	83.27	mg/m ³ (STP, dry)
Ratio NO / NO ₂	5	%
Range Used	250.0	ppm
Range Used [A]	513.1	mg/m ³
Cal gas conc.	200.0	ppm
Conversion	2.05	ppm to mg/m ³
MCERTS Range [B]	205.0	mg/m ³
Lower of [A] or [B]	205.0	mg/m ³
Cal gas conc.	410.5	mg/m ³

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/m ³
Standard deviation of repeatability at span level	0.01	mg/m ³
Lack of fit	0.24	mg/m ³
Drift	0.00	mg/m ³
Volume or pressure flow dependence	0.00	mg/m ³
Atmospheric pressure dependence	0.06	mg/m ³
Ambient temperature dependence	0.01	mg/m ³
Combined interference (from MCERTS Certificate)	0.75	mg/m ³
Dependence on voltage	-0.03	mg/m ³
Converter efficiency	0.12	mg/m ³
Losses in the line (leak)	0.00	mg/m ³
Uncertainty of calibration gas blending	0.67	mg/m ³
Uncertainty of calibration gas	0.96	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		83.27	mg/m ³
Expanded uncertainty		1.60	mg/m ³
Expanded uncertainty	k = 1.96	3.14	mg/m ³
Uncertainty corrected to std conds. (O ₂)		3.35	mg/m ³ (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 O₂ correction is applied less than 10% + the uncertainty associated with the O₂ 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/m ³	3.37	3.37
Uncertainty	±mg/m ³	0.68	0.68
Mass Emission	g/hr	8.5	8.5
Uncertainty	±g/hr	6.9	6.9

General Sampling Information

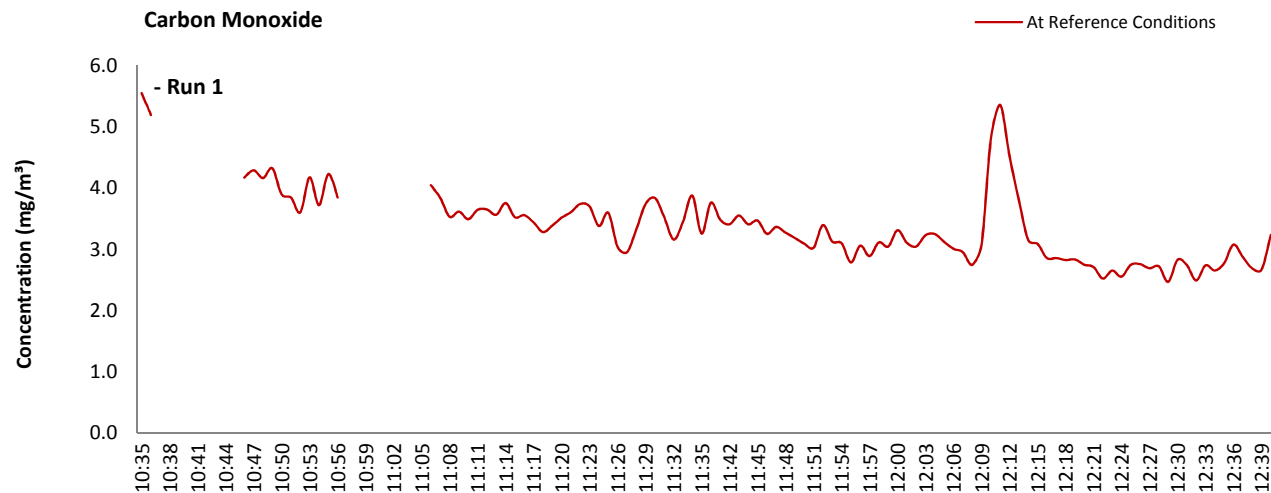
Parameter	Value	
Standard	EN 15058	
Technical Procedure	CAT-TP-39	
Probe Material	Titanium	
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Monoxide	
Span Gas Reference Number	12.0084	
Span Gas Expiry Date	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	Run Number
(x = deviation applies to the associated run)	1
There are no deviations associated with the sampling employed.	x

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	-	mg/m ³ (REF)
TGN M2 Allowable MU	6.0	%
Measured concentration	3.15	mg/m ³ (STP, dry)
Range Used	200.0	ppm
Range Used [A]	249.8	mg/m ³
Cal gas conc.	160.0	ppm
Conversion	1.25	ppm to mg/m ³
MCERTS Range [B]	75.0	mg/m ³
Lower of [A] or [B]	75.0	mg/m ³
Cal gas conc.	199.9	mg/m ³

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/m ³
Standard deviation of repeatability at span level	0.03	mg/m ³
Lack of fit	0.09	mg/m ³
Drift	0.04	mg/m ³
Volume or pressure flow dependence	0.00	mg/m ³
Atmospheric pressure dependence	0.05	mg/m ³
Ambient temperature dependence	-0.03	mg/m ³
Combined interference (from MCERTS Certificate)	-0.21	mg/m ³
Dependence on voltage	-0.04	mg/m ³
Losses in the line (leak)	0.03	mg/m ³
Uncertainty of calibration gas blending	0.03	mg/m ³
Uncertainty of calibration gas	0.04	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		3.15	mg/m ³
Expanded uncertainty	k =	0.32	mg/m ³
Expanded uncertainty	1.96	0.63	mg/m ³
Uncertainty corrected to std conds. (O ₂)		0.67	mg/m ³ (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 O₂ correction is applied less than 6% + the uncertainty associated with the O₂ 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

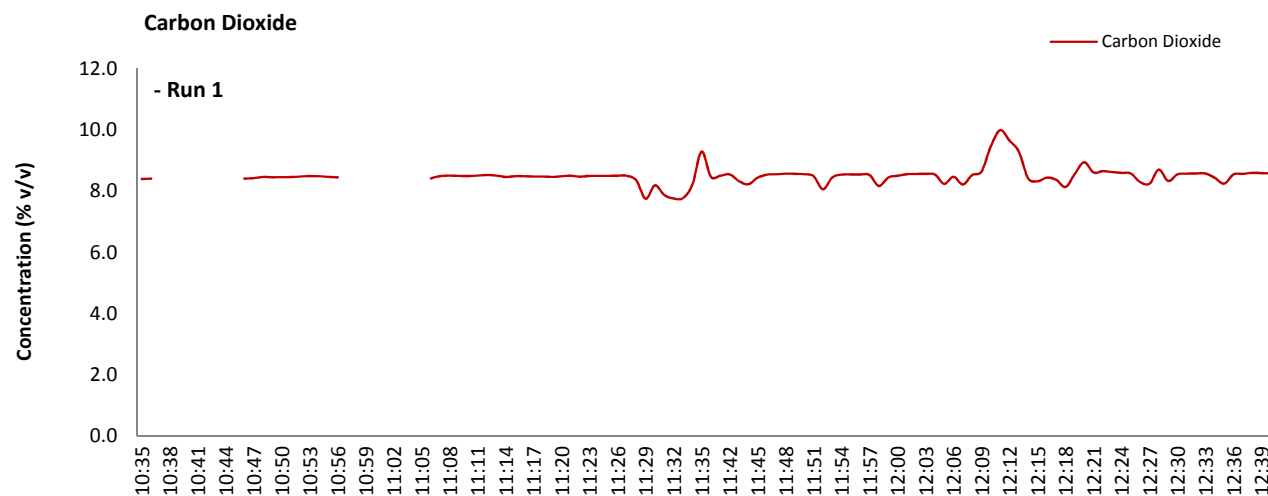
Parameter	Value
Standard	ISO 12039
Technical Procedure	CAT-TP-39
Probe Material	Titanium
Filtration Type / Size	2µm Stainless Steel and 0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Carbon Dioxide
Span Gas Reference Number	6.0043
Span Gas Expiry Date	09/05/2023
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
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	Middle

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

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	Run Number
(x = deviation applies to the associated run)	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

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

Expanded uncertainty (no O ₂) - at 95% Confidence	RUN 1	Units
	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
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	Middle

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

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
	Zero at Analyser (Post)	% v/v	-0.15	-0.15
	Zero Drift	% v/v	-0.15	-0.15
CAL 2	Zero at Analyser (Pre)	% v/v		
	Zero at Analyser (Post)	% v/v		
	Zero Drift	% v/v		
CAL 3	Zero at Analyser (Pre)	% v/v		
	Zero at Analyser (Post)	% v/v		
	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
	Span at Analyser (Post)	% v/v	4.78	4.78
	Span Drift	% v/v	-0.15	-0.15
CAL 2	Span at Analyser (Pre)	% v/v		
	Span at Analyser (Post)	% v/v		
	Span Drift	% v/v		
CAL 3	Span at Analyser (Pre)	% v/v		
	Span at Analyser (Post)	% v/v		
	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	Run Number		
(x = deviation applies to the associated run)	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.