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Stack Emissions Testing Report Commissioned by
NFU Energy Ltd

Installation Name & Address

XXXXXXXXXX
XXXXXXXXXX
XXXXXXXXXX
XXXXXXXXXX

LAPPC Guidance Note: PG 2/1 (13)

Stack Reference

BB1 - Biomass Boiler

Dates of the Monitoring Campaign

11th October 2019

Job Reference Number

EST-5218

Report Written by
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24th October 2019

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Signature of Report Approver


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Executive Summary

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MONITORING OBJECTIVES

BB1 - Biomass Boiler

11th October 2019

Overall Aim of the Monitoring Campaign

Element were commissioned by NFU Energy Ltd to carry out stack emissions testing for XXXXXXXXXX on the BB1 - Biomass Boiler at XXXX

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, Total VOCs (as Carbon), Oxides of Nitrogen (as NO₂), Carbon Monoxide

Executive Summary

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MONITORING RESULTS

BB1 - Biomass Boiler

11th October 2019

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	27.6	1.8	60	g/hr	39.8	3.9	-
Total VOCs (as Carbon) ¹	mg/m ³	7.7	0.47	20	g/hr	11.2	1.1	-
Oxides of Nitrogen (as NO ₂) ¹	mg/m ³	115	5.0	400	g/hr	165	14.0	-
Carbon Monoxide ¹	mg/m ³	87.6	3.6	150	g/hr	126	10.5	-
Oxygen	% v/v	Dry 7.1	0.21					
Water Vapour	% v/v	11.0	0.59					
Stack Gas Temperature	°C	174						
Stack Gas Velocity	m/s	6.4	0.36					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	1961	142					
Volumetric Flow Rate (REF) ¹	m ³ /hr	1443	105					

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, 11% oxygen.

Executive Summary

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MONITORING DATE(S) & TIMES

BB1 - Biomass Boiler
11th October 2019

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m ³	27.6	g/hr	39.8	11/10/2019	11:09 - 12:09	60
Total VOCs (as Carbon)	R1	mg/m ³	7.7	g/hr	11.2	11/10/2019	11:09 - 12:09	60
Oxides of Nitrogen (as NO ₂)	R1	mg/m ³	115	g/hr	165	11/10/2019	11:09 - 12:09	60
Carbon Monoxide	R1	mg/m ³	87.6	g/hr	126	11/10/2019	11:09 - 12:09	60
Oxygen	R1	% v/v	7.1			11/10/2019	11:09 - 12:09	60
Velocity Traverse	R1					11/10/2019	09:46 - 09:58	

All results are expressed at the respective reference conditions.

Executive Summary

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PROCESS DETAILS

BB1 - Biomass Boiler

11th October 2019

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operations
Capacity (of 100%) and Tonnes / Hour	100% of Capacity
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Woodchip
Abatement System	Multi-Cyclone
Abatement System Running Status	Yes
Fuel	N/A
Plume Appearance	None Visible

Executive Summary

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MONITORING & ANALYTICAL METHODS

BB1 - Biomass Boiler

11th October 2019

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	EET	CAT-TP-03	Gravimetric	Yes	EET	Yes	0.16 mg/m ³
Water Vapour	EN 14790	CAT-TP-05	Yes	EET	CAT-TP-05	Gravimetric	Yes	EET	Yes	0.1 % v/v
Total VOCs (as Carbon)	EN 12619:2013	CAT-TP-20	Yes	EET	Flame Ionisation Detection by Sick 3006 FID				Yes	0.32 mg/m ³
Oxides of Nitrogen (as NO ₂)	EN 14792	CAT-TP-39	Yes	EET	Chemiluminescence by Horiba PG-350E				Yes	0.41 mg/m ³
Carbon Monoxide	EN 15058	CAT-TP-39	Yes	EET	NDIR by Horiba PG-350E				Yes	0.25 mg/m ³
Oxygen	EN 14789	CAT-TP-39	Yes	EET	Dry Paramagnetic Cell by Horiba PG-350E				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	EET	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

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

Element Stockport (EET)	ISO 17025 Accreditation Number: 4279
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SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

Executive Summary

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SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.33
Width	m	-
Area	m ²	0.09
Port Depth	cm	9
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
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	Yes
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	22.0	> 5 Pa	Yes
Mean Velocity	m/s	6.44	-	-
Lowest Gas Velocity	m/s	6.44	-	-
Highest Gas Velocity	m/s	6.44	-	-
Ratio of Above	: 1	1.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	0.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

Executive Summary
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PLANT PHOTOS

Photo 1



Photo 2



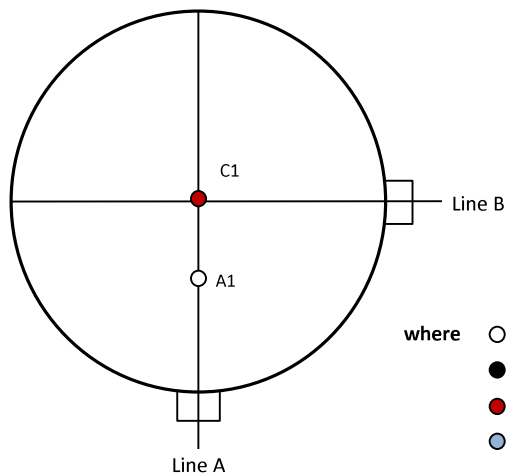
Photo 3



Photo 4



SAMPLE POINTS



- where
- = isokinetic point sampled at
 - = isokinetic point not sampled at
 - (red) = combustion gases sample point
 - (blue) = non-isokinetic sample point



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	David Burns	MCERTS Level 2	MM 05 579	TE1 TE2 TE3 TE4
Technician	Lee Heaton	MCERTS Level 1	MM 18 1433	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 7.58	Horiba PG-350E	CAT 39.11	Digital Manometer (1)	CAT 3.143
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	CAT 3.145
Box Thermocouples (1)	CAT 3.148	Servomex 4900	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.86
Umbilical (1)	CAT 3.148	ABB AO2020-URAS26	-	Barometer	CAT 13.41
Umbilical (2)	-	Servomex 5200MP	-	Stack Thermocouple (1)	CAT 4.1113
Oven Box (1)	CAT 12.201	Ankersmid APS 313	CAT 4.848	Stack Thermocouple (2)	CAT 4.1041
Oven Box (2)	-	Gasmet DX4000	-	Stack Thermocouple (3)	CAT 4.0117
Heated Probe (1)	CAT 5.129	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	CAT 5.130	Bernath 3006 FID	CAT 8.32	1m Heated Line (2)	-
Heated Probe (3)	CAT 5.131	M&C PSS	CAT 12.108	1m Heated Line (3)	-
S-Pitot (1)	CAT 21P.97	Mass Flow Controller (1)	CAT 6.63	5m Heated Line (1)	-
S-Pitot (2)	CAT 21S.56	Mass Flow Controller (2)	CAT 6.64	15m Heated Line (1)	-
L-Pitot	CAT 21L.41	Mass View (1)	CAT 25.61	20m Heated Line (1)	CAT 20.119
Site Balance	CAT 17.38	Mass View (2)	CAT 25.62	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.38	Hioki 5043 (V)	CAT 11.70	Dual Channel Heater Controller	CAT 3.002
Last Impinger Arm	CAT 4.902/4.903	Easylogger EN-EL-12 Bit	-	Single Channel Heater Controller	CAT 20.119
Callipers	CAT 23.41	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.49

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Water Vapour	EN 14790	CAT-TP-05
Total VOCs (as Carbon)	EN 12619:2013	CAT-TP-20
Oxides of Nitrogen (as NO ₂)	EN 14792	CAT-TP-39
Carbon Monoxide	EN 15058	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	0.33
Stack Width, W	m	-
Stack Area, A	m ²	0.09
Average Stack Gas Temperature, T _a	°C	174.0
Average Stack Gas Pressure	Pa	22.0
Average Stack Static Pressure, P _{static}	kPa	0.026
Average Barometric Pressure, P _b	kPa	98.5
Average Pitot Tube Calibration Coefficient, C _p	-	0.86

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 (Estimated)	-	15.00	13.35	0.1500	44.01	1.9635	0.29453
O ₂	-	7.07	6.29	0.0707	32.00	1.4277	0.10090
N ₂	-	77.93	69.38	0.7793	28.01	1.2498	0.97404
Moisture (H ₂ O)	-	-	10.98	0.1098	18.02	0.8037	0.08821

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	1.369
Wet Density (STP), P _{STW}	kg/m ³	1.307
Dry Density (Actual), P _{Actual}	kg/m ³	0.813
Average Wet Density (Actual), P _{ActualW}	kg/m ³	0.777

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} x (T_s / P_s) x (P_a / T_a)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF ¹
Temperature	°C	174.0	0.0
Total Pressure	kPa	98.5	101.3
Moisture	%	10.98	0.00
Oxygen (Dry)	%	7.1	11.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	1983
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	1178
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	1048
Gas Volumetric Flowrate REF ¹	m ³ /hr	1461

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	11/10/2019
Time of Survey	-	09:46 - 09:58
Atmospheric Pressure	kPa	98.5
Average Stack Static Pressure	Pa	26
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	Yes
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C _p	-	0.86
Number of Lines Available	-	2
Number of Lines Used	-	1

Sampling Line A						
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °
<i>STATIC (Units: Pa)</i>		26.0				
Mean		22.0	174.0	0.777	6.44	
1	0.17	22.0	174.0	0.777	6.44	0.0

Sampling Line B - Not Required				
ΔP	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °

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	$u(\Delta p_i)$	1.071	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.050	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	0.011	
- Overall corrections to dynamic measurements	$u(C_f)$	0.146	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00009	-
- $\varphi_{O_2,w}$	-	6.291	
- $\varphi_{CO_2,w}$	-	13.354	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.216	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.459	
- Water Vapour	$u(\phi_{H_2O})$	0.560	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.197	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.417	
Standard uncertainty associated with the stack temperature	$u(T_c)$	2.281	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.695	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.071	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00420	-
Standard uncertainty associated with the local velocities	$u(v_i)$	0.186	Pa
Standard uncertainty associated with the mean velocity	$u(\underline{v})$	0.186	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.365	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	5.67	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	143.9	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00137	
- $u^2(qV,w)$	-	5391	
- $u(qV,w)$	-	73.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	7.26	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

BB1 - Biomass Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	27.6	27.6
Uncertainty	±mg/m ³	1.8	1.8
Mass Emission	g/hr	39.8	39.8
Uncertainty	±g/hr	3.9	3.9

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	11.0	11.0
Uncertainty	±% v/v	0.59	0.59

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	0.37	0.37

General Sampling Information

Parameter	Value
Standard	EN 13284-1
Technical Procedure	CAT-TP-01
Probe Material	Titanium
Filter Housing Material	Titanium
Positioning of Filter	Out Stack
Filter Size and Material	90mm Quartz Fibre
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A1

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P _b	mmHg	738.8	
Stack static pressure, P _{static}	mmH ₂ O	2.5	
$P_s = (P_b + (P_{static} / 13.6))$	mmHg	738.9	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	73.3	
Total mass collected in impingers (silica trap)	g	3.9	
Total mass of liquid collected, V _{lc}	g	77.2	
$V_{wstd} = (0.001246)(V_{lc})$	m ³	0.0962	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V _m	m ³	0.8950	
Gas meter correction factor, Y _d	-	0.9790	
Average dry gas meter temperature, T _m	°C	25.7	
Average pressure drop across orifice, ΔH	mmH ₂ O	22.2	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m ³	0.7802	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m ³	0.1098	
B _{wo} as a percentage	% v/v	10.98	
Reported Water Vapour, checked with Tables in EN 14790, R _{wv}	% v/v	10.98	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m ³	0.8764	
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	6.29	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	7.07	
% oxygen reference condition, REF%O ₂	% v/v	11.00	
O ₂ Reference Factor wet ($O_{2REFw} = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$)	-	0.68	
O ₂ Reference Factor dry ($O_{2REFd} = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$)	-	0.72	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m ³	1.2891	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m ³	1.0871	
Molecular weight of dry gas stream, M_d			
CO ₂ (Estimated)	% v/v	15.00	
O ₂	% v/v	7.07	
Total	% v/v	22.07	
N ₂	% v/v	77.93	
$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$	g/gmol	30.68	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	29.29	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K _p	-	34.97	
Velocity pressure coefficient, C _p	-	0.86	
Average of velocity heads, ΔP _{avg}	mmH ₂ O	2.18	
Average square root of velocity heads, √ΔP	√mmH ₂ O	1.48	
Average stack gas temperature, T _s	°C	174.4	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(T_s + 273)) / (\sqrt{M_s}(P_s))$	m/s	6.37	
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	0.09	
$Q_a = (60)(A_s)(V_s)$	m ³ /min	32.7	
Conversion factor (K/mm.Hg), C _f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m ³ /min	19.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m ³ /min	17.3	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m ³ /min	28.5	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m ³ /min	24.0	
Percent isokinetic, %I			
Nozzle diameter, D _n	mm	8.95	
Nozzle area, A _n	mm ²	62.97	
Total sampling time, q	min	60	
$\%I = (4.6398E^6)(T_s + 273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	102.4	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:09 - 12:09
Sampling Dates	-	11/10/2019
Sampling Device	-	ISO
Volume Sampled (REF)	m ³	1.0871
Filter I.D. Number	-	90-6801
Start Filter Mass	g	0.54133
End Filter Mass	g	0.57049
Total Mass on Filter	g	0.02916
Probe Rinse I.D. Number	-	PR-90-6801
Start Probe Rinse Mass	g	3.00424
End Probe Rinse Mass	g	3.00503
Total Mass in Probe Rinse	g	0.00079
Total Mass Collected	mg	29.95
Calculated Concentration	mg/m ³	27.55
Balance Uncertainty / LOD	mg/m ³	0.16

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	11/10/2019
Average Volume Sampled (REF)	m ³	1.0871
Filter I.D. Number	-	90-6800
Start Filter Mass	g	0.54136
End Filter Mass	g	0.54162
Total Mass on Filter	g	0.00026
Probe Rinse I.D. Number	-	PR-90-6800
Start Probe Rinse Mass	g	2.94670
End Probe Rinse Mass	g	2.94684
Total Mass in Probe Rinse	g	0.00014
Total Mass Collected	mg	0.40
Calculated Concentration	mg/m ³	0.37
Balance Uncertainty / LOD	mg/m ³	0.16

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	14.6
Pre-Sampling Leak Rate	l/min	0.10
Post-Sampling Leak Rate	l/min	
Allowable Leak Rate	l/min	0.40
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.3
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	%	102.4
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	0.29
ELV [Daily ELV for IED]	mg/m ³	60.00
Allowable Weighing Uncertainty	mg/m ³	3.00
Weighing Uncertainty Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	120

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	20.0
Pre-Sampling Leak Rate	l/min	0.10
Post-Sampling Leak Rate	l/min	
Allowable Leak Rate	l/min	0.40
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m ³	6.0
Blank Acceptable	-	Yes

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
There are no deviations associated with the sampling employed.	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (Actual)	V _m	0.8950	uV _m	m ³	0.0179
Sampled Gas Temperature	T _m	298.7	uT _m	K	2.0
Sampled Gas Pressure	p _m	98.5	up _m	kPa	0.5
Sampled Gas Humidity	H _m	0.0	uH _m	% v/v	1.0
Leak	L	0.68	uL	%	-
Mass of Particulate	m	29.95	um	mg	0.17
Uncollected Mass	UCM	0.40	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	%	0.51	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.68	≤2%
Mass of Particulate	%	0.26	<5% of ELV
Uncollected Mass	%	-	-

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	Run 1	
Sampled Volume (STP)	V _m	m ³	0.7802	35.32
Leak	L	mg/m ³	0.109	1.00
Mass of Particulate	L _r	mg	29.953	0.92
Uncollected Mass	UCM	mg	0.23	0.92

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/m ³	0.727
Leak	mg/m ³	0.1089
Mass of Particulate	mg/m ³	0.1564
Uncollected Mass	mg/m ³	0.2124

Measured Quantities	Oxygen Correction Part of MU Budget	
	Units	Run 1
O ₂ Correction Factor	-	0.72
Stack Gas O ₂ Content	% v/v	7.07
MU for O ₂ Correction	-	0.03
Overall MU For O ₂ Measurement	%	3.59

Parameter	Units	Run 1
Combined uncertainty	mg/m ³	0.78
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	1.53
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	1.82
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	1.82
Reported Uncertainty	mg/m ³	1.82
Expanded uncertainty (95% confidence), without Oxygen Correction	%	5.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	6.6
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.6
Reported Uncertainty	%	6.6

TOTAL VOCs (as CARBON): RESULTS SUMMARY

BB1 - Biomass Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	7.7	7.7
Uncertainty	±mg/m ³	0.47	0.47
Mass Emission	g/hr	11.2	11.2
Uncertainty	±g/hr	1.1	1.1

General Sampling Information

Parameter	Value
Standard	EN 12619:2013
Technical Procedure	CAT-TP-20
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Propane in 5% O ₂ in N ₂ (5 Grade)
Span Gas Reference Number	CYL 1.0237n in N ₂ CYL 1.0292a in AIR
Span Gas Expiry Date	18/06/2021 12/09/2021
Span Gas Start Pressure (bar)	120 110
Gas Cylinder Concentration (ppm)	83.46 79.9
Span Gas Set Point (ppm)	82.61
Span Gas Uncertainty (%)	2 2
Zero Gas Type	5% O ₂ in N ₂ (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	C1

This is the blended concentration of both propane cylinders

FORMAT: Number Used / Number Required

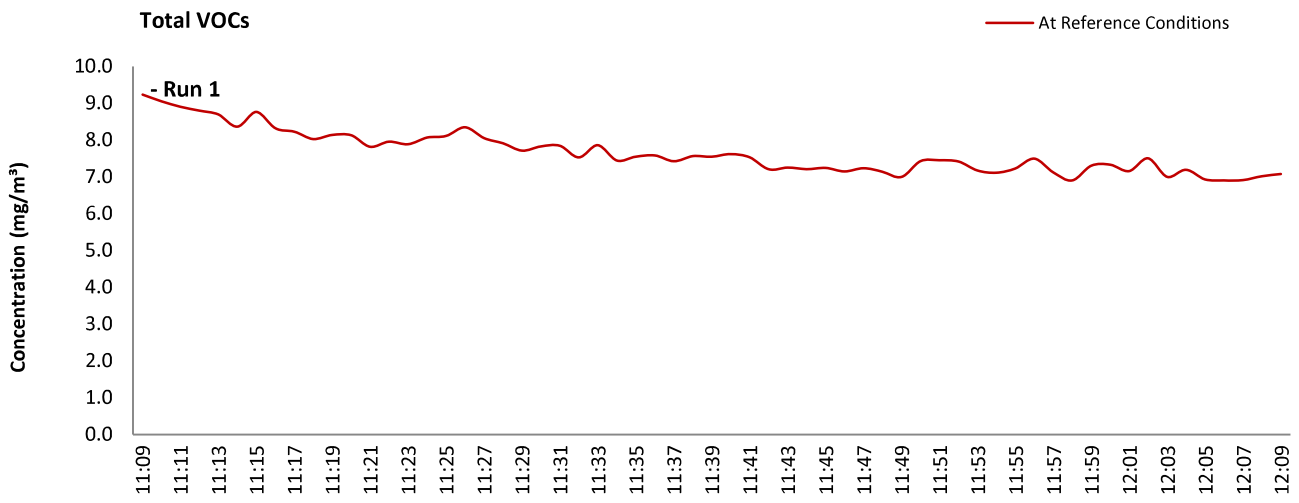
FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

TOTAL VOCs (as CARBON): DATA TREND

Graphical Trend of Data



TOTAL VOCs (as CARBON): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:09 - 12:09
Sampling Dates	-	11/10/2019
Instrument Range	ppm	100
Span Gas Value	ppm	82.6

Quality Assurance

	Zero Drift	Units	Run 1
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00
	Zero Down Sampling Line (Post)	ppm	0.10
	Zero Drift	ppm	0.10
	Allowable Zero Drift	± ppm	4.13
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span Down Sampling Line (Pre)	ppm	82.70
	Span Down Sampling Line (Post)	ppm	82.40
	Span Drift	ppm	-0.30
	Allowable Span Drift	± ppm	4.13
	Span Drift Acceptable	-	Yes

	Test Conditions	Units	Run 1
	Run Ambient Temperature Range	°C	20 - 22

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	

TOTAL VOCs (as CARBON): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	20.0	mg/m ³ (REF)
TGN M2 Allowable MU	15.0	%
Measured concentration	10.66	mg/m ³ (STP, dry)
Range Used	100.0	ppm
Range Used [A]	160.6	mg/m ³
Cal gas conc.	82.6	ppm
Conversion	1.61	ppm to mg/m ³
MCERTS Range [B]	15.0	mg/m ³
Lower of [A] or [B]	15.0	mg/m ³
Cal gas conc.	132.7	mg/m ³

Performance characteristics	RUN 1	Units
Response time	45	seconds
Number of readings in measurement	60	-
Repeatability at zero	2.00	% full scale
Repeatability at span level	0.00	% full scale
Deviation from linearity	0.21	% of value
Zero drift	0.12	% full scale
Span drift	-0.36	% full scale
Volume or pressure flow dependence	1.60	% of full scale
Atmospheric pressure dependence	0.30	% of value/kPa
Ambient temperature dependence	1.40	% full scale/10K
Combined interference	0.45	% range
Dependence on voltage	0.50	% full scale/10V
Losses in the line (leak)	0.00	% of value
Uncertainty of calibration gas	2.83	% 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	0.00	mg/m ³
Lack of fit	0.02	mg/m ³
Drift	0.07	mg/m ³
Volume or pressure flow dependence	0.00	mg/m ³
Atmospheric pressure dependence	0.01	mg/m ³
Ambient temperature dependence	0.20	mg/m ³
Combined interference (from MCERTS Certificate)	0.04	mg/m ³
Dependence on voltage	0.06	mg/m ³
Losses in the line (leak)	0.00	mg/m ³
Uncertainty of calibration gas	0.17	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		10.66	mg/m ³
Expanded uncertainty		0.29	mg/m ³
Expanded uncertainty	k = 1.96	0.56	mg/m ³
Uncertainty corrected to std conds. (O ₂)		0.41	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	5.29	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	2.82	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	15.0	% at ELV
Result of Compliance with Uncertainty Requirement in M2	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	6.09	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.62	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	15.3	% at ELV
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT	-

Requirement for SRM is that Uncertainty should be <15% of the value at the ELV, on a dry gas basis, or if O₂ correction is applied less than 15% + 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

BB1 - Biomass Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	115	115
Uncertainty	±mg/m ³	5.0	5.0
Mass Emission	g/hr	165	165
Uncertainty	±g/hr	14.0	14.0

General Sampling Information

Parameter	Value
Standard	EN 14792
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Date & Result of Last Converter Check	09/05/2019 - 95.4%
Span Gas Type	Nitrogen Monoxide
Span Gas Reference Number	CYL 12.0160
Span Gas Expiry Date	28/07/2020
Span Gas Start Pressure (bar)	160
Gas Cylinder Concentration (ppm)	427.4
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	C1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

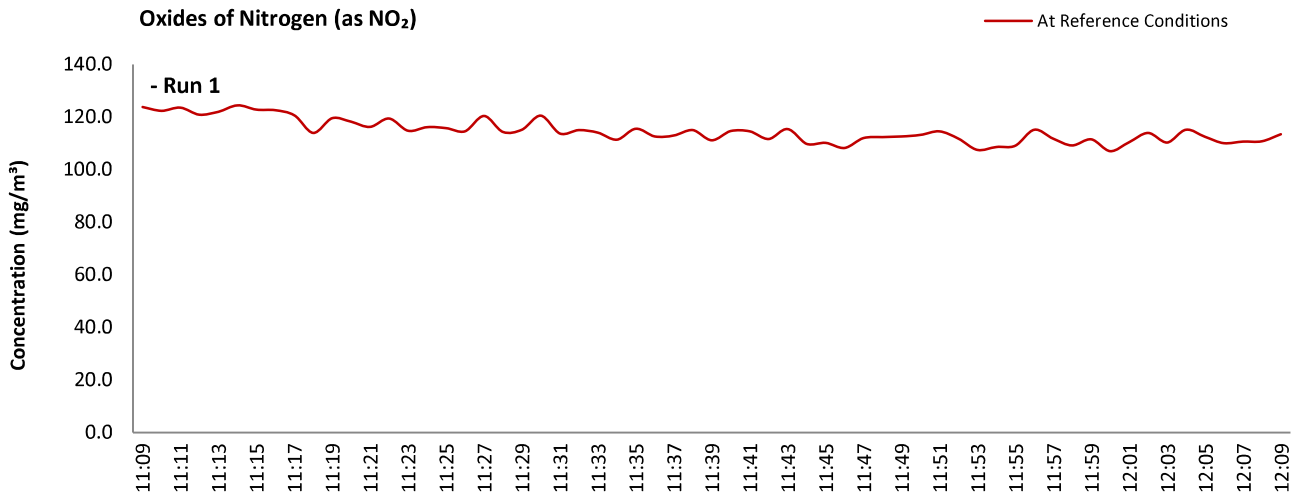
FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% 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	-	11:09 - 12:09
Sampling Dates	-	11/10/2019
Instrument Range	ppm	500
Span Gas Value	ppm	194.9

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	3.0
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
	Allowable Zero Drift	± ppm	9.75
	Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1	
CAL 1	Span at Analyser (Pre)	ppm	194.90
	Span at Analyser (Post)	ppm	196.00
	Span Drift	ppm	1.10
	Allowable Span Drift	± ppm	9.75
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	20 - 22

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 NO₂): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	400.0	mg/m ³ (REF)
TGN M2 Allowable MU	10.0	%
Measured concentration	159.69	mg/m ³ (STP, dry)
Ratio NO / NO ₂	5	%
Range Used	500.0	ppm
Range Used [A]	1026.1	mg/m ³
Cal gas conc.	194.9	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.	400.0	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	0.38	% of value
Zero drift	0.05	% full scale
Span drift	0.56	% 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	95.4	%
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	0.45	mg/m ³
Drift	0.64	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	0.21	mg/m ³
Losses in the line (leak)	0.00	mg/m ³
Uncertainty of calibration gas blending	1.29	mg/m ³
Uncertainty of calibration gas	1.84	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		159.69	mg/m ³
Expanded uncertainty		2.61	mg/m ³
Expanded uncertainty	k = 1.96	5.13	mg/m ³
Uncertainty corrected to std conds. (O ₂)		3.68	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.21	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	1.28	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	10.0	% at ELV
Result of Compliance with Uncertainty Requirement in M2	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	4.39	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.14	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	10.4	% at ELV
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT	-

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

BB1 - Biomass Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	87.6	87.6
Uncertainty	±mg/m ³	3.6	3.6
Mass Emission	g/hr	126	126
Uncertainty	±g/hr	10.5	10.5

General Sampling Information

Parameter	Value
Standard	EN 15058
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Carbon Monoxide
Span Gas Reference Number	CYL 12.0160
Span Gas Expiry Date	28/07/2020
Span Gas Start Pressure (bar)	160
Gas Cylinder Concentration (ppm)	429.5
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	C1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

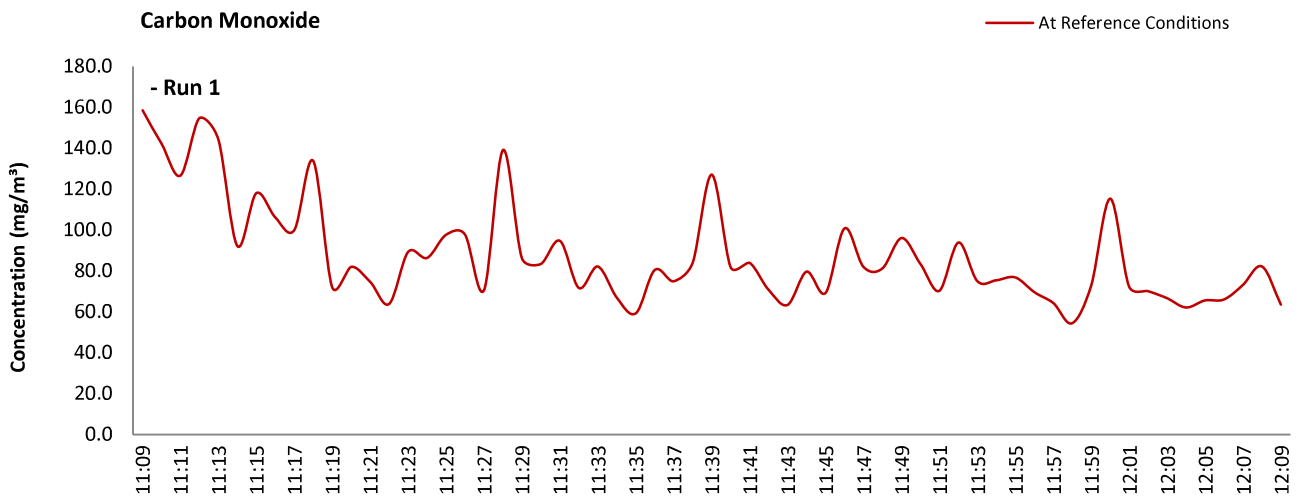
FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:09 - 12:09
Sampling Dates	-	11/10/2019
Instrument Range	ppm	500
Span Gas Value	ppm	120.1

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	3.0
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	0.20
	Zero Drift	ppm	0.20
	Allowable Zero Drift	± ppm	6.00
	Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1	
CAL 1	Span at Analyser (Pre)	ppm	120.10
	Span at Analyser (Post)	ppm	120.00
	Span Drift	ppm	-0.10
	Allowable Span Drift	± ppm	6.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	20 - 22

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	150.0	mg/m ³ (REF)
TGN M2 Allowable MU	6.0	%
Measured concentration	122.01	mg/m ³ (STP, dry)
Range Used	500.0	ppm
Range Used [A]	624.6	mg/m ³
Cal gas conc.	120.1	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.	150.0	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	0.40	% of value
Zero drift	0.17	% full scale
Span drift	-0.08	% 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)	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	0.03	mg/m ³
Lack of fit	0.17	mg/m ³
Drift	0.09	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)	0.00	mg/m ³
Uncertainty of calibration gas blending	0.99	mg/m ³
Uncertainty of calibration gas	1.41	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		122.01	mg/m ³
Expanded uncertainty		1.76	mg/m ³
Expanded uncertainty	k = 1.96	3.44	mg/m ³
Uncertainty corrected to std conds. (O ₂)		2.47	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	2.82	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	2.30	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	6.0	% at ELV
Result of Compliance with Uncertainty Requirement in M2	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	4.12	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.42	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	6.7	% at ELV
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT	-

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.

OXYGEN: RESULTS SUMMARY

BB1 - Biomass Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	% v/v	7.1	7.1
Uncertainty	±% v/v	0.21	0.21

General Sampling Information

Parameter	Value
Standard	EN 14789
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	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	CYL 11.0281
Span Gas Expiry Date	24/02/2022
Span Gas Start Pressure (bar)	140
Gas Cylinder Concentration (% v/v)	21.94
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	C1

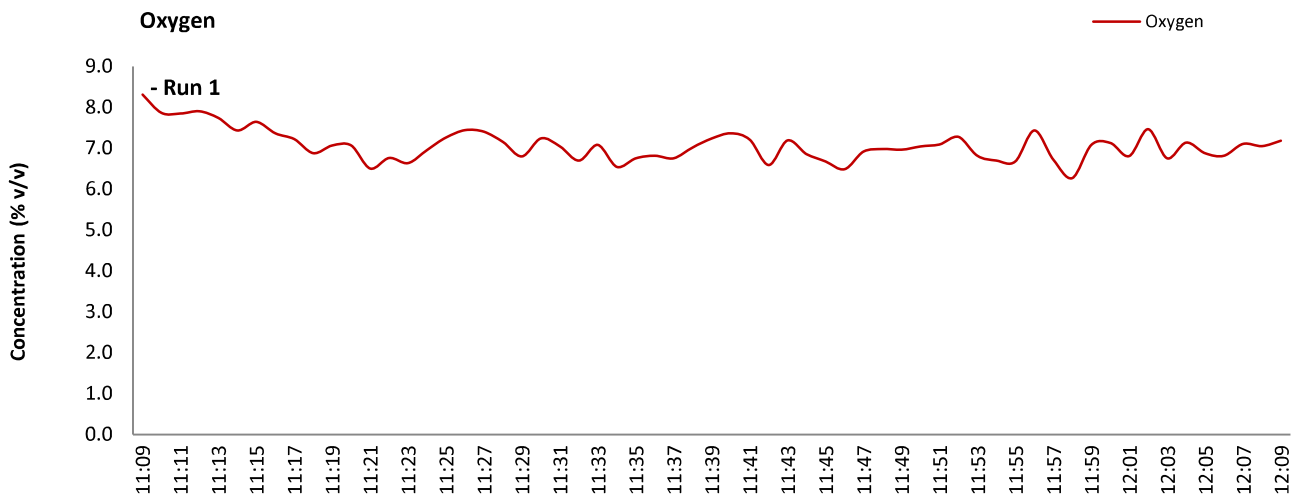
NOTE: Dilution performed to achieve correct span value

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
Sampling Times	-	11:09 - 12:09
Sampling Dates	-	11/10/2019
Instrument Range	% v/v	25
Span Gas Value	% v/v	6.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	3.0
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1	
CAL 1	Zero at Analyser (Pre)	% v/v	0.00
	Zero at Analyser (Post)	% v/v	-0.02
	Zero Drift	% v/v	-0.02
	Allowable Zero Drift	± % v/v	0.30
	Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1	
CAL 1	Span at Analyser (Pre)	% v/v	6.06
	Span at Analyser (Post)	% v/v	6.03
	Span Drift	% v/v	-0.03
	Allowable Span Drift	± % v/v	0.30
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	20 - 22

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

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	N/A	%vol
TGN M2 Allowable MU	6.0	%
Measured concentration	7.07	%vol
Range Used	25.0	%vol
Cal gas conc.	21.9	%vol

Performance characteristics	RUN 1	Units
Response time	41	seconds
Number of readings in measurement	60	-
Repeatability at zero	0.02	% full scale
Repeatability at span level	0.02	% full scale
Deviation from linearity	0.04	% of value
Zero drift	-0.33	% full scale
Span drift	-0.50	% full scale
Volume or pressure flow dependence	0.10	% of full scale
Atmospheric pressure dependence	0.19	% of value/kPa
Ambient temperature dependence	-0.21	% full scale/10K
Combined interference	0.00	% range
Dependence on voltage	0.02	% full scale/10V
Losses in the line (leak)	0.17	% 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	0.00	%vol
Lack of fit	0.01	%vol
Drift	-0.06	%vol
Volume or pressure flow dependence	0.00	%vol
Atmospheric pressure dependence	0.01	%vol
Ambient temperature dependence	-0.03	%vol
Combined interference (from MCERTS Certificate)	0.00	%vol
Dependence on voltage	0.00	%vol
Losses in the line (leak)	0.01	%vol
Uncertainty of calibration gas	0.08	%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		7.07	%vol
Expanded uncertainty	k = 1.96	0.11	%vol
		0.21	%vol

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.00	% of Value
Result of Compliance with Uncertainty Requirement in M2	COMPLIANT	-

Requirement for SRM is that Uncertainty should be 0.3% vol absolute or 6% relative whichever is the lower, on a dry gas basis. Source, EN 14789.