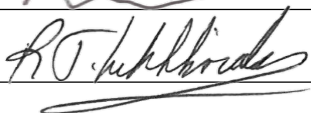




Report for the Periodic Monitoring of Emissions to Air

Part 1: Executive Summary

Permit Number:	EPR/WP3231NB
Operator:	Dairy Partners (Cymru Wales) Ltd
Installation:	Boilers 1 & 2

Test Report:	ALL100664/21/PR-1
Monitoring Dates:	14 & 20/12/2021
Client / Organisation:	Mr Daryl White
Address:	The Creamery
	Aberarad
	Newcastle Emlyn
	Carmarthenshire
	SA38 9DQ
Date of Report:	22/12/2021
Report Approved By:	Phillip Ruck BSc
MCERTS Number/Level/Technical Endorsement	MM 11 1117 Level 2, TE1, TE2, TE3, TE4
Designation:	Stack Emissions Co-ordinator
Signed:	 Phillip Ruck
Reviewed:	 Robert Lethbridge

Contents**Part 1 Executive summary**

Page number	Description
1	Executive Summary
2	Contents
3	Monitoring objectives
4 – 5	Monitoring results
6	Process status
7	Operating information
8	Monitoring deviations

Part 2 – Supporting information

Page number	Description
N/A	Appendix 1
N/A	Sampling personnel
N/A	Method specification
N/A	Equipment Checklist
N/A	Appendix 2 - Boiler 1 stack details including gas measurements (12 pages)
N/A	Appendix 3 - Boiler 2 stack details including gas measurements (8 pages)
N/A	Appendix 4 (Uncertainty)
N/A	Appendix 5 (Instrumental analyser details)
N/A	Appendix 6 (Calibration details retained at permanent laboratory)



Monitoring objectives

At the request of Mr Darryl White of Dairy Partners (Cymru Wales) Ltd, Anchem Laboratories Limited has carried out an “emissions to atmosphere” monitoring regime in the exhaust ductwork of the Boiler 1 and Boiler 2 process stacks at their Newcastle Emlyn plant. This is the only emissions monitoring regime to be carried out on an annual basis throughout 2021 and has been undertaken to meet the requirements of their Natural Resources Wales permit.

Emission point	Sample number	Substance to be monitored	Special requirements
Boiler 1 Exhaust LHS	100664/1	Oxides of nitrogen	1-hour sampling
		Oxygen	
Boiler 2 Exhaust RHS	100664/2	Oxides of nitrogen	1-hour sampling
		Oxygen	



Monitoring results

Emission Point	Boiler 1 Exhaust LHS	
Sample Number	100664/1	
Substance to be Monitored	Oxides of Nitrogen	Oxygen
Emission Limit Value	N/A	N/A
Periodic Monitoring Result	126.5	8.1
Uncertainty	±3.0	±0.4
Units	mg/Nm ³	% Vol
Reference Conditions	273K, 101.3kPa, 3% oxygen & dry gas	
Date of Sampling	20/12/2021	
Start/End Time	11:05 – 13:06	
Average Volumetric flow @ reference conditions / m³/hr	2041.0	
Standard Reference Method	BS EN 14792	BS EN 14789
Technical Procedure Reference	ANC/S/29	ANC/S/26
Accreditation Status	MCERTS	
Process Status (Load/Feedstock)	See Process Status (page 6)	



Emission Point	Boiler 2 Exhaust RHS	
Sample Number	100664/2	
Substance to be Monitored	Oxides of Nitrogen	Oxygen
Emission Limit Value	N/A	N/A
Periodic Monitoring Result	175.7	3.1
Uncertainty	±2.1	±0.5
Units	mg/Nm ³	% Vol
Reference Conditions	273K, 101.3kPa, 3% oxygen & dry gas	
Date of Sampling	14/12/2021	
Start/End Time	10:52 – 11:52	
Average Volumetric flow @ reference conditions / m³/hr	2473.2	
Standard Reference Method	BS EN 14792	BS EN 14789
Technical Procedure Reference	ANC/S/29	ANC/S/26
Accreditation Status	MCERTS	
Process Status (Load/Feedstock)	See Process Status (page 6)	



Process status

With regards to the monitoring carried out on the Boiler 1 exhaust stack, the boiler modulates with respect to load and will switch off for periods when load is very low. This is the normal operating capacity for the boiler and was experienced during the testing regime. No unusual occurrences reported by the operators.

With regards to the monitoring carried out on the Boiler 2 exhaust stack, the processes ran in a steady continuous state during the sampling regime with no unusual occurrences reported by the operators.

All boilers operated at the maximum level that the site steam demand would allow.

Detailed process information was unavailable; however, all boilers were confirmed as operational by site personnel prior to monitoring.



Operating information

Nature of process (continuous or batch)	The 2 boiler systems ran continuously during the sampling regime
What part of the batch was sampled or whole batch (if applicable)	Not applicable
What fuel was used (if applicable)	Both boilers were run on LNG
What feedstock was used during the monitoring (if applicable)	Not applicable
“Normal” load, throughput or continuous rating of plant	The boilers operated at the maximum level that the site demand would allow.
What type of abatement system and whether operating	There is currently no abatement present on the boilers.
The periodic monitoring result and the results from the operators CEMS	There are no CEMs fitted for the purpose of monitoring emissions to air.



Monitoring Deviations:

Why any substance(s) in the monitoring objectives were not monitored.

N/A

Why any substance(s) were not monitored in accordance with the monitoring method and any other issues relevant to the monitoring results.

The sampling carried out on the Boiler 1 exhaust process stack did not deviate from the procedural requirements of documented in-house methods ANC/S/36, ANC/S/26 & ANC/S/29. Where the boiler has shut down, the gas data has been omitted from the report. The report only includes data when the boiler was running under load. All raw data is available upon request.

The sampling carried out on the Boiler 2 exhaust process stack did not deviate from the procedural requirements of documented in-house methods ANC/S/36, ANC/S/26 & ANC/S/29.



Part 2: Supporting information

APPENDIX 1



Sampling personnel

Name	Function	MCERTS number	MCERTS level	Technical endorsements
P Ruck	Team Leader	MM 11 1117	Level 2	TE1, TE2, TE3, TE4
E Jones	Emissions Analyst	MM 17 1417	Level 2	TE1, TE2, TE4
D Hapgood	Emissions Analyst	MM 21 1664	Trainee	-



Method specifications

Substance	Standard reference method	Anchem technical procedure
Oxides of nitrogen	BS EN 14792	ANC/S/29
Oxygen	BS EN 14789	ANC/S/26
Velocity	BS ISO 16911	ANC/S/36



Equipment checklist

Please see relevant appendices and site-specific protocol associated with monitoring campaign for equipment utilised during monitoring & checklist.



APPENDIX 2

Boiler 1 Exhaust LHS

(12 Pages)



Stack Diagram:



Stack Dimension (m)	0.57m
Homogeneity test previously Carried out (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown



Combustion Gas Monitoring Summary

Sample Number	100664/1
Date	20/12/2021
Customer name	Dairy Partners
Site location	Aberarad
Emission point	Boiler 1
Emission point dimension (m)	0.57m
Emission point C.S.A. (m ²)	0.2552
Team leader	Phil Ruck
Analyst(s)	Daniel Hapgood
Average Ambient pressure (mb)	1024
Average Ambient temperature (°C)	15.5
Instrument number	A/S545 (PG-350)
Probe length (m)	0.5m
Timer	A/L148
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	11:05:00
Test end time	13:06:00
Volumetric flow @ reference conditions (m ³ /hour)	2041

Reference conditions

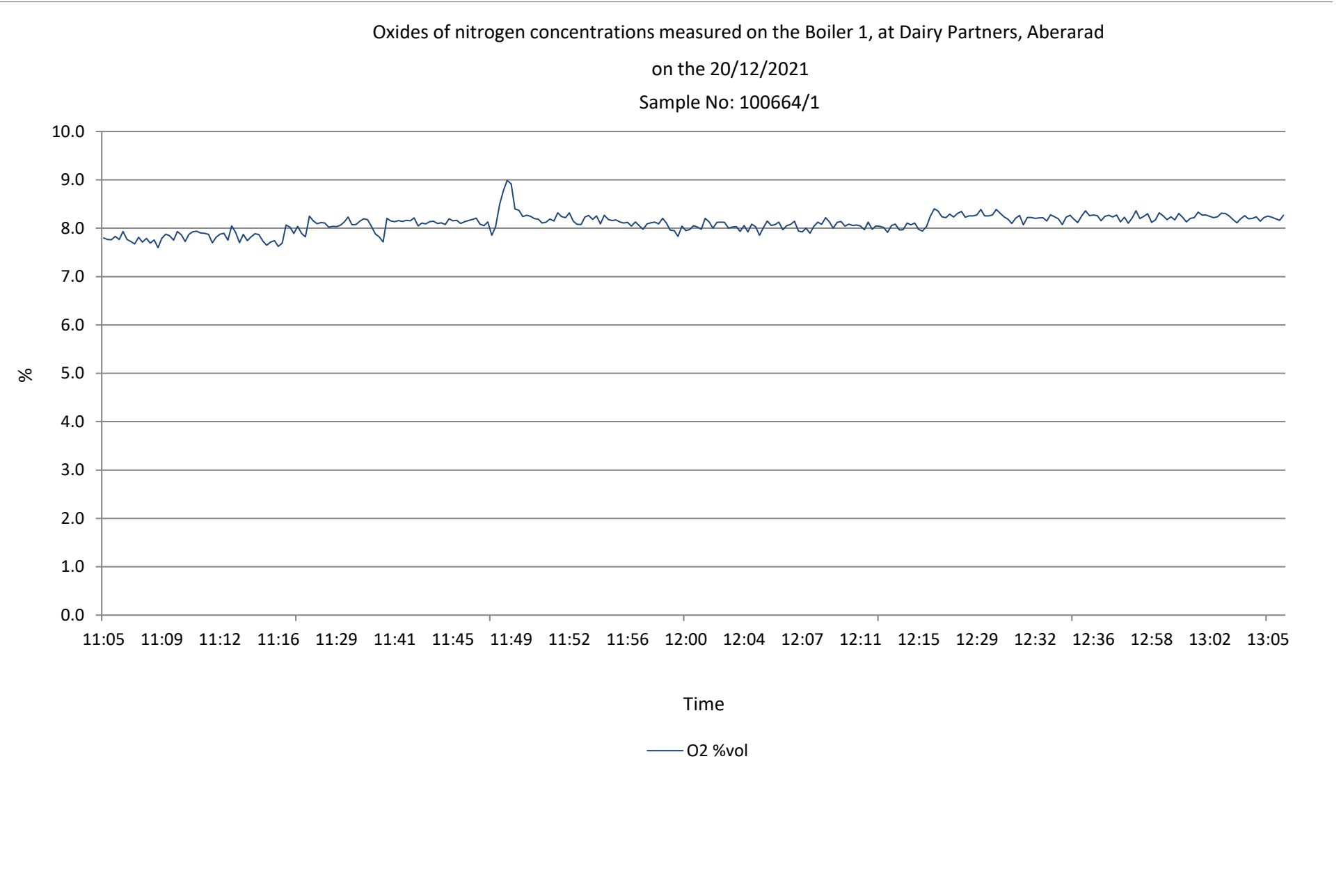
Temperature (K)	273
Pressure (kPa)	101.3
Moisture	Dry
Oxygen (%)	3

Oxygen

Average concentration O₂ (% vol)	8.1
Maximum concentration O₂ (% vol)	9.0
Minimum concentration O₂ (% Vol)	7.6
% Uncertainty of measurement	4.8
Uncertainty Concentration % vol	0.4

Oxides of nitrogen concentrations measured on the Boiler 1, at Dairy Partners, Aberarad
on the 20/12/2021
Sample No: 100664/1

Concentration	CO mg/m ³	30 Minute Rolling Mean	NOx mg/m ³	30 Minute Rolling Mean	SO2 mg/m ³	30 Minute Rolling Mean	O ₂ %vol
Minimum							7.6
Maximum							9.0
Average							8.1



Combustion Gas Monitoring Summary

Sample Number	100664/1
Date	20/12/2021
Customer name	Dairy Partners
Site location	Aberarad
Emission point	Boiler 1
Emission point dimension (m)	0.57m
Emission point C.S.A. (m ²)	0.2552
Team leader	Phil Ruck
Analyst(s)	Daniel Hapgood
Average Ambient pressure (mb)	1024
Average Ambient temperature (°C)	15.5
Instrument number	A/S545 (PG-350)
Probe length (m)	0.5m
Timer	A/L148
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	11:05:00
Test end time	13:06:00
Volumetric flow @ reference conditions (m ³ /hour)	2041

Reference conditions

Temperature (K)	273
Pressure (kPa)	101.3
Moisture	Dry
Oxygen (%)	3

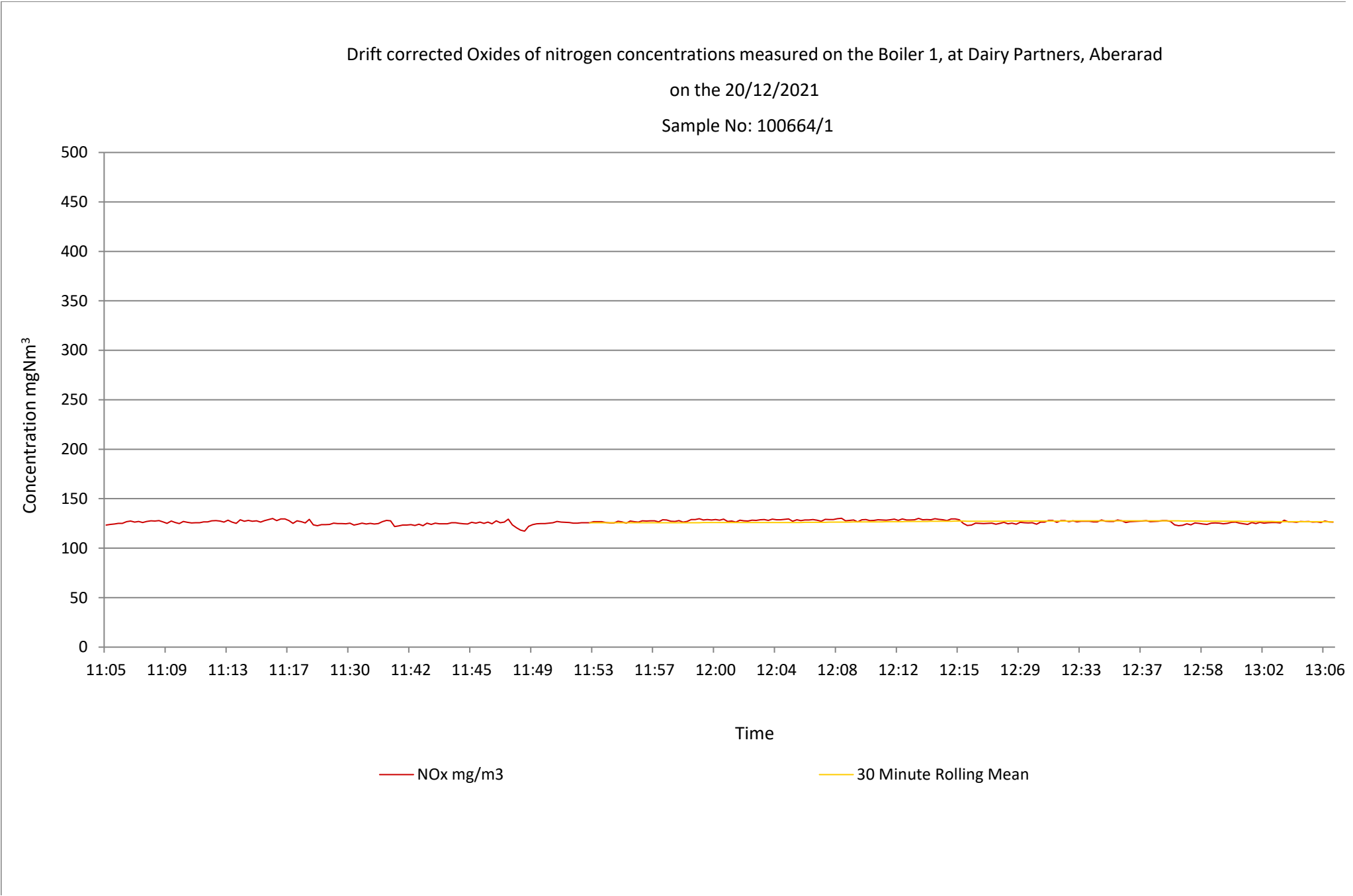
Oxides of Nitrogen (as NO₂)

Average concentration NOx (mg/m ³)	126.5
Maximum concentration NOx (mg/m ³)	130.1
Minimum concentration NOx (mg/m ³)	117.2
Mass Emission NOx (Kg/hour)	0.26
% Uncertainty of measurement	2.3
Uncertainty Concentration	3.0

Drift corrected Oxides of nitrogen concentrations measured on the Boiler 1, at Dairy Partners, Aberarad
on the 20/12/2021
Sample No: 100664/1

Concentration	CO mg/m ³	30 Minute Rolling Mean	NOx mg/m ³	30 Minute Rolling Mean	SO2 mg/m ³	30 Minute Rolling Mean	Oxygen (%) vol)
Minimum			117.2	125.6			
Maximum			130.1	127.6			
Average			126.5	126.7			

Drift corrected Oxides of nitrogen concentrations measured on the Boiler 1, at Dairy Partners, Aberarad
on the 20/12/2021
Sample No: 100664/1



Combustion Gas Site Data

Document Reference ANC417 B	Issue No: 10	Page 1 of 1
-----------------------------	--------------	-------------

Customer	Dairy Partners
Emission Point	Boiler 1
Date	20/12/2021
Sample No	100664/1

Pre test				
ANALYTE		NO	SO ₂	O ₂
Zero through analyser (ppm)		0		0
Span Through analyser (ppm)		152.8		6.0
Zero through analyser (ppm)		0.0		-0.01
Zero Through line (ppm)		-0.10		-0.01
Span Through line (ppm)		152.6		6.0
Residence Time (seconds)		40.0		42.0
System T90 (seconds)		47		50
T90 Value (ppm)		137.5		5.4
Initial leak test		0.1		0.2
Post test				
ANALYTE	CO	NO	SO ₂	O ₂
Zero Through Line		-0.10		-0.03
Span Through line (ppm)		147.60		5.98
Span Drift (%)		3.3		0.0
Zero Drift (%)		0.0		0.3

Oxygen cylinder grade/reference	5.99% H434AND
Nitrogen Monoxide cylinder grade/reference	152.8ppm 0081
Sulphur Dioxide cylinder grade/reference	N/A
Carbon Monoxide cylinder grade/reference	N/A

Gas conditioning Temperature Validation

Temperature @ Start of Test (°C)	N/A
Temperature During Test (°C)	N/A
Temperature @ End of Test (°C)	N/A
Temperature of Heated Line (°C)	120
Temperature of PD-100 oven (°C)	100

Stratification Data

Point	CO ppm	NO ppm	SO ₂ ppm	O ₂ % vol
1		43.80		
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

EN ISO 16911 L-Type Pitot Summary Page

Client	Dairy Partners
Site	Aberarad
Emission Point	Boiler 2
Date	20-Dec-21
Sample Number	100664/1
X-Sectional Area	0.255
Pitot Tube Factor	1.00
Average DP (kPa)	0.013
% Water Vapour	13.7
Average % Oxygen	8.1
Average % Carbon Dioxide	9.4
Average % Carbon Monoxide	0.0
Average % Nitrogen	82.5
Barometric Pressure (mb)	1024
Arithmetic Average Duct Static Pressure (hPa)	-0.57
Absolute Stack Gas Pressure (KPa)	102.3
Average Stack Gas Temperature (K)	441
Velocity in Stack (m/s)	5.8
Volumetric Flow at Stack Conditions (m ³ /sec)	1.47
Volumetric flow rate at reference conditions (m ³ /sec)	0.57
Volumetric flow rate at reference conditions (m ³ /hour)	2040.96
% Uncertainty of Measurement	5.6

Client	Dairy Partners
Site	Aberarad
Emission Point	Boiler 2
Date	20/12/2021
Sample Number	100664/1
Bar Pressure (mb)	1024
Moisture (%)	13.69

Gas Flow	Out
Port Nipple (cm)	30
Dimension (m)	0.57
Stack C.S.A (m ²)	0.255
Tape Measure	A/S544
Timer	A/L148
Barometer No.	A/S542

Field Performance Criteria	Acceptable
Pitch <±10°	N/A
Swirl <±15°	Yes
Stack Internal Area	Yes
Field Repeatability	N/A
Blockage Check	Yes
Average Stack Temp °C	168

% O ₂	% CO ₂	% CO
8.1	9.4	0.0

Traverse Line 1

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch
1	5.0	5.5	0.18	168	11	N/A
2	14.3	4.2	0.11	168	11	N/A
3	42.8	4.7	0.13	168	10	N/A
4	52.0	4.3	0.11	168	8	N/A

Traverse Line 2

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Traverse Line 3

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Traverse Line 4

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Number of Sample Points
4

Flow Characteristics Meet Requirements of EN ISO 16911?
Yes

APPENDIX 3

Boiler 2 Exhaust RHS

(8 Pages)



Stack diagram



Stack Dimension (m)	0.57m
Homogeneity test previously carried out (yes/no)	No
Is the gas stream homogeneous? (yes/no/unknown)	Unknown



Combustion Gas Monitoring Summary

Sample Number	100664/2
Date	14/12/2021
Customer name	Dairy Partners
Site location	Aberarad
Emission point	Boiler 2
Emission point dimension (m)	0.57m
Emission point C.S.A. (m²)	0.2552
Team leader	Phil Ruck
Analyst(s)	Elliot Jones
Average Ambient pressure (mb)	1021
Average Ambient temperature (°C)	18
Instrument number	A/S545 (PG-350)
Probe length (m)	0.5m
Timer	A/L148
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	10:52:00
Test end time	11:52:00
Volumetric flow @ reference conditions (m³/hour)	2473.2

Reference conditions

Temperature (K)	273
Pressure (kPa)	101.3
Moisture	Dry
Oxygen (%)	3

Oxides of Nitrogen (as NO₂)

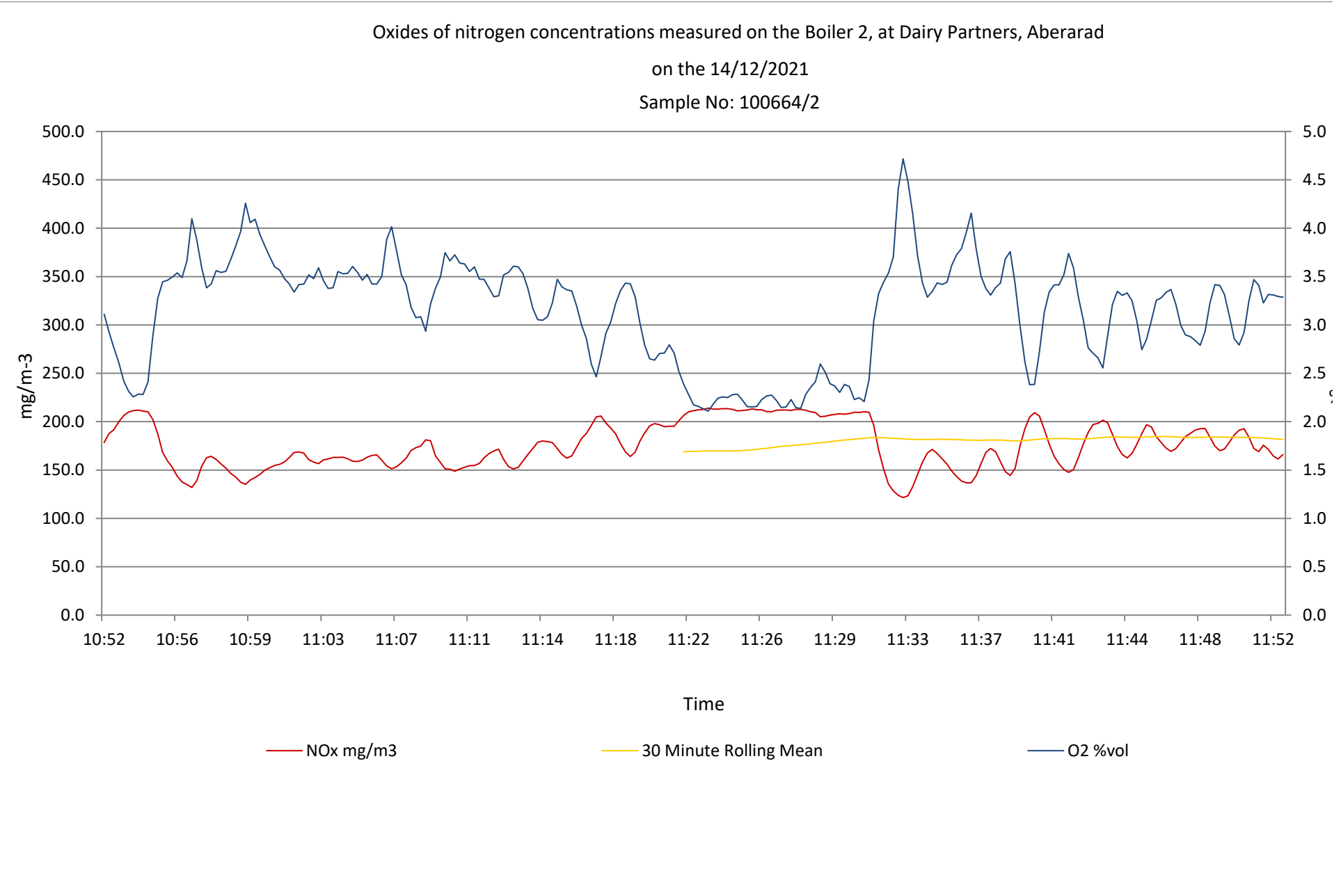
Average concentration NO_x (mg/m³)	175.7
Maximum concentration NO_x (mg/m³)	214.0
Minimum concentration NO_x (mg/m³)	121.5
Mass Emission NO_x (Kg/hour)	0.43
% Uncertainty of measurement	1.2
Uncertainty Concentration mg/m³	2.1

Oxygen

Average concentration O₂ (% vol)	3.1
Maximum concentration O₂ (% vol)	4.7
Minimum concentration O₂ (% Vol)	2.1
% Uncertainty of measurement	15.5
Uncertainty Concentration % vol	0.5

Oxides of nitrogen concentrations measured on the Boiler 2, at Dairy Partners, Aberarad
on the 14/12/2021
Sample No: 100664/2

Concentration	CO mg/m ³	30 Minute Rolling Mean	NOx mg/m ³	30 Minute Rolling Mean	SO2 mg/m ³	30 Minute Rolling Mean	O ₂ %vol
Minimum			121.5	168.9			2.1
Maximum			214.0	184.6			4.7
Average			175.7	180.1			3.1



Combustion Gas Site Data

Document Reference ANC417 B	Issue No: 10	Page 1 of 1
-----------------------------	--------------	-------------

Customer	Dairy Partners
Emission Point	Boiler 2
Date	14/12/2021
Sample No	100664/2

Pre test				
ANALYTE		NO	SO ₂	O ₂
Zero through analyser (ppm)		0		0
Span Through analyser (ppm)		152.8		6.0
Zero through analyser (ppm)		0.0		-0.01
Zero Through line (ppm)		0.00		-0.01
Span Through line (ppm)		152.8		6.0
Residence Time (seconds)		38.0		39.0
System T90 (seconds)		48		46
T90 Value (ppm)		137.5		5.4
Initial leak test		0.0		0.2
Post test				
ANALYTE	CO	NO	SO ₂	O ₂
Zero Through Line		-0.10		0.01
Span Through line (ppm)		152.10		5.97
Span Drift (%)		0.5		0.2
Zero Drift (%)		0.1		0.3

Oxygen cylinder grade/reference	5.99% H434AND
Nitrogen Monoxide cylinder grade/reference	152.8ppm 0081
Sulphur Dioxide cylinder grade/reference	N/A
Carbon Monoxide cylinder grade/reference	N/A

Gas conditioning Temperature Validation

Temperature @ Start of Test (°C)	N/A
Temperature During Test (°C)	N/A
Temperature @ End of Test (°C)	N/A
Temperature of Heated Line (°C)	120
Temperature of PD-100 oven (°C)	100

Stratification Data

Point	CO ppm	NO ppm	SO ₂ ppm	O ₂ % vol
1		86.25		
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

EN ISO 16911 L-Type Pitot Summary Page

Client	Dairy Partners
Site	Aberarad
Emission Point	Aberarad
Date	14-Dec-21
Sample Number	100664/2
X-Sectional Area	0.255
Pitot Tube Factor	1.00
Average DP (kPa)	0.009
% Water Vapour	13.6
Average % Oxygen	3.1
Average % Carbon Dioxide	13.7
Average % Carbon Monoxide	0.0
Average % Nitrogen	83.2
Barometric Pressure (mb)	1021
Arithmetic Average Duct Static Pressure (hPa)	-0.44
Absolute Stack Gas Pressure (KPa)	102.1
Average Stack Gas Temperature (K)	411
Velocity in Stack (m/s)	4.7
Volumetric Flow at Stack Conditions (m ³ /sec)	1.19
Volumetric flow rate at reference conditions (m ³ /sec)	0.69
Volumetric flow rate at reference conditions (m ³ /hour)	2473.15
% Uncertainty of Measurement	5.6

Client	Dairy Parners
Site	Aberarad
Emission Point	Aberarad
Date	14/12/2021
Sample Number	100664/2
Bar Pressure (mb)	1021
Moisture (%)	13.57

Gas Flow	Out
Port Nipple (cm)	30
Dimension (m)	0.57
Stack C.S.A (m ²)	0.255
Tape Measure	A/S383
Timer	A/L148
Barometer No.	A/S542

Field Performance Criteria	Acceptable
Pitch <±10°	N/A
Swirl <±15°	Yes
Stack Internal Area	Yes
Field Repeatability	N/A
Blockage Check	Yes
Average Stack Temp °C	138

% O ₂	% CO ₂	% CO
3.1	13.7	0.0

Traverse Line 1

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch
1	5.0	4.4	0.12	137	6	N/A
2	14.3	4.3	0.11	137	8	N/A
3	42.8	3.7	0.08	138	9	N/A
4	52.0	3.4	0.07	138	8	N/A

Traverse Line 2

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Traverse Line 3

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Traverse Line 4

Traverse Number	Distance (cm)	Average Velocity m/s	Pressure hPa	Average Stack Temp (°C)	Degree Angle of Swirl	Degree Angle of Pitch

Number of Sample Points
4

Flow Characteristics Meet Requirements of EN ISO 16911?
Yes

APPENDIX 4

(Uncertainty)

(6 Pages)



Uncertainty Budget for Oxygen

Document Reference ANC417 K	Issue No: 10	Page 1 of 1
-----------------------------	--------------	-------------

Client	Dairy Partners	Date	20/12/2021
Emission Point ID	Boiler 1	Sample Number	100664/1

Measured oxygen concentration (% Vol)	8.10	Calibration Value (% Vol)	5.99
ELV	N/A	Scale used (% Vol)	10.00

<u>Performance Characteristic</u>		<u>Specification</u>	<u>Uncertainty</u>	<u>% Vol</u>
Response Time (seconds)	25	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	121			
Number of Readings in Measurements	484			
Standard dev Repeat @ Zero	0.05	≤±0.2% Range	u_{r0}	N/A
Standard dev Repeat @ Span	0.03	≤±0.4% Range	u_{rs}	0.00
Deviation from Linearity (±)	0.02	≤±0.3% Range	u_{fit}	0.01
Zero Drift (During Measurement)	0.33	% vol at zero level	u_{odr}	0.19
Span Drift (During Measurement)	0.00	% vol at span level		
Losses in the Line (Leak)	0.17	<2% of value	u_{leak}	0.01
Sensitivity to Atmospheric Pressure	0.19	<1.5% of the certification range	u_{apres}	0.00
Sensitivity to Sample Gas Flow	0.1	<1.0% of the certification range	u_{spres}	0.00
Sensitivity to Ambient Temp @ Span	0.11	<0.30% of the certification range	u_{temp}	0.00
Sensitivity to Ambient Temp @ Zero	-0.21	<0.30% of the certification range		0.00
Sensitivity to Electric Voltage	0.02	<0.10% of the certification range	u_{volt}	0.00
Cross Sensitivity (Interferents)	0.00	<2% of the certification range	u_{int}	0.00
Uncertainty of calibration gas	0.4	<2% of value	u_{calib}	0.02
<u>Measurement Uncertainty</u>				
Combined Uncertainty (% vol)	0.19			
% of Value	2.40			
Coverage Factor k	2			
Expanded uncertainty (% of value)	4.80			
Expanded uncertainty (% Vol)	0.39			
Requirement for SRM is that uncertainty should be < ±6% of value, on a dry gas basis (absolute value of approx. 0.5%)				

Uncertainty Budget for Oxides of nitrogen

Document Reference ANC417 Q	Issue No: 10	Page 1 of 1
-----------------------------	--------------	-------------

Client	Dairy Partners	Date	20/12/2021
Emission Point ID	Boiler 1	Sample Number	100664/1

Measured NOx concentration (mg/m³)	126.48	Calibration Value (mg/m³)	313.24
ELV	N/A	Scale used (mg/m³)	512.50

Performance Characteristic		Specification	Uncertainty	
Response Time (seconds)	33	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	121			
Number of Readings in Measurements	484			
Standard dev Repeat @ Zero	0.04	≤±1.0% Range	u _{r0}	N/A
Standard dev Repeat @ Span	0.08	≤±2.0% Range	u _{rs}	0.00
Deviation from Linearity (±)	0.02	≤±2.0% Range	u _{fit}	0.06
Zero Drift (During Measurement)	0.00	% full scale	u _{odr}	0.76
Span Drift (During Measurement)	3.28	% full scale		
Losses in the Line (Leak)	0.13	<2% of value	u _{leak}	0.10
Sensitivity to Atmospheric Pressure	0.1	<1.5% of the certification range	u _{apres}	0.00
Sensitivity to Sample Gas Flow	0.1	<1.0% of the certification range	u _{spres}	0.00
Sensitivity to Ambient Temp @ Span	1.53	<3.0% of the certification range	u _{temp}	0.00
Sensitivity to Ambient Temp @ Zero	0.04	<3.0% of the certification range		0.00
Sensitivity to Electric Voltage	-0.23	<2.0% of the certification range	u _{volt}	0.00
Cross Sensitivity (Interferents)	0.00	<4% of the certification range	u _{int}	0.00
Uncertainty of calibration gas	1	<2% of value	u _{calib}	0.73
Uncertainty in Factor	0.00		u _f	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m ³)	1.06			
Coverage Factor k	2			
Expanded uncertainty (mg/m ³)	2.13			
Expanded uncertainty to std conditions (mg/m ³)	2.97			
Expanded Uncertainty (% ELV)	N/A			
Expanded uncertainty (mg/m³)	2.97			
Expanded uncertainty (% Value)	2.35			
Requirement in standard is for uncertainty to be < ±10% at ELV at standard conditions				

ISO 16911 L-Type Pitot Uncertainty

Document Reference: -	ANC365	Issue No: 5	Page 1 of 1
-----------------------	--------	-------------	-------------

Client	Dairy Partners
Site	Aberarad
Emission Point	Boiler 2
Date	20/12/2021
Sample Number	100664/1

Uncertainty	Estimated Value %	Measured Value %	sqr est	sqr meas
Equipment Sources				
Master System Velocity Measurements		1	0	1
Master System Air Density Measurement		0.15	0	0.0225
Tape Measure		2	0	4
Testo			0	0
Thermocouples		1	0	1
Sensitivity to Atmospheric Pressure	2		4	0
Sensitivity to Ambient Temperature	2		4	0
Site Sources				
Stack Internal Area		3.07631E-06	0	9.4637E-12
Uncertainty in Flow Measurement Device Calibration	1		1	0
Uncertainty in Differential Pressure Device Calibration	1		1	0
Time	0		0	0
L-Type Blockage Test		0.00%	0	0
Repeatability at single point			0	0
Swirl/Pitch Meter Position	2		4	0
Temperature on site			0	0
Pressure on Site			0	0
Humidity on Site	0		0	0
Laboratory Sources				
Uncertainty due to Caibration	2		4	0
Repeatability (hPa)		0.97	0	0.9409
Repeatability (m/s)		0.26		
Linearity	2		4	0
Measurement of Duct Diameter		0.67	0	0.4489
Effect of Swirl Angle (Clockwise)		1.2	0	1.44
Effect of Swirl Angle (Anti-clockwise)		0.88	0	0.7744
Sum of squares			31.6267	
		Total Uncertainty	5.6	

Uncertainty Budget for Oxides of nitrogen

Document Reference ANC417 I	Issue No: 10	Page 1 of 1
-----------------------------	--------------	-------------

Client	Dairy Partners	Date	14/12/2021
Emission Point ID	Boiler 2	Sample Number	100664/2

Measured NOx concentration (mg/m³)	175.69	Calibration Value (mg/m³)	313.24
ELV	N/A	Scale used (mg/m³)	512.50

Performance Characteristic		Specification	Uncertainty	
Response Time (seconds)	33	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	60			
Number of Readings in Measurements	240			
Standard dev Repeat @ Zero	0.04	≤±1.0% Range	u _{r0}	N/A
Standard dev Repeat @ Span	0.08	≤±2.0% Range	u _{rs}	0.01
Deviation from Linearity (±)	0.02	≤±2.0% Range	u _{fit}	0.06
Zero Drift (During Measurement)	0.07	% full scale	u _{odr}	0.19
Span Drift (During Measurement)	0.46	% full scale		
Losses in the Line (Leak)	0.00	<2% of value	u _{leak}	0.00
Sensitivity to Atmospheric Pressure	0.1	<1.5% of the certification range	u _{apres}	0.00
Sensitivity to Sample Gas Flow	0.1	<1.0% of the certification range	u _{spres}	0.00
Sensitivity to Ambient Temp @ Span	1.53	<3.0% of the certification range	u _{temp}	0.00
Sensitivity to Ambient Temp @ Zero	0.04	<3.0% of the certification range		0.00
Sensitivity to Electric Voltage	-0.23	<2.0% of the certification range	u _{volt}	0.00
Cross Sensitivity (Interferents)	0.00	<4% of the certification range	u _{int}	0.00
Uncertainty of calibration gas	1	<2% of value	u _{calib}	1.01
Uncertainty in Factor	0.00		u _f	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m ³)	1.03			
Coverage Factor k	2			
Expanded uncertainty (mg/m ³)	2.07			
Expanded uncertainty to std conditions (mg/m ³)	2.08			
Expanded Uncertainty (% ELV)	N/A			
Expanded uncertainty (mg/m³)	2.08			
Expanded uncertainty (% Value)	1.19			
Requirement in standard is for uncertainty to be < ±10% at ELV at standard conditions				

Uncertainty Budget for Oxygen

Document Reference ANC417 K	Issue No: 10	Page 1 of 1
-----------------------------	--------------	-------------

Client	Dairy Partners	Date	14/12/2021
Emission Point ID	Boiler 2	Sample Number	100664/2

Measured oxygen concentration (% Vol)	3.14	Calibration Value (% Vol)	5.99
ELV	N/A	Scale used (% Vol)	10.00

Performance Characteristic		Specification	Uncertainty	% Vol
Response Time (seconds)	25	<200s		
Logger Sampling Interval (seconds)	15			
Measurement Period (minutes)	60			
Number of Readings in Measurements	240			
Standard dev Repeat @ Zero	0.05	≤±0.2% Range	u _{r0}	N/A
Standard dev Repeat @ Span	0.03	≤±0.4% Range	u _{rs}	0.00
Deviation from Linearity (±)	0.02	≤±0.3% Range	u _{fit}	0.01
Zero Drift (During Measurement)	0.33	% vol at zero level	u _{odr}	0.24
Span Drift (During Measurement)	0.17	% vol at span level		
Losses in the Line (Leak)	0.17	<2% of value	u _{leak}	0.00
Sensitivity to Atmospheric Pressure	0.19	<1.5% of the certification range	u _{apres}	0.00
Sensitivity to Sample Gas Flow	0.1	<1.0% of the certification range	u _{spres}	0.00
Sensitivity to Ambient Temp @ Span	0.11	<0.30% of the certification range	u _{temp}	0.00
Sensitivity to Ambient Temp @ Zero	-0.21	<0.30% of the certification range		0.00
Sensitivity to Electric Voltage	0.02	<0.10% of the certification range	u _{volt}	0.00
Cross Sensitivity (Interferents)	0.00	<2% of the certification range	u _{int}	0.00
Uncertainty of calibration gas	0.4	<2% of value	u _{calib}	0.01
Measurement Uncertainty				
Combined Uncertainty (% vol)	0.24			
% of Value	7.77			
Coverage Factor k	2			
Expanded uncertainty (% of value)	15.54			
Expanded uncertainty (% Vol)	0.49			
Requirement for SRM is that uncertainty should be < ±6% of value, on a dry gas basis (absolute value of approx. 0.5%)				

ISO 16911 L-Type Pitot Uncertainty

Document Reference: -	ANC365	Issue No: 5	Page 1 of 1
-----------------------	--------	-------------	-------------

Client	Dairy Partners
Site	Aberarad
Emission Point	Aberarad
Date	14/12/2021
Sample Number	100664/2

Uncertainty	Estimated Value %	Measured Value %	sqr est	sqr meas
Equipment Sources				
Master System Velocity Measurements		1	0	1
Master System Air Density Measurement		0.15	0	0.0225
Tape Measure		2	0	4
Testo			0	0
Thermocouples		1	0	1
Sensitivity to Atmospheric Pressure	2		4	0
Sensitivity to Ambient Temperature	2		4	0
Site Sources				
Stack Internal Area		3.07631E-06	0	9.4637E-12
Uncertainty in Flow Measurement Device Calibration	1		1	0
Uncertainty in Differential Pressure Device Calibration	1		1	0
Time	0		0	0
L-Type Blockage Test		0.00%	0	0
Repeatability at single point			0	0
Swirl/Pitch Meter Position	2		4	0
Temperature on site			0	0
Pressure on Site			0	0
Humidity on Site	0		0	0
Laboratory Sources				
Uncertainty due to Caibration	2		4	0
Repeatability (hPa)		0.97	0	0.9409
Repeatability (m/s)		0.26		
Linearity	2		4	0
Measurement of Duct Diameter		0.67	0	0.4489
Effect of Swirl Angle (Clockwise)		1.2	0	1.44
Effect of Swirl Angle (Anti-clockwise)		0.88	0	0.7744
Sum of squares			31.6267	
		Total Uncertainty	5.6	

APPENDIX 5

(Instrumental analyser details)

(2 Pages)



Principle of Gas Conditioning

The sampling for oxygen and oxides of Nitrogen was carried out using a Horiba PG-350 combustion gas analyser fed via a heated sampling system comprising of a sampling probe, 15m sampling line and a PD100 permeation dryer gas conditioning system.

The sample gas enters a heated filter (approx. 100°C), separating all particles larger than 2µm. After filtration the sample gas proceeds to the permeation dryer, equipped with a temperature gradient. The installed permeation dryer is operated with dry purge gas, running in inverted direction flow. Due to the difference in partial pressure between sample and purge gas, humidity is driven out of the sample by equalization. The water is extracted from the sample gas through a semi permeable membrane and transported into an outer tube filled with the purge gas. This process does not have a distinguishable effect on the sample gas composition. The conditioned gas is then passed to the gas analyser for quantification.

Oxides of nitrogen are analysed using a standard technique called Chemiluminescence and during the sampling was set to cover the range 0-250 ppm.



Test Report ALL100664/21/PR-1

Performance Characteristic	Minimum performance characteristic			
	NO _x	CO	O ₂	SO ₂
Response Time (Required)	≤200 s	≤200 s	≤200 s	≤200 s
Results	<50	<50	<40	<60
Detection Limit	≤± 2% Range	≤± 2% Range	≤± 0.2% relative of Range	≤± 2%
Results	<0.1	<0.2	<0.05	<0.15
Lack of Fit (Linearity)	≤± 2% Range	≤± 2% Range	≤± 0.3% volume	≤± 2%
Results	<2 (R ² >0.9996)	<2 (R ² >0.9996)	<2 (R ² >0.9999)	<2 (R ² >0.9996)
Zero Drift	≤± 2% Range/24 hours	≤± 2% Range/24 hours	≤± 0.2% Volume/24 hours	≤± 2%/24 hours
Results	0.03%	0.35%	0.03%	0.14%
Span Drift	≤± 2% Range/24 hours	≤± 2% Range/24 hours	≤± 0.2% Volume/24 hours	≤± 2%/24 hours
Results	0.72%	0.21%	0.03%	0.89%
Sensitivity to Atmos Pressure	≤± 3% Range/2 kPa	≤± 3% Range/2 kPa	≤± 3% of Range for 2 kPa	≤± 3%/2 kPa
Results	≤± 3% Range/2 kPa	≤± 3% Range/2 kPa	≤± 3% of Range for 2 kPa	≤± 3%/2 kPa
Sensitivity to Sample Volume/pressure	-	-	-	≤± 1%
Results	-	-	-	≤± 1%
Sensitivity to ambient temperature	≤± 3% Range/10 K	≤± 3% Range/10 K	≤± 0.3% Volume/10 K	≤± 3% Range/10 K
Results	≤± 3% Range/10 K	≤± 3% Range/10 K	≤± 0.3% Volume/10 K	≤± 3% Range/10 K
Sensitivity to Electric Voltage	≤± 2% Range/10 V	≤± 2% Range/10 V	≤± 0.1% Volume/10 V	≤± 2% Range/10 V
Results	≤± 2% Range/10 V	≤± 2% Range/10 V	≤± 0.1% Volume/10 V	≤± 2% Range/10 V
Interferents	Total ≤± 4% Range	Total ≤± 4% Range	Total ≤± 0.2% Volume	Total ≤± 4%
Results	-0.52%	-0.87%	0%	-1.82%
Converter Efficiency	≥95.0%			
Results	96.30%			
Losses & Leakage in Sampling Line and Conditioning System	≤± 2% of measured value	≤± 2% of measured value	≤± 2.0% relative of the measured value	≤± 5%
Results	<2%	<2%	<2%	<5%
Std Deviation of repeatability in Lab at zero	≤± 1% Range	≤± 1% Range	≤± 0.20% relative of the range	≤± 1%
Results	0.04%	0.16%	0.05%	0.09%
Std Deviation of repeatability in Lab at span level	≤± 2% Range	≤± 2% Range	≤± 0.40% relative of the range	≤± 2%
Results	0.08%	0.35%	0.03%	0.12%



APPENDIX 6

(Calibration details retained at permanent laboratory)

