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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:	ALL95689/20/PR-1
Monitoring Dates:	27/02/2020
Client / Organisation:	Mr Simon Matthews
Address:	The Creamery
	Aberarad
	Newcastle Emlyn
	Carmarthenshire
	SA38 9DQ
Date of Report:	28/02/2020
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:	
Reviewed:	

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Part 1 Executive summary

Part 2 – Supporting information

Monitoring objectives

At the request of Mr Simon Matthews 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 2020 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	95689/1	Oxides of nitrogen	1-hour sampling
		Oxygen	
Boiler 2 Exhaust RHS	95689/2	Oxides of nitrogen	1-hour sampling
		Oxygen	

Monitoring results

Emission Point	Boiler 1 Exhaust LHS	
Sample Number	95689/1	
Substance to be Monitored	Oxides of Nitrogen	Oxygen
Emission Limit Value	N/A	N/A
Periodic Monitoring Result	162.9	11.0
Uncertainty	±4.6	±0.1
Units	mg/Nm^3	% Vol
Reference Conditions	273K, 101.3kPa, 3% oxygen & dry gas	
Date of Sampling	27/02/2020	
Start/End Time	12:30 – 13:30	
Average Volumetric flow @ reference conditions / m^3/hr	1642.9	
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	95689/2	
Substance to be Monitored	Oxides of Nitrogen	Oxygen
Emission Limit Value	N/A	N/A
Periodic Monitoring Result	174.2	4.0
Uncertainty	±2.6	±0.3
Units	mg/Nm^3	% Vol
Reference Conditions	273K, 101.3kPa, 3% oxygen & dry gas	
Date of Sampling	27/02/2020	
Start/End Time	14:00 – 15:00	
Average Volumetric flow @ reference conditions / m^3/hr	3954.1	
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. 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
R Lethbridge	Team Leader	MM 05 575	Level 2	TE1, TE2, TE3, TE4
E Jones	Emissions Analyst	MM 17 1417	Level 1	TE1, TE2, TE4

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

(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	95689/1
Date	27/02/2020
Customer name	Dairy Partners
Site location	Newcastle Emlyn
Emission point	Boiler 1
Emission point dimension (m)	0.57m
Emission point C.S.A. (m^2)	0.2552
Team leader	Robert Lethbridge
Analyst(s)	Elliot Jones
Average Ambient pressure (mb)	1004
Average Ambient temperature (°C)	10
Instrument number	A/S545 (PG-350)
Probe length (m)	1.0m
Timer	A/S323
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	12:30:00
Test end time	13:30:00
Volumetric flow @ reference conditions (m^3/hour)	1642.9

Reference conditions

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

Oxides of Nitrogen (as NO_2)

Average concentration NOx (mg/m^3)	162.9
Maximum concentration NOx (mg/m^3)	304.4
Minimum concentration NOx (mg/m^3)	0.6
Mass Emission NOx (Kg/hour)	0.27
% Uncertainty of measurement	2.8
Uncertainty Concentration mg/m^3	4.6

Oxygen

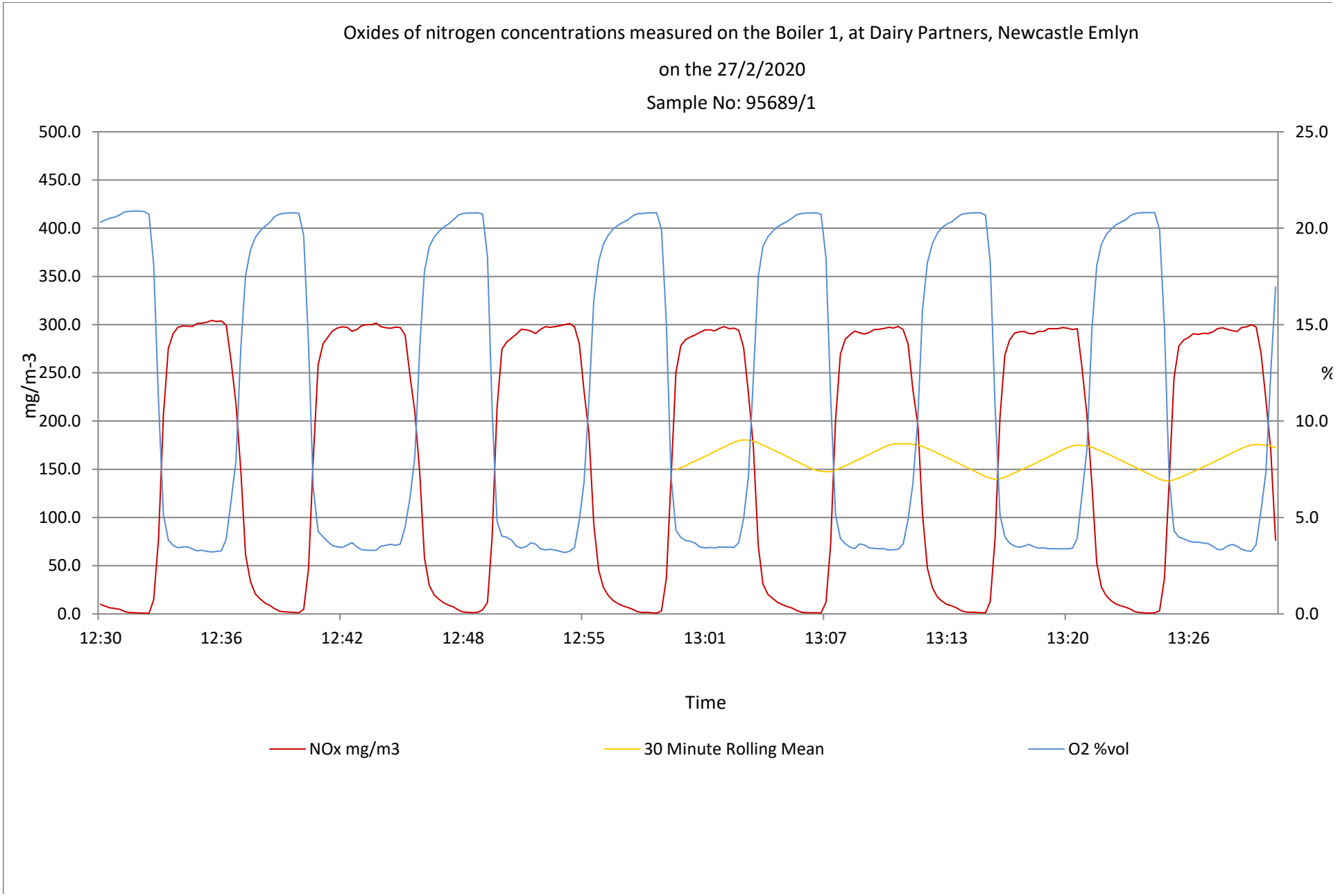
Average concentration O_2 (% vol)	11.0
Maximum concentration O_2 (% vol)	20.9
Minimum concentration O_2 (% Vol)	3.2
% Uncertainty of measurement	1.2
Uncertainty Concentration % vol	0.1

Oxides of nitrogen concentrations measured on the Boiler 1, at Dairy Partners, Newcastle Emlyn

on the 27/2/2020

Sample No: 95689/1

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			**0.6**	**137.7**			**3.2**
Maximum			**304.4**	**180.5**			**20.9**
Average			**162.9**	**160.9**			**11.0**


Oxides of nitrogen concentrations measured on the Boiler 1, at Dairy Partners, Newcastle Emlyn
on the 27/2/2020
Sample No: 95689/1
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
mg/m-3
25.0
20.0
15.0
10.0
5.0
0.0
%
12:30
12:36
12:42
12:48
12:55
13:01
13:07
13:13
13:20
13:26
Time
NOx mg/m3
30 Minute Rolling Mean
O2 %vol

Combustion Gas Site Data

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Customer	Dairy Partners
Emission Point	Boiler 1
Date	27/02/2020
Sample No	95689/1

Pre test				
ANALYTE	**CO**	**NO**	**SO_2**	**O_2**
Zero through analyszer (ppm)		0		0
Span Through analyser (ppm)		150.1		6.0
Zero through analyszer (ppm)		0.0		0.00
Zero Through line (ppm)		0.00		0.04
Span Through line (ppm)		150.2		6.1
Residence Time (seconds)		45.0		45.0
System T90 (seconds)		55		55
T90 Value (ppm)		135.1		5.4
Initial leak test		0.1		0.8
Post test				
ANALYTE	**CO**	**NO**	**SO_2**	**O_2**
Zero Through Line		0.20		0.04
Span Through line (ppm)		152.67		6.06
Span Drift (%)		1.6		0.0
Zero Drift (%)		0.1		0.0

Oxygen cylinder grade/reference	6.01% 296945
Nitrogen Monoxide cylinder grade/reference	150.1 PPM VC6533A
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		**2.70**		**20.32**
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

EN ISO 16911 S-Type Pitot Summary Page

Customer	Dairy Partners
Site	Newcastle Emlyn
Emission Point	Boiler 1
Date Measured	27-Feb-20
Sample Number	95689/1
X-Sectional Area	0.255
DH@	N/A
DY_d	N/A
Average sqrt DP (mmH_2O)	1.524
Average % Oxygen	11.0
Average % Carbon Dioxide	5.3
Average % Carbon Monoxide	0.0
Average % Nitrogen	83.7
Barometric Pressure (mb)	1005
Duct Static Pressure (mmH2O)	3.40
Absolute Stack Gas Pressure (KPa)	100.5
Average Stack Gas Temperature (K)	490
Actual moisture determined pre-test (%)	9.00
Velocity in Stack (m/s)	6.4
Volumetric Flow at Stack Conditions (m^3/sec)	1.64
Volumetric flow rate at reference conditions (m^3/sec)	0.46
Volumetric flow rate at reference conditions (m^3/hour)	1642.86
% Uncertainty of Measurement	5.3

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Client	Dairy Partners
Site	Newcastle Emlyn
Emission Point	Boiler 1
Date	27/02/2020
Sample Number	95689/1
Probe Operator	EJ
Console Operator	RL

DGM Inlet (°C)	N/A
DGM Outlet (°C)	N/A
Mean Temp (°C)	N/A
Bar Pressure (mb)	1005
Moisture (%)	9.00
Dimension (m)	0.57
Stack C.S.A (m^2)	0.2552

Gas Flow	Out
Port Nipple (cm)	30
Console No.	N/A
Pitot No.	A/S 143
Tape Measure	A/S223
Timer	A/S323
Barometer No.	A/S542

Traverse Line 1

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch
1	5.0	1.1	1.068	216	8	N/A
2	6.0	1.3	1.155	216	10	N/A
3	11.0	3.6	1.906	216	12	N/A
4	18.4	3.5	1.880	220	9	N/A
5	38.6	3.1	1.756	221	10	N/A
6	46.0	3.4	1.844	216	13	N/A
7	51.0	1.4	1.169	216	8	N/A
8	52.0	1.1	1.049	216	10	N/A

Traverse Line 2

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch

% O_2	11
% CO_2	5.34
% CO	0

Traverse Line 3

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch

Traverse Line 4

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch

Average DP (mmH_2O)	2.3
Average sqrt DP	1.524
Average Stack Temp (°C)	217

Field Performance Criteria	OK?
Pitch <±10°	N/A
Swirl <±15°	Yes
Stack internal Area	Yes
Field Repeatability	N/A
Static Pressure Check	Yes

Number of Sample Points
8

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	95689/2
Date	27/02/2020
Customer name	Dairy Partners
Site location	Newcastle Emlyn
Emission point	Boiler 2
Emission point dimension (m)	0.57m
Emission point C.S.A. (m^2)	0.2552
Team leader	Robert Lethbridge
Analyst(s)	Elliot Jones
Average Ambient pressure (mb)	1004
Average Ambient temperature (°C)	10
Instrument number	A/S545 (PG-350)
Probe length (m)	1.0m
Timer	A/S323
Homogeneity test previously conducted? (Yes/No)	No
Is the gas stream homogeneous? (Yes/No/Unknown)	Unknown
Test start time	14:00:00
Test end time	15:00:00
Volumetric flow @ reference conditions (m^3/hour)	3954.1

Reference conditions

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

Oxides of Nitrogen (as NO_2)

Average concentration NOx (mg/m^3)	174.2
Maximum concentration NOx (mg/m^3)	215.0
Minimum concentration NOx (mg/m^3)	150.4
Mass Emission NOx (Kg/hour)	0.69
% Uncertainty of measurement	1.5
Uncertainty Concentration mg/m^3	2.6

Oxygen

Average concentration O_2 (% vol)	4.0
Maximum concentration O_2 (% vol)	4.5
Minimum concentration O_2 (% Vol)	2.7
% Uncertainty of measurement	8.0
Uncertainty Concentration % vol	0.3

Oxides of nitrogen concentrations measured on the Boiler 2, at Dairy Partners, Newcastle Emlyn

on the 27/2/2020

Sample No: 95689/2

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			**150.4**	**172.1**			**2.7**
Maximum			**215.0**	**175.6**			**4.5**
Average			**174.2**	**174.1**			**4.0**

Combustion Gas Site Data

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Customer	Dairy Partners
Emission Point	Boiler 2
Date	27/02/2020
Sample No	95689/2

Pre test				
ANALYTE	**CO**	**NO**	**SO_2**	**O_2**
Zero through analyszer (ppm)		0		0
Span Through analyser (ppm)		150.1		6.0
Zero through analyszer (ppm)		0.0		0.00
Zero Through line (ppm)		0.00		0.04
Span Through line (ppm)		150.2		6.06
Residence Time (seconds)		30.0		35.0
System T90 (seconds)		49		48
T90 Value (ppm)		135.1		5.4
Initial leak test		0.1		0.8
Post test				
ANALYTE	**CO**	**NO**	**SO_2**	**O_2**
Zero Through Line		0.20		0.05
Span Through line (ppm)		149.90		6.05
Span Drift (%)		0.2		0.2
Zero Drift (%)		0.1		0.2

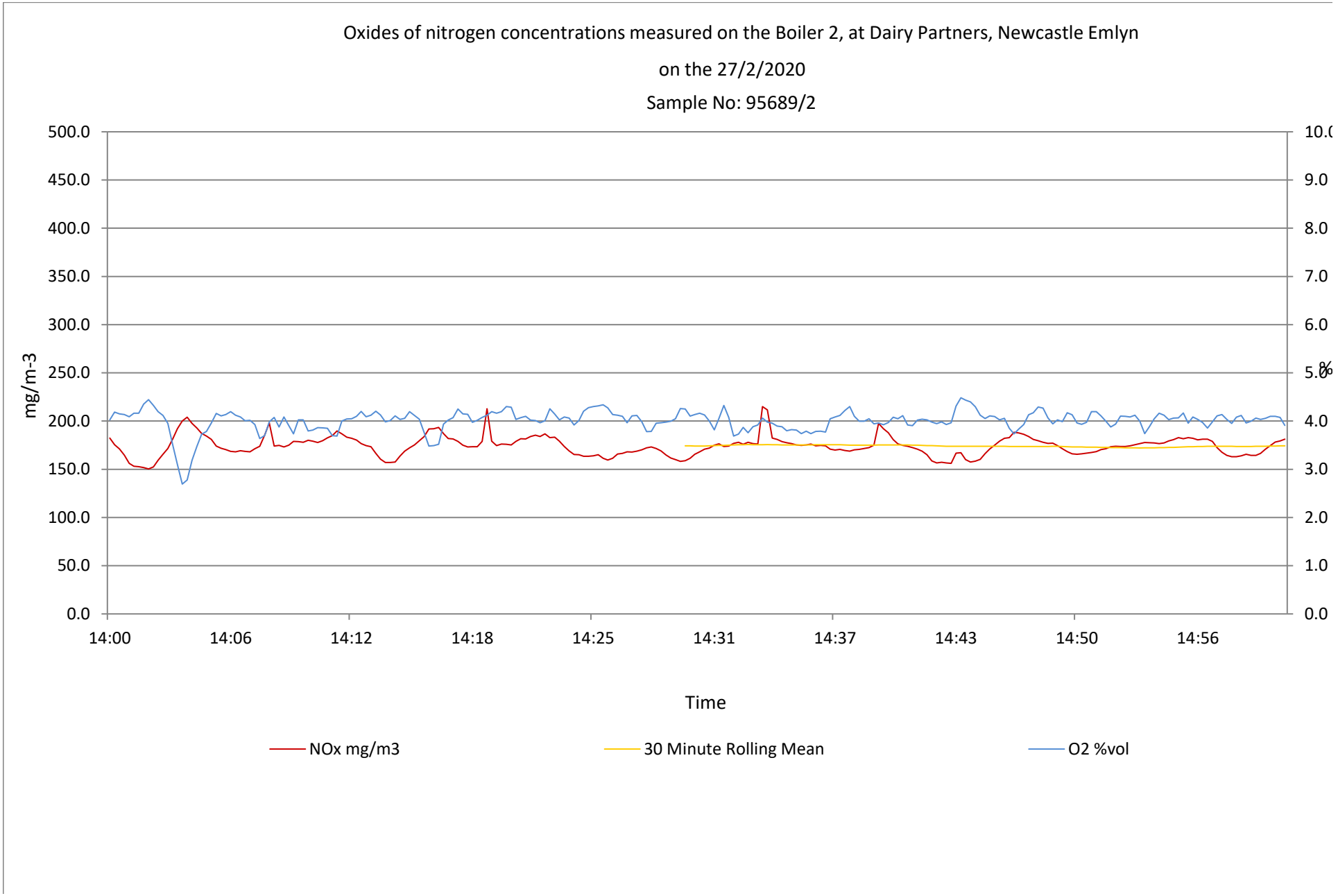
Oxygen cylinder grade/reference	6.01% 296945
Nitrogen Monoxide cylinder grade/reference	150.1 PPM VC6533A
Sulphur Dioxide cylinder grade/reference	N/A
Carbon Monoxide cylinder grade/reference	N/A

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		**83.80**		**4.03**
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				


Oxides of nitrogen concentrations measured on the Boiler 2, at Dairy Partners, Newcastle Emlyn
on the 27/2/2020
Sample No: 95689/2
mg/m-3
%
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
14:00
14:06
14:12
14:18
14:25
14:31
14:37
14:43
14:50
14:56
Time
NOx mg/m3
30 Minute Rolling Mean
O2 %vol

EN ISO 16911 S-Type Pitot Summary Page

Customer	Dairy Partners
Site	Newcastle Emlyn
Emission Point	Boiler 2
Date Measured	27-Feb-20
Sample Number	95689/2
X-Sectional Area	0.255
DH@	N/A
DY_d	N/A
Average sqrt DP (mmH_2O)	1.954
Average % Oxygen	4.0
Average % Carbon Dioxide	9.2
Average % Carbon Monoxide	0.0
Average % Nitrogen	86.8
Barometric Pressure (mb)	1005
Duct Static Pressure (mmH2O)	3.77
Absolute Stack Gas Pressure (KPa)	100.5
Average Stack Gas Temperature (K)	407
Actual moisture determined pre-test (%)	9.00
Velocity in Stack (m/s)	7.5
Volumetric Flow at Stack Conditions (m^3/sec)	1.92
Volumetric flow rate at reference conditions (m^3/sec)	1.10
Volumetric flow rate at reference conditions (m^3/hour)	3951.39
% Uncertainty of Measurement	5.3

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Client	Dairy Partners
Site	Newcastle Emlyn
Emission Point	Boiler 2
Date	27/02/2020
Sample Number	95689/2
Probe Operator	EJ
Console Operator	RL

DGM Inlet (°C)	N/A
DGM Outlet (°C)	N/A
Mean Temp (°C)	N/A
Bar Pressure (mb)	1005
Moisture (%)	9.00
Dimension (m)	0.57
Stack C.S.A (m^2)	0.2552

Gas Flow	Out
Port Nipple (cm)	30
Console No.	N/A
Pitot No.	A/S143
Tape Measure	A/S383
Timer	A/S323
Barometer No.	A/S542

Traverse Line 1

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch
1	5.0	6.2	2.497	133	7	N/A
2	6.0	6.5	2.550	133	9	N/A
3	11.0	3.5	1.871	135	10	N/A
4	18.4	4.5	2.113	137	8	N/A
5	38.6	3.3	1.817	135	9	N/A
6	46.0	2.7	1.643	134	11	N/A
7	51.0	1.9	1.390	130	13	N/A
8	52.0	1.9	1.378	131	13	N/A

Traverse Line 2

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch

% O_2	4
% CO_2	9.23
% CO	0

Traverse Line 3

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch

Traverse Line 4

Traverse Number	Distance (cm)	Av Velocity Head DP (mmH_2O)	$\sqrt{\Delta P}$	Av Stack Temp (°C)	Degree of Swirl	Degree of Pitch

Average DP (mmH_2O)	3.8
Average sqrt DP	1.954
Average Stack Temp (°C)	134

Field Performance Criteria	OK?
Pitch <±10°	N/A
Swirl <±15°	Yes
Stack internal Area	Yes
Field Repeatability	N/A
Static Pressure Check	Yes

Number of Sample Points
8

Flow Characteristics Meet Requirements of EN ISO 16911?
Yes

APPENDIX 4

(Uncertainty)

(6 Pages)

Uncertainty Budget for Oxides of nitrogen

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Client	Dairy Partners	**Date**	27/02/2020
Emission Point ID	Boiler 1	**Sample Number**	95689/1

Measured NOx concentration (mg/m^3)	162.88	**Calibration Value (mg/m^3)**	307.71
ELV	N/A	**Scale used (mg/m^3)**	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	0.03	≤±1.0% Range	u_{r0}	N/A
Standard dev Repeat @ Span	0.06	≤±2.0% Range	u_{rs}	0.00
Deviation from Linearity (±)	0.02	≤±2.0% Range	u_{fit}	0.06
Zero Drift (During Measurement)	0.13	% full scale	u_{0dr}	0.58
Span Drift (During Measurement)	1.64	% full scale		
Losses in the Line (Leak)	0.07	<2% of value	u_{leak}	0.06
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	<2% of value	u_{calib}	1.13
Uncertainty in Factor	0.00		u_f	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m^3)	1.27			
Coverage Factor k	2			
Expanded uncertainty (mg/m^3)	2.54			
Expanded uncertainty to std conditions (mg/m^3)	4.59			
Expanded Uncertainty (% ELV)	**N/A**			
Expanded uncertainty (mg/m^3)	**4.59**			
Expanded uncertainty (% Value)	**2.82**			
Requirement in standard is for uncertainty to be < ±10% at ELV at standard conditions				

Uncertainty Budget for Oxygen

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Client	Dairy Partners	**Date**	27/02/2020
Emission Point ID	Boiler 1	**Sample Number**	95689/1

Measured oxygen concentration (% Vol)	10.98	**Calibration Value (% Vol)**	6.01
ELV	N/A	**Scale used (% Vol)**	25.00

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	0.11	≤±0.2% Range	u_{r0}	N/A
Standard dev Repeat @ Span	0.08	≤±0.4% Range	u_{rs}	0.01
Deviation from Linearity (±)	0.02	≤±0.3% Range	u_{fit}	0.01
Zero Drift (During Measurement)	0.05	% vol at zero level	u_{0dr}	0.03
Span Drift (During Measurement)	0.00	% vol at span level		
Losses in the Line (Leak)	0.83	<2% of value	u_{leak}	0.05
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}	0.03
Measurement Uncertainty				
Combined Uncertainty (% vol)	0.07			
% of Value	0.60			
Coverage Factor k	2			
Expanded uncertainty (% of value)	**1.21**			
Expanded uncertainty (% Vol)	**0.13**			
Requirement for SRM is that uncertainty should be < ±6% of value, on a dry gas basis (absolute value of approx. 0.5%)				

ISO 16911 S-Type Pitot Uncertainty

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Client	Dairy Partners
Site	Newcastle Emlyn
Emission Point	Boiler 1
Date	27/02/2020
Sample Number	95689/1

Uncertainty	Estimated Value %	Measued 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
Dual Incline Manometer		0.05		0	0.0025
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
S-Type Reference/Stagnation Check		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)		0.66		0	0.4356
Repeatability (m/s)		0.14			
Linearity		0.15		0	0.0225
Measurement of Duct Diameter		0.67		0	0.4489
Effect of Swirl Angle (Clockwise)		0.16		0	0.0256
Effect of Swirl Angle (Anti-clockwise)		1.82		0	3.3124
Sum of squares				28.27	
		Total Uncertainty		**5.3**	

Uncertainty Budget for Oxides of nitrogen

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

Client	Dairy Partners	**Date**	27/02/2020
Emission Point ID	Boiler 2	**Sample Number**	95689/2

Measured NOx concentration (mg/m^3)	174.24	**Calibration Value (mg/m^3)**	307.71
ELV	N/A	**Scale used (mg/m^3)**	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	0.03	≤±1.0% Range	u_{r0}	N/A
Standard dev Repeat @ Span	0.06	≤±2.0% Range	u_{rs}	0.00
Deviation from Linearity (±)	0.02	≤±2.0% Range	u_{fit}	0.06
Zero Drift (During Measurement)	0.13	% full scale	u_{0dr}	0.14
Span Drift (During Measurement)	0.20	% full scale		
Losses in the Line (Leak)	0.07	<2% of value	u_{leak}	0.07
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	<2% of value	u_{calib}	1.21
Uncertainty in Factor	0.00		u_f	0.00
Measurement Uncertainty				
Combined Uncertainty (mg/m^3)	1.22			
Coverage Factor k	2			
Expanded uncertainty (mg/m^3)	2.44			
Expanded uncertainty to std conditions (mg/m^3)	2.58			
Expanded Uncertainty (% ELV)	**N/A**			
Expanded uncertainty (mg/m^3)	**2.58**			
Expanded uncertainty (% Value)	**1.48**			
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**	27/02/2020
Emission Point ID	Boiler 2	**Sample Number**	95689/2

Measured oxygen concentration (% Vol)	4.01	**Calibration Value (% Vol)**	6.01
ELV	N/A	**Scale used (% Vol)**	25.00

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	0.11	≤±0.2% Range	u_{r0}	N/A
Standard dev Repeat @ Span	0.08	≤±0.4% Range	u_{rs}	0.01
Deviation from Linearity (±)	0.02	≤±0.3% Range	u_{fit}	0.01
Zero Drift (During Measurement)	0.17	% vol at zero level	u_{0dr}	0.16
Span Drift (During Measurement)	0.17	% vol at span level		
Losses in the Line (Leak)	0.83	<2% of value	u_{leak}	0.02
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)	0.16			
% of Value	4.01			
Coverage Factor k	2			
Expanded uncertainty (% of value)	**8.02**			
Expanded uncertainty (% Vol)	**0.32**			
Requirement for SRM is that uncertainty should be < ±6% of value, on a dry gas basis (absolute value of approx. 0.5%)				

ISO 16911 S-Type Pitot Uncertainty

Document Reference: -	ANC364	Issue No: 4	Page 1 of 1

Client	Dairy Partners
Site	Newcastle Emlyn
Emission Point	Boiler 2
Date	27/02/2020
Sample Number	95689/2

Uncertainty	Estimated Value %	Measued 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
Dual Incline Manometer		0.05		0	0.0025
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
S-Type Reference/Stagnation Check		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)		0.66		0	0.4356
Repeatability (m/s)		0.14			
Linearity		0.15		0	0.0225
Measurement of Duct Diameter		0.67		0	0.4489
Effect of Swirl Angle (Clockwise)		0.16		0	0.0256
Effect of Swirl Angle (Anti-clockwise)		1.82		0	3.3124
Sum of squares				28.27	
		Total Uncertainty		**5.3**	

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.

Performance Characteristic	Minimum performance characteristic			
	NOx	**CO**	**O_2**	**SO_2**
Response Time (Required)	≤200 s	≤200 s	≤200 s	≤200 s
Results	<40	<40	<30	<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 >0.9999)	<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	0.02%	0.08%	0.04%	0.10%
Span Drift	≤± 2% Range/24 hours	≤± 2% Range24 hours	≤± 0.2% Volume/24 hours	≤± 2%/24 hours
Results	0.15%	0.13%	0.01%	0.03%
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	99.74%			
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	0.02%	0.14%	0.02%	0.05%
Std Deviation of repeatability in Lab at span level	≤± 2% Range	≤± 2% Range	≤± 0.40% relative of the range	≤± 2%
Results	0.22%	0.13%	0.05%	0.25%

APPENDIX 6

(Calibration details retained at permanent laboratory**)**