STACK EMISSIONS MONITORING REPORT

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Operator & Address:
Eni Liverpool Bay Operting Company Ltd Point Of Ayr Terminal Station Road Holywell Clwyd CH8 9RD

Permit:
EPR Permit: ZP3331LM

Release Point:
Thermal Oxidiser

Sampling Date(s):
19th May 2014

ESG Job Number:	LNO 11828
Report Date:	20th May 2014
Version:	1
Report By:	Keith Bird
MCERTS Number:	MM 07 825
MCERTS Level:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Report Approved By:	Dave Armitage
MCERTS Number:	MM 04 516
Business Title:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Signature:	

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EXECUTIVE SUMMARY

MONITORING OBJECTIVES

Eni Liverpool Bay Operting Company Ltd operates a gas enrichment process at Point Of Ayr Terminal which is subject to EPR Permit ZP3331LM, under the Environmental Permitting Regulations 2010.

Environmental Scientifics Group Limited were commissioned by Eni Liverpool Bay Operting Company Ltd to carry out stack emissions monitoring to determine the release of prescribed pollutants from the following Plant under normal operating conditions.

The results of these tests shall be used to demonstrate compliance with a set of emission limit values for prescribed pollutants as specified in the Plant's EPR Permit, ZP3331LM.

Plant

Thermal Oxidiser

Operator

Eni Liverpool Bay Operting Company Ltd
Point Of Ayr Terminal
Station Road
Holywell
Clwyd
CH8 9RD

EPR Permit: ZP3331LM

Stack Emissions Monitoring Test House

Environmental Scientifics Group Limited - Stockport Laboratory
Unit 5 Crown Industrial Estate
Kenwood Road
Stockport
SK5 6PH
UKAS and MCERTS Accreditation Number: 1015

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.
MCERTS accredited results will only be claimed where both the sampling and analytical stages are UKAS accredited.

EXECUTIVE SUMMARY

EMISSIONS SUMMARY					
Parameter	Units	Result	Calculated Uncertainty +/-	Limit	MCERTS accredited result
Oxides of Nitrogen (as NO_2)	mg/m³	40	3.5	120	✓
Oxides of Nitrogen (as NO_2) Emission Rate	g/hr	-	-	-	
Sulphur Dioxide	mg/m³	0.91	4.7	190	✓
Sulphur Dioxide Emission Rate	g/hr	-	-	-	
Carbon Monoxide	mg/m³	15	2.1	-	✓
Carbon Monoxide Emission Rate	g/hr	-	-	-	
Carbon Dioxide	% v/v	7.3	0.30	-	✓
Oxygen	% v/v	9.9	0.32	-	✓

ND = None Detected,
Results at or below the limit of detection are highlighted by bold italic text.
The above volumetric flow rate is calculated using data from the preliminary survey. Mass emissions for non isokinetic tests are calculated using these values. For all isokinetic testing the mass emission is calculated using test specific flow data and not the above values.
Reference conditions are 273K, 101.3kPa, dry gas .

EXECUTIVE SUMMARY

MONITORING TIMES			
Parameter	**Sampling Date(s)**	**Sampling Times**	**Sampling Duration**
Combustion Gases	19 May 2014	13:15 - 14:15	60 minutes

EXECUTIVE SUMMARY

PROCESS DETAILS	
Parameter	**Process Details**
Description of process	Gas enrichment
Continuous or batch	Continuous
Product Details	-
Part of batch to be monitored (if applicable)	Stable Conditions
Normal load, throughput or continuous rating	Normal load
Fuel used during monitoring	Natural Gas
Abatement	None
Plume Appearance	None Visible

EXECUTIVE SUMMARY

Monitoring Methods

The selection of standard reference / alternative methods employed by Environmental Scientifics Group Limited is determined, wherever possible by the hierarchy of method selection outlined in Environment Agency Technical Guidance Note (Monitoring) M2. i.e. CEN, ISO, BS, US EPA etc.

MONITORING METHODS						
Species	Method Standard Reference Method / Alternative Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	Calculated MU +/- %
NO_X	SRM - BS EN 14792	AE 102	1015	Yes	0.41 mg/m³	8.7%
SO_2	AM - M21	AE 102	1015	Yes	0.62 mg/m³	521.3%
CO	SRM - BS EN 15058	AE 102	1015	Yes	0.35 mg/m³	13.8%
CO_2	SRM - ISO 12039	AE 102	1015	Yes	0.003 %	4.1%
O_2	AM - BS EN 14789	AE 102	1015	Yes	0.01%	3.2%

Permit NO_x ISO 10849 : 1996 6 monthly.
SO_2 ISO 6069-4.4 continuous

EXECUTIVE SUMMARY

Analytical Methods

The following tables list the analytical methods employed together with the custody and archiving details:

SAMPLING METHODS WITH SUBSEQUENT ANALYSIS							
Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	UKAS Accredited Lab Analysis	Analysis Lab (ESG or Subcontract)	Sample Archive Location	Archive Period
-	-	-	-	-	-	-	-

ON-SITE TESTING							
Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	MCERTS Accredited Analysis	Laboratory	Data Archive Location	Archive Period
NO_X	Chemiluminescence	AE 102	1015	Yes	ESG Stockport	ESG Stockport	5 years
SO_2	Non Dispersive Infra Red	AE 102	1015	Yes	ESG Stockport	ESG Stockport	5 years
CO	Non Dispersive Infra Red	AE 102	1015	Yes	ESG Stockport	ESG Stockport	5 years
CO_2	Non Dispersive Infra Red	AE 102	1015	Yes	ESG Stockport	ESG Stockport	5 years
O_2	Zirconia Cell	AE 102	1015	Yes	ESG Stockport	ESG Stockport	5 years

EXECUTIVE SUMMARY

SAMPLING LOCATION					
Sampling Plane Validation Criteria	**Value**	**Units**	**Requirement**	**Compliant**	**Method**
Lowest Differential Pressure	-	Pa	>= 5 Pa	-	BS EN 13284-1
Lowest Gas Velocity	-	m/s	-	-	-
Highest Gas Velocity	-	m/s	-	-	-
Ratio of Gas Velocities	-	: 1	< 3 : 1	-	BS EN 13284-1
Mean Velocity	-	m/s	-	-	-
Maximum angle of flow with regard to duct axis	-	°	< 15°	-	BS EN 13284-1
No local negative flow	-	-	-	-	BS EN 13284-1

DUCT CHARACTERISTICS		
	Value	**Units**
Shape	Circular	-
Depth	-	m
Width	-	m
Area	-	m^2
Port Depth	40	mm

SAMPLING LINES & POINTS			
	Isokinetic (CEN Methods)	**Isokinetic (ISO Methods)**	**Non-Iso & Gases**
Sample port size	-	-	20mm Hole
Number of lines used	-	-	1
Number of points / line	-	-	1
Duct orientation	-	-	Vertical

SAMPLING PLATFORM	
General Platform Information	
Permanent / Temporary Platform / Ground level / Floor Level / Roof	Permanent
Inside / Outside	Outside

M1 Platform requirements	
Is there a sufficient working area so work can be performed in a compliant manner	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	Yes
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = >Stack depth / diameter + wall and port thickness + 1.5m	No

Sampling Platform Improvement Recommendations (if applicable)

Although small the platform is adequate for the method of sampling carried out. The sample port however is not of sufficient size to allow any stack dimension or flow measurements.

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

Stack Dimension and Flow Measurements

It is not possible to calculate a mass emission due to the inability to fit the measurement devices into the stack.

Required?

APPENDICES

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APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

MONITORING SCHEDULE					
Species	Method Standard Reference Method / Alternative Method	ESG Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Number of Samples
NOx	SRM - BS EN 14792	AE 102	1015	Yes	1
SO_2	AM - M21	AE 102	1015	Yes	1
CO	SRM - BS EN 15058	AE 102	1015	Yes	1
CO_2	SRM - ISO 12039	AE 102	1015	Yes	1
O_2	AM - BS EN 14789	AE 102	1015	Yes	1

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

CALIBRATEABLE EQUIPMENT CHECKLIST

Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	**Equipment I.D.**	**Equipment**	**Equipment I.D.**	**Equipment**	**Equipment I.D.**
Control Box DGM	-	Horiba PG-250 Analyser	LNO 21-13	Laboratory Balance	-
Box Thermocouples	-	FT-IR	-	Tape Measure	-
Meter In Thermocouple	-	FT-IR Oven Box	-	Stopwatch	-
Meter Out Thermocouple	-	Bernath 3006 FID	-	Protractor	-
Control Box Timer	-	Signal 3030 FID	-	Barometer	LNO 08-KB
Oven Box	-	Servomex	-	Digital Micromanometer	-
Probe	-	JCT Heated Head Filter	-	Digital Temperature Meter	-
Probe Thermocouple	-	Thermo FID	-	Stack Thermocouple	-
Probe	-	Stackmaster	-	Mass Flow Controller	-
Probe Thermocouple	-	FTIR Heater Box for Heated Line	-	MFC Display module	-
S-Pitot	-	Anemometer	-	1m Heated Line (1)	-
L-Pitot	-	Ecophysics NOx Analyser	-	1m Heated Line (2)	-
Site Balance	-	Chiller (JCT/MAK 10)	LNO 21-38	1m Heated Line (3)	-
Last Impinger Arm	-	Heated Line Controller (1)	LNO 03-86	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-	Heated Line Controller (2)	-	10m Heated Line (1)	-
Callipers	-	Site temperature Logger	-	10m Heated Line (2)	-
Small DGM	-		-	15m Heated Line (1)	-
Heater Controller	-		-	20m Heated Line (1)	LNO 18-86
Inclinometer (Swirl Device)	-		-	20m Heated Line (2)	-

NOTE: If the equipment I.D is represented by a dash (-), then this piece of equipment has not been used for this test.

CALIBRATION GASES

Gas (traceable to ISO 17025)	Cylinder I.D Number	Supplier	ppm	%	Analytical Tolerance +/- %
Nitric Oxide	HPC 787	BOC	200	-	2
Sulphur Dioxide	HPC 755	BOC	158.9	-	2
Carbon Monoxide	HPC 773	BOC	167	-	2
Carbon Dioxide	HPC 752	BOC	-	8.11	2

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

STACK EMISSIONS MONITORING TEAM

Team Leader	Keith Bird MCERTS Level 2, Technical Endorsements 1, 2, 3 & 4 MM 07 825 MCERTS Expiry Date - Dec 2018 H&S Expiry Date - Apr 2017
Technician	Mark Derbyshire MCERTS Level 1, Technical Endorsement 1 MM 07 824 MCERTS Expiry Date - Dec 2017 H&S Expiry Date - Apr 2017

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

COMBUSTION GASES SUMMARY

Test	Sampling Time and Date	Concentration mg/m³	LOD mg/m³	Limit mg/m³	Emission Rate g/hr
NOx	13:15 - 14:15 19 May 2014	40	0.41	120	-
SO_2	13:15 - 14:15 19 May 2014	0.91	0.62	190	-
CO	13:15 - 14:15 19 May 2014	15.2	0.35	-	-

Test	Sampling Time and Date	Concentration %	LOD %
CO_2	13:15 - 14:15 19 May 2014	7.3	0.003
O_2	13:15 - 14:15 19 May 2014	9.9	0.01

Reference conditions are 273K, 101.3kPa, dry gas .

PRE-SAMPLING CALIBRATION DATA

Date	19 May 2014
Start Time	11:00
End Time	11:30

Chiller Temperature (°C)	2.2
Requirement	< 4°C
Compliant	Yes

Gas	Range (ppm / %)	Zero Reading at analyser	Span Reading at analyser	Zero Check at analyser	Zero Check down line	Span Check down line	Response Time (Secs)	Leak Rate %
NO	200	0	200	-0.1	0.1	198	55	1.00
SO2	200	0	158.9	0.1	0.2	157.7	65	0.76
CO	200	0	167	0.2	0.3	166.5	45	0.30
CO2	25	0	8.11	0.04	0.06	8.15	40	-0.49
O_2	25	0	9.9	0.03	0.07	9.98	40	-0.81

POST-SAMPLING CALIBRATION DATA

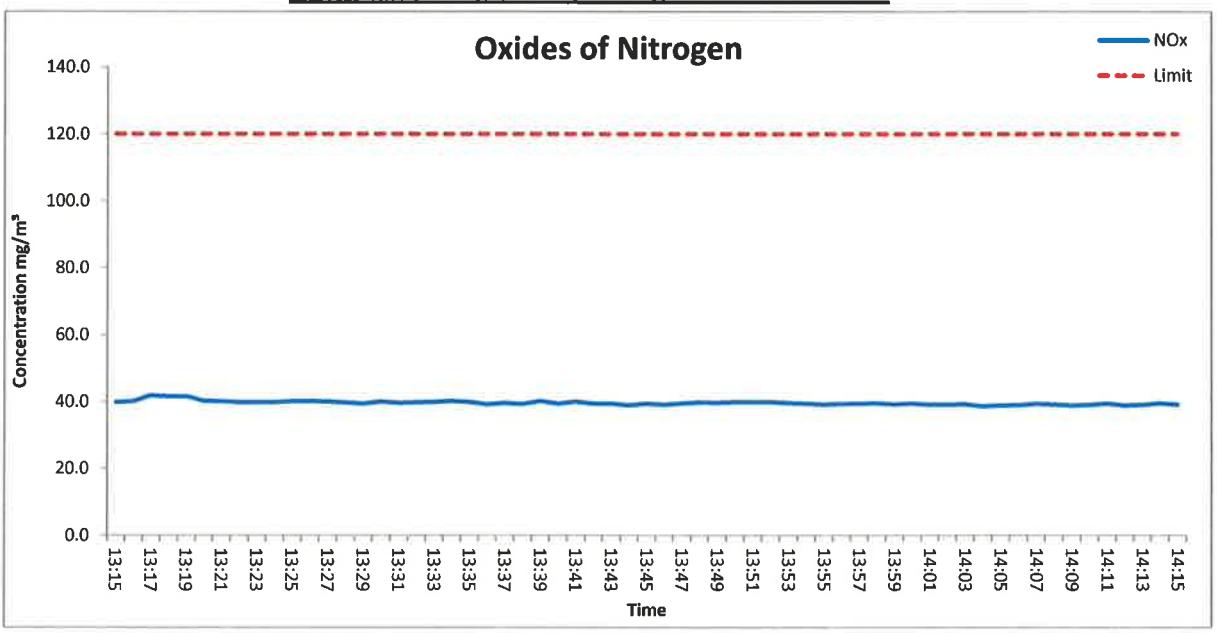
Date	19 May 2014
Start Time	14:18
End Time	14:30

Chiller Temperature (°C)	2.2
Requirement	< 4°C
Compliant	Yes

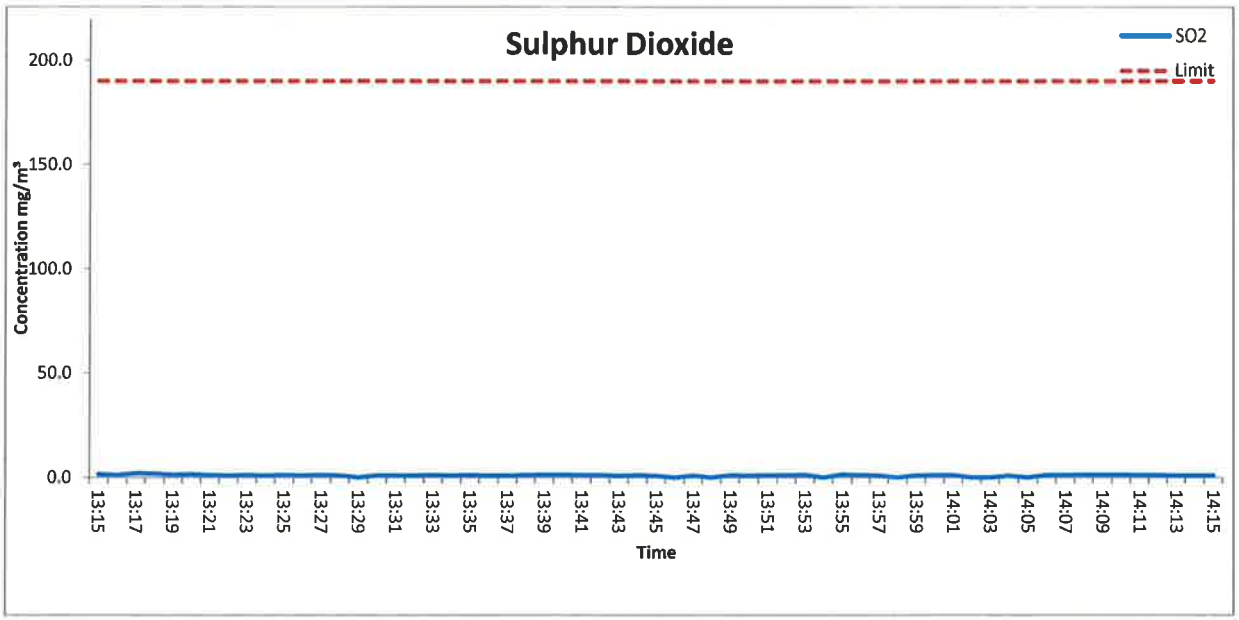
Gas	Zero Check down line	Span Check down line	Zero Drift (%)	Span Drift (%)
NO	0.2	199	0.05	0.45
SO2	0.1	159	-0.05	0.70
CO	0.2	164	-0.05	-1.20
CO2	0.06	8.12	0.00	-0.12
O_2	0.08	9.99	0.04	0.00

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

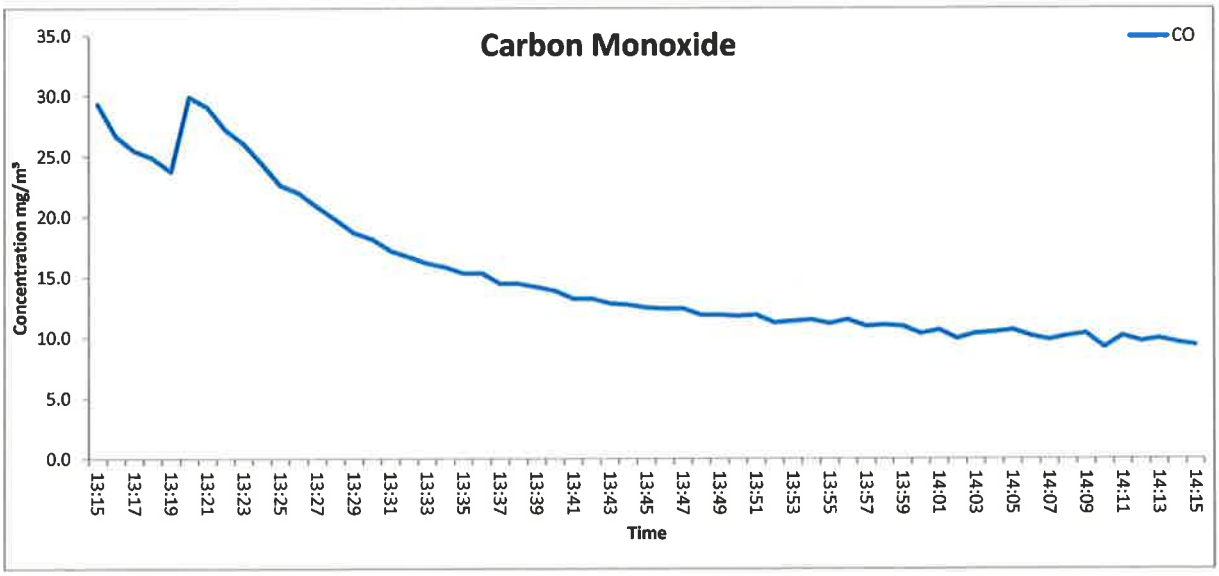
OXIDES OF NITROGEN (as NO_2) EMISSIONS CHART



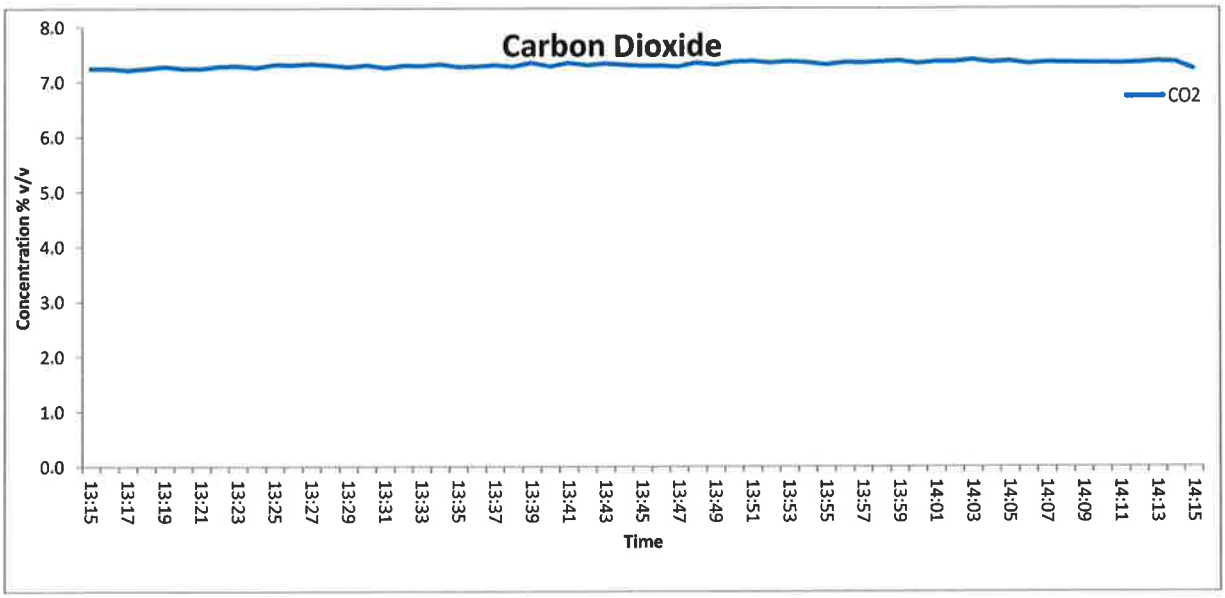
SULPHUR DIOXIDE EMISSIONS CHART



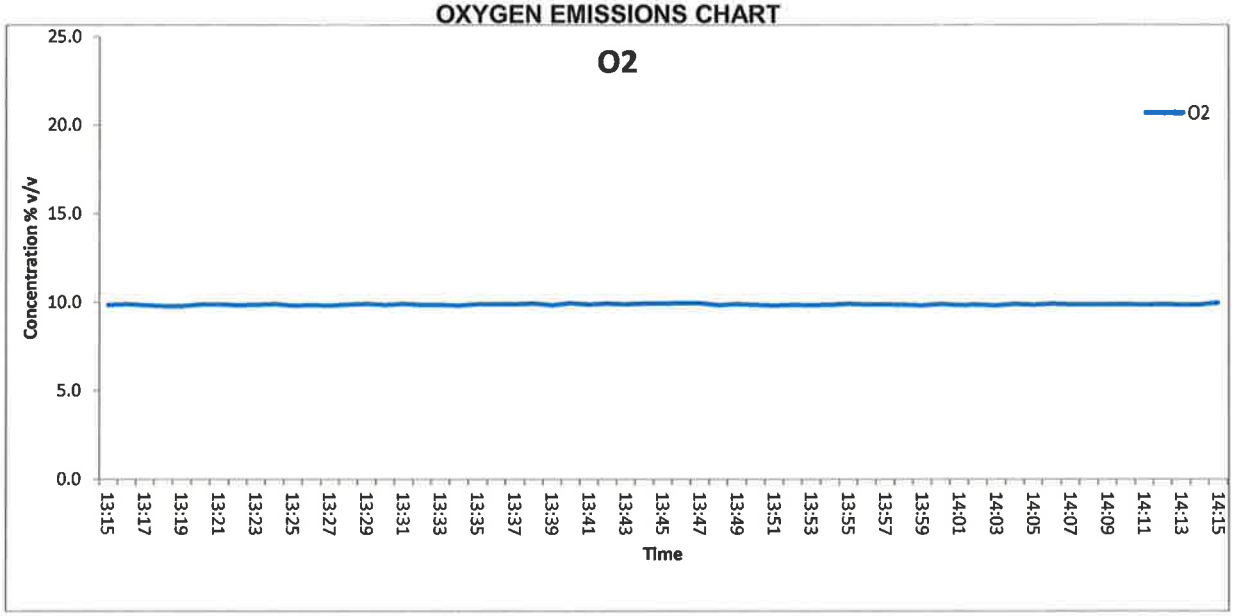
CARBON MONOXIDE EMISSIONS CHART



CARBON DIOXIDE EMISSIONS CHART



OXYGEN EMISSIONS CHART



APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

STACK DIAGRAM

	Value	Units
Stack Depth	-	m
Stack Width	-	m
Area	-	m^2

Non-Isokinetic/Gases Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack	Units
-	-	-	-

Isokinetic Sampling CEN Methods			
Sampling Point	Distance (% of Depth)	Distance into Stack (m)	Swirl °
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
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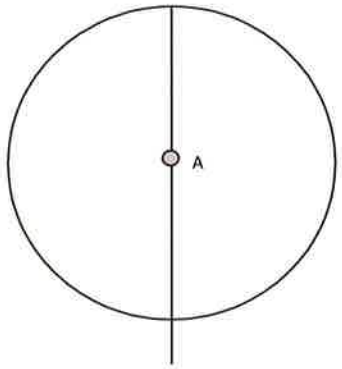
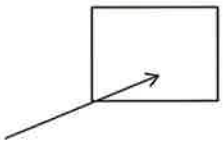


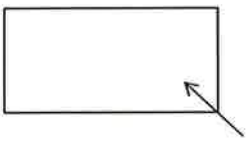
Sampling Line

○ Isokinetic sampling point
● Isokinetic sampling points not used
● Non Isokinetic/Gases sampling point

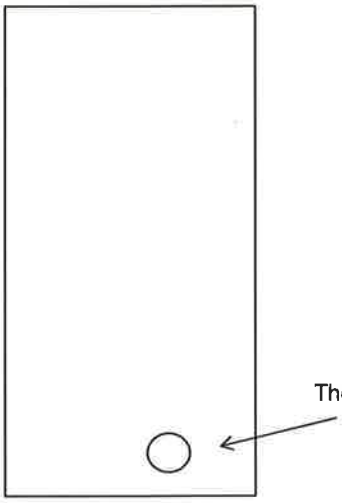
SAMPLING LOCATION



Gatehouse



Control Room



Thermal Oxidiser

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - OXIDES OF NITROGEN

Limit value	120	mg/m^3
Concentration @ Ref conditions	39.6	mg/m^3
Cal gas conc	410	mg/m^3
Analyser Full Scale	410	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	55	seconds	180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.7	% of value	<2 % range	Yes
Zero drift	0.10	% full scale	<2% range / 24hr	Yes
Span drift	0.90	% full scale	<2% range/24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.8	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.1	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	1.00	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.02
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	1.66
Drift	u0dr	0.11
volume or pressure flow dependence	uspres	0.002
atmopsheric pressure dependence	uapres	0.10
ambient temperature dependence	utemp	0.00001
Dependence on voltage	uvolt	0.35
losses in the line (leak)	uleak	0.23
Uncertainty of calibration gas	ucalib	0.23
Uncertainty in factor	uf	0.00

Measurement uncertainty (Concentration Measured)	39.6	mg/m^3
Combined uncertainty	1.7	mg/m^3
Expanded at a 95% confidence interval	3.5	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**2.9**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**3.5**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**8.7**	**% value**

Developed for the STA by R Robinson, NPL

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - SULPHUR DIOXIDE

Limit value	190	mg/m^3
Concentration @ Ref conditions	0.9	mg/m^3
Cal gas conc	451.276	mg/m^3
Analyser Full Scale	572	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	65	seconds	180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.7	% of value	<2 % range	Yes
Zero drift	-0.10	% full scale	<2% range / 24hr	Yes
Span drift	1.40	% full scale	<2% range/24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.8	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.1	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.76	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.019
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	2.31
Drift	u0dr	-0.06
volume or pressure flow dependence	uspres	0.00
atmopsheric pressure dependence	uapres	0.14
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.49
losses in the line (leak)	uleak	0.00
Uncertainty of calibration gas	ucalib	0.01
Uncertainty in factor	uf	0.00

Measurement uncertainty (Concentration Measured)	0.9	mg/m^3
Combined uncertainty	2.4	mg/m^3
Expanded uncertainty	4.7	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**2.5**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**4.7**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**521.3**	**% value**

Developed for the STA by R Robinson, NPL

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CARBON MONOXIDE

Limit value	-	mg/m^3
Concentration @ Ref conditions	15.2	mg/m^3
Cal gas conc	208.75	mg/m^3
Analyser Full Scale	250	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	45	seconds	180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.7	% of value	<2 % range	Yes
Zero drift	-0.10	% full scale	<2% range / 24hr	Yes
Span drift	-2.40	% full scale	<2% range/24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.80	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.10	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.30	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.02
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	1.01
Drift	u0dr	-0.16
volume or pressure flow dependence	uspres	0.001
atmopsheric pressure dependence	uapres	0.06
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.22
losses in the line (leak)	uleak	0.03
Uncertainty of calibration gas	ucalib	0.09
Uncertainty in factor	uf	0.00

Measurement uncertainty (Concentration Measured)	15.2	mg/m^3
Combined uncertainty	1.1	mg/m^3
Expanded uncertainty	2.1	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**-**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**2.1**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**13.8**	**% value**

Developed for the STA by R Robinson, NPL

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CARBON DIOXIDE

Limit value	-	%vol
Reported Concentration	7.31	%vol
Calibration gas	8.11	%vol
Analyser Full Scale	25	%vol

Performance characteristics	Value	Units	specification	MU Met?
Response time	40	seconds	< 200 s	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.015	% by volume	<0.2 % range	Yes
Repeatability at span level	0.014	% by volume	<0.4 % range	Yes
Deviation from linearity	0.13	% vol	<0.3 % volume	Yes
Zero drift (during measurement period)	0.00	% vol at zero level	<2% of volume / 24hr	Yes
Span drift (during measurement period)	-0.03	% vol at span level	<2% volume/24hr	Yes
volume or pressure flow dependence	0.02	% of fs / 10l/h	<1% range	Yes
atmospheric pressure dependence	0.8	% of fs/kPa	< 1.5 % range	Yes
ambient temperature dependence	0.01	% by volume /10K	<0.3% volume 10 K	Yes
Combined interference	0.56	% range	<2% range	Yes
Dependence on voltage	0.1	% by volume /10V	< 0.1%vol /10 volt	Yes
Losses in the line (leak)	-0.49	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	-
Standard deviation of repeatability at span level	urs	0.00
Lack of fit	ufit	0.08
Drift	u0dr	-0.02
volume or pressure flow dependence	uspres	0.00003
atmospheric pressure dependence	uapres	0.01
ambient temperature dependence	utemp	0.001
Combined interference (from mcerts)	-	0.08
dependence on voltage	uvolt	0.086
losses in the line (leak)	uleak	-0.02
Uncertainty of calibration gas	ucalib	0.04

Measurement uncertainty (Concentration Measured)	7.31	%vol
Combined uncertainty	0.15	%vol
% of value	2.04	%

Expanded uncertainty expressed with a level of confidence of 95%	**4.08**	**% of value**

Expanded uncertainty expressed with a level of confidence of 95%	**0.30**	**% vol**

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APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - OXYGEN

Reference	N/A	%vol
Reported Concentration	9.86	%vol
Calibration gas	9.9	%vol
Analyser Full Scale	25	%vol

Performance characteristics	Value	Units	specification	MU Met?
Response time	40	seconds	< 200 s	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.015	% by volume	<0.2 % range	Yes
Repeatability at span level	0.014	% by volume	<0.4 % range	Yes
Deviation from linearity	0.13	% vol	<0.3 % volume	Yes
Zero drift (during measurement period)	0.01	% vol at zero level	<2% of volume / 24hr	Yes
Span drift (during measurement period)	0.00	% vol at span level	<2% volume/24hr	Yes
volume or pressure flow dependence	0.02	% of fs / 10l/h	<1% range	Yes
atmospheric pressure dependence	0.80	% of fs/kPa	< 1.5 % range	Yes
ambient temperature dependence	0.01	% by volume /10K	<0.3% volume 10 K	Yes
Combined interference	0.14	% range	<2% range	Yes
Dependence on voltage	0.10	% by volume /10V	< 0.1%vol /10 volt	Yes
Losses in the line (leak)	-0.81	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1.00	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	-
Standard deviation of repeatability at span level	urs	0.0018
Lack of fit	ufit	0.0751
Drift	u0dr	0.0058
volume or pressure flow dependence	uspres	0.00003
atmospheric pressure dependence	uapres	0.0122
ambient temperature dependence	utemp	0.0005
Combined interference (from mcerts)	-	0.0808
dependence on voltage	uvolt	0.0862
losses in the line (leak)	uleak	-0.0460
Uncertainty of calibration gas	ucalib	0.0569

Measurement uncertainty (Concentration Measured)	9.86	%vol
Combined uncertainty	0.16	%vol
% of value	1.61	%

Expanded uncertainty expressed with a level of confidence of 95%	**3.2**	**% of value**

Expanded uncertainty expressed with a level of confidence of 95%	**0.317**	**% vol**

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END OF REPORT