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Stack Emissions Testing Report Commissioned by
Asgard Renewables Ltd

Installation Name & Address
Asgard Renewables Ltd
Unit 2
Crugmore Farm
Penparc
Cardigan
SA43 1RD

EPR Permit: EPR/AB3097FU

Stack Reference
A1 Engine 1 500kWe

Dates of the Monitoring Campaign
22nd March 2024


Job Reference Number
EMT08959

Report Written by
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Report Approved by
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Report Date
8th April 2024

Version
Version 1

Signature of Report Approver


TITLE PAGE

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Executive Summary

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MONITORING OBJECTIVES

Asgard Renewables Ltd, Cardigan

A1 Engine 1 500kWe

22nd March 2024

Overall Aim of the Monitoring Campaign

Element were commissioned by Asgard Renewables Ltd to carry out stack emissions testing on the A1 Engine 1 500kWe at Cardigan.

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

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

Executive Summary

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MONITORING RESULTS

Asgard Renewables Ltd, Cardigan

A1 Engine 1 500kWe

22nd March 2024

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration			
	Units	Result	MU +/-	Limit
Sulphur Dioxide	¹ mg/m ³	112	6.8	350
Total VOCs (as Carbon)	¹ mg/m ³	975	42.5	1000
Oxides of Nitrogen (as NO ₂)	¹ mg/m ³	385	15.8	500
Carbon Monoxide	¹ mg/m ³	711	30.8	1400
Oxygen	% v/v	Dry 9.3	0.25	
Water Vapour	% v/v	11.3	0.60	

¹ Reference Conditions (REF) are: 273K, 101.3kPa, dry gas, 5% oxygen.

Executive Summary

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MONITORING DATE(S) & TIMES

Asgard Renewables Ltd, Cardigan
A1 Engine 1 500kWe
22nd March 2024

Parameter	Units	Concentration	Sampling Date(s)	Sampling Times	Duration mins
Sulphur Dioxide	R1 mg/m ³	112	22/03/2024	10:40 - 11:40	60
Total VOCs (as Carbon)	R1 mg/m ³	975	22/03/2024	10:40 - 11:40	60
Oxides of Nitrogen (as NO ₂)	R1 mg/m ³	385	22/03/2024	10:40 - 11:40	60
Carbon Monoxide	R1 mg/m ³	711	22/03/2024	10:40 - 11:40	60
Oxygen	R1 % v/v	9.3	22/03/2024	10:40 - 11:40	60

All results are expressed at the respective reference conditions.

Executive Summary

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PROCESS DETAILS

Asgard Renewables Ltd, Cardigan

A1 Engine 1 500kWe

22nd March 2024

Standard Operating Conditions

Parameter	Value
Process Status	Operational
Capacity (of 100%) and Tonnes / Hour	100% ~ 500kw/h
Continuous or Batch Process	Continuous
Feedstock (if applicable)	N/A
Abatement System	None
Abatement System Running Status	N/A
Fuel	Bio-Gas
Plume Appearance	None Visible

Executive Summary

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MONITORING & ANALYTICAL METHODS

Asgard Renewables Ltd, Cardigan

A1 Engine 1 500kWe

22nd March 2024

Parameter	Monitoring				Analysis				Overall Status	LOD (Average)
	Standard	Technical Procedure	Sampling Status	Testing Lab	Analytical Procedure	Analytical Technique	Analysis Status	Analysis Lab		
Sulphur Dioxide	EN 14791	MD 009	MCERTS	EET	CAT-AP-01	IC	MCERTS	EET	MCERTS	0.325 mg/m ³
Water Vapour	EN 14790	MD 005	MCERTS	EET	MD 105	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Total VOCs (as Carbon)	EN 12619:2013	MD 020	MCERTS	EET	Flame Ionisation Detection by Sick 3006			MCERTS	0.32 mg/m ³	
Oxides of Nitrogen (as NO ₂)	EN 14792	MD 039	MCERTS	EET	Chemiluminescence by Horiba PG-350E			MCERTS	0.41 mg/m ³	
Carbon Monoxide	EN 15058	MD 039	MCERTS	EET	NDIR by Horiba PG-350E			MCERTS	0.56 mg/m ³	
Oxygen	EN 14789	MD 039	MCERTS	EET	Dry Paramagnetic Cell by Horiba PG-350E			MCERTS	0.1 %	

ANALYSIS LABORATORIES

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

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

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

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.30
Width	m	-
Area	m ²	0.07
Port Depth	cm	9
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	2" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	On Ground
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)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
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

Due to the nature of the access into the duct, it is not possible to conduct a full velocity profile, however no particulate phase sampling was required and all gaseous species were considered to be mixed sufficiently for the purposes of these tests. There is also no requirement to undertake a homogeneity test as per EN 15259 and as such the location cannot be compared against that or the criteria within TGN M1. The sampling location used in this instance has been approved for use by the Environment Agency.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

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PLANT PHOTOS

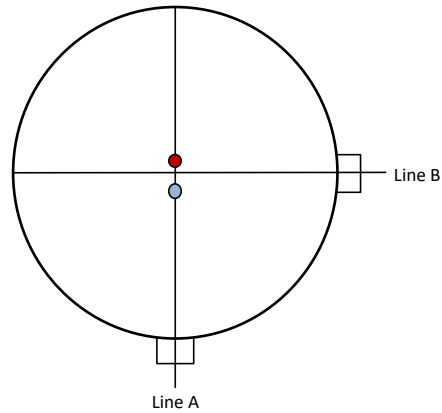
Photo 1



Photo 2



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	Craig Harley	MCERTS Level 2	MM 05 670	TE1 TE2 TE3 TE4
Technician	Simon Dwyer	MCERTS Level 1	MM 23 1768	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)	-	Horiba PG-350E	CAT 39.25	Digital Manometer (1)	CAT 3.228
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	CAT 3.177
Box Thermocouples (1)	-	Servomex 4900	CAT 24.8	Digital Temperature Meter	CAT 3.228
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	-
Umbilical (1)	-	ABB AO2020-URAS26	-	Barometer	CAT 13.46
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.1661
Oven Box (1)	-	JCT JCC P1 Cooler	CAT 4.44	Stack Thermocouple (2)	CAT 4.1707
Oven Box (2)	-	Gasmet DX4000	-	Stack Thermocouple (3)	CAT 4.00139
Heated Probe (1)	CAT 5.175	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	CAT 5.176	Sick 3006	CAT 8.28	1m Heated Line (2)	-
Heated Probe (3)	CAT 5.177	M&C PSS	-	1m Heated Line (3)	-
S-Pitot (1)	-	Mass Flow Controller (1)	CAT 6.34	5m Heated Line (1)	CAT 20.36
S-Pitot (2)	-	Mass Flow Controller (2)	CAT 6.35	10m Heated Line (1)	CAT 20.84
L-Pitot	-	Mass View (1)	CAT 25.13	20m Heated Line (1)	CAT 20.1018
Site Balance	CAT 17.57	Mass View (2)	CAT 25.14	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.57	Hioki 5043 (V)	CAT 11.99	Dual Channel Heater Controller	-
Last Impinger Arm	CAT 4.1130	Hioki 5043 (V)	-	Single Channel Heater Controller	-
Callipers	CAT 23.50	Bioaerosols Temperature Logger	-	Laboratory Balance	-
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.22

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Sulphur Dioxide	EN 14791	MD 009
Water Vapour	EN 14790	MD 005
Total VOCs (as Carbon)	EN 12619:2013	MD 020
Oxides of Nitrogen (as NO ₂)	EN 14792	MD 039
Carbon Monoxide	EN 15058	MD 039
Oxygen	EN 14789	MD 039

SULPHUR DIOXIDE: RESULTS SUMMARY

Asgard Renewables Ltd, Cardigan
A1 Engine 1 500kWe

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	112	112
Uncertainty	±mg/m ³	6.8	6.8

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	11.3	11.3
Uncertainty	±% v/v	0.60	0.60

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	0.56	0.56

General Sampling Information

Parameter	Value	
Standard	EN 14791	
Technical Procedure	MD 009	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	CAT-AP-01	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	28 03 24	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Polyethylene	
Absorption Solution	0.3% Hydrogen Peroxide	
Positioning of Filter	Out Stack Heated Head	
Filter Size and Material	0.1µm Glass Fibre	
Number of Sampling Lines Used	1/1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1/1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

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

SULPHUR DIOXIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	10:40 - 11:40
Sampling Dates	-	22/03/2024
Sampling Device	-	MFC / MV
Duration	mins	60
Volume Sampled (STP, Dry)	m ³	0.0617
Volume Sampled (STP, Wet)	m ³	0.0696
Volume Sampled (REF)	m ³	0.0452
Sample Flow Rate	l/min	1.01
Laboratory Result for Front Impingers	µg/ml	26.35
Laboratory Result for Back Impinger	µg/ml	0.31
Volume in Front Impingers	ml	191.8
Volume in Back Impinger	ml	102.6
Mass in Front Impingers	µg	5053.9
Mass in Back Impinger	µg	31.8
Total Mass Collected	µg	5085.7
Calculated Concentration	mg/m ³	112.41
Liquid Trap Start Mass	g	1522.8
Liquid Trap End Mass	g	1528.6
Silica Trap Start Mass	g	1589.9
Silica Trap End Mass	g	1590.4
Total Mass Of Water Vapour	g	6.3
Calculated Water Vapour	% v/v	11.28

Where: MFC stands for Mass Flow Controller, MV stands for Mass View Flowmeter

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	22/03/2024
Average Volume Sampled (REF)	m ³	0.0452
Laboratory Result for Impingers	µg/ml	0.08
Volume in Impingers	ml	314.8
Total Mass Collected	µg	25.2
Calculated Concentration	mg/m ³	0.56

SULPHUR DIOXIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	1.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	0.00
Allowable Leak Rate	l/min	0.02
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	99.4
Allowable Absorption Efficiency	%	95
Absorption Efficiency 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

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	1.5
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	0.00
Allowable Leak Rate	l/min	0.03
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m ³	35.0
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	

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (STP)	V _m	0.0617	uV _m	m ³	0.0012
Leak	L	0.00	uL	%	-
Laboratory Result	L _r	0.90	uL _r	%	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
Sampled Volume (STP)	%	2.00	≤2%
Leak	%	0.00	≤2%
Laboratory Result	%	0.90	No Requirement

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient	
	Symbol	Units	Run 1	Run 1	
Sampled Volume (STP)	V _m	m ³	0.0617	1821	
Leak	L	mg/m ³	0.000	1.00	
Laboratory Result	L _r	mg/m ³	1.012	1.00	

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/m ³	2.248
Leak	mg/m ³	0.0000
Laboratory Result	mg/m ³	1.0117

Measured Quantities	Oxygen Correction Part of MU Budget	
	Units	Run 1
O ₂ Correction Factor	-	1.36
Stack Gas O ₂ Content	% v/v	9.27
MU for O ₂ Correction	-	0.06
Overall MU For O ₂ Measurement	%	4.26

Parameter	Units	Run 1
Combined uncertainty	mg/m ³	2.47
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	4.83
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	6.81
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	6.81
Reported Uncertainty	mg/m ³	6.81
Expanded uncertainty (95% confidence), without Oxygen Correction	%	4.3
Expanded uncertainty (95% confidence), with Oxygen Correction	%	6.1
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.1
Reported Uncertainty	%	6.1

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Asgard Renewables Ltd, Cardigan
A1 Engine 1 500kWe

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	975	975
Uncertainty	±mg/m ³	42.5	42.5

General Sampling Information

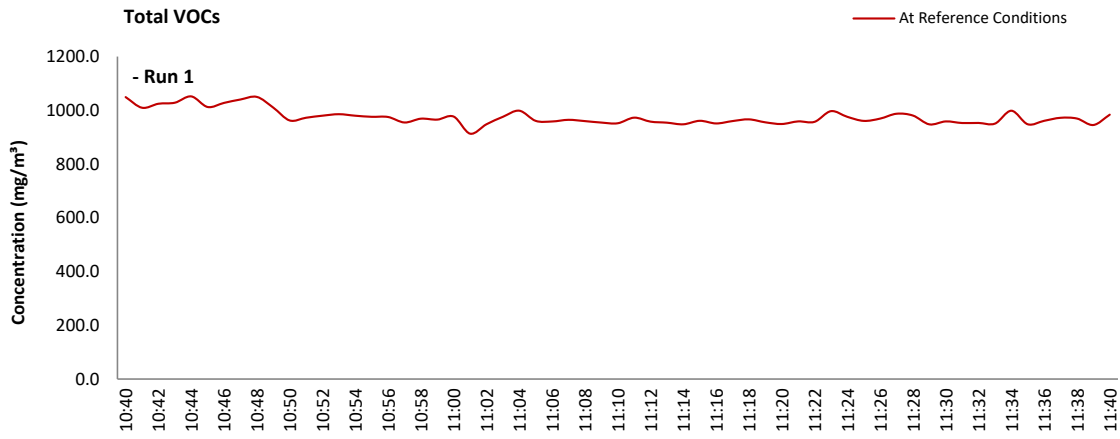
Parameter	Value	
Standard	EN 12619:2013	
Technical Procedure	MD 020	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Propane in 8% O ₂ in N ₂ (5 Grade)	
Span Gas Reference Number	12.0593 in N ₂ 1.0442a in AIR	
Span Gas Expiry Date	28/02/2026 23/04/2026	
Span Gas Start Pressure (bar)	140 40	
Gas Cylinder Concentration (ppm)	819.11 802.35	
Span Gas Set Point (ppm)	812.73	This is the blended concentration of both propane cylinders
Span Gas Uncertainty (%)	2 2	
Zero Gas Type	8% O ₂ in N ₂ (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 5% 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	-	10:40 - 11:40
Sampling Dates	-	22/03/2024
Instrument Range	ppm	1000
Span Gas Value	ppm	812.7

Quality Assurance

Zero Drift	Units	Run 1
CAL 1	Zero Down Sampling Line (Pre)	ppm 0.00
	Zero Down Sampling Line (Post)	ppm 4.50
	Zero Drift	ppm 4.50
	Zero Drift	% 0.55
	Drift Correction Applied	2-5% No
	Allowable Zero Drift	± ppm 40.64
	Zero Drift Acceptable	- Yes

Span Drift	Units	Run 1
CAL 1	Span Down Sampling Line (Pre)	ppm 812.00
	Span Down Sampling Line (Post)	ppm 835.00
	Span Drift	ppm 23.00
	Span Drift	% 2.83
	Drift Correction Applied	2-5% Yes
	Allowable Span Drift	± ppm 40.64
	Span Drift Acceptable	- Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10 / 08

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

TOTAL VOCs (as CARBON): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	1000.0	mg/m ³ (REF)
Allowable MU	15.0	%
Measured concentration	714.86	mg/m ³ (STP, dry)
Range Used	1000.0	ppm
Range Used [A]	1606.1	mg/m ³
Cal gas conc.	812.7	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.	1305.3	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	0.25	% of value
Zero drift	0.55	% full scale
Span drift	0.00	% 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	4.18	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	11.67	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		714.86	mg/m ³
Expanded uncertainty		12.40	mg/m ³
Expanded uncertainty	k = 1.96	24.30	mg/m ³
Uncertainty corrected to std conds. (O ₂)		33.16	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.40	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	2.43	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	15.0	% at ELV
Result of Compliance with Uncertainty Requirement	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	4.35	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	4.29	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	15.2	% at ELV
Result of Compliance with Uncertainty Requirement	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).

OXIDES OF NITROGEN (as NO₂): RESULTS SUMMARY

Asgard Renewables Ltd, Cardigan
A1 Engine 1 500kWe

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	385	385
Uncertainty	±mg/m ³	15.8	15.8

General Sampling Information

Parameter	Value
Standard	EN 14792
Technical Procedure	MD 039
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	24/11/2023 - 96.1%
Span Gas Type	Nitrogen Monoxide
Span Gas Reference Number	12.0593
Span Gas Expiry Date	28/02/2026
Span Gas Start Pressure (bar)	180
Gas Cylinder Concentration (ppm)	2108.8
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	A1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

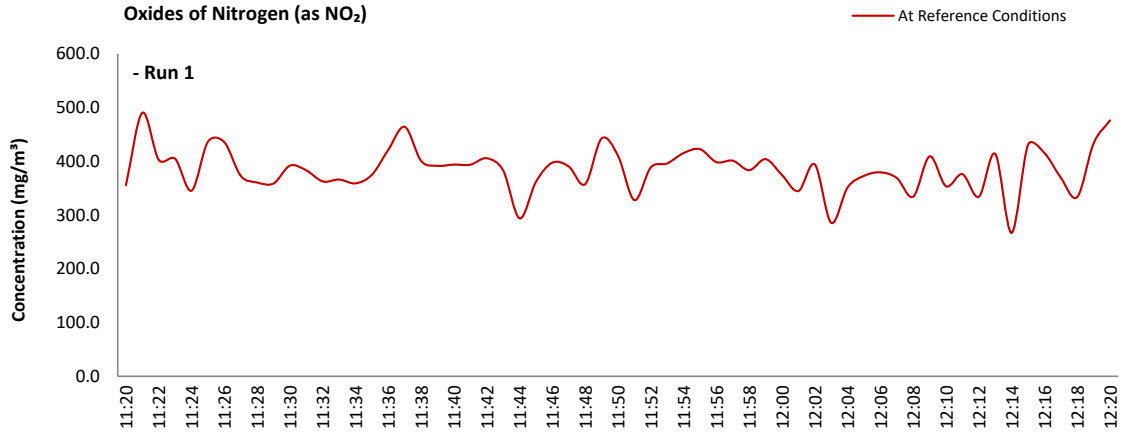
FORMAT: Number Used / Number Required

Reference Conditions

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

OXIDES OF NITROGEN (as NO₂): DATA TREND

Graphical Trend of Data



OXIDES OF NITROGEN (as NO₂): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	10:40 - 11:40
Sampling Dates	-	22/03/2024
Instrument Range	ppm	500
Span Gas Value	ppm	243.6

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.1
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1
Zero at Analyser (Pre)	ppm	0.00
Zero at Analyser (Post)	ppm	1.80
Zero Drift	ppm	1.80
Zero Drift	%	0.74
Drift Correction Applied	2-5%	No
Allowable Zero Drift	± %	5.00
Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1
Span at Analyser (Pre)	ppm	244.00
Span at Analyser (Post)	ppm	245.00
Span Drift	ppm	1.00
Zero Adj. Span Drift	%	0.33
Drift Correction Applied	2-5%	No
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10 / 08

Method Deviations

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

OXIDES OF NITROGEN (as NO₂): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	500.0	mg/m ³ (REF)
Allowable MU	10.0	%
Measured concentration	281.93	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.	243.6	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.	500.0	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	0.35	% of value
Zero drift	0.74	% full scale
Span drift	-0.33	% 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	96.1	%
Losses in the line (leak)	0.41	% 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	0.41	mg/m ³
Drift	1.60	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	0.32	mg/m ³
Losses in the line (leak)	0.67	mg/m ³
Uncertainty of calibration gas blending	2.28	mg/m ³
Uncertainty of calibration gas	3.26	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		281.93	mg/m ³
Expanded uncertainty		4.43	mg/m ³
Expanded uncertainty	k = 1.96	8.68	mg/m ³
Uncertainty corrected to std conds. (O ₂)		11.84	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.08	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	1.74	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	10.0	% at ELV
Result of Compliance with Uncertainty Requirement	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	4.11	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.61	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	10.4	% at ELV
Result of Compliance with Uncertainty Requirement	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).

CARBON MONOXIDE: RESULTS SUMMARY

Asgard Renewables Ltd, Cardigan
A1 Engine 1 500kWe

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	711	711
Uncertainty	±mg/m ³	30.8	30.8

General Sampling Information

Parameter	Value
Standard	EN 15058
Technical Procedure	MD 039
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	12.0593
Span Gas Expiry Date	28/02/2026
Span Gas Start Pressure (bar)	180
Gas Cylinder Concentration (ppm)	4139.2
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	A1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

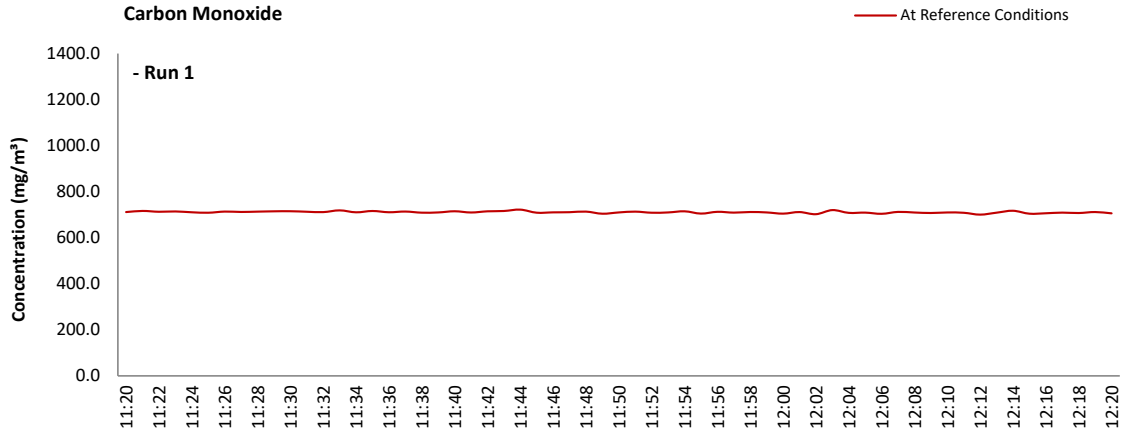
FORMAT: Number Used / Number Required

Reference Conditions

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

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	10:40 - 11:40
Sampling Dates	-	22/03/2024
Instrument Range	ppm	1000
Span Gas Value	ppm	1120.7

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.1
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1
Zero at Analyser (Pre)	ppm	0.00
Zero at Analyser (Post)	ppm	-2.00
Zero Drift	ppm	-2.00
Zero Drift	%	0.18
Drift Correction Applied	2-5%	No
Allowable Zero Drift	± %	5.00
Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1
Span at Analyser (Pre)	ppm	1120.00
Span at Analyser (Post)	ppm	1105.00
Span Drift	ppm	-15.00
Zero Adj. Span Drift	%	1.16
Drift Correction Applied	2-5%	No
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10 / 08

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	1400.0	mg/m ³ (REF)
Allowable MU	6.0	%
Measured concentration	521.11	mg/m ³ (STP, dry)
Range Used	1000.0	ppm
Range Used [A]	1249.2	mg/m ³
Cal gas conc.	1120.7	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.	1400.0	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	0.49	% of value
Zero drift	-0.18	% full scale
Span drift	-1.16	% 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)	0.45	% 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	0.21	mg/m ³
Drift	-4.93	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)	1.34	mg/m ³
Uncertainty of calibration gas blending	4.21	mg/m ³
Uncertainty of calibration gas	6.02	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		521.11	mg/m ³
Expanded uncertainty		8.95	mg/m ³
Expanded uncertainty	k = 1.96	17.55	mg/m ³
Uncertainty corrected to std conds. (O ₂)		23.94	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.37	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	1.25	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	6.0	% at ELV
Result of Compliance with Uncertainty Requirement	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	4.33	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.21	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	6.6	% at ELV
Result of Compliance with Uncertainty Requirement	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).

OXYGEN: RESULTS SUMMARY

Asgard Renewables Ltd, Cardigan
A1 Engine 1 500kWe

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	% v/v	9.3	9.3
Uncertainty	±% v/v	0.25	0.25

General Sampling Information

Parameter	Value
Standard	EN 14789
Technical Procedure	MD 039
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	11.06
Span Gas Expiry Date	01 03 28
Span Gas Start Pressure (bar)	100
Gas Cylinder Concentration (% v/v)	21.13
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	A1

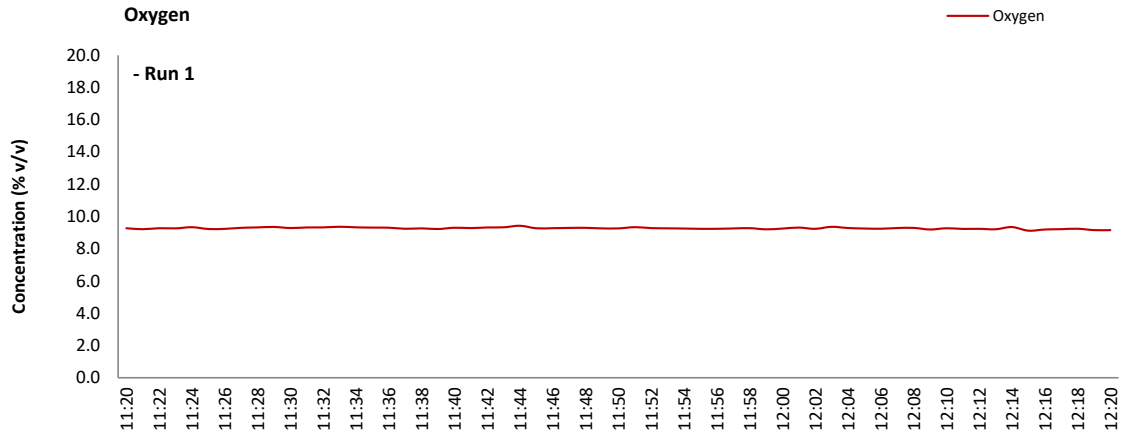
NOTE: Dilution performed to achieve correct span value

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	-	10:40 - 11:40
Sampling Dates	-	22/03/2024
Instrument Range	% v/v	25.0
Span Gas Value	% v/v	8.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.1
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1
Zero at Analyser (Pre)	% v/v	0.00
Zero at Analyser (Post)	% v/v	-0.04
Zero Drift	% v/v	-0.04
Zero Drift	%	0.51
Drift Correction Applied	2-5%	No
Allowable Zero Drift	± %	5.00
Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1
Span at Analyser (Pre)	% v/v	7.89
Span at Analyser (Post)	% v/v	7.67
Span Drift	% v/v	-0.22
Zero Adj. Span Drift	%	2.25
Drift Correction Applied	2-5%	Yes
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10 / 08

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
Allowable MU	6.0	%
Measured concentration	9.27	%vol
Range Used	25.0	%vol
Cal gas conc.	21.1	%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	0.08	% of value
Zero drift	-0.51	% full scale
Span drift	0.00	% 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)	0.00	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	%vol
Standard deviation of repeatability at span level	0.00	%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)	0.00	%vol
Uncertainty of calibration gas	0.11	%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		9.27	%vol
Expanded uncertainty		0.13	%vol
Expanded uncertainty	k = 1.96	0.25	%vol

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	2.72	% of Value
Result of Compliance with Uncertainty Requirement	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.

VERSION HISTORY

Version Number	Record of changes made within this version of the document
V1	The original document issued to the client