

Report for the Periodic Monitoring of Emissions to Atmosphere

Asgard Renewables Ltd

A1 - 2G Engine

Permit No: EPR/AB3097FU
Installation: Asgard Renewables Cardigan
Monitoring Dates: 17th August 2023
Site Address: Unit 2 Crugmore Farm, Penparc, Cardigan, SA43 1RD

Report Number:	ES-1418	Version:	1	Visit:	1 in 2023
Date of Report:	18th September 2023				
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MCERTS No:	MM 18 1478	MCERTS Level:	2 (TE1, TE2, TE3, TE4)		
Approved By:	Ian Baggley	Function:	Training Manager		
MCERTS No:	MM 05 653	MCERTS Level:	2 (TE1, TE2, TE3, TE4)		

Signed:



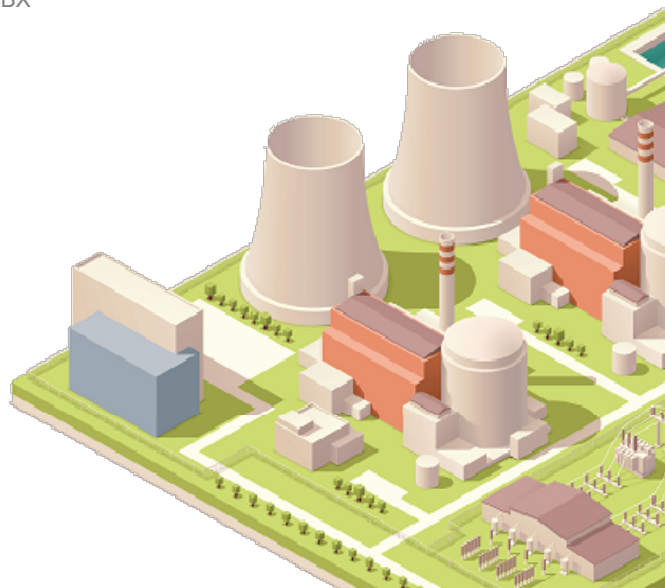
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Executive Summary

Monitoring Objectives

Envirocare Technical Consultancy were contracted by Asgard Renewables Ltd to carry out emissions monitoring, to determine the compliance of A1 - 2G Engine with the conditions specified in the operators permit (EPR/AB3097FU) for emissions to atmosphere. The methodologies utilised and the results obtained form the basis of this report.

The substances requested for monitoring are listed below.

Emission Point Identification

Substances to be Monitored	A1 - 2G Engine
Carbon Monoxide	✓
Oxides of Nitrogen (as NO ₂)	✓
Total VOC	✓
Oxygen	✓
Sulphur Dioxide	✓
Water Vapour	✓

Special requirements: none

Opinions and interpretations expressed within this report are outside the scope of Envirocare Technical Consultancy's MCERTS and UKAS accreditation. Envirocare accepts no responsibility for information in this report that was provided by the client, the client's representative or employees of the client. Where such information has been provided by external sources this is identified in footnotes of the respective tables.

Executive Summary

Monitoring Results

where MU = Measurement Uncertainty associated with the result (95% Confidence)

		Concentration			Reference Conditions	Mass Emission			Sampling Date	Sampling Times
Substance		Limit (mg/m ³)	Result (mg/m ³)	Measurement Uncertainty (MU) +/-		Limit (g/hr)	Result (g/hr)	Measurement Uncertainty (MU) +/-		
Carbon Monoxide	R1	1400	641	8	273k, 101.3kPa, Dry Gas, 5% O ₂	-	-	-	17/08/2023	15:06-16:06
Oxides of Nitrogen (as NO ₂)	R1	500	625	12		-	-	-	17/08/2023	15:06-16:06
Total VOC	R1	1000	833	12		-	-	-	17/08/2023	15:06-16:06
Sulphur Dioxide	R1	350	2.0	0.16		-	-	-	17/09/2023	14:06-15:06
Oxygen	R1	-	7.7%	0.56	As Measured, Dry Gas	-	-	-	17/08/2023	15:06-16:06

Reference conditions (REF) are: 273k, 101.3kPa, Dry Gas, 5% O₂.

Supporting Information

Appendix 1: General Information

Operating Information

Parameter	Process Details
Process Type	Bio-gas Engine
Continuous or Batch Process	Continuous
Operating Status	Normal
Feedstock	-
Normal Load, Throughput or Continuous Rating	500kw
Abatement System	None
Abatement System Status	N/A
Process Fuel	Biogas from waste
Plume Appearance	None visible

Monitoring Deviations

Parameter	Run	Deviation
All Parameters	All	There are no deviations associated with the monitoring undertaken.

Monitoring Organisation Staff Details

Personnel	Position	MCERTS Level	MCERTS Number
Mr T Arden	Team Leader	2 (TE1, TE2, TE3, TE4)	MM 18 1478
Mr J Doyle	Team Leader	Trainee	MM 22 1757

Monitoring Methods

Pollutant Species	Standard	Technical Procedure	Testing MCERTS	Analysis Laboratory	Analytical Procedure	Analytical Technique	Analysis MCERTS
Sulphur Dioxide	BS EN 14791	ETC-SE-14	Yes	RPS	C27(U)	IC	Yes
Carbon Monoxide	BS EN 15058	ETC-SE-10 (a/b)	Yes	NDIR by Horiba PG-250 or PG350E			
Oxides of Nitrogen	BS EN 14792	ETC-SE-10 (a/b)	Yes	Chemiluminescence by Horiba PG-250 or Horiba PG-350			
Oxygen	BS EN 14789	ETC-SE-10 (a/b)	Yes	Dry Zirconia Cell by Horiba PG-250 or Dry Paramagnetic by Horiba PG-350E			
Total VOC	BS EN 12619	ETC-SE-04	Yes	Flame Ionisation Detector by M&C Thermo FID or Sick 3006 FID			
Water Vapour	BS EN 14790	ETC-SE-11	Yes	ENV	ETC-SE-11	Gravimetric	Yes

Envirocare: 2522 | RPS Laboratories Ltd (RPS): 0605

Equipment Checklist

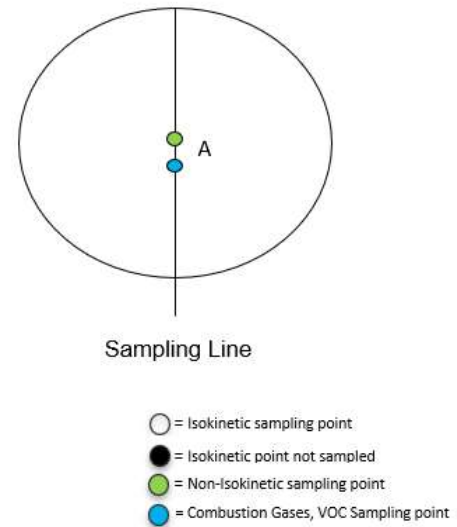
Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM	8.05(b)	Horiba PG-250	-	Tape Measure	17.02
Box Thermocouples	-	Horiba PG-250 SRM	-	Bevel Box	-
Box Thermocouple In	-	Horiba PG-350	12.03	Stopwatch	10.03/10.11
Box Thermocouple Out	-	JCT JCC Cooler	-	Barometer	11.04
Control Box Timer	-	MAK10 Cooler	-	Digital Manometer	24.a/b
Umbilical	-	Horiba PS200 Cooler	-	Digital Temperature Meter	24.a/b
Oven Box	-	M&C PSS Gas Preparation	3.42b	Dual Channel Heat Controller	-
Heated Probe (1)	-	Gasmet DX4000 FTIR	-	1m Heated Line	-
Heated Probe (2)	-	Gasmet Sampling System	-	3m Heated Line	-
Stack Thermocouple (1)	-	SK-Thermo FID	13.04	5m Heated Line	-
Stack Thermocouple (2)	-	Bernath 3006 FID	-	10m Heated Line	-
S-Type Pitot (1)	-	Testo 350XL	-	20m Heated Line	5.11
S-Type Pitot (2)	-	M&C PSP 4000	7.04	30m Heated Line	-
L-Type Pitot	-	Easylogger EN-EL-12 Bit	-	Impinger Arm Thermocouple (1)	3.17A
Site Balance	18.06	Hioki 5043 (V)	-	Impinger Arm Thermocouple (2)	3.18A
500g Check Weight	18.06 500g	Analyser Temperature Logger	-	Dioxins Kit Thermocouple	-
1KG Check Weight	18.06 1kg	-	-	Sample Temperature Logger	-
Digital Callipers	16.01	-	-	Laboratory Balance	-

Appendix 2: A1 - 2G Engine Results and Calculations

Picture of the sampling location



Sampling Points Diagram



Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	-
Width	m	-
Area	m ²	-
Port Depth	cm	0.0
Orientation of Stack / Duct	-	Angled
Sampling Port Size	-	1" BSP
Number of Ports	-	1

Manual Sampling Points	Used / Required
Number of Sampling Lines	1 / 1
Number of Sampling Points	1 / 1
Instrumental Sampling Points	Used / Required
Number of Sampling Lines	1 / 1
Number of Sampling Points	1 / 1

Platform Type and Location	
Platform Type - Permanent / Temporary	Ground Level
Location - Inside / Outside	Inside

EA Technical Guidance Note M1 Platform Requirements		
Load Baring Capacity	Load baring capacity of platform sufficient to fulfil the measurement objective	Yes
Position & Work Space	Sufficient work area to manipulate probe & operate the measurement instruments	Yes
	Depth of work area > internal diameter of stack and wall thickness plus 1.5m	Yes
	Ports on vertical ducts 1.2m to 1.5m above platform floor	No
	Platform has chains / self closing gates at top of ladders	Yes
Fall Prevention	Platform has adequate drainage to prevent accumulation of free-standing water	N/A
	Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	N/A
	Gaps between handrails not >0.5m	N/A
Access	Platform has vertical base boards (approx. 0.25m high)	N/A
	Access to sampling ports unhindered by obstructions	Yes
	Easy & safe access and egress available	Yes

Sampling Location / Platform Recommendations

Although the platform does not meet the requirements specified in Environment Agency Guidance Note M1 and BS EN 15259, it is adequate for the monitoring specified in the Site Specific Protocol.

Instrumental Gas Analyser Calibrations

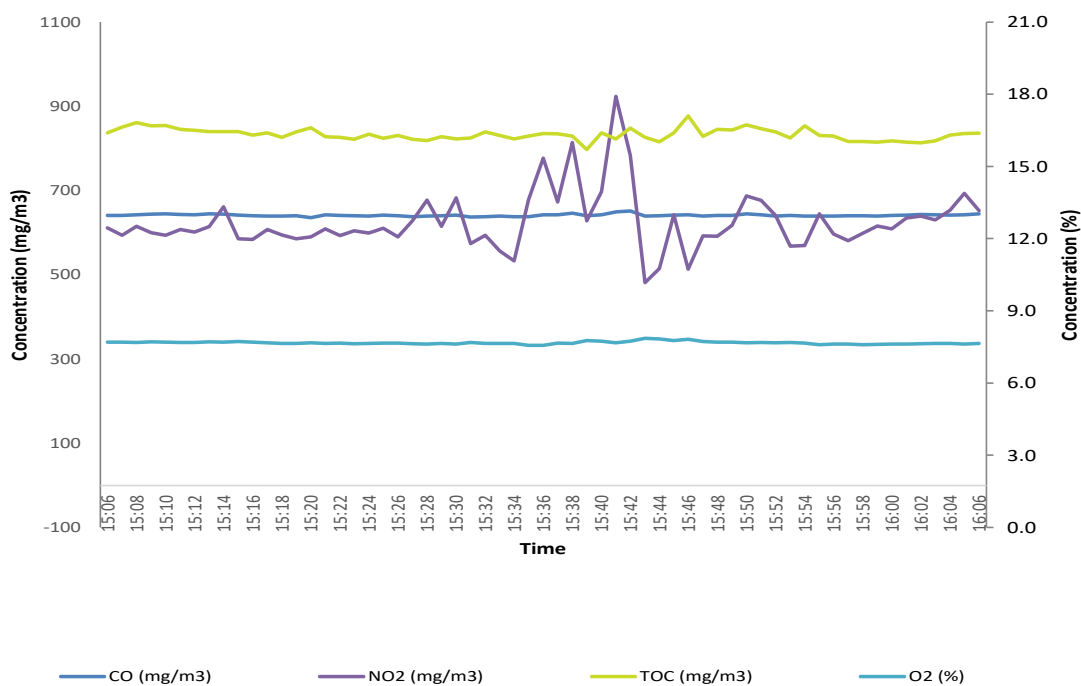
Date	Operators	Combustion Gas Analyser	Flame Ionisation Detector
17/08/2023	TA/MK	ETC-S12.03	ETC-S13.04

Calibration Gas	Certified Concentration	Analyser Range	T90 Time	Analyser Span	Pre-sample Cal		Post-sample Cal		Zero Drift (%)	Span Drift (%)	Drift Acceptable
					Zero	Span	Zero	Span			
Carbon Monoxide	161ppm	200ppm	67	161	0.00	161	0.30	158	0.19	-2.05	Yes
Nitrogen Monoxide	201.9ppm	250ppm	67	202	0.00	202	0.40	198	0.20	-2.03	Yes
Propane	81ppm	100ppm	65	81.0	-0.10	81.0	-1.50	82.0	-1.85	3.09	Yes
Oxygen	20.77%	25%	57	20.8	-0.08	20.8	-0.22	20.4	-1.06	-0.72	Yes

Instrumental Gas Analyser Results

Substance	Run	Corrected Concentration			Units	Basis	O ₂ Correction
		Average	Max	Min			
Carbon Monoxide	1	641	651	636	mg/m ³	-	5%
Oxides of Nitrogen (as NO ₂)	1	625	923	481	mg/m ³	NO _x as NO ₂	5%
Total VOC	1	833	877	797	mg/m ³	VOC as C	5%
Oxygen	1	7.7	7.8	7.6	%	-	-

Instrumental Gas Analyser Chart - Run 1



Sulphur Dioxide - Run 1 Calculations

Sampling Details		
Meter Box Number	8.05 (b)	-
Gas Meter Coefficient	0.956	-
Pitot Coefficient	-	-
Stack Gas Molecular Weight	30.2	g/mole
Static Pressure in Stack		cmH ₂ O

Analysis Details		
Collection Media	H2O2	
1st Collector Reference	Imp A&B	
1st Collector Concentration	123.487	µg
2nd Collector Reference	Imp C	
2nd Collector Concentration	5.934	µg
Blank Concentration	< 0.20	mg/Nm ³
Has breakthrough occurred?	No	-

Isokineticity Details		
Nozzle Diameter	-	mm
Average Gas Meter Temperature	21.0	°C
Average Stack Temperature	450	°C
Average Stack Velocity	-	m/s
Isokineticity	-	%

Date	Operators
17/09/2023	TA/JD

Parameter	Before	After	Unit
Barometric Pressure	1019	1019	mbar
Ambient Temperature	19.0	20.0	°C
Leak Check	0.01	0.01	L/min
Time	14:06	15:06	-

Emissions Calculations		
Total Sampling Time	60.0	min
Gas Meter Difference	86.8	L
Corrected Gas Meter Volume	83.0	L
Mean Sampling Rate	1.4	L/min
Gas Meter Volume (STP Dry)	0.078	Nm ³
Gas Meter Volume (REF)	0.065	Nm ³
Stack Gas Water Vapour Content	10.1	% v/v
Stack Gas Oxygen Content	7.7	% v/v
Emission Limit Value	350	mg/Nm ³
Concentration (REF)	2.00	mg/Nm ³
Mass Emissions (REF)	-	g/hr

Reference conditions (REF) are: 273k, 101.3kPa, Dry Gas, 5% O₂.

Uncertainty

Uncertainty of Carbon Monoxide by Horiba Gas Analyser - Run 1

Parameter	Value	Unit
Emission Limit Value (ELV)	1400	mg/m ³
Reading	512.8	ppm
Span Gas Certified Value	161	ppm
Range	200	ppm

Cal Gas
CO

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u ²
Zero Drift/Lower limit of detection (ppm)	0.10	Rectangular	1.73	0.06	0.003
Span Drift (ppm)	3.0	Rectangular	1.73	1.73	3.00
Linearity (% of value)	0.46	Rectangular	1.73	1.36	1.85
Setting Gas Divider (% of value)	0.35	Normal	1.00	1.79	3.22
Interference (% of value)	-0.48	Rectangular	1.73	-1.42	2.02
Standard deviation of repeatability at zero point (% of range)	0.10	Rectangular	-	0.20	0.04
Standard deviation of repeatability at span point (% of range)	0.20	Rectangular	-	0.40	0.16
Total					10.30
Combined Standard Uncertainty [(sum u²)^{0.5}]					3.21
Expanded Total Uncertainty (ppm) (95% confidence)					6.3
Expanded Total Uncertainty as a % of emission conc. (95% confidence)					1
Expanded Total Uncertainty (mg/m³) (95% confidence)					7.9
Expanded Total Uncertainty as a % of emission limit value (95% confidence)					0.6

Uncertainty of Oxides of Nitrogen by Horiba Gas Analyser - Run 1

Parameter	Value	Unit
Emission Limit Value (ELV)	500	mg/m ³
Reading	304.4	ppm
Span Gas Certified Value	202	ppm
Range	250	ppm

Cal Gas
NO

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u ²
Zero Drift/Lower limit of detection (ppm)	0.00	Rectangular	1.73	0.00	0.000
Span Drift (ppm)	3.70	Rectangular	1.73	2.14	4.56
Linearity (% of value)	0.76	Rectangular	1.73	1.34	1.78
Setting Gas Divider (% of value)	0.35	Normal	1.00	1.07	1.14
Interference (% of value)	0.63	Rectangular	1.73	1.11	1.23
Standard deviation of repeatability at zero point (% of range)	0.00	Rectangular	-	0.000	0.000
Standard deviation of repeatability at span point (% of range)	0.10	Rectangular	-	0.25	0.06
Total					8.77
Combined Standard Uncertainty [(sum u²)^{0.5}]					2.96
Expanded Total Uncertainty (ppm) (95% confidence)					5.8
Expanded Total Uncertainty as a % of emission conc. (95% confidence)					1.9
Expanded Total Uncertainty (mg/m³) (95% confidence)					11.9
Expanded Total Uncertainty as a % of emission limit value (95% confidence)					2.4

Uncertainty of Total VOC by FID - Run1

Parameter	Value	Unit
Emission Limit Value (ELV)	1000	mg/m³
Reading	518.11	ppm
Span Gas Certified Value	81.0	ppm
Range	100	ppm

Cal Gas
C ₃ H ₈

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u²
Zero Drift/Lower limit of detection (ppm)	1.40	Rectangular	1.73	0.81	0.65
Span Drift (ppm)	-1.00	Rectangular	1.73	-0.58	0.33
Linearity (% of value)	0.19	Rectangular	1.73	0.57	0.32
Setting Gas Divider (% of value)	0.35	Normal	1.00	1.81	3.29
Noise (ppm)	0.10	Rectangular	1.73	0.06	0.003
Temperature Drift (% of value)	1.0	Rectangular	1.73	2.99	8.95
Standard deviation of repeatability at zero point (% of range)	0.20	Rectangular	-	0.20	0.04
Standard deviation of repeatability at span point (% of range)	0.20	Rectangular	-	0.20	0.04
Total					13.63
Combined Standard Uncertainty [(sum u²)^{0.5}]					3.69
Expanded Total Uncertainty (ppm) (95% confidence)					7.24
Expanded Total Uncertainty as a % of emission conc. (95% confidence)					1
Expanded Total Uncertainty (mg/m³) (95% confidence)					11.6
Expanded Total Uncertainty as a % of emission limit value (95% confidence)					1.2

Uncertainty of Oxygen by Horiba Gas Analyser - Run 1

Parameter	Value	Unit
Reading	7.7	%
Span Gas Certified Value	20.8	%
Range	25.0	%

Cal Gas
O ₂

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u²
Zero Drift/Lower limit of detection (%vol)	0.32	Rectangular	1.73	0.18	0.0341
Span Drift (%vol)	0.37	Rectangular	1.73	0.21	0.0456
Linearity (% of value)	0.24	Rectangular	1.73	0.01	0.00011
Setting Gas Divider (% of value)	0.35	Normal	1.00	0.03	0.0007
Interference (% of value)	0.00	Rectangular	1.73	0.000	0.000
Standard deviation of repeatability at zero point (% of range)	0.02	Rectangular	-	0.005	0.00003
Standard deviation of repeatability at span point (% of range)	0.02	Rectangular	-	0.005	0.00003
Total					0.081
Combined Standard Uncertainty [(sum u²)^{0.5}]					0.28
Expanded Total Uncertainty (%) (95% confidence)					0.56
Expanded Total Uncertainty as a % of emission conc. (95% confidence)					7.3

Uncertainty of Sulphur Dioxide - Run 1

Parameter	Value	Unit
Emission Limit Value (ELV)	350	mg/m³
Mean Sampling Rate	1.4	L/min
Leak Rate	0.01	L/min
Barometric Pressure	1019	mbar
Average Stack Temperature	450	°C
Sampled Stack Gas Volume	87	L

Parameter	Value	Unit
Mean Emission Concentration	2.004	mg/m³
Monitoring Duration	60	min
Console ID	8.05 (b)	-
Temperature Uncertainty	0.24	°C
Gas Meter Uncertainty	0.37	%
Barometer Uncertainty	1.0	mbar

Source of Uncertainty	ASD*	BS EN 14791		Certified Value	Units	% Actual Value	Source Uncertainty u	Combined Uncertainty u²
		Uncertainty Criteria	Max. Value					
Analysis Procedure	Std	<2.5% of measured value	-	7.7	%	3.9	0.08	0.01
Leak Rate	Rect	<2% of sampling rate	0.03	0.01	L/min	0.72	0.0084	0.0001
Time	Std	1sec in 1hour = 0.028%	2.0	1.0	sec	0.03	0.0006	0.000003
Gasmeter Volume	Std	<2.5% volume of gas	2.2	0.32	L	0.37	0.01	0.0001
Temperature	Std	<1% absolute temperature	4.5	0.24	°C	0.05	0.001	0.00000
Pressure	Std	<1% absolute pressure	10.2	1.0	mbar	0.10	0.002	0.000004
Total								0.01
Combined Standard Uncertainty $[(\sum u^2)^{0.5}]$								0.08
Expanded Total Uncertainty as a % of emission conc. (95% confidence)								7.8
Expanded Total Uncertainty (mg/m³) (95% confidence)								0.16
Expanded Total Uncertainty as a % of emission limit value (95% confidence)								0.04

Document Version Number	Record of change within different version numbers
V1	Original version of the document issued to client.