



Assured Environmental

SOURCE EMISSIONS MONITORING – BUTTONDERRY

LMS

Project ID. 12303

R_0

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Table 1: Document approval

	Name	Position Title	Signature	Date
Author	Aaron Dobson	Senior Consultant		03.03.2020
Reviewer	Adam Dixon	Senior Consultant		04.08.2020
Approver	Aaron Dobson	Senior Consultant		04.08.2020

Table 2: Revision register

Revision	Date	Issued by	Issued to	Comment
R_0	04.03.2020	A. Dobson	Kara Richardson	Initial release

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ACCREDITED FOR COMPLIANCE TO ISO/IEC 17025 TESTING

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Accreditation ID: 19703



EXECUTIVE SUMMARY

The objective of this project was to measure stack emissions from the generator operated by LMS at the Buttonderry renewable energy facility. Emissions are to be measured from each unit at least once every 5 years and compared to compliance conditions as specified in the Environmental Protection Licence 20059. The results in table 3 provide an overview of the test results collected in February 2020.

Table 3: Executive summary – release limits

Release Point Parameter	Unit of Measure	GMI	License Limit
Date of testing	dd-mm-yy	11/02/2020	-
Average stack temperature	°C	450	-
Moisture	%	6.0	-
Average carbon dioxide content	%	11.6	-
Average oxygen content	%	7.9	-
Dry gas density	kg/Nm ³	1.35	-
Dry gas molecular weight	g/g mole	30.2	-
Sample volume (dry gas meter)	Nm ³	0.224	-
Exhaust Velocity	m/sec	38.7	-
Dry standard stack flow rate	Nm ³ /sec	0.969	-
Sulphur dioxide emission rate	mg/Nm ³ g/min	< 2.86 < 0.166	- -
Oxides of nitrogen (NO ₂) NOx Concentration at 7 % O ₂ emission rate	mg/Nm ³ mg/Nm ³ g/min	415 444 24.1	- 450 -
Carbon monoxide CO Concentration at 7 % O ₂ emission rate	mg/Nm ³ mg/Nm ³ g/min	1,217 1,301 70.8	- - -
SO ₃ (as H ₂ SO ₄ mist) emission rate	mg/Nm ³ g/min	6.38 0.371	100 -
TVOC emission rate	mg/Nm ³ g/min	7.51 0.437	- -

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1 INTRODUCTION

Assured Environmental (AE) was appointed by LMS Generation to monitor source emissions at the facility in Buttonderry, New South Wales. One Generator Module (GMI) was tested on this visit.

Sampling was conducted by AE on the 11th of February 2020. Sampling work was conducted from an Elevated Work Platform (EWP) to access the sampling ports.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed below in this report.

2 METHODOLOGY & EQUIPMENT

2.1 Sampling methodology

All sampling and analysis was carried in accordance to the listed requirements in table 4. Any sample specific comments have been documented where required.

Table 4: Test methods

Parameter	Test Method	Analysis	Deviations	NATA
Sample plane criteria	AS 4323.1	1	Nil	Yes
Gas velocity and temperature	TM-2	1	Nil	Yes
Stack gas density	TM-23	1	Nil	Yes
Oxygen & carbon dioxide	TM-24 & 25	1	A	Yes
Moisture	TM-22	1	Nil	Yes
Sulphuric acid mist (as SO ₃)	TM-3	1	B	Yes
Sulphur dioxide	TM-4	1	Nil	Yes
Nitrogen oxides	TM-11	1	A	Yes
Volatile organic compounds	OM-2	2	Nil	Yes
Carbon monoxide	OM-1	1	A	Yes

Table 5: Analysis notes

Note	Company	Work performed	NATA ID	Report Number
1	AE Pty Ltd	Sampling & analysis	19703	12303
2	Envirolab Services	Analysis	2901	236938

Table 6: Comment

Note	Comment
A	Pre & post calibration of the analyser was completed in the laboratory.
B	At the source temperature no sulphuric acid mist is present, a constant flow sample train was used for the determination.

2.2 Sampling location



Figure 1: Sample location

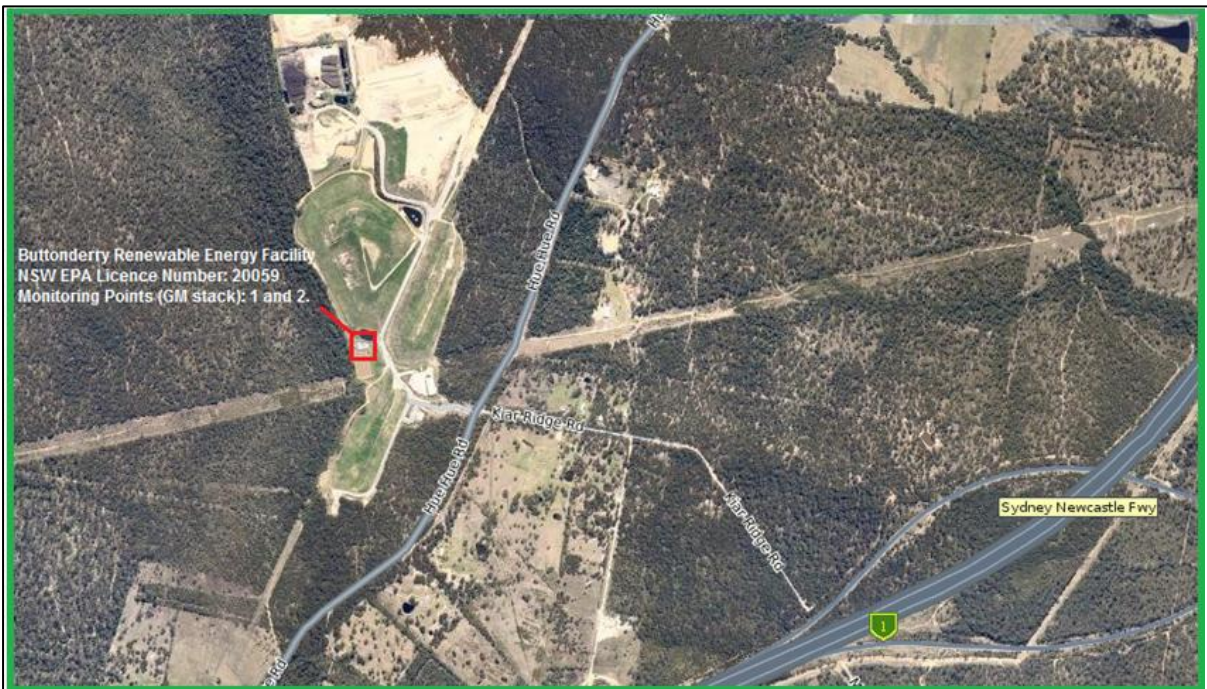


Figure 2: Site location

2.3 Test equipment

All equipment used during the course of the testing meets or exceeds all relevant performance standards as required by all jurisdictions. Combustion gases were monitored using a MRU Optima7 flue gas analyser.



Figure 3: MRU Optima7 Flue Gas Analyser

2.4 Sampling Notes

- **NOTES on engine operating conditions**
 - Emissions were relatively stable throughout the testing period.
 - See table 7 for operating conditions

Table 7: Operating conditions

Item	Buttonderry
Source	GMI
Operation	Automatic
Load	-1123Kw
Methane content	57.8%

3 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

AE operates within a quality system based upon the requirements of ISO17025. Our quality system defines specific procedures and methodologies to ensure any project undertaken by AE is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure representativeness of field work, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure representativeness of lab work, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

AE maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in section 2 of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures has been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 8: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 9: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

4 DEFINITIONS

The following terms and abbreviations may be used in this report:

Table 10: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am ³	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
°C	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
f/ml	Fibres per millilitre
g	Grams
kg	Kilograms
m	Metres
m ³	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10 ⁻³ grams)
min	Minute
ml	Millilitres
mmH ₂ O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10 ⁻⁹ grams)
NATO	North Atlantic Treaty Organisation
NIOSH	National institute for occupational safety and health (USA)
Nm ³	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM TVOC	Non methane volatile organic compounds (total)
NR	Not required on this occasion
OSHA	Occupational Safety and Health Act
ou	Odour unit
PCDD	Polychlorinated dibenzo- <i>p</i> -dioxin
PCDF	Polychlorinated dibenzofuran
PM	Particulate matter
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm ³	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O ₂)
STP	Standard temperature and pressure (0°C and 101.3 kPa)
TO	USEPA air toxics method
TWA	Time weighted average
USEPA	United States Environmental Protection Authority

5 RESULTS

Table 11: Sample information

RESULTS				
Source Data				
Client				LMS
Site				Buttonderry
Sample Point				GM1
Reference Method				USEPA Method 8 - CONSTANT FLOW
Test Parameters				SO3, TVOC & Gases
Process conditions				1123kw / 57.8% methane
Historical Data & Hardware Information - Manual Sample				
Run Start Date		dd-mm-yy		11/02/2020
Project ID				12303
Run ID				-1
Run Start Time	Ti	hh:mm		9:50
Run Stop Time	Tf	hh:mm		10:50
Positioning compliance check with AS4323.1				Non-ideal
Flow & temperature compliance check with AS4323.1				YES
Traverse pt factors; up, down, total & trav pts				1.05 , 1 , 1.05 , 1
Console Serial Number				SN576
Meter Calibration Factor	(Y)			0.999
Stack Test Data				
Initial Meter Volume	(Vm)i	m ³		0.00
Final Meter Volume	(Vm)f	m ³		0.250
Actual Sampling Time	(Q)	minutes		60
Average Meter Temperature	(tm)avg	°C		30.0
Average Stack Temperature	(ts)avg	°C		450
Barometric Pressure	(Pb)	mb		1009
Stack Static Pressure	(Pstatic)	mm H ₂ O		30
Absolute Stack Pressure	(Ps)	mb		1012
Sample Volumes				
Actual Meter Volume	(Vm)	m ³		0.250
Standard Meter Volume	(Vm)std	Nm ³		0.224
Moisture Content Data				
Water vapour concentration	(Bws(calc))	%		6.00
Stack Gas Density Analysis Data				
Carbon Dioxide Percentage	(%CO ₂)	%		11.6
Oxygen Percentage	(%O ₂)	%		7.90
Carbon Monoxide Percentage	(%CO)	%		0.10
Nitrogen Percentage	(%N ₂)	%		80.4
Dry Gas Molecular Weight	(Md)	kg/Nm ³		1.35
Dry Gas Molecular Weight	(Md)	g/g-mole		30.2
Wet Stack Gas Molecular Weight	(Ms)	g/g-mole		29.4
Volumetric Flow Rate Data (at Sample Plane)				
Average Stack Gas Velocity	(vs)	m/sec		38.7
Stack Diameter	Ds	m		0.30
Stack Cross-Sectional Area	(As)	m ²		0.071
Upstream distance (from disturbance)	B	m		1.50
Downstream distance (from disturbance)	A	m		0.50
Actual Stack Flow Rate	(Qaw)	m ³ /min		164.0
Wet Standard Stack Flow Rate	(Qsw)	Nm ³ /min-wet		61.9
Dry Standard Stack Flow Rate	(Qsd)	Nm ³ /min-dry		58.1
Instrumental Analyser - Historical Data & Hardware Information				
Analyser serial number, make & model		value		SN450
Analyser Run Start Time	Ti	hh:mm		9:50
Analyser Run Stop Time	Tf	hh:mm		10:50
Analyser Total Sampling Time	(Q)	hh:min		1:00
Instrumental Analyser Raw Data Averages				
Sulphur Dioxide	(SO ₂)	ppm	<	1.0
Oxides of Nitrogen	(NO _x)	ppm		202
Carbon Monoxide	(CO)	ppm		973
Average Sulphur Dioxide (USEPA Method 6C - instrumental analyser)				
Sulphur Dioxide (SO ₂)	(Conc)	mg/Nm ³	<	2.86
Sulphur Dioxide at 7 % O ₂	(Conc)	mg/Nm ³	<	3.06
Sulphur Dioxide (SO ₂)	(E)	g/min	<	0.17
Average Oxides of Nitrogen (USEPA Method 7E - instrumental analyser)				
Nitrogen Oxides (NO _x as NO ₂)	(Conc)	mg/Nm ³		415
Nitrogen Oxides at 7 % O ₂	(Conc)	mg/Nm ³		444
Nitrogen Oxides (NO _x as NO ₂)	(E)	g/min		24.1
Average Carbon Monoxide (USEPA Method 10 - instrumental analyser)				
Carbon Monoxide (CO)	(Conc)	mg/Nm ³		1217
Carbon Monoxide at 7 % O ₂	(Conc)	mg/Nm ³		1301
Carbon Monoxide (CO)	(E)	g/min		70.8
SO3 & NMVOC				
SO3 (as H2SO4 mist)	(Conc)	mg/Nm ³		6.38
SO3 (as H2SO4 mist) emission rate	(E)	g/min		0.37
Non-methane TVOC	(Conc)	mg/Nm ³		7.51
Non-methane TVOC emission rate	(E)	g/min		0.44

Table 12: Combustion gas averages

Combustion Gas Source Data				
Site			LMS	
Sample Location			GMI	
Reference Method			USEPA Method 7E	
Run ID			1	
Date	dd/mm/yyyy		11/02/2020	
Start Time	hh:mm		9:50:00	
End Time	hh:mm		10:50:00	
Total Sample Time	hh:mm		1:00:00	
Average Stack Temperature	°C		450	
Absolute Stack Pressure	mb		1012	
Stack Moisture Content	%		6.0	
Actual Stack Flow Rate	m ³ /min		164	
Dry Standard Stack Flow Rate	Nm ³ /min		58	
Gas Analysis Data		Average	Minimum	Maximum
Carbon Dioxide	% v/v	11.6	11.0	11.8
Oxygen	% v/v	7.90	7.84	7.97
Carbon Monoxide	ppm	973	943	1009
Oxides of Nitrogen	ppm	202	175	213
Oxides of Nitrogen - USEPA Method 7E				
NOx - concentration	mg/Nm ³	415	359	437
Nitrogen Oxides at 7 % O2 reference	mg/Nm ³	444	383	470
NOx - emission rate	g/min	24.1	20.9	25.4
Carbon Monoxide - USEPA Method 10				
CO - concentration	mg/Nm ³	1217	1179	1262
Carbon monoxide at 7 % O2 reference	mg/Nm ³	1301	1255	1356
CO - emission rate	g/min	70.8	68.6	73.4