Ektimo

Santos Limited, Wilga Park

Emission Testing Report

Report Number R013473

Document Information

Template Version 190722

Client Name:	Santos Limited
Report Number:	R013473
Date of Issue:	15 December 2022
Attention:	Abigail Kahi
Address:	Level 22, 32 Turbot Street BRISBANE QLD 4000
Testing Laboratory:	Ektimo Pty Ltd, ABN 86 600 381 413

Report Authorisation

Aaron Davis
Operations Manager

NATA Accredited Laboratory
No. 14601

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration, and inspection reports.

Please note that only numerical results pertaining to measurements conducted directly by Ektimo are covered by Ektimo's terms of NATA accreditation as described in the Test Methods table. This does not include calculations that use data supplied by third-parties, comments, conclusions, or recommendations based upon the results. Refer to 'Test Methods' for full details of testing covered by NATA accreditation.

Table of Contents

1 Executive Summary

1.1 Background

Ektimo was engaged by Santos Limited to perform emission testing from gas fired engines situated at their Wilga Park plant.

1.2 Project Objective

The objective of the project was to conduct a monitoring programme to quantify emissions from multiple discharge points to determine compliance with Santos Limited's Development Approval DA07-0023.

Monitoring was performed as follows:

Location	Test Date	Test Parameters*
GO1A	16 November 2022	Solid particles Nitrogen oxides (NO_x) Nitric oxide (NO) Nitrogen dioxide (NO_2) Carbon monoxide Carbon dioxide Oxygen Sulfur dioxide Sulfur trioxide
GO3B		
GO5B		
GO2A	17 November 2022	
GO3A		
GO4B		
GO6A		

* Flow rate, velocity, temperature, and moisture were also determined.

Emission testing was conducted on all engines at Wilga Park that were operational on the designated occasion for monitoring.

At time of sampling, engines 1MW units G04A, G05A and 3MW unit GO6B were offline.

Santos Operators have advised G04A has been offline since February 2022 and G05A offline since April 2022. Both units will likely be offline for the remainder of 2022 as both have a faulty PLC awaiting parts.

Additionally, GO6B was offline for servicing.

All results are reported on a dry basis at STP.

Plant operating conditions have been noted in the report.

1.3 Results Summary

The following licence comparison table shows that all analytes highlighted in green are within the licence limit set by the Department of Planning DA 07_0023.

Location Description	Pollutant	Units	Department Planning limit	Detected values	Corrected to 3% O_3
GO1A	Oxides of Nitrogen (as NO_2)	mg/m^3	450	230	420
GO2A	Oxides of Nitrogen (as NO_2)	mg/m^3	450	170	330
GO3A	Oxides of Nitrogen (as NO_2)	mg/m^3	450	280	420
GO3B	Oxides of Nitrogen (as NO_2)	mg/m^3	450	210	410
GO4B	Oxides of Nitrogen (as NO_2)	mg/m^3	450	200	400
GO5B	Oxides of Nitrogen (as NO_2)	mg/m^3	450	220	440
GO6A	Oxides of Nitrogen (as NO_2)	mg/m^3	450	280	440

Please note that the measurement uncertainty associated with the test results was not considered when determining whether the results were compliant or non-compliant.

Refer to the Test Methods table for the measurement uncertainties.

2 Results

2.1 GO1A

Date	16/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO1A
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 3000kW		221110

Sampling Plane Details		
Sampling plane dimensions	600 mm	
Sampling plane area	0.283 m²	
Sampling port size, number	4" Flange (x2)	
Access & height of ports	Elevated work platform 10 m	
Duct orientation & shape	Vertical Circular	
Downstream disturbance	Exit 8 D	
Upstream disturbance	Change in diameter 3 D	
No. traverses & points sampled	2 12	
Sample plane conformance to AS 4323.1	Conforming but non-ideal	

The sampling plane is deemed to be non-ideal due to the following reasons:
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	8.5	
Gas molecular weight, g/g mole	28.5 (wet)	29.4 (dry)
Gas density at STP, kg/m³	1.27 (wet)	1.31 (dry)
Gas density at discharge conditions, kg/m³	0.51	
% Oxygen correction & Factor	3 %	1.88
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1425 & 1535	
Temperature, °C	391	
Temperature, K	664	
Velocity at sampling plane, m/s	37	
Volumetric flow rate, actual, m³/s	10	
Volumetric flow rate (wet STP), m³/s	4.2	
Volumetric flow rate (dry STP), m³/s	3.8	
Mass flow rate (wet basis), kg/hour	19000	

Gas Analyser Results	Average		
Sampling time	1430 - 1529		
		Corrected to	
	Concentration mg/m³	3% O2 mg/m³	Mass Rate g/min
Combustion Gases			
Nitric oxide (as NO_2)	220		51
Nitrogen dioxide (as NO_2)	<2		<0.5
Nitrogen oxides (as NO_2)	230	420	52
Sulfur dioxide	<6		<1
Carbon monoxide	410		93
	Concentration % v/v		
Carbon dioxide	5.3		
Oxygen	11.4		

Isokinetic Results	Results	
Sampling time	1430-1532	
	Concentration mg/m³	Mass Rate g/min
Solid Particles	<3	<0.6
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.053	0.012
Isokinetic Sampling Parameters		
Sampling time, min	60	
Isokinetic rate, %	98	
Gravimetric analysis date (total particulate)	07-12-2022	

2.2 GO3B

Date	16/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO3B
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 3000kW		221110

Sampling Plane Details	
Sampling plane dimensions	600 mm
Sampling plane area	0.283 m²
Sampling port size, number	4" Flange (x2)
Access & height of ports	Elevated work platform 10 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Change in diameter 3 D
No. traverses & points sampled	2 12
Sample plane conformance to AS 4323.1	Conforming but non-ideal

The sampling plane is deemed to be non-ideal due to the following reasons:
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	8.4	
Gas molecular weight, g/g mole	28.5 (wet)	29.4 (dry)
Gas density at STP, kg/m³	1.27 (wet)	1.31 (dry)
Gas density at discharge conditions, kg/m³	0.52	
% Oxygen correction & Factor	3 %	1.92
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1235 & 1345	
Temperature, °C	375	
Temperature, K	648	
Velocity at sampling plane, m/s	36	
Volumetric flow rate, actual, m³/s	10	
Volumetric flow rate (wet STP), m³/s	4.1	
Volumetric flow rate (dry STP), m³/s	3.8	
Mass flow rate (wet basis), kg/hour	19000	

Gas Analyser Results	Average		
Sampling time	1243 - 1342		
	Concentration mg/m³	Corrected to 3% O2 mg/m³	Mass Rate g/min
Combustion Gases			
Nitric oxide (as NO_2)	210		48
Nitrogen dioxide (as NO_2)	<2		<0.5
Nitrogen oxides (as NO_2)	210	410	48
Sulfur dioxide	<6		<1
Carbon monoxide	550		130
	Concentration % v/v		
Carbon dioxide	5.3		
Oxygen	11.6		

Isokinetic Results	Results	
Sampling time	1240-1342	
	Concentration mg/m³	Mass Rate g/min
Solid Particles	<3	<0.6
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.05	0.011
Isokinetic Sampling Parameters		
Sampling time, min	60	
Isokinetic rate, %	99	
Gravimetric analysis date (total particulate)	07-12-2022	

2.3 GO5B

Date	16/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO5B
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 3000kW		221110

Sampling Plane Details		
Sampling plane dimensions	600 mm	
Sampling plane area	0.283 m²	
Sampling port size, number	4" Flange (x2)	
Access & height of ports	Elevated work platform 10 m	
Duct orientation & shape	Vertical Circular	
Downstream disturbance	Exit 8 D	
Upstream disturbance	Change in diameter 3 D	
No. traverses & points sampled	2 12	
Sample plane conformance to AS 4323.1	Conforming but non-ideal	

The sampling plane is deemed to be non-ideal due to the following reasons:
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	8.3	
Gas molecular weight, g/g mole	28.5 (wet)	29.4 (dry)
Gas density at STP, kg/m³	1.27 (wet)	1.31 (dry)
Gas density at discharge conditions, kg/m³	0.53	
% Oxygen correction & Factor	3 %	2.01
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1010 & 1120	
Temperature, °C	355	
Temperature, K	629	
Velocity at sampling plane, m/s	36	
Volumetric flow rate, actual, m³/s	10	
Volumetric flow rate (wet STP), m³/s	4.3	
Volumetric flow rate (dry STP), m³/s	3.9	
Mass flow rate (wet basis), kg/hour	20000	

Gas Analyser Results	Average		
Sampling time	1013 - 1112		
	Concentration mg/m³	Corrected to 3% O2 mg/m³	Mass Rate g/min
Combustion Gases			
Nitric oxide (as NO_2)	220		52
Nitrogen dioxide (as NO_2)	<2		<0.5
Nitrogen oxides (as NO_2)	220	440	52
Sulfur dioxide	<6		<1
Carbon monoxide	520		120
	Concentration % v/v		
Carbon dioxide	5		
Oxygen	12		

Isokinetic Results	Results	
Sampling time	1015-1116	
	Concentration mg/m³	Mass Rate g/min
Solid Particles	<2	<0.6
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.04	0.0095
Isokinetic Sampling Parameters		
Sampling time, min	60	
Isokinetic rate, %	99	
Gravimetric analysis date (total particulate)	07-12-2022	

2.4 GO2A

Date	17/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO2A
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 3000kW		221110

Sampling Plane Details	
Sampling plane dimensions	600 mm
Sampling plane area	0.283 m²
Sampling port size, number	4" Flange (x2)
Access & height of ports	Elevated work platform 10 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Change in diameter 3 D
No. traverses & points sampled	2 12
Sample plane conformance to AS 4323.1	Conforming but non-ideal

The sampling plane is deemed to be non-ideal due to the following reasons:
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	8.4	
Gas molecular weight, g/g mole	28.5 (wet)	29.5 (dry)
Gas density at STP, kg/m³	1.27 (wet)	1.32 (dry)
Gas density at discharge conditions, kg/m³	0.51	
% Oxygen correction & Factor	3 %	1.91
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	0930 & 1040	
Temperature, °C	387	
Temperature, K	660	
Velocity at sampling plane, m/s	37	
Volumetric flow rate, actual, m³/s	10	
Volumetric flow rate (wet STP), m³/s	4.2	
Volumetric flow rate (dry STP), m³/s	3.8	
Mass flow rate (wet basis), kg/hour	19000	

Gas Analyser Results	Average		
Sampling time	0935 - 1034		
		Corrected to	
	Concentration	3% O2	Mass Rate
Combustion Gases	mg/m³	mg/m³	g/min
Nitric oxide (as NO_2)	170		40
Nitrogen dioxide (as NO_2)	<2		<0.5
Nitrogen oxides (as NO_2)	170	330	40
Sulfur dioxide	<9		<2
Carbon monoxide	610		140
	Concentration		
	% v/v		
Carbon dioxide	5.5		
Oxygen	11.6		

Isokinetic Results	Results	
Sampling time	0935-1037	
	Concentration	Mass Rate
	mg/m³	g/min
Solid Particles	<3	<0.6
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.057	0.013
Isokinetic Sampling Parameters		
Sampling time, min	60	
Isokinetic rate, %	99	
Gravimetric analysis date (total particulate)	07-12-2022	

2.5 GO3A

Date	17/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO3A
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 1000kW		221110

Sampling Plane Details	
Sampling plane dimensions	320 mm
Sampling plane area	0.0804 m²
Sampling port size, number	Sampled at exit
Access & height of ports	Fixed ladder 4 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 0 D
Upstream disturbance	Exit 0 D
No. traverses & points sampled	2 8
Sample plane conformance to AS 4323.1	Non-conforming

The sampling plane is deemed to be non-conforming due to the following reasons:
The highest to lowest gas velocity ratio exceeds 1.6:1
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane
The stack or duct does not have the required number of access holes (ports)

Stack Parameters		
Moisture content, %v/v	11	
Gas molecular weight, g/g mole	28.3 (wet)	29.6 (dry)
Gas density at STP, kg/m³	1.26 (wet)	1.32 (dry)
Gas density at discharge conditions, kg/m³	0.44	
% Oxygen correction & Factor	3 %	1.53
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1435 & 1550	
Temperature, °C	492	
Temperature, K	765	
Velocity at sampling plane, m/s	40	
Volumetric flow rate, actual, m³/s	3.2	
Volumetric flow rate (wet STP), m³/s	1.1	
Volumetric flow rate (dry STP), m³/s	0.99	
Mass flow rate (wet basis), kg/hour	5100	

Gas Analyser Results	Average		
Sampling time	1440 - 1539		
	Concentration	Corrected to 3% O2	Mass Rate
	mg/m³	mg/m³	g/min
Combustion Gases			
Nitric oxide (as NO_2)	270		16
Nitrogen dioxide (as NO_2)	7.4		0.44
Nitrogen oxides (as NO_2)	280	420	16
Sulfur dioxide	<9		<0.5
Carbon monoxide	390		24
	Concentration % v/v		
Carbon dioxide	6.9		
Oxygen	9.2		

Isokinetic Results	Results	
Sampling time	1440-1545	
	Concentration mg/m³	Mass Rate g/min
Solid Particles	<3	<0.2
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.047	0.0028
Isokinetic Sampling Parameters		
Sampling time, min	64	
Isokinetic rate, %	99	
Gravimetric analysis date (total particulate)	07-12-2022	

2.6 GO4B

Date	17/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO4B
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 3000kW		221110

Sampling Plane Details	
Sampling plane dimensions	600 mm
Sampling plane area	0.283 m²
Sampling port size, number	4" Flange (x2)
Access & height of ports	Elevated work platform 10 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Change in diameter 3 D
No. traverses & points sampled	2 12
Sample plane conformance to AS 4323.1	Conforming but non-ideal

The sampling plane is deemed to be non-ideal due to the following reasons:
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	8.8	
Gas molecular weight, g/g mole	28.4 (wet)	29.5 (dry)
Gas density at STP, kg/m³	1.27 (wet)	1.31 (dry)
Gas density at discharge conditions, kg/m³	0.53	
% Oxygen correction & Factor	3 %	1.95
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1110 & 1220	
Temperature, °C	365	
Temperature, K	638	
Velocity at sampling plane, m/s	37	
Volumetric flow rate, actual, m³/s	11	
Volumetric flow rate (wet STP), m³/s	4.4	
Volumetric flow rate (dry STP), m³/s	4	
Mass flow rate (wet basis), kg/hour	20000	

Gas Analyser Results	Average		
Sampling time	1115 - 1214		
	Concentration mg/m³	Corrected to 3% O2 mg/m³	Mass Rate g/min
Combustion Gases			
Nitric oxide (as NO_2)	200		49
Nitrogen dioxide (as NO_2)	<2		<0.5
Nitrogen oxides (as NO_2)	200	400	49
Sulfur dioxide	<9		<2
Carbon monoxide	460		110
	Concentration % v/v		
Carbon dioxide	5.4		
Oxygen	11.7		

Isokinetic Results	Results	
Sampling time	1115-1217	
	Concentration mg/m³	Mass Rate g/min
Solid Particles	<2	<0.6
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.058	0.014
Isokinetic Sampling Parameters		
Sampling time, min	60	
Isokinetic rate, %	100	
Gravimetric analysis date (total particulate)	07-12-2022	

2.7 GO6A

Date	17/11/2022	**Client**	Santos Limited
Report	R013473	**Stack ID**	GO6A
Licence No.	DA 07_0023	**Location**	Wilga Park
Ektimo Staff	Aaron Davis / Scott Woods	**State**	NSW
Process Conditions	Engine operating at 1000kW		221110

Sampling Plane Details	
Sampling plane dimensions	320 mm
Sampling plane area	0.0804 m²
Sampling port size, number	Sampled at exit
Access & height of ports	Fixed ladder 4 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 0 D
Upstream disturbance	Exit 0 D
No. traverses & points sampled	2 8
Sample plane conformance to AS 4323.1	Non-conforming

The sampling plane is deemed to be non-conforming due to the following reasons:
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane
The stack or duct does not have the required number of access holes (ports)

Stack Parameters		
Moisture content, %v/v	11	
Gas molecular weight, g/g mole	28.3 (wet)	29.6 (dry)
Gas density at STP, kg/m³	1.26 (wet)	1.32 (dry)
Gas density at discharge conditions, kg/m³	0.44	
% Oxygen correction & Factor	3 %	1.55
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1310 & 1420	
Temperature, °C	489	
Temperature, K	762	
Velocity at sampling plane, m/s	45	
Volumetric flow rate, actual, m³/s	3.7	
Volumetric flow rate (wet STP), m³/s	1.3	
Volumetric flow rate (dry STP), m³/s	1.1	
Mass flow rate (wet basis), kg/hour	5800	

Gas Analyser Results	Average		
Sampling time	1315 - 1414		
	Concentration	Corrected to 3% O2	Mass Rate
Combustion Gases	mg/m³	mg/m³	g/min
Nitric oxide (as NO_2)	280		19
Nitrogen dioxide (as NO_2)	2.2		0.15
Nitrogen oxides (as NO_2)	280	440	19
Sulfur dioxide	<9		<0.6
Carbon monoxide	420		29
	Concentration % v/v		
Carbon dioxide	6.7		
Oxygen	9.4		

Isokinetic Results	Results	
Sampling time	1315-1420	
	Concentration mg/m³	Mass Rate g/min
Solid Particles	<2	<0.1
Sulfur trioxide and/or Sulfuric acid (as SO3)	0.84	0.057
Isokinetic Sampling Parameters		
Sampling time, min	64	
Isokinetic rate, %	105	
Gravimetric analysis date (total particulate)	07-12-2022	

3 Plant Operating Conditions

The below plant operating conditions have been supplied by Santos Limited personnel.

Location	Test Date	Engine Operating Conditions
GO1A	16 November 2022	3000kW
GO3B		3000kW
GO5B		3000kW
GO2A	17 November 2022	3000kW
GO3A		1000kW
GO4B		3000kW
GO6A		1000kW

4 Test Methods

All sampling and analysis performed by Ektimo unless otherwise specified. Specific details of the methods are available upon request.

Parameter	Sampling method	Analysis method	Uncertainty*	NATA accredited Sampling	NATA accredited Analysis
Sampling points - Selection	NSW EPA TM-1 (AS 4323.1)	NA	NA	✓	NA
Flow rate, temperature & velocity	NSW EPA TM-2 (USEPA Method 2)	NSW EPA TM-2 (USEPA Method 2)	8%, 2%, 7%	NA	✓
Moisture content	NSW EPA TM-22 (USEPA Alt-Method 008)	NSW EPA TM-22 (USEPA Alt-Method 008)	19%	✓	✓
Molecular weight	NA	NSW EPA TM-23 (USEPA Method 3)	not specified	NA	✓
Dry gas density	NA	NSW EPA TM-23 (USEPA Method 3)	not specified	NA	✓
Carbon dioxide	NSW EPA TM-24 (USEPA Method 3A)	NSW EPA TM-24 (USEPA Method 3A)	13%	✓	✓
Carbon monoxide	NSW EPA TM-32 (USEPA Method 10)	NSW EPA TM-32 (USEPA Method 10)	12%	✓	✓
Nitrogen oxides	NSW EPA TM-11 (USEPA Method 7E)	NSW EPA TM-11 (USEPA Method 7E)	12%	✓	✓
Oxygen	NSW EPA TM-25 (USEPA Method 3A)	NSW EPA TM-25 (USEPA Method 3A)	13%	✓	✓
Sulfur dioxide	NSW EPA TM-4 (USEPA Method 6C)	NSW EPA TM-4 (USEPA Method 6C)	12%	✓	✓
Solid particles (total)	NSW EPA TM-15 (AS 4323.2)	NSW EPA TM-15 (AS 4323.2)	3%	✓	✓††
Sulfuric acid mist and/or sulfur trioxide	NSW EPA TM-3 (USEPA Method 8)	Ektimo 235	16%	✓	✓†

221129

* Uncertainties cited in this table are estimated using typical values and are calculated at the 95% confidence level (coverage factor = 2).

† Analysis conducted at the Ektimo Mitcham, VIC laboratory, NATA accreditation number 14601. Result was reported on 5 December 2022 in report LV-003667.

†† Gravimetric analysis conducted at the Ektimo, NSW laboratory, NATA accreditation number 14601.

5 Quality Assurance/Quality Control Information

Ektimo is accredited by the National Association of Testing Authorities (NATA) for the sampling and analysis of air pollutants from industrial sources. Unless otherwise stated test methods used are accredited with the National Association of Testing Authorities. For full details, search for Ektimo at NATA's website www.nata.com.au.

Ektimo is accredited by NATA to ISO/IEC 17025 - Testing. ISO/IEC 17025 - Testing requires that a laboratory have adequate equipment to perform the testing, as well as laboratory personnel with the competence to perform the testing. This quality assurance system is administered and maintained by the Quality Director.

NATA is a member of APAC (Asia Pacific Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through mutual recognition arrangements with these organisations, NATA accreditation is recognised worldwide.

6 Compliance Summary

Emission monitoring was performed on each release point for a minimum of 60 minutes.

The measured parameters were found to be below the emission limits specified in the Santos Development Approval DA07_0023.

Location	Compliant/non-compliant with approval conditions
GO1A	Compliant
GO3B	Compliant
GO5B	Compliant
GO2A	Compliant
GO3A	Compliant
GO4B	Compliant
GO6A	Compliant

7 Definitions

The following symbols and abbreviations may be used in this test report:

% v/v	Volume to volume ratio, dry or wet basis
~	Approximately
<	Less than
>	Greater than
≥	Greater than or equal to
APHA	American Public Health Association, Standard Methods for the Examination of Water and Waste Water
AS	Australian Standard
BSP	British standard pipe
CARB	Californian Air Resources Board
CEM/CEMS	Continuous emission monitoring/Continuous emission monitoring system
CTM	Conditional test method
D	Duct diameter or equivalent duct diameter for rectangular ducts
DECC	Department of Environment & Climate Change (NSW)
Disturbance	A flow obstruction or instability in the direction of the flow which may impede accurate flow determination. This includes centrifugal fans, axial fans, partially closed or closed dampers, louvres, bends, connections, junctions, direction changes or changes in pipe diameter.
EPA	Environment Protection Authority
FTIR	Fourier transform infra-red
ISC	Intersociety Committee, Methods of Air Sampling and Analysis
ISO	International Organisation for Standardisation
ITE	Individual threshold estimate
Lower bound	When an analyte is not present above the detection limit, the result is assumed to be equal to zero.
Medium bound	When an analyte is not present above the detection limit, the result is assumed to be equal to half of the detection limit.
NA	Not applicable
NATA	National Association of Testing Authorities
NIOSH	National Institute of Occupational Safety and Health
NT	Not tested or results not required
OM	Other approved method
RATA	Relative accuracy test audit
STP	Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0 °C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa.
TM	Test method
USEPA	United States Environmental Protection Agency
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
Velocity difference	The percentage difference between the average of initial flows and after flows.
Vic EPA	Victorian Environment Protection Authority
XRD	X-ray diffractometry
Upper bound	When an analyte is not present above the detection limit, the result is assumed to be equal to the detection limit.
95% confidence interval	Range of values that contains the true result with 95% certainty. This means there is a 5% risk that the true result is outside this range.

8 Appendix 1: Gas Calibration Certificates

coregas

CERTIFIED REFERENCE MATERIAL
CERTIFICATE OF ANALYSIS

Coregas Pty Ltd

Page 1

Prod. Order No.	LGP018944	Certificate No.	QCSPC027747
Prod. Order Batch No.	LGP018944-1	Date Certified	05/08/21
Cylinder Serial No.	660075	Analyst Name	Victor Sun
Cylinder Capacity	11 L	Mixture Type	Gas
Customer No. :	10032487	Cylinder Content	1.5m3
Customer :	EKTIMO PTY LTD	Valve Type	BS14
Order No. :	SO02584574		

Component	Required Concentration	Actual Concentration	Concentration Unit of Measure	Measurement Uncertainty	Method
Nitrogen Dioxide	50	51.4	ppm mol	5% rel	8085 Chemi-luminescence
Nitrogen		Balance			

Comments : Mixture contains 1% of oxygen for nitrogen dioxide stability.

All concentration are expresssed on mole fraction basis.
The certified values are traceable to Australian National Standards of mass and thus to the International System of Units (SI).
The certified gas mixture is typically for calibration of instruments. Measurement Uncertainty is calculated using a coverage factor K=2, which gives 95% Confidence Interval.

Technical Note :

Filling Pressure	150	BAR
Min. Useable Pressure	5	BAR
Min. Storage Temperature	10	C
Period of Validity	2 Years	

Analyst

Victor Sun
Chemist

NATA Signatory

Mark Qin
Manager Spec. Gas Lab

NATA
ACCREDITED FOR
TECHNICAL
COMPETENCE

Accredited Reference Material Producer
Number: 12803
Site Number: 15135

Accredited for compliance with ISO17034

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutal recognition of the equivalence of reference material certificates

<CMS-10-SOP-8115-F3 Approved by SG&QC Manager 13/10/2020>

Print Date : 05/08/21

---End of Document---

Coregas Pty Ltd
66 Loftus Road, Yennora NSW 2161, Australia
Phone (+61) 1800 807 203 | coregas.com.au

coregas

OSG 3110201718

CERTIFIED REFERENCE MATERIAL
CERTIFICATE OF ANALYSIS

Coregas Pty Ltd

Prod. Order No.	LGP019757	**Certificate No.**	**QCSPC029391**
Prod. Order Batch No.	LGP019757-1	**Date Certified**	14/03/22
Cylinder Serial No.	834210	**Analyst Name**	Jason Yap
Cylinder Capacity	11 L	**Mixture Type**	Gas
Customer No. :	10032487	**Cylinder Content**	1.6m3
Customer :	EKTIMO PTY LTD	**Valve Type**	BS14
Order No. :	SO02776929		

Component	Required Concentration	Actual Concentration	Concentration Unit of Measure	Measurement Uncertainty	Method
Nitric Oxide	100	101.9	ppm mol	2% rel	8085 Chemi-luminescence
Sulphur Dioxide	100	100.9	ppm mol	2% rel	7094 NDIRUltramat
Carbon Monoxide	100	97.8	ppm mol	2% rel	7050 NDIRS710
Carbon Dioxide	20	19.97	% mol	1% rel	7050 NDIRS710
Nitrogen		Balance			

All concentration are expresssed on mole fraction basis.
The certified values are traceable to Australian National Standards of mass and thus to the International System of Units (SI).
The certified gas mixture is typically for calibration of instruments. Measurement Uncertainty is calculated using a coverage factor K=2, which gives 95% Confidence Interval.

Technical Note :

Filling Pressure	150	BAR
Min. Useable Pressure	5	BAR
Min. Storage Temperature	10	C
Period of Validity	3 Years	

Analyst

Jason Yap
Chemist

NATA Signatory

Mark Qin
Manager Spec. Gas Lab

NATA
ACCREDITED FOR
TECHNICAL COMPETENCE

Accredited Reference Material Producer Number: 12803
Site Number: 15135

Accredited for compliance with ISO17034

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates

<CMS-10-SOP-8115-F3 Approved by SG&QC Manager 04/02/2022>

Print Date : 14/03/22

---End of Document---

Coregas Pty Ltd
66 Lotus Road, Yennora NSW 2161, Australia
Phone (+61) 1800 807 203 | coregas.com.au

9 Appendix 2: Sampling Locations

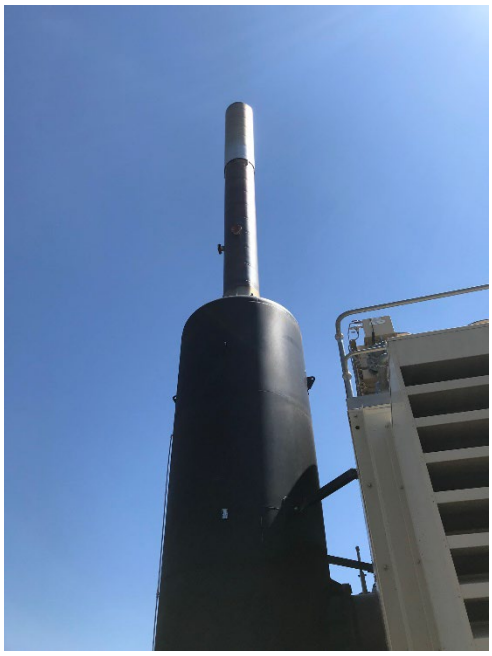

Figure 1: GO 1A, 2A, 3B, 4B, 5B

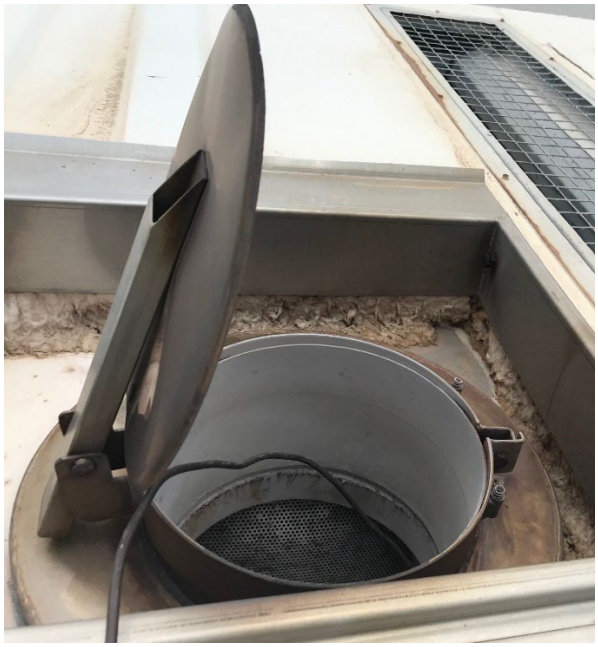

Figure 2: GO 3A, 6A

Ektimo

ektimo.com.au
1300 364 005

MELBOURNE (Head Office)
26 Redland Drive
Mitcham
VIC 3132
AUSTRALIA

SYDNEY
6/78 Reserve Road
Artarmon
NSW 2064
AUSTRALIA

WOLLONGONG
1/251 Princes Highway
Unanderra
NSW 2526
AUSTRALIA

PERTH
52 Cooper Road
Cockburn Central
WA 6164
AUSTRALIA

BRISBANE
3/109 Riverside Place
Morningside
QLD 4170
AUSTRALIA