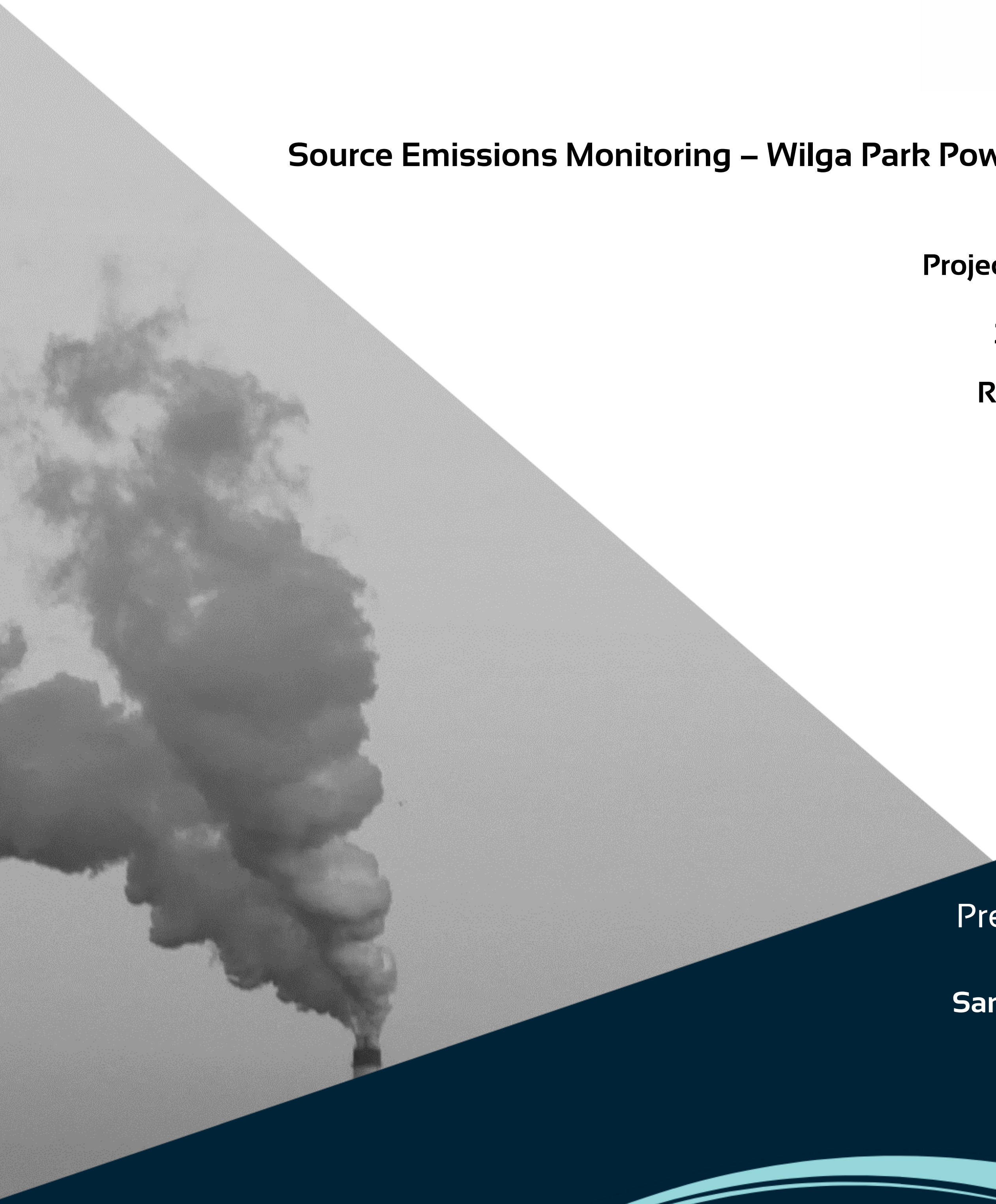

Source Emissions Monitoring – Wilga Park Power Station

Project ID: 16090

29/11/2024

Release: R_0

Prepared For:

Santos Limited

Assured Environmental

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Project Reference ID: 16090

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Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_0	29/11/2024	A. Kahi	Formal report release
DRAFT_0	22/11/2024	A. Kahi	Draft release for comment

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Accredited for compliance to ISO/IEC 17025

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

Accreditation number: 19703

EXECUTIVE SUMMARY

Assured Environmental conducted emissions monitoring from the eight operational generator stack release points at the Wilga Park Power Station (WPPS) outside Narrabri, New South Wales. Sampling was performed on each source for a period of at least 60 minutes.

The monitoring points included;

- 6 x 3 MW Generators
- 2 x 1 MW Generators

The table below details the monitoring schedule performed in November 2024, along with the dates of the last emissions monitoring performed on each release point.

Results are reported at dry, 273.15 °K and 101.325 kPa (STP), unless otherwise indicated. Results are also presented at 3 % oxygen correction.

Table 2: Summary of test schedule

3MW Units	Date last tested
G01A	Nov 2024
G02A	Nov 2024
G03B	Nov 2024
G04B	Nov 2024
G05B	Nov 2024
G06B	Nov 2024
1MW Units	
G03A	Nov 2024
G04A	Nov 2024
G05A	Not operational[a]
G06A	Not operational[a]
G07A	Not operational[a]

It is understood that there are no emissions limits defined under the NSW EPA Environment Protection Licence, in this case reference is made to the development approval conditions (NSW POEO – Stationary reciprocating internal combustion engine – Group 6). In comparison to these guidelines, oxides of nitrogen emissions fell below the target values[b].

The emissions monitoring results and permit limits are summarised in the following tables.

[a] Due to a transformer issue, these three units could not be operated during the time the emissions monitoring project took place. The observations of the 2024 emissions testing are representative of the typical operating conditions of WPPS as not all engines operate all of the time.

[b] The measurement uncertainty associated with the test has not been considered when determining compliance or non-compliance.

Table 3: Summary of emissions – 3MW Generators 1 & 2

Release Point Parameter	Unit of Measure	Emission Target	3MW G01A	3MW G02A
Date of testing	dd-mm-yyyy	-	5/11/2024	4/11/2024
Exhaust velocity	m/sec	-	38.7	37.7
Average stack temperature	°C	-	392	389
Moisture content	vol-%	-	9.5	7.7
Dry standard stack flow rate	Nm^3/sec	-	3.7	3.7
Carbon dioxide concentration	vol-%	-	5.3	5.5
Oxygen concentration	vol-%	-	11.3	11.3
Oxides of nitrogen (as NO_2)	mg/Nm^3	-	208	237
	mg/Nm^3 @ 3% O_2	450	386	442
- emission rate	g/sec	-	0.77	0.89
Solid particles (total)	mg/Nm^3	-	4.0	5.1
	mg/Nm^3 @ 3% O_2	-	7.4	9.4
- emission rate	g/sec	-	0.01	0.02
Sulfur trioxide (as SO_3)	mg/Nm^3	-	< 0.1	< 0.1
	mg/Nm^3 @ 3% O_2	-	< 0.2	< 0.2
- emission rate	g/sec	-	< 0.0005	< 0.0005
Load	kW	-	3,037	3,011
Engine Speed	rpm	-	1,500	1,500
Fuel used	-	-	Natural gas	Natural gas

Table 4: Summary of emissions – 3MW Generators 3 & 4

Release Point Parameter	Unit of Measure	Emission Target		3MW G03B	3MW G04B
Date of testing	dd-mm-yyyy	-		5/11/2024	4/11/2024
Exhaust velocity	m/sec	-		37.1	38.3
Average stack temperature	°C	-		395	376
Moisture content	vol-%	-		6.9	7.2
Dry standard stack flow rate	Nm^3/sec	-		3.7	3.9
Carbon dioxide concentration	vol-%	-		5.4	5.3
Oxygen concentration	vol-%	-		11.2	11.7
Oxides of nitrogen (as NO_2)	mg/Nm^3	-		239	226
	mg/Nm^3 @ 3% O_2	450		441	440
- emission rate	g/sec	-		0.88	0.88
Solid particles (total)	mg/Nm^3	-	<	2.6	5.8
	mg/Nm^3 @ 3% O_2	-	<	4.8	11.3
- emission rate	g/sec	-	<	0.01	0.02
Sulfur trioxide (as SO_3)	mg/Nm^3	-	<	0.2	0.3
	mg/Nm^3 @ 3% O_2	-	<	0.4	0.5
- emission rate	g/sec	-	<	0.0007	0.0011
Load	kW	-		3,037	3,048
Engine Speed	rpm	-		1,500	1,500
Fuel used	-	-		Natural gas	Natural gas

Table 5: Summary of permit limits – 3MW Generators 5 & 6

Release Point Parameter	Unit of Measure	Emission Target	3MW G05B	3MW G06B
Date of testing	dd-mm-yyyy	-	5/11/2024	4/11/2024
Exhaust velocity	m/sec	-	35.3	37.7
Average stack temperature	°C	-	380	399
Moisture content	vol-%	-	7.8	6.9
Dry standard stack flow rate	Nm^3/sec	-	3.5	3.7
Carbon dioxide concentration	vol-%	-	5.1	5.4
Oxygen concentration	vol-%	-	11.6	11.1
Oxides of nitrogen (as NO_2)	mg/Nm^3	-	172	239
	mg/Nm^3 @ 3% O_2	450	333	439
- emission rate	g/sec	-	0.60	0.89
Solid particles (total)	mg/Nm^3	-	5.6	3.9
	mg/Nm^3 @ 3% O_2	-	10.9	7.1
- emission rate	g/sec	-	0.02	0.01
Sulfur trioxide (as SO_3)	mg/Nm^3	-	< 0.1	0.2
	mg/Nm^3 @ 3% O_2	-	< 0.3	0.4
- emission rate	g/sec	-	< 0.0005	0.0008
Load	kW	-	3,037	2,890
Engine Speed	rpm	-	1,500	1,500
Fuel used	-	-	Natural gas	Natural gas

Table 6: Summary of emissions – 1MW Generators 3 & 4

Release Point Parameter	Unit of Measure			1MW G03A		1MW G04A
Date of testing	dd-mm-yyyy			6/11/2024		6/11/2024
Exhaust velocity	m/sec			40.0		42.3
Average stack temperature	°C			514		481
Moisture content	vol-%			7.0		9.0
Dry standard stack flow rate	Nm^3/sec			1.0		1.1
Carbon dioxide concentration	vol-%			6.7		6.4
Oxygen concentration	vol-%			8.7		9.4
Oxides of nitrogen (as NO_2)	mg/Nm^3	-		299		277
	mg/Nm^3 @ 3% O_2	450		438		431
- emission rate	g/sec	-		0.30		0.30
Solid particles (total)	mg/Nm^3	-		4.5	<	2.4
	mg/Nm^3 @ 3% O_2	-		6.6	<	3.7
- emission rate	g/sec	-		0.005	<	0.003
Sulfur trioxide (as SO_3)	mg/Nm^3	-	<	0.1		0.3
	mg/Nm^3 @ 3% O_2	-	<	0.2		0.5
- emission rate	g/sec	-	<	0.0001		0.0004
Load	MW			850		850
Engine Speed	rpm			1500		1,500
Fuel used	-			Natural gas		Natural gas

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1 INTRODUCTION

Assured Environmental Pty Ltd (AE) was appointed by Santos to sample and analyse source emission samples at the Wilga Park Power Station facility located outside Narrabri in Central New South Wales. Sampling was conducted by Assured Environmental from 4th to 6th November 2024.

Assured Environmental was responsible for the collection and analysis of samples unless otherwise indicated.

This test program was conducted as per the scope of works issued by Santos, which included sampling from 11 release points at the facility.[c]

- During this emissions sampling program all Oxides of Nitrogen (as NO_2) results were found to be within the development approval standard concentration limit of 450 mg/Nm^3 corrected to 3 % O_2[d].

Monitoring of each unit was performed with close communication between operations and the test team to ensure that the process was operating at stable, uninterrupted load.

[c] A total of 8 release points were tested on this occasion due to 3 of the 1MW generators being offline due to a transformer issue preventing safe operation.

[d] The measurement uncertainty is not considered in this statement. This value is taken from the *NSW Protection of the Environment Operations (Clean Air) Regulation 2020 (POEO) – Schedule 4*, general standards of concentration for Stationary reciprocating internal combustion engines as a Group 6 activity. Further, *Part 3 – Reference Conditions* requires a Group 5 or 6 activity using gas or liquid fuel to correct concentrations to 3 % Oxygen.

2 PROCESS DESCRIPTION & RELEASE POINTS

2.1 Process Description

The Wilga Park Power Station is a natural gas fired power station supplying electricity into the grid. The generators are comprised of six 3MW Jenbacher Gas Engines and five 1MW Jenbacher Gas Engines.

Figure 1: 3MW Generator Stack Release Points

Figure 2: 1MW Generator Stack Release Points

2.2 Sample locations

The tables below outline the details of each sample location in relation to the requirements of AS4323.1. A summary of the requirements of the Standard are:

- **Ideal sample location** – An ideal sample location shall conform to the requirements of Table 1 in Clause 4.2.2 of the standard and items 'a' through 'e'

Table 1 — Criteria for selection of sampling planes

Type of flow disturbance	Minimum distance upstream from disturbance, diameters (*D*)	Minimum distance downstream from disturbance, diameters (*D*)
Bend, connection, junction, direction change, stack silencer, flow straightener, stack exit	> 2	> 6
Louvre, butterfly damper (partially closed or closed)	> 3	> 6
Axial fan	> 3	> 8[a]
Centrifugal fan	> 3	> 6

[a] The plane should be selected as far as practicable from an axial fan. Flow straighteners may still be required to ensure that the selected position meets the criteria listed in Items (a) to (e) below.

  - a. The gas flow shall be in the same direction at all points along each sampling traverse,
  - b. The gas flow profile at the sampling plane shall be steady, evenly distributed and not have a cyclonic or swirl component which exceeds an angle of 15 ° to the duct axis, when measured near the periphery of circular sampling plane,
  - c. The temperature difference between adjacent points of the survey along each sampling traverse shall be less than 10 % of the absolute temperature in Kelvin, with the temperature at any point differing by less than 10 % from the mean.
  - d. The ratio of the highest to lowest pitot tube differential pressure across the sampling plane shall not exceed 9:1. The ration of the highest to lowest gas velocities shall also not exceed 3:1. For isokinetic testing with the use of impingers, the gas velocity ration across the sampling plane should not exceed 1.6:1,
  - e. The differential pressure at all sampling points shall be greater than or equal to 5 Pa. Sampling planes with differential pressures less than 5 Pa do not conform with this document.
- **Non-ideal sampling plane** – A non-ideal sampling plane does not conform to the separation distances listed in Table 1 of the Standard but is located greater than or equal to one duct diameter upstream of a flow disturbance and greater than or equal to two duct diameters downstream of a flow disturbance; or conforms with Table 1 separation distances but not with the criteria contained in Clause 4.2.2 (a) to (d).
  The number of sampling points shall be based on the maximum sampling point factor specified by Clause 4.2.3.
- **Non-conforming sampling plane** – A non-conforming sampling point does not conform with the criterion contained in Clause 4.2.2 (e); or is located less than one duct diameter upstream of a flow disturbance or less than two duct diameters downstream of a flow disturbance; or in Items (c)(i) and (ii), the requirements of Clause 4.2.4 apply.

The details of each sample location are provided in the tables below with reference to Australian Standard AS4323.1. All 3MW Generators have identical release points, as do all the 1MW Generators.

Table 7: Sample location details

AS4323.1	Sample location	3MW	1MW
	Stack Shape	Circular	Circular
	Ideal Sampling Plane Assessment		
	Equivalent Diameter (m)	0.58	0.32
	Stack Cross Section Area (m^2)	0.26	0.08
	Distance to upstream disturbance (m) (from disturbance)	2.3	0.2
	Upstream Diameters (D)	4.0	0.6
	Distance to downstream disturbance (m) (from disturbance)	1.8	0.4
	Downstream diameters (D)	3.1	1.3
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No	No
	Non-ideal Sampling Plane Assessment		
	Assessment required?	No	No
	Total traverse point factors	1.1	1.3
	Non-conforming Sampling Plane Assessment		
4.2.2(a)	Gas flow in same direction	Yes	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	1.4 1.2	2.6 1.6
4.2.2(e)	Minimum differential pressure	40	22
	Gas temperature above dewpoint	Yes	Yes
	Sampling Plane Type		
4.2.2, 4.2.3, 4.2.4	Sampling plane type	Non-ideal[e]	Non-conforming[f]
	Alternative sampling plane available?	No	No
	Number of Sample Points Adopted		
	Port size (mm)	75	-
	Port Thread Type	Flange end	-
	Number of traverses	2	2
	Number of points per traverse	6	4
	Total number of traverse points	12	8
	Flow & temperature compliance check	Yes	Yes

[e] Testing at this sample plane is unavoidable, all efforts have been made to collect a representative sample.
[f] Testing at this sample plane is unavoidable, all efforts have been made to collect a representative sample.

3 MONITORING METHODOLOGY

3.1 Sampling Methodology

All sampling and analysis were carried out in accordance with the listed requirements in Table 8. Any sampling specific comments about the sampling and analysis have been documented where required.

Table 8: Test Methods

Parameter	Reference Test Method	NSW Test Method	NATA accreditation	Analysis by	Notes
Sample plane criteria	AS4323.1	TM-1	yes	1	nil
Gas velocity & volume flow rate	USEPA Method 2	TM-2	yes	1	nil
Temperature	USEPA Method 2	TM-2	yes	1	nil
Stack gas density	USEPA Method 3	TM-23	yes	1	nil
Oxygen	USEPA Method 3A	TM-25	yes	1	nil
Carbon dioxide	USEPA Method 3A	TM-24	yes	1	nil
Moisture	USEPA Method 4	TM-22	yes	1	nil
Solid particles – total	AS4323.2	TM-15	yes	1	nil
Oxides of nitrogen	USEPA Method 7E	TM-11	yes	1	nil
Carbon monoxide	USEPA Method 10	TM-32	yes	1	nil
Sulfuric acid mist (SO3)	USEPA Method 8	TM-3	yes	1	nil
Sulfur dioxide	USEPA Method 8	TM-4	yes	1	nil

Table 9: Analysis Performed By

Note	Company	Work Performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	16090

3.1 Test equipment

The sampling equipment was transported to site and setup at the base of the sample location. An elevated work platform was used to access the sample access point on the stack, with sample tubing connecting the probes to the sample equipment at the base.

All equipment used during the testing meets all relevant performance standards as required by the relevant jurisdiction. Combustion gases were monitored using a Testo and Horiba combustion gas analyser.

Figure 3: Testo 350 multi gas analyser

Table 10: Combustion gas analyser specifications

Compound	Range	Lower Detection Limit	Linearity
O_2	0 to 25 %	0.01 %	+/- 1% selected range
CO	0 to 200 ppm	1 ppm	+/- 2% selected range
CO_2	0 to 20 %	500 ppm	+/- 2% selected range
NO (Testo)	0 to 3,000ppm	1 ppm	+/- 2% selected range
NOx (Horiba)	0 to 50 ppm	0.1 ppm	+/- 2% selected range
NO_2 (Testo)	0 to 500ppm	0.5 ppm	+/- 2% selected range
Lower Detection Limit	2X Noise at 60sec averaging		
Precision (% of point)	+/- 0.1%, measured with single gases at the span concentration		
Flow Rate	~ 0.5 liters per minute		
Accuracy	2% of span		
Span Drift	Less than 2% per week		
Zero Noise	0.5 ppm RMS (60sec averaging time)		
Response Time	60 seconds		

Table 11: Test equipment identification

Equipment	Equipment make	Equipment ID	Last calibration date	Calibration information
Sampling console	Apex XC572	SN368	16/08/2024	Y = 0.1.054 ΔH@ = 42.18
Manometer	Apex XC572	SN368	20/08/2024	Correction factor = 1
Thermocouple indicator	Apex XC572	SN368	16/08/2024	Correction factor = 1
S-type pitot end	APEX	PN118	22/10/2024	Dimension check as per USEPA M2 Visual inspection on site OK
Combustion gas analyser	Testo 350	SN935	daily zero and single point onsite	Multipoint pre and post sample campaign
Gas dilution calibrator	Ecotech	SN786	22/10/2024	Correction required: Nil

4 TECHNICAL COMMENTS

4.1 AS4323.1 – Sample point location

- In the case where the sample location is considered non-ideal (less than 6 diameters downstream from a disturbance and/or less than 2 diameters upstream from a disturbance), an increased number of sample traverse points is sampled to maintain compliance to AS4323.1.
- Where the sample location is considered non-conforming (less than 2 diameters downstream from a disturbance and/or less than 1 diameter upstream from a disturbance), the number of sample points is increased. In this case there is no alternative sample location available.
- In each case the gas flow profile conforms to the standard.
- The release points of the 1MW generators are contained within the generator enclosure and therefore do not contain a true 'stack'. All efforts were made to perform representative sampling from these release points.

4.2 USEPA Method 2 – Exhaust gas volume flow rate

- The total traverse points at each sample location is calculated using the factors listed in AS4323.1 At each stack sample location, each traverse was sampled and measurements of differential pressure and temperature is recorded.
- The stack gas velocity result reported is the average of the individual measurements at each traverse point for each stack.
- The average velocity measurement is then multiplied by the stack cross sectional area to calculate the volume flow of stack flue gas.

4.3 USEPA Method 7E – Combustion gas measurement

- Combustion gases were measured using multi-gas analysers.
- Analyser calibration checks were performed both on and off-site. Direct three-point linearity checks were performed in the laboratory before and at completion of the site work, while zero and single point span checks were performed at the beginning and end of each day of sampling. Direct analyser calibration checks were performed directly to the analyser. The single point system bias check is performed by sending the gas to the beginning of the sampling system, in this case, the sampling probe, to determine any possible bias introduced by the sampling system. All calibration checks were within Method 7E tolerances.
- Combustion gas results are presented as hourly averages over the sampling period representing 1-minute data points.
- The results of the stratification testing are presented below.
- The calibration gases used are listed in the table below along with the reference certificate identification.

Table 12: Calibration gas details

Parameter	Zero cylinder	Span cylinder 1	Span cylinder 2
Contents	Nitrogen (UHP)	Carbon dioxide	Nitrogen dioxide
	-	15 %	40.5 ppm
	-	Nitric oxide	Oxygen
	-	611 ppm	18.9 %
	-	Carbon monoxide	-
	-	100 ppm	-
Certificate number	na	385891	456981
Expiry date	na	23/05/2026	25/01/2027

4.3.1 Stratification determination

Stratification testing was performed on each source following the requirements of USEPA Method 7E, specifically the following points are considered;

- Definition of stratification;
  - If the concentration at each traverse point differs from the mean concentration for all traverse points by no more than: (a) ±5 % of the mean concentration; or (b) ±0.5 ppm (whichever is less restrictive), the gas stream is considered unstratified, and samples may be collected from a single point that most closely matches the mean.
  - If the 5 % or 0.5 ppm criterion is not met, but the concentration at each traverse point differs from the mean concentration for all traverse points by no more than: (a) ±10 % of the mean concentration; or (b) ±1 ppm (whichever is less restrictive), the gas stream is considered to be minimally stratified and you may take samples from 3 points.
  - If the gas stream is found to be stratified because the 10 % or 1 ppm criterion is not met, locate 12 traverse points for the test in accordance with USEPA Method 1 (AS4323.1 in Australia).
- In this case the NOx and O_2 concentration was measured at three traverse points on each release point. No significant stratification was observed.

Table 13: Stratification testing

Source	Number of traverse points sampled	Oxygen (vol-%)		Oxides of nitrogen (%)	
		Maximum difference from mean	criteria	Maximum difference from mean	criteria
G01A	3	0.0	< 0.3 vol-%	0.5	< 10 %
G02A	3	0.1	< 0.3 vol-%	2.0	< 10 %
G03B	3	0.2	< 0.3 vol-%	4.9	< 10 %
G04B	3	0.1	< 0.3 vol-%	4.5	< 10 %
G05B	3	0.2	< 0.3 vol-%	1.5	< 10 %
G06B	3	0.1	< 0.3 vol-%	1.4	< 10 %
G03A	3	0.1	< 0.3 vol-%	2.2	< 10 %
G04A	3	0.0	< 0.3 vol-%	3.3	< 10 %

4.4 General Process Comments

- Monitoring was performed with close communication between the testing team and process operators to ensure the unit was operating at a stable load throughout the test period.
- It should be noted that the results presented in this report are representative of the operation of the compressor turbines at the time of sampling. As such, care should be taken in the application of these results where further mapping (tuning) of the generators was undertaken following completion of the monitoring.

5 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty assigned, due to factors such as the stack sample location in relation to the positioning requirements of AS4323.1, stack temperature, water vapour content and sample analysis.

The table below outlines the estimated uncertainties associate with reports presented within this report.

Table 14: Sample uncertainty

Parameter	Reference method	Uncertainty ± %	Coverage factor	Confidence coefficient %
Gas velocity & volume flow rate	USEPA Method 2	3	2	95
Temperature	USEPA Method 2	3	2	95
Stack gas density	USEPA Method 3	7	2	95
Oxygen	USEPA Method 3A	7	2	95
Carbon dioxide	USEPA Method 3A	7	2	95
Moisture	USEPA Method 4	4	2	95
Solid particles – total	AS4323.2	8	2	95
Oxides of nitrogen	USEPA Method 7E	7	2	95
Carbon monoxide	USEPA Method 10	7	2	95
Sulfuric acid mist (SO3)	USEPA Method 8	31	2	95
Sulfur dioxide	USEPA Method 8	21	2	95

6 TEST RESULTS

Table 15: Test information – G01A

Site		Wilga Park Power Station
Sample Location		3MW G01A
Reference Method		USEPA M8 - ISOKINETIC
Run ID		3MW G01A
Test Parameter		PM,SOx,NOx
Test Date	dd/mm/yyyy	5/11/2024
Start Time	hh:mm	8:18
End Time	hh:mm	9:24
Average Stack Temperature	°C	392
Absolute Stack Pressure	mb	985
Moisture Content	% v/v	9.5
Oxygen	% v/v	11.3
Carbon dioxide	% v/v	5.3
Dry Gas Density	kg/Nm^3	1.31
Dry Gas Molecular Weight	g/g-mole	29.3
Sample Volume (dry gas meter)	Nm^3	0.80
Stack Gas Velocity	m/sec	38.7
Actual Stack Flow Rate	m^3/sec	10
Dry Standard Stack Flow Rate	Nm^3/sec	3.7
Percent Isokinetic Rate	%	102

Parameter	Concentration (standard conditions)		Emission Rate
	mg/Nm^3	mg/Nm^3 & 3% O_2	g/sec
Solid Particles - total	4.0	7.4	0.01
Oxides of Nitrogen (as NO_2)	208	386	0.77
Carbon Monoxide	613	1,138	2.26
Sulfur trioxide (as SO_3)	< 0.1	< 0.2	< 0.0005
Sulfur dioxide	2.0	3.8	0.01

Table 16: Test information – G02A

Site		Wilga Park Power Station
Sample Location		3MW G02A
Reference Method		USEPA M8 - ISOKINETIC
Run ID		3MW G02A
Test Parameter		PM,SOx,NOx
Test Date	dd/mm/yyyy	4/11/2024
Start Time	hh:mm	10:25
End Time	hh:mm	11:34
Average Stack Temperature	°C	389
Absolute Stack Pressure	mb	984
Moisture Content	% v/v	7.7
Oxygen	% v/v	11.3
Carbon dioxide	% v/v	5.5
Dry Gas Density	kg/Nm^3	1.31
Dry Gas Molecular Weight	g/g-mole	29.4
Sample Volume (dry gas meter)	Nm^3	0.79
Stack Gas Velocity	m/sec	37.7
Actual Stack Flow Rate	m^3/sec	10
Dry Standard Stack Flow Rate	Nm^3/sec	3.7
Percent Isokinetic Rate	%	100

Parameter	standard conditions Concentration		Emission Rate
	mg/Nm^3	mg/Nm^3 & 3% O_2	g/sec
Solid Particles - total	5.1	9.4	0.02
Oxides of Nitrogen (as NO_2)	237	442	0.89
Carbon Monoxide	595	1,111	2.23
Sulfur trioxide (as SO_3)	< 0.1	< 0.2	< 0.0005
Sulfur dioxide	< 1.7	< 3.3	< 0.01

Table 17: Test information – G03B

Site		Wilga Park Power Station			
Sample Location		3MW G03B			
Reference Method		USEPA M8 - ISOKINETIC			
Run ID		3MW G03B			
Test Parameter		PM,SOx,NOx			
Test Date	dd/mm/yyyy	5/11/2024			
Start Time	hh:mm	15:21			
End Time	hh:mm	16:33			
Average Stack Temperature	°C	395			
Absolute Stack Pressure	mb	985			
Moisture Content	% v/v	6.9			
Oxygen	% v/v	11.2			
Carbon dioxide	% v/v	5.4			
Dry Gas Density	kg/Nm³	1.31			
Dry Gas Molecular Weight	g/g-mole	29.3			
Sample Volume (dry gas meter)	Nm³	0.77			
Stack Gas Velocity	m/sec	37.1			
Actual Stack Flow Rate	m³/sec	10			
Dry Standard Stack Flow Rate	Nm³/sec	3.7			
Percent Isokinetic Rate	%	99			
		standard conditions			
Parameter		Concentration		Emission Rate	
	mg/Nm³		mg/Nm³ & 3% O_2		g/sec
Solid Particles - total	< 2.6	<	4.8	<	0.01
Oxides of Nitrogen (as NO_2)	239		441		0.88
Carbon Monoxide	476		880		1.76
Sulfur trioxide (as SO_3)	< 0.2	<	0.4	<	0.00
Sulfur dioxide	< 1.5	<	2.7	<	0.01

Table 18: Test information – G04B

Site		Wilga Park Power Station
Sample Location		3MW G04B
Reference Method		USEPA M8 - ISOKINETIC
Run ID		3MW G04B
Test Parameter		PM,SOx,NOx
Test Date	dd/mm/yyyy	4/11/2024
Start Time	hh:mm	12:46
End Time	hh:mm	13:53
Average Stack Temperature	°C	376
Absolute Stack Pressure	mb	984
Moisture Content	% v/v	7.2
Oxygen	% v/v	11.7
Carbon dioxide	% v/v	5.3
Dry Gas Density	kg/Nm^3	1.31
Dry Gas Molecular Weight	g/g-mole	29.3
Sample Volume (dry gas meter)	Nm^3	0.82
Stack Gas Velocity	m/sec	38.3
Actual Stack Flow Rate	m^3/sec	10
Dry Standard Stack Flow Rate	Nm^3/sec	3.9
Percent Isokinetic Rate	%	99

Parameter	Concentration (standard conditions)		Emission Rate
	mg/Nm^3	mg/Nm^3 & 3% O_2	g/sec
Solid Particles - total	5.8	11.3	0.02
Oxides of Nitrogen (as NO_2)	226	440	0.88
Carbon Monoxide	576	1,121	0.21
Sulfur trioxide (as SO_3)	0.3	0.5	0.001
Sulfur dioxide	< 1.6	< 3.1	< 0.01

Table 19: Test information – G05B

Site		Wilga Park Power Station	
Sample Location		3MW G05B	
Reference Method		USEPA M8 - ISOKINETIC	
Run ID		3MW G05B	
Test Parameter		PM,SOx,NOx	
Test Date	dd/mm/yyyy	5/11/2024	
Start Time	hh:mm	13:36	
End Time	hh:mm	14:36	
Average Stack Temperature	°C	380	
Absolute Stack Pressure	mb	983	
Moisture Content	% v/v	7.8	
Oxygen	% v/v	11.6	
Carbon dioxide	% v/v	5.1	
Dry Gas Density	kg/Nm³	1.31	
Dry Gas Molecular Weight	g/g-mole	29.3	
Sample Volume (dry gas meter)	Nm³	0.74	
Stack Gas Velocity	m/sec	35.3	
Actual Stack Flow Rate	m³/sec	9.3	
Dry Standard Stack Flow Rate	Nm³/sec	3.5	
Percent Isokinetic Rate	%	99	
	standard conditions		
Parameter	Concentration		Emission Rate
	mg/Nm³	mg/Nm³ & 3% O_2	g/sec
Solid Particles - total	5.6	10.9	0.02
Oxides of Nitrogen (as NO_2)	172	333	0.60
Carbon Monoxide	555	1,073	1.94
Sulfur trioxide (as SO_3)	< 0.1	< 0.3	< 0.0005
Sulfur dioxide	1.4	2.6	0.005

Table 20: Test information – G06B

Site		Santos
Sample Location		Wilga Park Power Station
Reference Method		3MW G06B
Run ID		Wilga Park Power Station
Test Parameter		USEPA M8 - ISOKINETIC
Test Date	dd/mm/yyyy	4/11/2024
Start Time	hh:mm	14:55
End Time	hh:mm	16:01
Average Stack Temperature	°C	399
Absolute Stack Pressure	mb	985
Moisture Content	% v/v	6.9
Oxygen	% v/v	11.1
Carbon dioxide	% v/v	5.4
Dry Gas Density	kg/Nm^3	1.31
Dry Gas Molecular Weight	g/g-mole	29.3
Sample Volume (dry gas meter)	Nm^3	0.78
Stack Gas Velocity	m/sec	37.7
Actual Stack Flow Rate	m^3/sec	10
Dry Standard Stack Flow Rate	Nm^3/sec	3.7
Percent Isokinetic Rate	%	99

Parameter	Concentration (standard conditions)		Emission Rate
	mg/Nm^3	mg/Nm^3 & 3% O_2	g/sec
Solid Particles - total	3.9	7.1	0.01
Oxides of Nitrogen (as NO_2)	239	439	0.89
Carbon Monoxide	616	1,130	2.30
Sulfur trioxide (as SO_3)	0.2	0.4	0.001
Sulfur dioxide	< 1.4	< 2.6	< 0.01

Table 21: Test information – G03A

Site		Wilga Park Power Station
Sample Location		1MW G03A
Reference Method		USEPA M8 - ISOKINETIC
Run ID		1MW G03A
Test Parameter		PM,SOx,NOx
Test Date	dd/mm/yyyy	6/11/2024
Start Time	hh:mm	8:23
End Time	hh:mm	9:27
Average Stack Temperature	°C	514
Absolute Stack Pressure	mb	987
Moisture Content	% v/v	7.0
Oxygen	% v/v	8.7
Carbon dioxide	% v/v	6.7
Dry Gas Density	kg/Nm^3	1.31
Dry Gas Molecular Weight	g/g-mole	29.4
Sample Volume (dry gas meter)	Nm^3	0.76
Stack Gas Velocity	m/sec	40.0
Actual Stack Flow Rate	m^3/sec	3
Dry Standard Stack Flow Rate	Nm^3/sec	1
Percent Isokinetic Rate	%	100

Parameter	Concentration (standard conditions)		Emission Rate
	mg/Nm^3	mg/Nm^3 & 3% O_2	g/sec
Solid Particles - total	4.5	6.6	0.005
Oxides of Nitrogen (as NO_2)	299	438	0.30
Carbon Monoxide	510	745	0.52
Sulfur trioxide (as SO_3)	< 0.1	< 0.2	< 0.0001
Sulfur dioxide	< 1.4	< 2.0	< 0.001

Table 22: Test information – G04A

Site		Wilga Park Power Station
Sample Location		1MW G04A
Reference Method		USEPA M8 - ISOKINETIC
Run ID		1MW G04A
Test Parameter		PM,SOx,NOx
Test Date	dd/mm/yyyy	6/11/2024
Start Time	hh:mm	10:18
End Time	hh:mm	11:22
Average Stack Temperature	°C	481
Absolute Stack Pressure	mb	986
Moisture Content	% v/v	9.0
Oxygen	% v/v	9.4
Carbon dioxide	% v/v	6.4
Dry Gas Density	kg/Nm^3	1.31
Dry Gas Molecular Weight	g/g-mole	29.4
Sample Volume (dry gas meter)	Nm^3	0.83
Stack Gas Velocity	m/sec	42.3
Actual Stack Flow Rate	m^3/sec	3
Dry Standard Stack Flow Rate	Nm^3/sec	1
Percent Isokinetic Rate	%	102

Parameter	Concentration (standard conditions) mg/Nm^3	Concentration (standard conditions) mg/Nm^3 & 3% O_2	Emission Rate g/sec
Solid Particles - total	< 2.4	< 3.7	< 0.003
Oxides of Nitrogen (as NO_2)	277	431	0.30
Carbon Monoxide	540	839	0.59
Sulfur trioxide (as SO_3)	0.3	0.5	0.0004
Sulfur dioxide	< 1.1	< 1.7	< 0.001

7 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

Assured Environmental 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 Assured Environmental 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

Assured Environmental 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 the methods section 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 23: 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 24: 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

8 GLOSSARY OF TERMS

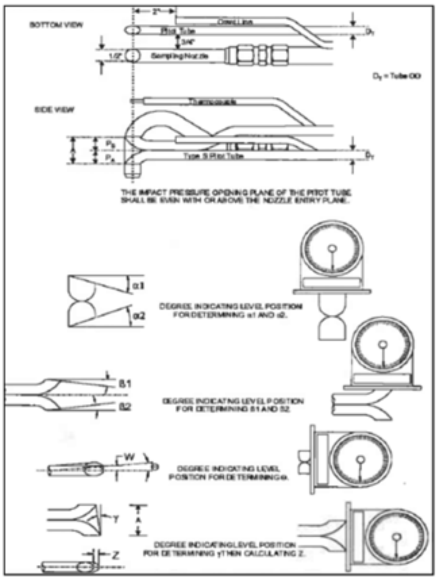
The following terms and abbreviations may be used in this report:

Table 25: 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
°C	Degrees Celsius
CO	Carbon monoxide
dscm	dry standard cubic meters
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_2O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NOx	Oxides of nitrogen expressed as NO_2 equivalent (nitric oxide (NO) + nitrogen dioxide (NO_2))
NR	Not required on this occasion
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)
SO_3	Sulfur trioxide
SO_2	Sulfur dioxide
TWA	Time weighted average
USEPA	United States Environmental Protection Authority

9 APPENDIX A - CALIBRATION CERTIFICATES

Doc number	File Name	Last modified	Authorised by	Version	QUALITY - CALIBRATION
F101.009.008	S-type Pitot Tube Dimension Check	18/04/2023	JW	3.4	



Pitot tube Serial Number	PN118	Reference Calliper Serial Number	SN438
Checked by :	JH	Reference Calliper Last Calibration Date	28/02/2024
Date Checked	22/10/2024	Reference Calliper Calibration Due Date	28/02/2026
Date for next calibration check	22/10/2026		

Parameter	Inspection result	Tolerance	Check
General condition	PASS	PASS	OK
Openings damaged	NO	NO	OK
Dt (mm)	9.5	4 to 10 AS 4323.1 4.8 - 9.5 USEPA M2	OK
A	22.1	2.1 Dt ≤ A ≤ 3 Dt	OK
A - Pa(mm)	11.05	Pa = Pb	OK
B - Pb (mm)	11.05		
P check		1.05 ≤ Pa/Dt ≤ 1.5	OK
A - α1	1	-10° < α < +10°	OK
B - α2	0		
A - β1	0	-5° < β < +5°	OK
B - β2	0		
Z = A tan γ	0.5	Z ≤ 3.2	OK
W = A tan θ	0.2	W ≤ 0.8	OK

Note: If any of the check column result = NO, remove pitot from service and notify technical manager for action.

Reviewed By:	JW

Date Reviewed:	25/10/2024

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Figure 4: S-type pitot tube dimension check

NATA WORLD RECOGNISED ACCREDITATION

Doc number	File Name	Last modified	Authorised by	Version	QUALITY - CALIBRATION
F101.009.002	Thermocouple Indicator Check	13/09/2022	DL	5.2	

Background Information	
Equipment Serial Number	SN368
Date Calibrated	16-Aug-24
Calibrated By	JH
Reference Indicator Serial Number	SN459
Reference Indicator Calibration Date	08-Aug-23
Reference Indicator Calibration due date Date	08-Aug-25
% Error Tolerance	2

Data Input										Results				
		Indicator Response								% Error/Difference				
Channel ID	Channel Name (if applicable)	Zero		Span 1		Span 2		Span 3		Zero	Span 1	Span 2	Span 3	Response
Channel 2 Setpoint	STACK	0	°C	100	°C	250	°C	800	°C	1.0	1.0	0.6	0.2	OK
Channel 2 Response		-1	°C	99	°C	248.5	°C	801.5	°C					
Channel 3 Setpoint	PROBE	0	°C	100	°C	250	°C	800	°C	0.5	0.5	0.8	0.1	OK
Channel 2 Response		-0.5	°C	99.5	°C	248	°C	800.5	°C					
Channel 4 Setpoint	OVEN	0	°C	100	°C	250	°C	800	°C	1.0	1.5	0.8	0.1	OK
Channel 3 Response		-1	°C	98.5	°C	248	°C	800.5	°C					
Channel 5 Setpoint	FILTER	0	°C	100	°C	250	°C	800	°C	0.5	1.0	0.6	0.1	OK
Channel 4 Response		-0.5	°C	99	°C	249	°C	801	°C					
Channel 6 Setpoint	EXIT	0	°C	100	°C	250	°C	800	°C	1.0	1.0	0.6	0.2	OK
Channel 5 Response		-1	°C	99	°C	249	°C	802	°C					

Reviewed By:	JW	Date Reviewed:	20/08/2024

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Figure 5: Thermocouple indicator check

Doc number	File Name	Last modified	Authorised by	Version	QUALITY - CALIBRATION
F101.009.005	Working Manometer Calibration Check	21/09/2022	JW	7.3	

Background Information	
Manometer Serial Number	SN368
Date Calibrated:	20-Aug-24
Next Calibration Due Date:	20/08/2025
Calibrated By:	JH
Reference Manometer Serial Number	SN119
Last Reference manaometer Calibration Date	25/03/2022
Next Reference manaometer Calibration Due Date:	25/03/2025
% Error Tolerance (Across Span)	2

Results				
DP side		ΔH side		
2.3	0.5	1.9	0.3	Average % Error
7.2	1.2	7.2	1.2	Maximum % Error
	NO		NO	Calibration Required?

*Zero manometers prior to beginning calibration checks

Input Data					Calibration Results			
Suggested	Reference set point	Channel 1 response	Channel 2 response	Reference Manometer	DP side		ΔH side	
		DP side	ΔH side					
mm H_2O	kPa	mm H_2O	mm H_2O	mm H_2O	% Error	% Error Accross Span	% Error	% Error Accross Span
*0 (Zero)	0.01	1	1	1.02071	-1	1	-1	-1
*180 (Span)	1.9	194	193	195	0.4	0.4	1.0	1.0
2	0.12	11.8	11.8	12.2	3.7	0.2	3.7	0.2
5	0.15	15.8	15.6	15.3	3.1	0.3	1.9	0.1
10	0.2	21.1	20.7	20	3.3	0.4	1.4	0.1
20	0.3	33	33	31	7.2	1.2	7.2	1.2
40	0.5	53	52	51	3.3	0.9	1.5	0.4
80	0.9	92	91	92	0.2	0.1	1.3	0.6
120	1.3	134	133	133	0.5	0.3	0.3	0.2

Reviewed By:	JW	Date Reviewed:	27/08/2024

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Figure 6: Manometer check

Gas analyser SN		SN935				
Calibration performed by:		TB LJ				
		Carbon dioxide	Oxygen	Carbon monoxide	Nitric oxide	Nitrogen dioxide
Upscale gas cylinder reference number		385891	456981	385891	385891	456981
Certificate expiry date	dd.mm.yyyy	23/05/2026	25/01/2027	23/05/2026	23/05/2026	25/01/2027
Upscale calibration gas value (Cma)	ppm / vol-%	15	18.9	2010	611	40.5
Mid-point gas cylinder reference number		385891	456981	385891	385891	456981
Certificate expiry date	dd.mm.yyyy	23/05/2026	25/01/2027	23/05/2026	23/05/2026	25/01/2027
Mid-point calibration gas value	ppm / vol-%	7.5	9.45	1005	305.5	20.25
Date of pre-calibration	dd.mm.yyyy	1/11/2024				
Initial zero check response	ppm / vol-%	0.02	0.02	0	0	0
Zero point calibration error (initial)	%	-0.1	-0.1	0.0	0.0	0.0
Initial upscale calibration response	ppm / vol-%	14.99	18.8	1999	610	40.4
Upscale calibration error (initial)	%	0.1	0.5	0.5	0.2	0.2
Initial mid-point calibration response	ppm / vol-%	7.48	9.62	1002	301	20.9
Mid-point calibration error (initial)	%	0.1	-0.9	0.1	0.7	-1.6
Date of post-calibration	dd.mm.yyyy	8/11/2024				
Post sampling zero check response	ppm / vol-%	0.02	0.03	0	0	0
Zero point calibration error (post sampling)	%	-0.1	-0.2	0.0	0.0	0.0
Zero drift	%	0.0	0.1	0.0	0.0	0.0
Post sampling upscale calibration response	ppm / vol-%	15.02	18.82	2005	618	40.3
Upscale calibration error (post sampling)	%	-0.1	0.4	0.2	-1.1	0.5
Upscale drift	%	0.2	0.1	0.3	1.3	0.2
Post sampling mid-point calibration response	ppm / vol-%	7.51	9.52	999	310	21
Mid-point calibration error (post sampling)	%	-0.1	-0.4	0.3	-0.7	-1.9
Mid-point drift	%	0.2	0.5	0.1	1.5	0.2

Figure 7: Gas analyser calibration check