Air Noise Environment
Environmental Monitoring and Assessment

Emissions Monitoring: Talinga GPF

Origin Energy

144 Montague Road
West End
QLD, 4101

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Prepared by:
Air Noise Environment
ABN: 13 081 834 513

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Should you have any queries regarding the contents of this document, please contact Air Noise Environment.

Brisbane Office

A: Unit 3, 4 Tombo Street,

Capalaba, QLD 4157

T: +61 7 3245 7808

E: qld@ane.com.au

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The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Air Noise Environment Pty Ltd for the purposes of this project is both complete and accurate.

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Executive Summary

Table 1 Presents a summary of results from emissions monitoring completed at the Origin Talinga Gas Processing Facility during the period 13th - 19th August 2015. Results that do not comply with the release limits are highlighted in bold.

Table 1: Summary ofResults.

Release Point		Velocity (m/s)	NO_x (expressed as NO_2) (g/s)
Reciprocating Compressors	K4406-01.1	37.9	0.444
	K4406-01.2	20.9	0.489
	K4406-02.1	38.4	0.510
	K4406-02.2	21.6	0.356
	K4406-03.1	38.2	0.438
	K4406-03.2	24.2	0.247
Screw Compressors	K4404-01.1	32.9	6.630
	K4404-02.1	33.2	5.900
	K4404-03.1	33.1	0.770
	K4404-05.1	28.7	4.210
	K4404-06.1	31.6	1.010
	K4404-07.1	33.0	0.360
	K4404-08.1[a.]	31.7	3.840
	K4404-12.1	33.2	5.660
Power Generation	G4408-01.1	8.8	0.749
	G4408-02.1	12.1	1.260
	G4408-03.1	7.9	0.888

a. A minor exhaust leak on a sample line may underestimate emissions results from testing of K4404-08.1

Technician Comments

Origin personnel advised that tuning of gas compressor engines was not completed prior to annual emissions testing which is the preferred approach.

1 Introduction

Origin Energy commissioned Air Noise Environment Pty Ltd to conduct monitoring of air emissions from their Talinga Facility as part of their requirements under the Queensland Department of Environment and Resource Management Environmental Authority for the facility.

Table 1.1 details the monitoring locations and the monitoring performed at each location. The monitoring was completed during the period 13th - 19th August 2015.

Table 1.1: Monitoring Locations and Parameters

Parameter	NO_x	Velocity	Temperature & Moisture	O_2, CO_2 & CO
Reciprocating Compressor K4404-01.1	x	x	x	x
Reciprocating Compressor K4404-01.2	x	x	x	x
Reciprocating Compressor K4404-02.1	x	x	x	x
Reciprocating Compressor K4404-02.2	x	x	x	x
Reciprocating Compressor K4404-03.1	x	x	x	x
Reciprocating Compressor K4404-03.2	x	x	x	x
Screw Compressor K4404-01.1	x	x	x	x
Screw Compressor K4404-02.1	x	x	x	x
Screw Compressor K4404-03.1	x	x	x	x
Screw Compressor K4404-05.1	x	x	x	x
Screw Compressor K4404-06.1	x	x	x	x
Screw Compressor K4404-07.1	x	x	x	x
Screw Compressor K4404-08.1	x	x	x	x
Screw Compressor K4404-12.1	x	x	x	x
Power Generator G4408-01.1	x	x	x	x
Power Generator G4408-02.1	x	x	x	x
Power Generator G4408-03.1	x	x	x	x

The monitoring of air emissions at the Talinga Facility was completed during normal operating conditions. Any factors that may have affected the monitoring results were not observed by, or brought to the notice of Air Noise Environment (ANE) staff except where noted in this report.

2 Methodology

2.1 Emission Testing

Table 2.1 below lists the Methods used when undertaking emission monitoring at Talinga Facility.

All air quality monitoring undertaken by the Company has been undertaken in accordance with the methods identified in Table 2.1 below unless as specified in Section 2.3.

Table 2.1: Summary Of Emission Monitoring Methods

Measurement Parameter	Method Equivalency
Sampling Positions	**AS 4323.1-1995** Method 1: selection of sampling positions
Velocity, Flowrate and Temperature	**AS 4323.2-1995** Stationary Source Emissions - Method 2: Determination of Total Particulate Matter - Isokinetic Manual Sampling - Gravimetric Method
Oxygen and Carbon Dioxide	**USEPA Method 3A** Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources
Moisture Content	**USEPA Method 4** Determination of Moisture Content in Stack Gases
Oxides of Nitrogen (NO, NO_2, NO_x)	**USEPA Method 7E** Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Carbon Monoxide	**USEPA Method 10B** Determination of Carbon Monoxide Emissions from Stationary Source

2.2 Deviation from Methods

None.

3 Results

3.1 Process Conditions

Table 3.1 provides a summary of process conditions during the air emissions monitoring at Talinga Facility.

Table 3.1: Process Conditions During Emissions Monitoring for Compressors

Parameter	Average Engine Load (%)	Average Engine RPM
Reciprocating Compressor K4406-01.1	101	999
Reciprocating Compressor K4406-01.2		
Reciprocating Compressor K4406-02.1	100	1000
Reciprocating Compressor K4406-02.2	101	1000
Reciprocating Compressor K4406-03.1	104	1000
Reciprocating Compressor K4406-03.2		
Screw Compressor K4404-01.1	103	1203
Screw Compressor K4404-02.1	102	1201
Screw Compressor K4404-03.1	91	1165
Screw Compressor K4404-05.1	86	1202
Screw Compressor K4404-06.1	94	1203
Screw Compressor K4404-07.1	101	1205
Screw Compressor K4404-08.1[a.]	102	1200
Screw Compressor K4404-12.1	100	1205

a. A minor exhaust leak on a sample line may underestimate emissions results from testing completed

Table 3.2: Process Conditions During Emissions Monitoring for Power Generators

Parameter	Generator Load (kW)	Average Engine RPM	Combustion Temperature (°C)
Power Generation G4408-01.1	110	1500	43.1
Power Generation G4408-02.1	109	1501	49.2
Power Generation G4408-03.1	102	1500	46.8

3.2 Monitoring Results

The results of the emissions monitoring for the Talinga Facility completed during the period of 13th - 19th August 2015 are provided in Table 3.3 to Table 3.5.

Table 3.3: Flow and Sample Characteristics for Reciprocating Compressors

Parameter	K4406-01.1	K4406-01.2	K4406/02.1	K4406-02.2	K4406-03.1	K4406-03.2
Date (dd/mm/yy)	17/08/15		15/08/15	17/08/15	14/08/15	
Run Times: Moisture CO_2, O_2, CO, NO_x	14:03 – 14:43 14:05 – 14:43	15:08 – 15:48 15:11 – 16:10	08:37 – 09:17 08:44 – 09:42	12:29 – 13:09 12:23 – 13:38	12:04 – 12:44 12:32 – 13:28	14:18 – 14:58 14:21 – 15:47
Moisture Sample Volume (m^3)	0.417	0.423	0.404	0.412	0.403	0.415
Average Stack Temperature (°C)	396	328	416	344	396	335
Stack Diameter (m)	0.50					
Barometric Pressure (kPa)	102.12	102.12	102.17	102.12	102.17	102.17
Calculated Stack Moisture (%)	10.3	7.7	10.7	9.2	8.1	10.3
Carbon Dioxide Percentage (%)	5.30	5.49	4.53	5.69	4.45	4.79
Oxygen Percentage (%)	12.02	11.74	11.59	11.28	12.64	12.45
Dry Gas Molecular Weight (g/gmole)	29.33	29.35	29.19	29.36	29.22	29.26
Average Stack Gas Velocity (m/s)	37.9	20.9	38.4	21.6	38.2	24.2
Actual Stack Flow Rate (m^3/s)	7.5	4.1	7.6	4.3	7.5	4.8
Dry Standard Stack Flow Rate (Nm^3/s)	2.7	1.7	2.7	1.7	2.8	1.9

Table 3.4: Emissions Results for Reciprocating Compressors

Parameter		K4406-01.1	K4406-01.2	K4406-02.1	K4406-02.2	K4406-03.1	K4406-03.2
NO_x (expressed as NO_2)	(mg/Nm^3)	162	283	190	207	154	128
	(g/s)	0.44	0.489	0.510	0.356	0.438	0.247
CO	(mg/Nm^3)	451	511	492	523	461	496
	(g/s)	1.24	0.89	1.33	0.901	1.31	0.96

Table 3.5: Flow and Sample Characteristics for Screw Compressors

Parameter	K4404-01	K4404-02	K4404-03	K4404-05	K4404-06	K4404-07	K4404-08	K4404-12
Date (dd/mm/yyyy)	18/08/15					19/08/15		
Run Times: Moisture CO_2, O_2, CO, NO_x	 08:38 – 09:18 08:41 – 09:48	 10:11 – 10:51 10:12 – 11:17	 11:45 – 12:25 11:48 – 12:55	 13:31 – 14:11 13:33 – 14:33	 15:06 – 15:46 15:07 – 15:58	 11:38 – 12:18 11:40 – 12:24	 10:28 – 11:15 10:29 – 11:15	 08:48 – 09:28 08:52 – 09:59
Moisture Sample Volume (m^3)	0.416	0.394	0.401	0.404	0.415	0.400	0.401	0.385
Average Stack Temperature (°C)	483	475	468	448	455	471	464	467
Stack Diameter (m)	0.35							
Barometric Pressure (kPa)	102.16					102.47		
Calculated Stack Moisture (%)	15.1	19.1	17.3	16.5	16.3	18.6	17.4	16.5
Carbon Dioxide Percentage (%)	11.36	10.82	11.58	11.48	11.18	11.73	11.18	9.46
Oxygen Percentage (%)	0.94	2.18	1.07	1.52	2.16	1.20	1.96	4.50
Dry Gas Molecular Weight (g/g-mole)	29.86	29.82	29.90	29.90	29.87	29.92	29.87	29.69
Average Stack Gas Velocity (m/s)	32.9	33.2	33.1	28.7	31.6	33.0	31.7	33.2
Actual Stack Flow Rate (m^3/s)	3.2	3.2	3.2	2.8	3.0	3.2	3.1	3.2
Dry Standard Stack Flow Rate (Nm^3/s)	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0

Table 3.6: Emissions Results for Screw Compressors

Parameter		K4404-01	K4404-02	K4404-03	K4404-05	K4404-06	K4404-07	K4404-08	K4404-12
NO_x (expressed as NO_2)	(mg/Nm^3)	6750	6190	778	4769	1040	371	4059	5683
	(g/s)	6.63	5.90	0.77	4.21	1.01	0.36	3.84	5.66
CO	(mg/Nm^3)	3250	3155	503	163	149	678	330	1460
	(g/s)	3.19	3.01	0.50	0.144	0.144	0.653	0.312	1.45

Table 3.7: Flow and Sample Characteristics for Power Generators

Parameter	G4408-01.1	G4408-02.1	G4408-03.1
Date (dd/mm/yyyy)	13/08/15		
Run Times: Moisture CO_2, O_2, CO, NO_x	 12:23 – 13:03 12:31 – 13:25	 13:48 – 14:28 13:50 – 14:46	 15:19 – 15:59 15:21 – 16:13
Moisture Sample Volume (m^3)	0.406	0.402	0.402
Average Stack Temperature (°C)	406	393	421
Stack Diameter (m)	0.20		
Barometric Pressure (kPa)	102.17		
Calculated Stack Moisture (%)	16.5	15.8	16.6
Carbon Dioxide Percentage (%)	9.31	9.28	10.51
Oxygen Percentage (%)	3.84	4.82	3.01
Dry Gas Molecular Weight (g/g-mole)	29.64	29.68	29.80
Average Stack Gas Velocity (m/s)	8.8	12.1	7.9
Actual Stack Flow Rate (m^3/s)	0.28	0.38	0.25
Dry Standard Stack Flow Rate (Nm^3/s)	0.09	0.13	0.08

Table 3.8: Emissions Results for Power Generators

Parameter		G4408-01.1	G4408-02.1	G4408-03.1
NO_x (expressed as NO_2)	(mg/Nm^3)	7967	9578	10805
	(g/s)	0.749	1.26	0.888
CO	(mg/Nm^3)	491	484	521
	(g/s)	0.046	0.064	0.043

3.3 Accuracy of Monitoring Results

Table 3.9 presents a summary of the estimated method uncertainties for each of the monitoring parameters.

Table 3.9: Estimated Method Uncertainties

Measurement Parameter	Method	% Uncertainty
Oxygen	USEPA Method 3A	12
Carbon Dioxide		10
Oxides of Nitrogen (NO, NO_2, NO_x)	USEPA Method 7E	10
Carbon Monoxide	USEPA Method 10B	

Uncertainty values cited are calculated at a 95% confidence level, with a coverage factor of 2.

Appendix A – Glossary of Terms

APPENDIX A: GLOSSARY OF TERMS	
<	The analytes tested for was not detected, the value stated is the reportable limit of detection
µg	Micrograms (10^{-6}grams)
AS	Australian Standard
dscm	dry standard cubic meters (at 0°C and 1 atmosphere)
g	grams
kg	kilograms
m	metres
m^3	Cubic Metres, actual gas volume in cubic metres as measured.
mg	Milligrams
min	Minute
mg/m^3	Milligrams (10^{-3}) per cubic metre.
mmH_2O	Millimetres of water
Mole	SI Unit defined as an amount of a substance that contains as many elementary entities (e.g. atoms, molecules, ions, electrons) as there are atoms in 12 grams of pure Carbon-12 (^{12}C)
N/A	Not Applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Normalised Cubic Metres - Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa).
ou	Odour Units
°C	Degrees Celsius
$µg/m^3$	Micrograms (10^{-6}) per cubic metre.
ppb / ppm	Parts per billion / million.
PM	Particulate Matter.

APPENDIX A: GLOSSARY OF TERMS	
PM_{10}, $PM_{2.5}$, PM_1	Fine particulate matter with an equivalent aerodynamic diameter of less than 10, 2.5 or 1 micrometres respectively. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
sec	Second
Sm^3	Standardised Cubic Metres - 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. 7% O_2).
STP	Standard Temperature and Pressure (0°C and 101.3 kPa).
TVOC	Total Volatile Organic Compounds. These compounds can be both toxic and odorous.
USEPA	United States Environmental Protection Agency

Appendix B – Gas Calibration Records

APPENDIX C: GAS CALIBRATION RECORDS			
Test Location:	ANE Office	**Cylinder No.**	356 615 461 397 429 829
Calibration Date:	11-Aug-15 21-Aug-15		
Testo ID:	ANE 01		

Pre Test Calibration							
Range		CO_2 %	O_2 %	CO ppm	SO_2 ppm	NO ppm	NO_2 ppm
LOW	Target	-	-	0	0	0	0.0
	Actual	-	-	0	0	0	0.0
	Calibration	-	-	-	-	-	-
HIGH	Target	-	-	511	437	1010	22.5
	Actual	-	-	513	450	990	20.3
	Calibration	-	-	-	437	1010	22.6

Post Test Calibration							
Range		CO_2 %	O_2 %	CO ppm	SO_2 ppm	NO ppm	NO_2 ppm
LOW	Target	-	-	0	0	0	0.0
	Actual	-	-	0	13	1	0.0
MID	Target	-	-	511	437	1010	22.5
	Actual	-	-	494	396	1020	24.5

APPENDIX C: GAS CALIBRATION RECORDS			
Test Location:	SIMTARS Redbank[#] ANE Office	**Cylinder No.**	356 615 461 397 429 829
Calibration Date:	19-Feb-15 27-Aug-15		
Testo ID:	SIMTARS 04741		

[#]SIMTARS Calibration Report OG490988N2

Pre Test Calibration							
Range		CO_2 %	O_2 %	CO ppm	SO_2 ppm	NO ppm	NO_2 ppm
LOW	Target	0.00	0.00	-	-	-	-
	Actual	0.00	0.00	-	-	-	-
	Calibration	-	-	-	-	-	-
HIGH	Target	25.00	20.95	-	-	-	-
	Actual	24.79	20.92	-	-	-	-
	Calibration	-	-	-	-	-	-

Post Test Calibration							
Range		CO_2 %	O_2 %	CO ppm	SO_2 ppm	NO ppm	NO_2 ppm
LOW	Target	0.00	0.0	-	-	-	-
	Actual	0.04	0.0	-	-	-	-
MID	Target	13.80	6.00	-	-	-	-
	Actual	14.30	6.05	-	-	-	-