



**Stephenson**

Environmental Management Australia

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**CO-GENERATION PLANT STACK EMISSION TESTING - 2016**

**TOOHEYS PTY LTD**

**LIDCOMBE, NSW**

**PROJECT NO.: 5648/S24184/16**

**DATE OF SURVEY: 24 MARCH 2016**

**DATE OF ISSUE: 21 APRIL 2016**

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**Stephenson**

**Environmental Management Australia**

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**P W STEPHENSON**

**A PRADHAN**

**J WEBER**

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>1</b>
<b>2</b>	<b>PRODUCTION CONDITIONS.....</b>	<b>2</b>
<b>3</b>	<b>EMISSION TEST RESULTS AND DISCUSSION.....</b>	<b>3</b>
	3.1 INTRODUCTION .....	3
	3.2 OXIDES OF NITROGEN (NO <sub>x</sub> ).....	3
	3.3 VOLATILE ORGANIC COMPOUNDS .....	3
<b>4</b>	<b>CONCLUSIONS.....</b>	<b>5</b>
<b>5</b>	<b>TEST METHODS .....</b>	<b>6</b>
	5.1 EXHAUST GAS VELOCITY AND TEMPERATURE .....	6
	5.2 CONTINUOUS GASEOUS ANALYSIS .....	6
	5.3 VOLATILE ORGANIC COMPOUNDS (VOCs) .....	6
	5.4 MEASUREMENT OF UNCERTAINTY .....	6
	<b>APPENDIX A – EMISSION TEST RESULTS .....</b>	<b>1</b>
	<b>APPENDIX B – CONTINUOUS LOGGED DATA.....</b>	<b>1</b>
	<b>APPENDIX C – NATA ENDORSED TEST REPORT .....</b>	<b>1</b>
	<b>APPENDIX D – PRODUCTION DATA.....</b>	<b>1</b>
	<b>APPENDIX E – INSTRUMENT CALIBRATION DETAILS.....</b>	<b>1</b>
	<b>APPENDIX F – STACK SAMPLING LOCATION .....</b>	<b>1</b>

## TABLE OF TABLES

TABLE 1-1 EPL ID No. 7 – EMISSION CONCENTRATION LIMITS AND MONITORING REQUIREMENTS.....	1
TABLE 3-1 SUMMARY OF AVERAGE EMISSION TEST RESULTS.....	4
TABLE 5-1 MEASUREMENT OF UNCERTAINTY.....	7

## TABLE OF TABLES – APPENDICES

TABLE A-1 EMISSION TEST RESULTS – EPL ID No.7 – FLOW & VOCs.....	11
TABLE E-1 INSTRUMENT CALIBRATION DETAILS .....	11

## TABLE OF FIGURES – APPENDICES

FIGURE B-1 CONTINUOUS LOG OF NITROGEN OXIDES EMISSIONS @ 5% O <sub>2</sub> 24 MARCH 2016.....	11
FIGURE F-1 CO-GENERATION ENGINE STACK – EPA ID No. 7 .....	11

## 1 INTRODUCTION

Stephenson Environmental Management Australia (SEMA) was requested by Tooheys Pty Ltd to assess emissions from the stack serving their Co-generation Plant at their brewing facility at Lidcombe, New South Wales (NSW).

Tooheys operates under the NSW Office of Environment and Heritage (OEH) EPL No. 1167. Condition L3.4 specifies the emission concentration limits for the stack serving the Co-generation Plant (EPA Identification (ID) No. 7). The objective of this monitoring is to meet the requirements for EPA ID No. 7 and to determine if the specified emission concentration limits are met.

The tests were undertaken on 24 March 2016.

**TABLE 1-1 EPL ID NO. 7 – EMISSION CONCENTRATION LIMITS AND MONITORING REQUIREMENTS**

Parameter	Units of measure	Frequency	OEH test method	100% conc. limit	Reference condition	Oxygen correction
Volatile Organic Compounds (as n-propane)	mg/m <sup>3</sup>	Annual	TM-34	40	Dry, 273k, 101.3kPa,	5%
Nitrogen Oxides	mg/m <sup>3</sup>	Annual	TM-11	250	Dry, 273k, 101.3kPa,	5%
Dry Gas Density	kg/m <sup>3</sup>	Annual	TM-23	--	--	--
Moisture	%	Annual	TM-22	--	--	--
Molecular Weight	g/g mole	Annual	TM-23	--	--	--
Temperature	°C	Annual	TM-2	--	--	--
Volumetric Flow Rate	m/s	Annual	TM-2	--	--	--
Velocity	m <sup>3</sup> /s	Annual	TM-2	--	--	--

Key:

mg/m <sup>3</sup>	=	milligrams per cubic metre
OEH	=	Office of Environment and Heritage
TM	=	Approved Test Method
mg/m <sup>3</sup>	=	milligrams per cubic metre @ 0°C and 1 atmosphere
kg/m <sup>3</sup>	=	kilograms per cubic metre
%	=	percent
g/g mole	=	grams per gram mole
°C	=	degrees Celsius
m/s	=	metres per second
m <sup>3</sup> /s	=	cubic metres per second
conc.	=	concentration
--	=	no specified limit

## **2 PRODUCTION CONDITIONS**

On the day of testing, the plant operating procedures and production rate were considered typical by Tooheys personnel. Refer to Appendix D for Screen Shot of Co-generation engine operating conditions for the day of testing.

In essence, the Co-generation Engine and associated waste heat boiler was producing of the order of 2.0 megawatts (MW) of power and steam on the day of testing.

### **3 EMISSION TEST RESULTS AND DISCUSSION**

#### **3.1 INTRODUCTION**

SEMA completed all the sampling and analysis for velocity, flow, dry gas density, molecular weight of stack gases, temperature, moisture, Volatile Organic Compounds (VOCs), Oxygen (O<sub>2</sub>) and Nitrogen Oxides (NO<sub>x</sub>). SEMA is NATA accredited to ISO 17025 to complete the sampling and analysis for the above parameters. SEMA NATA accreditation number is 15043.

The VOC sample, collected by SEMA, was analysed by the NATA accredited Testsafe Australia, accreditation number 3726, Report No. 2016-0863.

The emission test results are summarised in table format in Table 3-1. Sections 3.2 and 3.3 provide a description of the results.

Refer to Appendix B for a graphical logged record of NO<sub>x</sub> continuous emission analysis.

Appendix C presents SEMA's NATA endorsed Emission Test Report, No. 5648.

Details of the most recent calibration of each instrument used to take measurements is summarised in Appendix E, and the sample location is illustrated in Appendix F.

#### **3.2 OXIDES OF NITROGEN (NO<sub>x</sub>)**

The one-hour average NO<sub>x</sub> (expressed as NO<sub>2</sub>) emission concentration during the sampling period was 65 parts per million (ppm) and when corrected to 5% O<sub>2</sub> was 194 mg/m<sup>3</sup>. This emission concentration was in compliance with the Co-generation EPL NO<sub>x</sub> concentration limit of 250 mg/m<sup>3</sup> at 5% O<sub>2</sub>. Refer to Table 3-1 and Figure B-1 in Appendix B for detailed results in tabulated and graphical formats respectively.

#### **3.3 VOLATILE ORGANIC COMPOUNDS**

The sum of the total VOC emission concentrations in the suite of 73 analytes is reported as n-propane equivalent as required by the NSW OEH Approved Methods and POEO (Clean Air) Regulation 2010.

The measured total VOCs emission concentration as n-propane was 0.65 mg/m<sup>3</sup> (0.95 mg/m<sup>3</sup> corrected to 5% O<sub>2</sub>). Refer to Table 3-1 and Appendix C for details.

**TABLE 3-1 SUMMARY OF AVERAGE EMISSION TEST RESULTS**

Parameter	Unit	EPL ID No.7 Average Result	EPL Concentration Limit
Temperature	°C	260	--
Pressure	kPa	101.2	--
Velocity	m/s	15.9	--
Volumetric Flow	m <sup>3</sup> /s	1.39	--
Moisture	%	5.2	--
Molecular Weight Dry Stack Gas	g/g mole	29.4	--
Gas Density	kg/m <sup>3</sup>	1.31	--
Nitrogen Oxides	mg/m <sup>3</sup> @ 5% O <sub>2</sub>	194	250
Oxygen	%	10.0	--
Volatile Organic Compounds	mg/m <sup>3</sup> @ 5% O <sub>2</sub> as n-propane equiv.	0.95	40

Key:

°C	=	degrees Celsius
<	=	less than
*	=	reported as n-propane equivalent
%	=	percentage
EPA	=	Environment Protection Authority
EPL	=	Environment Protection Licence
kg/m <sup>3</sup>	=	kilograms per cubic metre
kPa	=	kilo Pascals
g/g mole	=	grams per gram mole
m <sup>3</sup> /s	=	dry cubic metre per second 0°C and 101.3 kilopascals (kPa)
m/s	=	metres per second
mg/m <sup>3</sup>	=	milligrams per cubic metre at 0°C and 101.3 kilopascals (kPa)

## 4 CONCLUSIONS

From the data presented and test work conducted during typical production, the following conclusions were drawn for the stack emissions:

- The one-hour average NO<sub>x</sub> emission concentration, corrected to 5% O<sub>2</sub>, was 194 mg/m<sup>3</sup>, which was in compliance with the EPL NO<sub>x</sub> emission limit of 250 mg/m<sup>3</sup>.
- The VOC emission concentration corrected to 5% O<sub>2</sub> was 0.95 mg/m<sup>3</sup>, which was in compliance with the EPL VOC emission limit of 40 mg/m<sup>3</sup> (expressed as n-propane).



## 5 TEST METHODS

### 5.1 EXHAUST GAS VELOCITY AND TEMPERATURE

(OEH NSW TM-1 & 2)

Velocity profiles were obtained across each stack utilising an Airflow Developments Ltd. S-type pitot tube and digital manometer. Where practicable, each sampling plane complied with AS4323.1. The temperature of the exhaust gas was measured using a digital thermometer (0-1200°C) connected to a chromel/alumel (K-type) thermocouple probe.

### 5.2 CONTINUOUS GASEOUS ANALYSIS

(OEH NSW TM-11, 24, 25 & 32)

Sampling and analysis of exhaust gas were performed using one of Stephenson Environmental Management Australia's mobile combustion and environmental monitoring laboratories. Emission gases were distributed to the analysers via a manifold. Flue gas from each stack was pumped continuously. The following components of the laboratory were relevant to this work:

Oxides of Nitrogen	Testo 350XL
Oxygen	Testo 350XL
Calibration	BOC / Air Liquide Special Gas Mixtures relevant for each analyser. Instrument calibrations were performed at the start and finish of sampling at each location.
QA/QC	Calibration (Zero/Span) checks Sample line integrity calibration check

### 5.3 VOLATILE ORGANIC COMPOUNDS (VOCs)

(OEH NSW TM-34)

A sample of stack air is drawn onto a carbon adsorption tube and analysed using Gas Chromatography/Mass Spectrometry (GC/MS) performed by the NATA accredited laboratory TestSafe Australia, accreditation number, 3726.

### 5.4 MEASUREMENT OF UNCERTAINTY

All results are quoted on a dry basis. SEMA has adopted the following (Table 5-1) uncertainties for various stack emission testing methods.

**TABLE 5-1 MEASUREMENT OF UNCERTAINTY**

<b>Pollutant</b>	<b>Methods</b>	<b>Uncertainty</b>
Moisture	AS4323.2, TM-22, USEPA 4	25%
Nitrogen Oxides	NSW TM-11, USEPA 7E	15%
Oxygen	NSW TM-24, USEPA 3A	1% actual
Velocity	AS4323.1, TM-2, USEPA 2	5%
Volatile Organic Compounds (adsorption tube)	TM-34, USEPA M18	25%

Key:

Unless otherwise indicated the uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source - Measurement Uncertainty)

Sources: *Measurement Uncertainty - implications for the enforcement of emission limits* by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK

*Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.*

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## APPENDIX A – EMISSION TEST RESULTS

### Glossary:

%	=	percent
°C	=	Degrees Celsius
am <sup>3</sup> /min	=	cubic metre of gas at actual conditions per minute
Normal Volume (m <sup>3</sup> )	=	cubic metre at 0°C and 760 mm pressure and 1 atmosphere
am <sup>3</sup>	=	cubic metre of gas at actual conditions
g/g mole	=	grams per gram mole
g/s	=	grams per second
hrs	=	hours
kg/m <sup>3</sup>	=	kilograms per cubic metre
kPa	=	kilo Pascals
m <sup>2</sup>	=	square metre
m/s	=	metre per second
m <sup>3</sup> /sec	=	cubic metre per second at 0°C and 1 atmosphere
mg	=	milligrams
mg/ m <sup>3</sup>	=	milligrams per cubic metre at 0°C and 1 atmosphere
O <sub>2</sub>	=	Oxygen
SEMA	=	Stephenson Environmental Management Australia
VOC	=	Volatile Organic Compounds

### Abbreviations of Personnel

PWS	=	Peter Stephenson
AP	=	Alok Pradhan
JW	=	Jay Weber

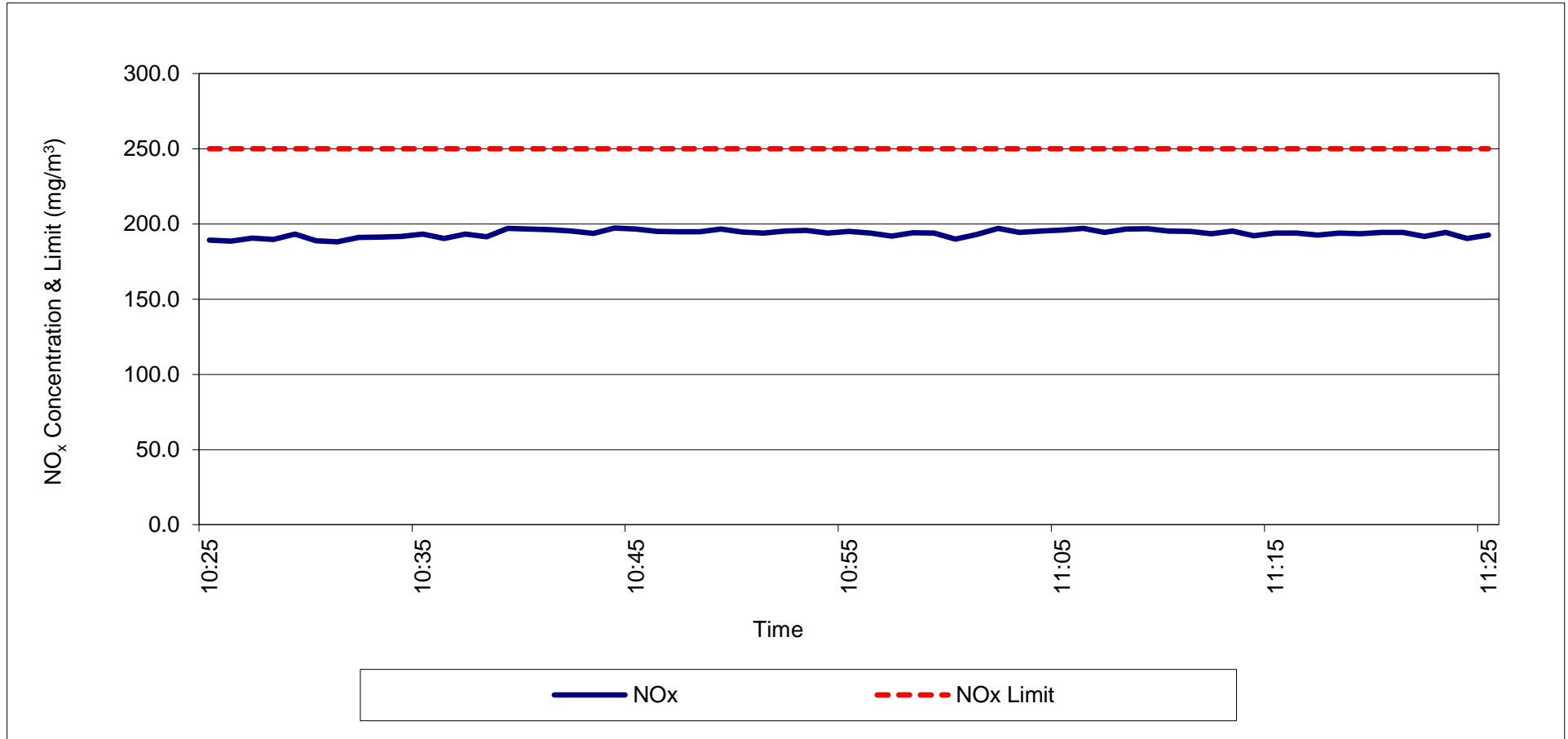
**TABLE A-1 EMISSION TEST RESULTS – EPL ID No.7 – FLOW & VOCs**

<b>Emission Test Results</b>	<b>Flow &amp; VOC's</b>
Project Number	5648
Project Name	Tooheys
Test Location	<b>EPA ID Point No.7 - Gas Engine</b>
Date	24 March 2016
RUN	1
Sample Start Time (hrs)	8:40
Sample Finish Time (hrs)	11:35
Sample Location (Inlet/Exhaust)	Exhaust
Stack Temperature (°C)	260
Stack Cross-Sectional area (m <sup>2</sup> )	0.181
Average Stack Gas Velocity (m/s)	15.9
Actual Gas Flow Volume (am <sup>3</sup> /min)	172
Total Normal Gas Flow Volume (m <sup>3</sup> /min)	84
Total Normal Gas Flow Volume (m <sup>3</sup> /sec)	1.39
Total Stack Pressure (kPa)	101.2
Moisture Content (% by volume)	5.2
Molecular Weight Dry Stack Gas (g/g-mole)	29.35
Dry Gas Density (kg/m <sup>3</sup> )	1.31
Oxygen (%)	10.0
Carbon Dioxide (%)	6.0
Sampling Performed by	PWS, JW, AP
Sample Analysed by (Laboratory)	SEMA
Calculations Entered by	JW
Calculations Checked by	AP
<b>Volatile Organic Compounds</b>	
VOCs Sample Start Time:	9:57
VOCs Sample Finish Time:	10:57
Sampling Period (min):	60
SEMA Sample No.:	725401
Concentration (mg/m <sup>3</sup> ) @ 5% O <sub>2</sub>	0.65
Concentration as n-prop. Equiv. (mg/m <sup>3</sup> ) @ 5% O <sub>2</sub>	0.95

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**APPENDIX B – CONTINUOUS LOGGED DATA**

FIGURE B-1 CONTINUOUS LOG OF NITROGEN OXIDES EMISSIONS @ 5% O<sub>2</sub> 24 MARCH 2016



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**APPENDIX C – NATA ENDORSED TEST REPORT**



**Stephenson**  
Environmental Management Australia

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ABN 75 002 600 526  
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E-Mail: [info@stephensonenv.com.au](mailto:info@stephensonenv.com.au)

## Emissions Test Report No. 5648

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**The sampling and analysis was commissioned by:**

**Client**

Organisation: Tooheys Pty Ltd  
Contact: Paul Kiely  
Address: 29 Nyrang Street Lidcombe NSW 2141  
Telephone: 9647 9647  
Email: [paul.kiely@lionco.com](mailto:paul.kiely@lionco.com)

Project Number: 5648/S24184/16  
Test Date(s): 24/03/2016  
Production Conditions: Normal operating conditions during testing

Analysis Requested: Flow, temperature, moisture, Oxygen, Nitrogen Oxides, Dry Gas Density and Volatile Organic Compounds  
Sample Locations: Co-Generation Engine Stack  
Sample ID Nos.: See Attachment A

This report cannot be reproduced except in full.

NATA accredited laboratory number 15043.

Accredited for Compliance with ISO/IEC 17025.





## EMISSION TEST REPORT NO.5648

Identification	The samples are labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time and whether further analysis is required.	
Test	<i>Test Method Number for Sampling and Analysis</i>	<i>NATA Laboratory Analysis By: NATA Accreditation No. &amp; Report No.</i>
Dry Gas Density	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report 5648
Flow	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report 5648
Moisture	NSW TM-22, USEPA M4	SEMA, Accreditation No. 15043, Emission Test Report 5648
Molecular Weight of Stack Gases	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report 5648
Oxides of Nitrogen	NSW TM-11, USEPA M7E	SEMA, Accreditation No. 15043, Emission Test Report 5648
Oxygen	NSW TM-25, USEPA M3A	SEMA, Accreditation No. 15043, Emission Test Report 5648
Stack Pressure	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report 5648
Stack Temperature	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report 5648

EMISSION TEST REPORT No.5648

Velocity	NSW TM-2, USEPA M2	SEMA, Accreditation No. 15043, Emission Test Report 5648
Volatile Organic Compounds	NSW TM-34, USEPA M18	TestSafe, Accreditation No. 3726, Report No. 2016-0863
Deviations from Test Methods	Nil	
Sampling Times	NSW - As per Test Method requirements or if not specified in the Test Method then as per Protection of the Environment Operations (Clean Air) Regulations Part 2.	
Reference Conditions	NSW - As per (1) Environment Protection Licence conditions, or (2) Part 3 of the Protection of the Environment Operations (Clean Air) Regulations	

All associated NATA endorsed Test Reports/Certificates of Analysis are provided separately in Attachment A.

Issue Date  
6 April 2016



P W Stephenson  
Managing Director

EMISSION TEST REPORT No.5648

SUMMARY OF THE AVERAGE EMISSION TEST RESULTS – TEST REPORT NO. 5648

Co-Generation Engine Stack – EPA ID No.7		
Date Tested – 24/03/2016		
Stack Emission Test Parameter	Unit	Average Emission Test Result
Temperature	°C	260
Pressure	kPa	101.2
Velocity	m/s	15.9
Volumetric Flow	m <sup>3</sup> /s	1.39
Moisture	%	5.2
Molecular Weight Dry Stack Gas	g/g mole	29.35
Gas Density	kg/m <sup>3</sup>	1.31
Nitrogen Oxides	mg/m <sup>3</sup> @ 5% O <sub>2</sub>	194
Oxygen	%	10.0
Volatile Organic Compounds (expressed as n-propane equivalent)	mg/m <sup>3</sup> @ 5% O <sub>2</sub>	0.95

Key: °C = degrees Celsius  
 < = less than  
 % = percentage  
 kg/m<sup>3</sup> = kilograms per cubic metre  
 kPa = kilo Pascals  
 g/g mole = grams per gram mole  
 m<sup>3</sup>/s = dry cubic metre per second 0°C and 101.3 kilopascals (kPa)  
 m/s = metres per second  
 mg/m<sup>3</sup> = milligrams per cubic metre at 0°C and 101.3 kilopascals (kPa)

ESTIMATED UNCERTAINTY OF MEASUREMENT

Pollutant	Methods	Uncertainty
Moisture	AS4323.2, NSW TM-22, USEPA 4	25%
Nitrogen Oxides	NSW TM-11, USEPA 7E	15%
Oxygen	NSW TM-24, USEPA 3A	1% actual
Velocity	AS4323.1, NSW TM-2, USEPA 2	5%
Volatile Organic Compounds (adsorption tube)	NSW TM-34, USEPA 18	25%

Key:

Unless otherwise indicated the uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source - Measurement Uncertainty)

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK*

*Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.*

EMISSION TEST REPORT No.5648

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**ATTACHMENT A – NATA CERTIFICATES OF ANALYSIS**



Alok Pradhan  
Stephenson Environmental Management Australia  
PO Box 6398  
SILVERWATER NSW 1811

Lab. Reference: 2016-0863

**SAMPLE ORIGIN:** Project No. 5648

**DATE OF INVESTIGATION:** 24/03/2016

**DATE RECEIVED:** 29/03/16

**ANALYSIS REQUIRED:** Volatile Organic Compounds

**REPORT OF ANALYSIS**

See attached sheet(s) for sample description and test results.

The results of this report have been approved by the signatory whose signature appears below.

For all administrative or account details please contact the Laboratory.

Martin Mazereeuw

Manager

Date: 4/04/16

TestSafe Australia – Chemical Analysis Branch  
Level 2, Building 1, 9-15 Chilvers Road, Thornleigh, NSW 2120, Australia  
T: +61 2 9473 4000 E: [lab@safework.nsw.gov.au](mailto:lab@safework.nsw.gov.au) W: [testsafe.com.au](http://testsafe.com.au)  
ABN 81 913 830 179



Accreditation No. 3726

Accredited for compliance with ISO/IEC 17025





SafeWork NSW



**Analysis of Volatile Organic Compounds in Workplace Air by GC/MS**

Client : Alok Pradhan

Sample ID : 725401

Sample : 2016-0863-1

No	Compounds	CAS No	Front	Back	No	Compounds	CAS No	Front	Back
			µg/section					µg/section	
<b>Aliphatic hydrocarbons (LOD = 5µg/compound/section)</b>					<b>Aromatic hydrocarbons (LOD = 1µg/compound/section)</b>				
1	2-Methylbutane	78-78-4	7	ND	39	Benzene	71-43-2	ND	ND
2	n-Pentane	109-66-0	ND	ND	40	Ethylbenzene	100-41-4	ND	ND
3	2-Methylpentane	107-83-5	ND	ND	41	Isopropylbenzene	98-82-8	ND	ND
4	3-Methylpentane	96-14-0	ND	ND	42	1,2,3-Trimethylbenzene	526-73-8	ND	ND
5	Cyclopentane	287-92-3	ND	ND	43	1,2,4-Trimethylbenzene	95-63-6	ND	ND
6	Methylcyclopentane	96-37-7	ND	ND	44	1,3,5-Trimethylbenzene	108-67-8	ND	ND
7	2,3-Dimethylpentane	565-59-3	ND	ND	45	Styrene	100-42-5	ND	ND
8	n-Hexane	110-54-3	ND	ND	46	Toluene	108-88-3	ND	ND
9	3-Methylhexane	589-34-4	ND	ND	47	p-Xylene &/or m-Xylene	106-42-8 106-34-3	ND	ND
10	Cyclohexane	110-82-7	ND	ND	48	o-Xylene	95-47-6	ND	ND
11	Methylcyclohexane	108-87-2	ND	ND	<b>Ketones (LOD #49, #54 &amp; #55 = 5µg/c/s; #50, #51, #52 &amp; #53 = 25µg/c/s)</b>				
12	2,2,4-Trimethylpentane	540-84-1	ND	ND	49	Acetone	67-64-1	ND	ND
13	n-Heptane	142-82-5	ND	ND	50	Acetoin	513-86-0	ND	ND
14	n-Octane	111-65-9	ND	ND	51	Diacetone alcohol	123-42-2	ND	ND
15	n-Nonane	111-84-2	ND	ND	52	Cyclohexanone	108-94-1	ND	ND
16	n-Decane	124-18-5	ND	ND	53	Isophorone	78-59-1	ND	ND
17	n-Undecane	1120-21-4	ND	ND	54	Methyl ethyl ketone (MEK)	78-93-3	ND	ND
18	n-Dodecane	112-40-3	ND	ND	55	Methyl isobutyl ketone (MIBK)	108-10-1	ND	ND
19	n-Tridecane	629-50-5	ND	ND	<b>Alcohols (LOD = 25µg/compound/section)</b>				
20	n-Tetradecane	629-59-4	ND	ND	56	Ethyl alcohol	64-17-5	ND	ND
21	α-Pinene	80-56-8	ND	ND	57	n-Butyl alcohol	71-36-3	ND	ND
22	β-Pinene	127-91-3	ND	ND	58	Isobutyl alcohol	78-83-1	ND	ND
23	D-Limonene	138-86-3	ND	ND	59	Isopropyl alcohol	67-63-0	ND	ND
<b>Chlorinated hydrocarbons (LOD = 5µg/compound/section)</b>					60	2-Ethyl hexanol	104-76-7	ND	ND
24	Dichloromethane	75-09-2	ND	ND	61	Cyclohexanol	108-93-0	ND	ND
25	1,1-Dichloroethane	75-34-3	ND	ND	<b>Acetates (LOD = 25µg/compound/section)</b>				
26	1,2-Dichloroethane	107-06-2	ND	ND	62	Ethyl acetate	141-78-6	ND	ND
27	Chloroform	67-66-3	ND	ND	63	n-Propyl acetate	109-60-4	ND	ND
28	1,1,1-Trichloroethane	71-55-6	ND	ND	64	n-Butyl acetate	123-86-4	ND	ND
29	1,1,2-Trichloroethane	79-00-5	ND	ND	65	Isobutyl acetate	110-19-0	ND	ND
30	Trichloroethylene	79-01-6	ND	ND	<b>Ethers (LOD = 25µg/compound/section)</b>				
31	Carbon tetrachloride	56-23-5	ND	ND	66	Ethyl ether	60-29-7	ND	ND
32	Perchloroethylene	127-18-4	ND	ND	67	tert-Butyl methyl ether (MTBE)	1634-04-4	ND	ND
33	1,1,2,2-Tetrachloroethane	79-34-5	ND	ND	68	Tetrahydrofuran (THF)	109-99-9	ND	ND
34	Chlorobenzene	108-90-7	ND	ND	<b>Glycols (LOD = 25µg/compound/section)</b>				
35	1,2-Dichlorobenzene	95-50-1	ND	ND	69	PGME	107-98-2	ND	ND
36	1,4-Dichlorobenzene	106-46-7	ND	ND	70	Ethylene glycol diethyl ether	629-14-1	ND	ND
<b>Miscellaneous (LOD #37= 5µg &amp; #38=25µg/compound/section)</b>					71	PGMEA	108-65-6	ND	ND
37	Acetonitrile	75-05-8	ND	ND	72	Cellosolve acetate	111-15-9	ND	ND
38	n-Vinyl-2-pyrrolidone	88-12-0	ND	ND	73	DGMEA	112-15-2	ND	ND
<b>Total VOCs (LOD = 50µg/compound/section)</b>			ND	ND	Worksheet check			YES	YES

2016-0863.xlsx

Page 2 of 3

TestSafe Australia – Chemical Analysis Branch

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Accreditation No. 3726

Accredited for compliance with ISO/IEC 17025

SW08051 1215



SafeWork NSW



**Analysis of Volatile Organic Compounds in Workplace Air by GC/MS**

**Client : Alok Pradhan**

**Stephenson Environmental Management Australia**

ND = Not Detected

VOCs = Volatile Organic Compounds

All compounds numbered 1-73 are included of this analysis in the scope of NATA accreditation. Any additional compounds annotated with \* are not covered by NATA accreditation.

Method : Analysis of Volatile Organic Compounds in Workplace Air by Gas Chromatography/Mass Spectrometry

Method Number : WCA.207

Detection Limit : 5µg/section; 25µg/section for oxygenated hydrocarbons except acetone, MEK and MIBK at 5µg/section and aromatic hydrocarbon at 1µg/section.

Brief Description : Volatile organic compounds are trapped from the workplace air onto charcoal tubes by the use of a personal air monitoring pump. The volatile organic compounds are then desorbed from the charcoal in the laboratory with CS<sub>2</sub>. An aliquot of the desorbant is analysed by capillary gas chromatography with mass spectrometry detection.

Total Volatile Organic Compounds (TVOC) test result in µg/section is calculated by comparison to the average mass detector response of the 73 quantified compounds. The response of a mass detector is dependent on the fragmentation of the molecule. Therefore, the TVOC test result should be interpreted as a semi-quantitative guide to the amount of VOCs present. If the TVOC test result is less than the addition of the total amount of the 73 quantified compounds then the TVOC result is of little value other than for comparative purposes. If the TVOC test result is greater than the addition of all the compounds quantified then this can indicate that there are additional compounds present other than the 73 quantified compounds reported.

PGME : Propylene Glycol Monomethyl Ether

PGMEA : Propylene Glycol Monomethyl Ether Acetate

DGMEA : Diethylene Glycol Monoethyl Ether Acetate

Measurement Uncertainty

The measurement uncertainty is an estimate that characterises the range of values within which the true value is asserted to lie. The uncertainty estimate is an expanded uncertainty using a coverage factor of 2, which gives a level of confidence of approximately 95%. The estimate is compliant with the "ISO Guide to the Expression of Uncertainty in Measurement" and is a full estimate based on in-house method validation and quality control data.

Quality Assurance

In order to ensure the highest degree of accuracy and precision in our analytical results, we undertake extensive intra- and inter-laboratory quality assurance (QA) activities. Within our own laboratory, we analyse laboratory and field blanks and perform duplicate and repeat analysis of samples. Spiked QA samples are also included routinely in each run to ensure the accuracy of the analyses. WorkCover Laboratory Services has participated for many years in several national and international inter-laboratory comparison programs listed below:-

- Workplace Analysis Scheme for Proficiency (WASP) conducted by the Health & Safety Executive UK;
- Quality Management in Occupational and Environmental Medicine QA Program, conducted by the Institute for Occupational, Social and Environmental Medicine, University of Erlangen - Nuremberg, Germany;
- Quality Control Technologies QA Program, Australia;
- Royal College of Pathologists QA Program, Australia.

2016-0863.xlsx

Page 3 of 3

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SW08051 1215

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## **APPENDIX D – PRODUCTION DATA**



### Screenshot

12/06/2010 - 2nd eng 09/2014  
PLC-date = 24.03.2016 10:33:20

PLC release = 2.29.43  
Comment: Toohey's

Number of faults = 0  
Number of alarms = 0  
Operation hours = 31242

Number: 9296876  
Engine type: TCG2020V20

Actual load = 1466 kW  
Actual speed = 1501.1 1/min  
Starts = 2032



The screenshot displays a monitoring interface with a dark green header and a central data area. On the left, there is a vertical navigation bar with icons for home, clock, list, graph, and help. The main area is divided into several sections:

- Operating information:**
  - Operation hours gas type A: 31242 h
  - Operation hours in total: 31242 h
  - Black start: 1
  - Starts: 2032
  - Last oil change: 26.02.2016
  - At operation hours: 30704 h
  - Operation hours since oil change: 538 h
- Operation hours analysis:**

Load value	Gas type A
> 105%	0.0 %
80..105%	82.3 %
50..80%	15.1 %
25..50%	2.2 %
< 25%	0.4 %

At the bottom, there is a control bar with buttons for '1', 'Auto', 'Load run', and 'Bridge Ap-monitoring in the AWT circuit'. The 'Load run' button shows '1466 kW' and '1501.1 1/min'. The 'Bridge Ap-monitoring in the AWT circuit' button shows '0' and '0'. The top right corner of the interface displays the date and time: '24.03.2016 10:33:20'.

### Screenshot

12/06/2010 - 2nd eng 09/2014  
PLC-date = 24.03.2016 10:30:18

PLC release = 2.29.43  
Comment: Toohey's  
Number of faults = 0  
Number of alarms = 0  
Operation hours = 31242

Number: 9296876  
Engine type: TCG2020V20  
Actual load = 1426 kW  
Actual speed = 1500.6 1/min  
Starts = 2032



**Data**

- 
- 
- 
- 
- 
- 
- 
- 
- 
- 
-

Overview

**Engine**

Heating/cooling circuits

Gas/fuel/ure

Air/Generator

Wastegate

Data/collected measurements

Operating information

Comb. chamber	Side A	Side B
Cylinder 1	294 °C	282 °C
Cylinder 2	292 °C	293 °C
Cylinder 3	259 °C	287 °C
Cylinder 4	289 °C	307 °C
Cylinder 5	289 °C	294 °C
Cylinder 6	275 °C	322 °C
Cylinder 7	304 °C	298 °C
Cylinder 8	319 °C	288 °C
Cylinder 9	287 °C	311 °C
Cylinder 10	336 °C	318 °C
Average value	289 °C	
Gas mixer	-38 Steps	

Measured values	
Intake air	36.9 °C
Receiver	44.2 °C
T202 Jacket water GKS inlet	34.2 °C
T207 Jacket water engine inlet	77.7 °C
T208 Jacket water engine outlet	86.2 °C
P145 Crankcase	-3.1 mbar

Speed, power	
Operation mode	Mains
E199.7 Demand active	71.4 %
E198.9 Internal set power	70.6 %
Power switch	<input checked="" type="checkbox"/>
E199.6 Power limit	100.0 %
E198.4 Set power	71.4 %
E198.2 Actual power	70.6 %
S200.0 Engine speed	1500.6 1/min
Throttle valve	48.9 %

Lube oil	
T208 Lube oil	91.0 °C
F195 Lube oil before filter	5.26 bar
L234.1 Lube oil level	103.0 %

Exhaust gas	
Exhaust after ATL	462 °C
	465 °C

Save as not

**1** **Auto**

**Load run**

21.03.2016 12:17:58

**1426 kW**

1500.6 1/min

**0**

21.03.2016 12:18:58 On

**Bridge Δp - monitoring in the AWT circuit**

24.03.2016 10:30:18

---

## **APPENDIX E – INSTRUMENT CALIBRATION DETAILS**

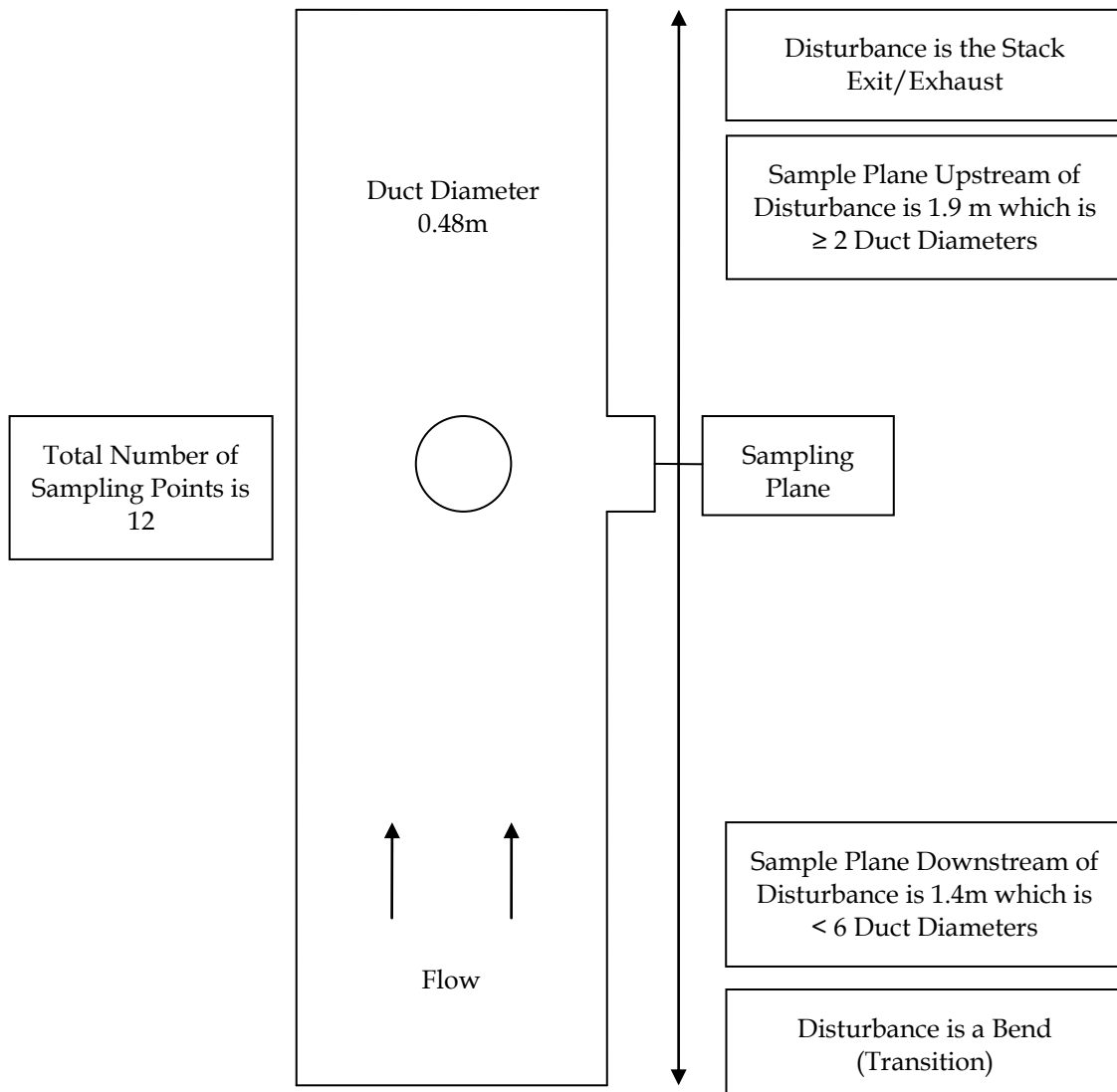
**TABLE E-1 INSTRUMENT CALIBRATION DETAILS**

<b>SEMA Asset No.</b>	<b>Equipment Description</b>	<b>Date Last Calibrated</b>	<b>Calibration Due Date</b>
858	Digital Temperature Reader	06-Jan-16	06-Jul-16
720	Thermocouple	23-Mar-16	23-Sep-16
815	Digital Manometer	26-Feb-16	26-Feb-17
613	Barometer	26-Feb-16	26-Feb-17
726	Pitot	03-Jun-15	03-Jun-2016 Visually inspected On-Site before use
834	Personal Sampler	22-Mar-16	22-Mar-17
946	TESTO Combustion Analyser	24-Feb-16	24-Aug-16
928	Balance		Response Check with SEMA Site Mass
930	Calibrated Site Mass	23-Mar-16	23-Mar-17
936	Buck Calibrator 1ml/min - 6L/min	21-Mar-16	21-Sep-16
<b>Gas Mixtures used for Analyser Span Response</b>			
<b>Conc.</b>	<b>Mixture</b>	<b>Cylinder No.</b>	<b>Expiry Date</b>
0.099% 9.8% 10.1%	Carbon Monoxide Carbon Dioxide Oxygen In Nitrogen	ALST 9799	19-Mar-19
245 ppm 245 ppm 250 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen Sulphur Dioxide In Nitrogen	ALSB 1372	05-Jan-20
400 ppm 400 ppm 401 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen Sulphur Dioxide In Nitrogen	ALWB 6150	05-May-20

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## **APPENDIX F – STACK SAMPLING LOCATION**

FIGURE F-1 CO-GENERATION ENGINE STACK – EPA ID NO. 7



In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were used in compliance with AS4323.1 as the sampling plane was non-ideal.

However the sample plane does meet the minimum sampling plane position; sampling plane conditions will be found to exit at 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance.

The location of the sampling plane complies with AS4323.1 temperature, velocity and gas flow profile criteria for sampling.