



Address (Head Office)
427 Canterbury Road,
SURREY HILLS VIC 3127

Postal Address
Unit 3, 4 Monash Gate,
JANDAKOT WA 6164

Office Locations
VIC NSW WA QLD

Freecall: 1300 364 005
Int'l Call: +61 3 9813 7200
www.ektimo.com.au
ABN: 86 600 381 413

Report Number R002285

**Emission Testing Report
Brookfield District Energy, Mascot**

Document Information

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 Attention: Chris Smith
 Address: Building TG1, 10 Bourke Rd
 Mascot NSW 2020
 Testing Laboratory: Ektimo (ETC) ABN 74 474 273 172

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Aaron Davis
Operations Manager

NATA Accredited Laboratory
No. 14601

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1 EXECUTIVE SUMMARY

Ektimo was engaged by Brookfield District Energy to perform emission testing at the trigeneration facility located at Mascot NSW to satisfy conditions within NSW Environment Protection licence 20246.

Monitoring was performed for the following parameters:

Location	Test Date	Test Parameters*
DP2 – Unit 2	5 February 2016	Nitrogen oxides, oxygen, volatile organic compounds (VOC's) includes n-propane equivalent
DP1 – Unit 1	9 March 2016	Nitrogen oxides, oxygen, volatile organic compounds (VOC's) includes n-propane equivalent

* Flow rate, velocity, temperature and moisture were determined unless otherwise stated

The sampling methodologies chosen by Ektimo are those recommended by the NSW Office of Environment and Heritage (as specified in the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales, January 2007*).

All results are reported on a dry basis at STP. Unless otherwise indicated, the methods cited in this report have been performed without deviation.

Plant operating conditions have been noted in the report.

2 RESULTS SUMMARY


The following licence comparison table shows that all analytes highlighted in green are below the licence limit set by the NSW EPA as per licence 20246 (last amended on 2/12/15).

EPA No.	Pollutant	Units	Licence limit	Detected values 5/02/2016 & 9/03/2016	Detected values (Corrected to 3% O2)
DP 1-Unit 1	Nitrogen Oxides	mg/m ³	250	75	120
	Volatile Organic Compounds (as n-propane)	mg/m ³	40	<0.04	<0.06
DP 2-Unit 2	Nitrogen Oxides	mg/m ³	250	99	160
	Volatile Organic Compounds (as n-propane)	mg/m ³	40	<0.04	<0.06

3 RESULTS

3.1 DP2 – Unit 2

Date	5/02/2016	Client	Brookfield District Energy		
Report	R002285	Stack ID	DP2 - Unit 2		
Licence No.	20246	Location	Mascot	State	NSW
Ektimo Staff	Swo/Swe				
Process Conditions	Plant operating at 100% load (chilling unit off)				

Sampling Plane Details			
Sampling plane dimensions		900 mm	
Sampling plane area		0.636 m ²	
Sampling port size, number		1" BSP (x2)	
Access & height of ports	Stairs	25 m	
Duct orientation & shape	Vertical	Circular	
Downstream disturbance	Exit	10 D	
Upstream disturbance	Junction	2 D	
No. traverses & points sampled		2 16	
Compliance of sample plane to AS4323.1		Compliant but non-ideal ⁽¹⁾	

Stack Parameters			
Moisture content, %v/v	8.4		
Gas molecular weight, g/g mole	28.6 (wet)	29.5 (dry)	
Gas density at STP, kg/m ³	1.27 (wet)	1.32 (dry)	
% Oxygen correction & Factor	3 %	1.65	
Gas Flow Parameters			
Measurement time (hhmm)	908		
Temperature, °C	389		
Velocity at sampling plane, m/s	20		
Volumetric flow rate, discharge, m ³ /s	13		
Volumetric flow rate (wet STP), m ³ /s	5.3		
Volumetric flow rate (dry STP), m ³ /s	4.8		
Mass flow rate (wet basis), kg/hour	24000		
Velocity difference, %	<1		

Gases	Sampling time	Average 906-1011 Corrected to 3%			Minimum 906-1011 Corrected to 3%			Maximum 906-1011 Corrected to 3%		
		Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min	Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min	Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min
Nitrogen oxides (as NO ₂)		99	160	29	84	140	24	120	200	35
Oxygen		10			9.9			10.1		

Total VOCs* (as n-Propane)	Sampling time	Results 0910-1010 Corrected to 3%		
		Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min
Total		<0.04	<0.06	<0.01

*Total VOCs does not include methane

VOC's (speciated)	Sampling time	Results 0910-1010 Corrected to 3%		
		Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min
Detection limit ⁽²⁾		<0.04	<0.07	<0.01

(1) The sampling plane is deemed to be non-ideal or non-compliant due to the following reasons:

The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D


(2) Unless otherwise reported, the following target compounds were found to be below detection:

Ethanol, Isoopropanol, Isobutanol, Butanol, 1-Methoxy-2-propanol, Cyclohexanol, 2-Butoxyethanol, Pentane, Hexane, Heptane, Octane, Nonane, Decane, Undecane, Dodecane, Tridecane, Tetradecane, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Isooctane, Methylcyclohexane, alpha-Pinene, beta-Pinene, d-Limonene, 3-Carene, Acetone, Methyl ethyl ketone, Ethyl acetate, Isopropyl acetate, Propyl acetate, MIBK, 2-Hexanone, Butyl acetate, 1-Methoxy-2-propyl acetate, Cyclohexanone, Cellosolve acetate, 2-Butoxyethyl acetate, Ethylidiglycol acetate, Diacetone alcohol, Isophorone, Benzene, Toluene, Ethylbenzene, m-p-Xylene, Styrene, o-Xylene, Isopropylbenzene, Propylbenzene, 1,3-Trimethylbenzene, alpha-Methylstyrene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, m-Diethylbenzene, o-Diethylbenzene, p-Diethylbenzene, Dichloromethane, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, 1,1-Dichloroethene, cis-1,2-Dichloroethene, trans-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, 1,1,2-Trichloroethane, 1,1,2,2-Tetrachloroethane, Chlorobenzene, Fluorobenzene

3.2 DP1 – Unit 1

Date	9/03/2016	Client	Brookfield District Energy
Report	R002285	Stack ID	DP1 - Unit 1
Licence No.	20246	Location	Mascot
Ektimo Staff	Sco	State	NSW
Process Conditions Plant operating at 100% load, Chilling unit on			

Sampling Plane Details	
Sampling plane dimensions	900 mm
Sampling plane area	0.636 m ²
Sampling port size, number & depth	1" BSP (x2), 20 mm
Access & height of ports	Stairs 25 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 10 D
Upstream disturbance	Junction 2 D
No. traverses & points sampled	2 16
Compliance of sample plane to AS4323.1	Compliant but non-ideal ⁽¹⁾



Stack Parameters	
Moisture content, %v/v	8.7
Gas molecular weight, g/g mole	28.5 (wet) 29.5 (dry)
Gas density at STP, kg/m ³	1.27 (wet) 1.32 (dry)
% Oxygen correction & Factor	3 % 1.63
Gas Flow Parameters	
Measurement time (hhmm)	945
Temperature, °C	400
Velocity at sampling plane, m/s	19
Volumetric flow rate, discharge, m ³ /s	12
Volumetric flow rate (wet STP), m ³ /s	4.9
Volumetric flow rate (dry STP), m ³ /s	4.5
Mass flow rate (wet basis), kg/hour	22000
Velocity difference, %	<1

Gases	Sampling time	Average 948-1050 Corrected to 3%			Minimum 948-1050 Corrected to 3%			Maximum 948-1050 Corrected to 3%		
		Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min	Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min	Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min
Nitrogen oxides (as NO ₂)		75	120	20	68	110	18	90	150	24
Oxygen		9.9			9.9			10		

Total VOCs* (as n-propane)	Sampling time	Results 0948-1048 Corrected to 3%		
		Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min
Total		<0.04	<0.06	<0.01

* Total VOCs does not include methane

VOC's (speciated)	Sampling time	Results 0948-1048 Corrected to 3%		
		Concentration mg/m ³	O ₂ mg/m ³	Mass Rate g/min
Detection limit ⁽²⁾		<0.04	<0.07	<0.01

(1) The sampling plane is deemed to be non-ideal or non-compliant due to the following reasons:

The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

(2) Unless otherwise reported, the following target compounds were found to be below detection:

Ethanol, Isopropanol, Isobutanol, Butanol, 1-Methoxy-2-propanol, Cyclohexanol, Pentane, Hexane, Heptane, Octane, Nonane, Decane, Dodecane, Tridecane, Tetradecane, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Isooctane, Methylcyclohexane, beta-Pinene, d-Limonene, 3-Carene, Acetone, Methyl ethyl ketone, Ethyl acetate, Isopropyl acetate, Propyl acetate, MIBK, Butyl acetate, 1-Methoxy-2-propyl acetate, Cyclohexanone, Cyclohexanone, 2-Butoxyethyl acetate, Ethyl diglycol acetate, Diacetone alcohol, Isophorone, Benzene, Toluene, Ethylbenzene, m-p-Xylene, Styrene, o-Xylene, Propylbenzene, 1,3,5-Trimethylbenzene, alpha-Methylstyrene, alpha-Methylstyrene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, m-Diethylbenzene, o-Diethylbenzene, p-Diethylbenzene, 1,1,2-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, 1,1-Dichloroethene, trans-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, Tetrachloroethane, 1,1,2,2-Tetrachloroethane, Chlorobenzene, Fluorobenzene

4 PLANT OPERATING CONDITIONS

Testing was conducted on DP1 and DP 2 under 100% load conditions. The Chilling Unit was 'on' for DP 1 and 'off' for DP2. See Brookfield District Energy's records for complete process conditions.

5 TEST METHODS

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

Parameter	Sampling Method	Analysis Method	Method Detection Limit	Uncertainty*	NATA Accredited	
					Sampling	Analysis
Sample plane criteria	NSW TM-1	NA	NA	-	✓	NA
Moisture content	NSW TM-22	NSW TM-22	0.4%	8%	✓	✓
Temperature	NSW TM-2	NA	0°C	2%	✓	NA
Flow rate	NSW TM-2	NA	Location specific	8%	✓	NA
Velocity	NSW TM-2	NA	2ms ⁻¹	7%	✓	NA
Nitrogen oxides (NO _x)	NSW TM-11	NSW TM-11	4mg/m ³	12%	✓	✓
Oxygen	NSW TM-25	NSW TM-25	0.1%	13%	✓	✓
Speciated volatile organic compounds (VOC's)	NSW TM-34	USEPA SW-846 8260	0.33mg/m ³	19%	✓	✓

* Uncertainty values cited in this table are calculated at the 95% confidence level (coverage factor = 2)

6 QUALITY ASSURANCE/ QUALITY CONTROL INFORMATION

Ektimo (EML) and Ektimo (ETC) are 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 (EML) and Ektimo (ETC) are accredited by NATA (National Association of Testing Authorities) to ISO/IEC 17025. – General Requirements for the Competence of Testing and Calibration Laboratories. ISO/IEC 17025 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 Compliance Manager.

NATA is a member of APLAC (Asia Pacific Laboratory Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through the mutual recognition arrangements with both of these organisations, NATA accreditation is recognised world –wide.

A formal Quality Control program is in place at Ektimo to monitor analyses performed in the laboratory and sampling conducted in the field. The program is designed to check where appropriate; the sampling reproducibility, analytical method, accuracy, precision and the performance of the analyst. The Laboratory Manager is responsible for the administration and maintenance of this program.

7 DEFINITIONS

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

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, unless otherwise specified.
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.
VOC	Any chemical compound based on carbon with a vapour pressure of at least 0.010 kPa at 25°C or having a corresponding volatility under the particular conditions of use. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
TOC	The sum of all compounds of carbon which contain at least one carbon to carbon bond, plus methane and its derivatives.
OU	The number of odour units per unit of volume. The numerical value of the odour concentration is equal to the number of dilutions to arrive at the odour threshold (50% panel response).
PM _{2.5}	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 2.5 microns (µm).
PM ₁₀	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 10 microns (µm).
BSP	British standard pipe
NT	Not tested or results not required
NA	Not applicable
D ₅₀	'Cut size' of a cyclone defined as the particle diameter at which the cyclone achieves a 50% collection efficiency ie. half of the particles are retained by the cyclone and half are not and pass through it to the next stage. The D ₅₀ method simplifies the capture efficiency distribution by assuming that a given cyclone stage captures all of the particles with a diameter equal to or greater than the D ₅₀ of that cyclone and less than the D ₅₀ of the preceding cyclone.
D	Duct diameter or equivalent duct diameter for rectangular ducts
<	Less than
>	Greater than
≥	Greater than or equal to
~	Approximately
CEM	Continuous Emission Monitoring
CEMS	Continuous Emission Monitoring System
DER	WA Department of Environment & Regulation
DECC	Department of Environment & Climate Change (NSW)
EPA	Environment Protection Authority
FTIR	Fourier Transform Infra Red
NATA	National Association of Testing Authorities
RATA	Relative Accuracy Test Audit
AS	Australian Standard
USEPA	United States Environmental Protection Agency
Vic EPA	Victorian Environment Protection Authority
ISC	Intersociety committee, Methods of Air Sampling and Analysis
ISO	International Organisation for Standardisation
APHA	American public health association, Standard Methods for the Examination of Water and Waste Water
CARB	Californian Air Resources Board
TM	Test Method
OM	Other approved method
CTM	Conditional test method
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
NIOSH	National Institute of Occupational Safety and Health
XRD	X-ray Diffractometry