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Report Number R004807

**Emission Testing Report
Enwave Mascot Pty Ltd, Mascot**



Document Information

Client Name: Enwave Mascot Pty Ltd
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 Attention: Chris Smith
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 Testing Laboratory: Ektimo Pty Ltd, ABN 86 600 381 413

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Aaron Davis
Ektimo Signatory

NATA Accredited Laboratory
 No. 14601

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

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1 EXECUTIVE SUMMARY

Ektimo was engaged by Enwave Mascot Pty Ltd to perform emission testing at the trigeneration facility located at Mascot NSW to satisfy conditions within NSW Environment Protection licence 20246.

Monitoring was performed as follows:

Location	Test Date	Test Parameters*
DP1 – Unit 1	25 June 2018	Nitrogen oxides, oxygen, volatile organic compounds (VOC's) includes n-propane equivalent
DP2 – Unit 2	25 June 2018	Nitrogen oxides, oxygen, volatile organic compounds (VOC's) includes n-propane equivalent

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

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 LICENCE 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 14/11/17).

EPA No.	Pollutant	Units	Licence limit	Detected values 25/06/18	Detected values (Corrected to 3% O ₂)
DP 1-Unit 1	Nitrogen Oxides	mg/m ³	250	140	230
	Volatile Organic Compounds (as n-propane)	mg/m ³	40	0.22	0.37
DP 2-Unit 2	Nitrogen Oxides	mg/m ³	250	130	220
	Volatile Organic Compounds (as n-propane)	mg/m ³	40	0.21	0.35

3 RESULTS

3.1 DP1 – Unit 1

Date	25/06/2018	Client	Enwave Mascot Pty Ltd
Report	R004807	Stack ID	DP1 - Unit 1
Licence No.	20246	Location	Mascot
Ektimo Staff	Steven Cooper & Steven Weekes	State	NSW
Process Conditions	Plant operating at 100% load, chiller unit on		

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
Sample plane compliance to AS4323.1	Compliant but non-ideal



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

Stack Parameters			
Moisture content, %w/v	9.4		
Gas molecular weight, g/g mole	28.5 (wet)	29.6 (dry)	
Gas density at STP, kg/m ³	1.27 (wet)	1.32 (dry)	
% Oxygen correction & Factor	3 %	1.65	
Gas Flow Parameters			
Flow measurement time(s) (hh:mm)	1045 & 1155		
Temperature, °C	394		
Temperature, K	667		
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		

Gas Analyser Results	Sampling time	Average			Minimum			Maximum		
		1050 - 1149			1050 - 1149			1050 - 1149		
		Corrected to			Corrected to			Corrected to		
		Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min	Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min	Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min
Nitrogen oxides (as NO ₂)		140	230	40	120	200	36	160	260	46
Oxygen		Concentration %			Concentration %			Concentration %		
		10.1			10			10.1		

Total VOCs (as n-Propane)	Sampling time	Results		
		1051-1151		
		Corrected to		
		Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min
Total		0.22	0.37	0.064

VOC (speciated)	Sampling time	Results		
		1051-1151		
		Corrected to		
		Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min
Detection limit ⁽¹⁾		<0.03	<0.06	<0.01
Toluene		0.23	0.39	0.068
Pentane		0.18	0.3	0.052

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

Ethanol, Isopropanol, 1,1-Dichloroethene, Dichloromethane, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Benzene, Carbon tetrachloride, Butanol, 1-Methoxy-2-propanol, Trichloroethylene, 1,1,2-trichloroethane, Tetrachloroethene, Chlorobenzene, Ethylbenzene, m + p-Xylene, Styrene, o-Xylene, 2-Butoxyethanol, 1,1,2,2-Tetrachloroethane, Isopropylbenzene, Propylbenzene, 1,3,5-trimethylbenzene, tert-Butylbenzene, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, Acetone, Acrylonitrile, n-Hexane, Methyl ethyl ketone, Ethyl acetate, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, Isopropyl acetate, 3-Methylhexane, Ethyl acrylate, Heptane, Methyl methacrylate, Propyl acetate, Methylcyclohexane, MIBK, 2-Hexanone, Octane, Butyl acetate, 1-methoxy-2-propyl acetate, Butyl acrylate, Nonane, Cellosolve acetate, alpha-Pinene, beta-Pinene, Decane, 3-Carene, D-Limonene, Undecane, Dodecane, Tridecane, Tetradecane

3.2 DP2 – Unit 2

Date	25/06/2018	Client	Enwave Mascot Pty Ltd
Report	R004807	Stack ID	DP2 - Unit 2
Licence No.	20246	Location	Mascot
Ektimo Staff	Steven Cooper & Steven Weekes	State	NSW
Process Conditions	Plant operating at 100% load, chiller 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
Sample plane compliance to AS4323.1	Compliant but non-ideal



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

Stack Parameters			
Moisture content, %w/v	9.6		
Gas molecular weight, g/g mole	28.5 (wet)	29.6 (dry)	
Gas density at STP, kg/m ³	1.27 (wet)	1.32 (dry)	
% Oxygen correction & Factor	3 %	1.67	
Gas Flow Parameters			
Flow measurement time(s) (hh:mm)	1215 & 1319		
Temperature, °C	406		
Temperature, K	679		
Velocity at sampling plane, m/s	20		
Volumetric flow rate, discharge, m ³ /s	13		
Volumetric flow rate (wet STP), m ³ /s	5.2		
Volumetric flow rate (dry STP), m ³ /s	4.7		
Mass flow rate (wet basis), kg/hour	24000		
Velocity difference, %	<1		

Gas Analyser Results	Sampling time	Average			Minimum			Maximum		
		1217 - 1317			1217 - 1317			1217 - 1317		
		Corrected to			Corrected to			Corrected to		
		Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min	Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min	Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min
Nitrogen oxides (as NO ₂)		130	220	37	110	190	32	150	250	43
		Concentration %			Concentration %			Concentration %		
Oxygen		10.2			10.2			10.3		

Total VOCs (as n-Propane)	Sampling time	Results		
		1217-1317		
		Corrected to		
		Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min
Total		0.21	0.35	0.06

VOC (speciated)	Sampling time	Results		
		1217-1317		
		Corrected to		
		Concentration mg/m ³	3% O2 mg/m ³	Mass Rate g/min
Detection limit ⁽¹⁾		<0.04	<0.06	<0.01
Toluene		0.19	0.32	0.054
Pentane		0.2	0.33	0.055

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

Ethanol, Isopropanol, 1,1-Dichloroethene, Dichloromethane, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Chloroform, 1,1-Trichloroethane, 1,2-Dichloroethane, Benzene, Carbon tetrachloride, Butanol, 1-Methoxy-2-propanol, Trichloroethylene, 1,1,2-trichloroethane, Tetrachloroethene, Chlorobenzene, Ethylbenzene, m + p-Xylene, Styrene, o-Xylene, 2-Butoxyethanol, 1,1,2,2-Tetrachloroethane, Isopropylbenzene, Propylbenzene, 1,3,5-trimethylbenzene, tert-Butylbenzene, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, Acetone, Acrylonitrile, n-Hexane, Methyl ethyl ketone, Ethyl acetate, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, Isopropyl acetate, 3-Methylhexane, Ethyl acrylate, Heptane, Methyl methacrylate, Propyl acetate, Methylcyclohexane, MIBK, 2-Hexanone, Octane, Butyl acetate, 1-methoxy-2-propyl acetate, Butyl acrylate, Nonane, Cellosolve acetate, alpha-Pinene, beta-Pinene, Decane, 3-Carene, D-Limonene, Undecane, Dodecane, Tridecane, Tetradecane

4 PLANT OPERATING CONDITIONS

Testing was conducted on DP1 - Unit 1 under 100% load, chilling unit on and DP 2 - Unit 2 under 100% load, chilling unit off. See Enwave Mascot Pty Ltd'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	Uncertainty*	NATA Accredited	
				Sampling	Analysis
Sample plane criteria	NSW TM-1	NA	-	✓	NA
Flow rate, temperature and velocity	NSW TM-2	NA	8%, 2%, 7%	✓	NA
Moisture content	NSW TM-22	NSW TM-22	19%	✓	✓
Nitrogen oxides (NO _x)	NSW TM-11	NSW TM-11	12%	✓	✓
Oxygen	NSW TM-25	NSW TM-25	13%	✓	✓
Speciated volatile organic compounds (VOC's)	NSW TM-34	Ektimo 344	19%	✓	✓ [†]

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

† Analysis performed by Ektimo, NATA accreditation number 14601. Laboratory analytical results were reported on 9 July 2018 in report number R004807_SVOCs.

6 QUALITY ASSURANCE/QUALITY CONTROL INFORMATION

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

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

NATA is a member of 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 worldwide.

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:

~	Approximately
<	Less than
>	Greater than
≥	Greater than or equal to
APHA	American public health association, Standard Methods for the Examination of Water and Waste Water
AS	Australian Standard
BSP	British standard pipe
CARB	Californian Air Resources Board
CEM	Continuous Emission Monitoring
CEMS	Continuous Emission Monitoring System
CTM	Conditional test method
D	Duct diameter or equivalent duct diameter for rectangular ducts
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.
DECC	Department of Environment & Climate Change (NSW)
Disturbance	A flow obstruction or instability in the direction of the flow which may impede accurate flow determination. This includes centrifugal fans, axial fans, partially closed or closed dampers, louvres, bends, connections, junctions, direction changes or changes in pipe diameter.
DWER	Department of Water and Environmental Regulation
EPA	Environment Protection Authority
FTIR	Fourier Transform Infra Red
ISC	Intersociety committee, Methods of Air Sampling and Analysis
ISO	International Organisation for Standardisation
NA	Not applicable
NATA	National Association of Testing Authorities
NIOSH	National Institute of Occupational Safety and Health
NT	Not tested or results not required
OM	Other approved method
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 ₁₀	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 10 microns (µm).
PM _{2.5}	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 2.5 microns (µm).
PSA	Particle size analysis
RATA	Relative Accuracy Test Audit
STP	Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0°C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa, unless otherwise specified.
TM	Test Method
TOC	The sum of all compounds of carbon which contain at least one carbon to carbon bond, plus methane and its derivatives.
USEPA	United States Environmental Protection Agency
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
Vic EPA	Victorian Environment Protection Authority
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.
XRD	X-ray Diffractometry