



Stephenson

Environmental Management Australia

CO-GENERATION PLANT STACK EMISSION TESTING - ANNUAL, 2014

TOOHEYS PTY LTD

LIDCOMBE, NSW

PROJECT NO.: 5449/S23558/14

DATE OF SURVEY: 4 DECEMBER 2014

DATE OF ISSUE: 10 DECEMBER 2014



Stephenson

Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526
Newington Business Park
Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
e-mail: info@stephensonenv.com.au

CO-GENERATION PLANT STACK EMISSION TESTING - ANNUAL, 2014

TOOHEYS PTY LTD

LIDCOMBE, NSW

PROJECT NO.: 5449/S23558/14

DATE OF SURVEY: 4 DECEMBER 2014

DATE OF ISSUE: 10 DECEMBER 2014

P W STEPHENSON

A MCGHIE

A PRADHAN

TABLE OF CONTENTS

| | | |
|----------|---|----------|
| 1 | INTRODUCTION | 1 |
| 2 | PRODUCTION CONDITIONS..... | 2 |
| 3 | EMISSION TEST RESULTS AND DISCUSSION..... | 3 |
| | 3.1 INTRODUCTION | 3 |
| | 3.2 OXIDES OF NITROGEN (NO _x)..... | 3 |
| | 3.3 VOLATILE ORGANIC COMPOUNDS | 3 |
| 4 | CONCLUSIONS..... | 5 |
| 5 | TEST METHODS | 6 |
| | 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 | 7 |
| | APPENDIX A – EMISSION TEST RESULTS | 1 |
| | APPENDIX B – CONTINUOUS LOGGED DATA..... | 1 |
| | APPENDIX C – NATA ENDORSED TEST REPORT | 1 |
| | APPENDIX D – PRODUCTION DATA..... | 1 |
| | APPENDIX E – INSTRUMENT CALIBRATION DETAILS..... | 1 |
| | APPENDIX F – STACK SAMPLING LOCATION | 1 |
| | APPENDIX G – OEH – CO-GENERATION AND TRI-GENERATION DOCUMENT | 1 |

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 ₂ 4 DECEMBER 2014 | 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 objectives of this were to meet the requirements for EPA ID No. 7 and to determine if the specified emission concentration limits were met.

The tests were undertaken on 4 December 2014.

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 ³ | Annual | TM-34 | 40 | Dry, 273k, 101.3kPa, | 5% |
| Nitrogen Oxides | mg/m ³ | Annual | TM-11 | 250 | Dry, 273k, 101.3kPa, | 5% |
| Dry Gas Density | kg/m ³ | 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 ³ /s | Annual | TM-2 | -- | -- | -- |

Key:

| | | |
|-------------------|---|---|
| mg/m ³ | = | milligrams per cubic metre |
| OEH | = | Office of Environment and Heritage |
| TM | = | Approved Test Method |
| mg/m ³ | = | milligrams per cubic metre @ 0°C and 1 atmosphere |
| kg/m ³ | = | kilograms per cubic metre |
| % | = | percent |
| g/g mole | = | grams per gram mole |
| °C | = | degrees Celsius |
| m/s | = | metres per second |
| m ³ /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 Shots 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.

Tooheys advise that this engine was designed by the manufacturer to meet an emission specification corrected to 5% Oxygen (O₂). This has been acknowledged by OEHL because co-generation is considered by OEHL to be best available technology and thus, has been confirmed in OEHL Interim NO_x for Policy for Co-generation in Sydney and the Illawarra, which is presented in Appendix G.

This policy concept of 5% oxygen reference correction for co-generation plant emissions has now been incorporated into EPL 1167 for the Tooheys brewery site.

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 (O₂) and Nitrogen Oxides (NO_x). SEMA is NATA accredited to ISO17025 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. 2014-2920.

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_x continuous emission analysis.

Appendix C presents SEMA's NATA endorsed Emission Test Report, No. 5449.

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_x)

The one-hour average NO_x (expressed as NO₂) emission concentration during the sampling period was 80 parts per million (ppm) and when corrected to 5% O₂ was 238 mg/m³. This emission concentration was in compliance with the Co-generation EPL NO_x concentration limit of 250 mg/m³ at 5% O₂. 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) corrected to 5% O₂ was less than 6.19 mg/m³ which was *in compliance* with EPL concentration emission limit of 40 mg/m³. 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 | 296 | -- |
| Pressure | kPa | 101.0 | -- |
| Velocity | m/s | 27.3 | -- |
| Volumetric Flow | m ³ /s | 2.16 | -- |
| Moisture | % | 8.6 | -- |
| Molecular Weight Dry Stack Gas | g/g mole | 29.425 | -- |
| Gas Density | kg/m ³ | 1.31 | -- |
| Nitrogen Oxides | mg/m ³ @ 5% O ₂ | 238 | 250 |
| Oxygen | % | 9.9 | -- |
| Volatile Organic Compounds | mg/m ³ @ 5% O ₂ as n-propane equiv. | < 6.19 | 40 |

Key:

| | | |
|-------------------|---|---|
| °C | = | degrees Celsius |
| < | = | less than |
| * | = | reported as n-propane equivalent |
| % | = | percentage |
| EPA | = | Environment Protection Authority |
| EPL | = | Environment Protection Licence |
| kg/m ³ | = | kilograms per cubic metre |
| kPa | = | kilo Pascals |
| g/g mole | = | grams per gram mole |
| m ³ /s | = | dry cubic metre per second 0°C and 101.3 kilopascals (kPa) |
| m/s | = | metres per second |
| mg/m ³ | = | 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_x emission concentration corrected to 5% O₂ was 238 mg/m³, which was in compliance with the EPL NO_x emission limit of 250 mg/m³.
- This NO_x emission concentration was also in compliance with the OEHL Interim Co-generation Policy NO_x concentration limit corrected to 5% O₂.
- The VOC emission concentration corrected to 5% O₂ was less than 6.19 mg/m³, which was in compliance with the EPL VOC emission limit of 40 mg/m³ (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 exhaust gas temperature 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 |
| Carbon Dioxide | 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 testing methods.

TABLE 5-1 MEASUREMENT OF UNCERTAINTY

| Pollutant | Methods | Uncertainty |
|---|--------------------------|-------------|
| Moisture | AS4323.2, TM-22, USEPA 4 | 25% |
| Nitrogen Oxides | NSW TM-11, USEPA 7E | 15% |
| Oxygen a | 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.

APPENDIX A – EMISSION TEST RESULTS

Glossary:

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

Abbreviations of Personnel

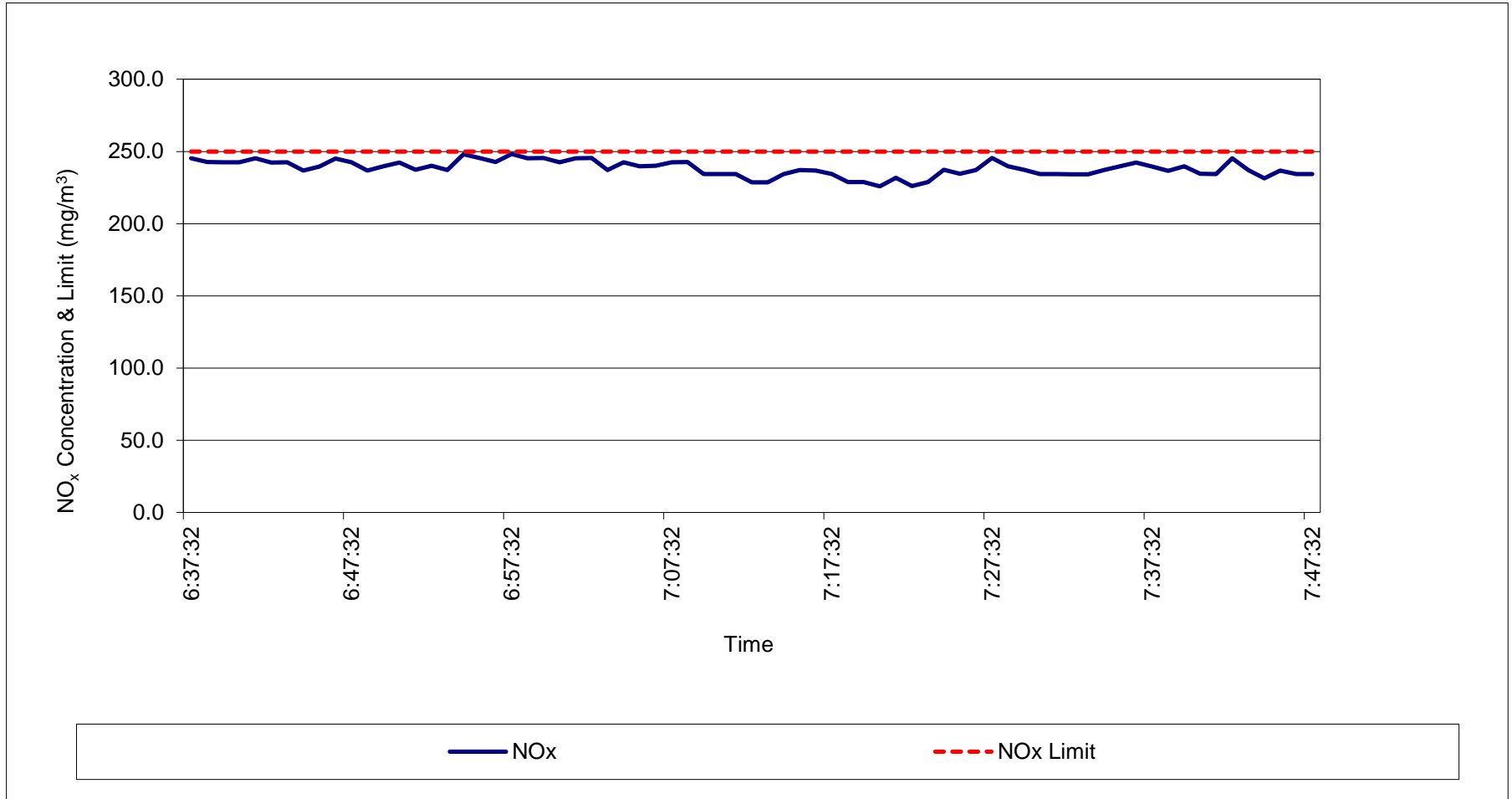
| | | |
|-----|---|------------------|
| PWS | = | Peter Stephenson |
| AM | = | Argyll McGhie |
| AP | = | Alok Pradhan |
| AN | = | Ali Naghizadeh |

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

| Emission Test Results | Flow |
|--|---------------------------------------|
| Project Number | 5449 |
| Project Name | Tooheys |
| Test Location | EPA ID Point No.7 - Gas Engine |
| Date | 4 December 2014 |
| | |
| RUN | 1 |
| Sample Start Time (hrs) | 6:10 |
| Sample Finish Time (hrs) | 8:03 |
| Sample Location (Inlet/Exhaust) | Exhaust |
| Stack Temperature (°C) | 296.0 |
| Stack Cross-Sectional area (m ²) | 0.181 |
| Average Stack Gas Velocity (m/s) | 27.3 |
| Actual Gas Flow Volume (am ³ /min) | 296 |
| Total Normal Gas Flow Volume (m ³ /min) | 130 |
| Total Normal Gas Flow Volume (m ³ /sec) | 2.16 |
| Total Stack Pressure (kPa) | 101.0 |
| Moisture Content (% by volume) | 8.6 |
| Molecular Weight Dry Stack Gas (g/g-mole) | 29.425 |
| Dry Gas Density (kg/m ³) | 1.31 |
| Oxygen (Grab Sample) (%) | 9.89 |
| Carbon Dioxide (Grab Sample) (%) | 6.44 |
| Sampling Performed by | PWS, AM, AP |
| Sample Analysed by (Laboratory) | SEMA |
| Calculations Entered by | AN |
| Calculations Checked by | AP |
| VOCs Sample Start Time: | 7:03 |
| VOCs Sample Finish Time: | 8:03 |
| Sampling Period (min): | 60 |
| SEMA Sample No.: | 724370 |
| Concentration (mg/m ³) @ 5% O ₂ | < 6.49 |
| Concentration as n-prop. Equiv. (mg/m ³) @ 5% O ₂ | <6.19 |

APPENDIX B – CONTINUOUS LOGGED DATA

FIGURE B-1 CONTINUOUS LOG OF NITROGEN OXIDES EMISSIONS @ 5% O₂ 4 DECEMBER 2014



APPENDIX C – NATA ENDORSED TEST REPORT



CHEMICAL ANALYSIS BRANCH



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

Lab. Reference: 2014-2920

SAMPLE ORIGIN: 5449

DATE OF INVESTIGATION: 04/12/2014

DATE RECEIVED: 5/12/14

ANALYSIS REQUIRED: VOC Screen

REPORT OF ANALYSIS

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

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

For all administrative or account details please contact Jeanine Wells.

Martin Mazereeuw
Manager

Date: 8/12/14



E-MAILED

8/12

WorkCover NSW Chemical Analysis Branch
ABN 77 682 742 966 L2, Bldg 1, 9-15 Chilvers Road Thornleigh NSW 2120 AUSTRALIA
T: +61 2 9473 4000 F: +61 2 9980 6849 E: lab@workcover.nsw.gov.au
WorkCover Assistance Service: 13 10 50 W: www.workcover.nsw.gov.au



Accreditation No. 3726

Accredited for compliance with ISO/IEC 17025



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

Client : Alok Pradhan
Sample ID : 724370

Sample : 2014-2920-1

| No | Compounds | CAS No | Front | Back | No | Compounds | CAS No | Front | Back |
|--|---------------------------|-----------|------------|------|---|--------------------------------|-----------|------------|------|
| | | | µg/section | | | | | µg/section | |
| Aliphatic hydrocarbons (LOD = 5µg/compound/section) | | | | | Aromatic hydrocarbons (LOD = 1µg/compound/section) | | | | |
| 1 | 2-Methylbutane | 78-78-6 | ND | ND | 39 | Benzene | 71-43-2 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND | 40 | Ethylbenzene | 106-41-1 | ND | ND |
| 3 | 2-Methylpentane | 107-83-3 | ND | ND | 41 | Isopropylbenzene | 98-62-0 | ND | ND |
| 4 | 3-Methylpentane | 96-74-9 | ND | ND | 42 | 1,2,3-Trimethylbenzene | 526-73-6 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND | 43 | 1,2,4-Trimethylbenzene | 95-61-6 | ND | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND | 44 | 1,3,5-Trimethylbenzene | 108-67-8 | ND | ND |
| 7 | 2,3-Dimethylpentane | 345-52-1 | ND | ND | 45 | Styrene | 100-42-5 | ND | ND |
| 8 | n-Hexane | 110-54-1 | ND | ND | 46 | Toluene | 108-88-3 | ND | ND |
| 9 | 3-Methylhexane | 589-31-1 | ND | ND | 47 | p-Xylene &/or m-Xylene | 106-48-6 | ND | ND |
| 10 | Cyclohexane | 110-82-7 | ND | ND | 48 | n-Xylene | 95-47-6 | ND | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND | Ketones (LOD 0.05, 0.5 & 0.5 - 5µg/compound/section) | | | | |
| 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 | 108-93-1 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND | 53 | Isohexanone | 78-39-1 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND | 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 18 | n-Dodecane | 112-19-1 | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | ND | ND |
| 19 | n-Tridecane | 629-50-3 | ND | ND | Alcohols (LOD = 25µg/compound/section) | | | | |
| 20 | n-Tetradecane | 629-59-4 | ND | ND | 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 21 | n-Pentadecane | 80-56-8 | ND | ND | 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 22 | n-Hexadecane | 127-91-2 | 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 |
| Chlorinated hydrocarbons (LOD = 5µg/compound/section) | | | | | 60 | 2-Ethyl hexanol | 104-76-2 | 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 | Acetates (LOD = 25µg/compound/section) | | | | |
| 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 | 100-60-4 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-33-6 | 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 | Ethers (LOD = 25µg/compound/section) | | | | |
| 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 (TBME) | 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 | Glycols (LOD = 25µg/compound/section) | | | | |
| 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 |
| Miscellaneous (LOD 0.01- 5µg & 0.01- 25µg/compound/section) | | | | | 71 | PGMEA | 108-65-6 | ND | ND |
| 37 | Acetonitrile | 75-05-5 | ND | ND | 72 | Cellulose acetate | 111-13-8 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidone | 88-12-0 | ND | ND | 73 | DGMEA | 112-13-3 | ND | ND |
| Total VOCs (LOD = 0.1µg/compound/section) | | | 457 | ND | Worksheet check | | | YES | YES |



Accreditation No. 3726

Accredited for compliance with ISO/IEC 17025



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
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 hydrocarbons 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 CS₂. An aliquot of the desorbent is analysed by capillary gas chromatography with mass spectrometry detection.
The Total Volatile Organic Compounds (TVOC) test result in µg/section is calculated by combining the determined values of the 73 compounds with other VOCs that have been identified by mass spectrometry in the sample. These extra VOCs were individually estimated by the response of the nearest internal standard to that compound. 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 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 Monomethyl 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.



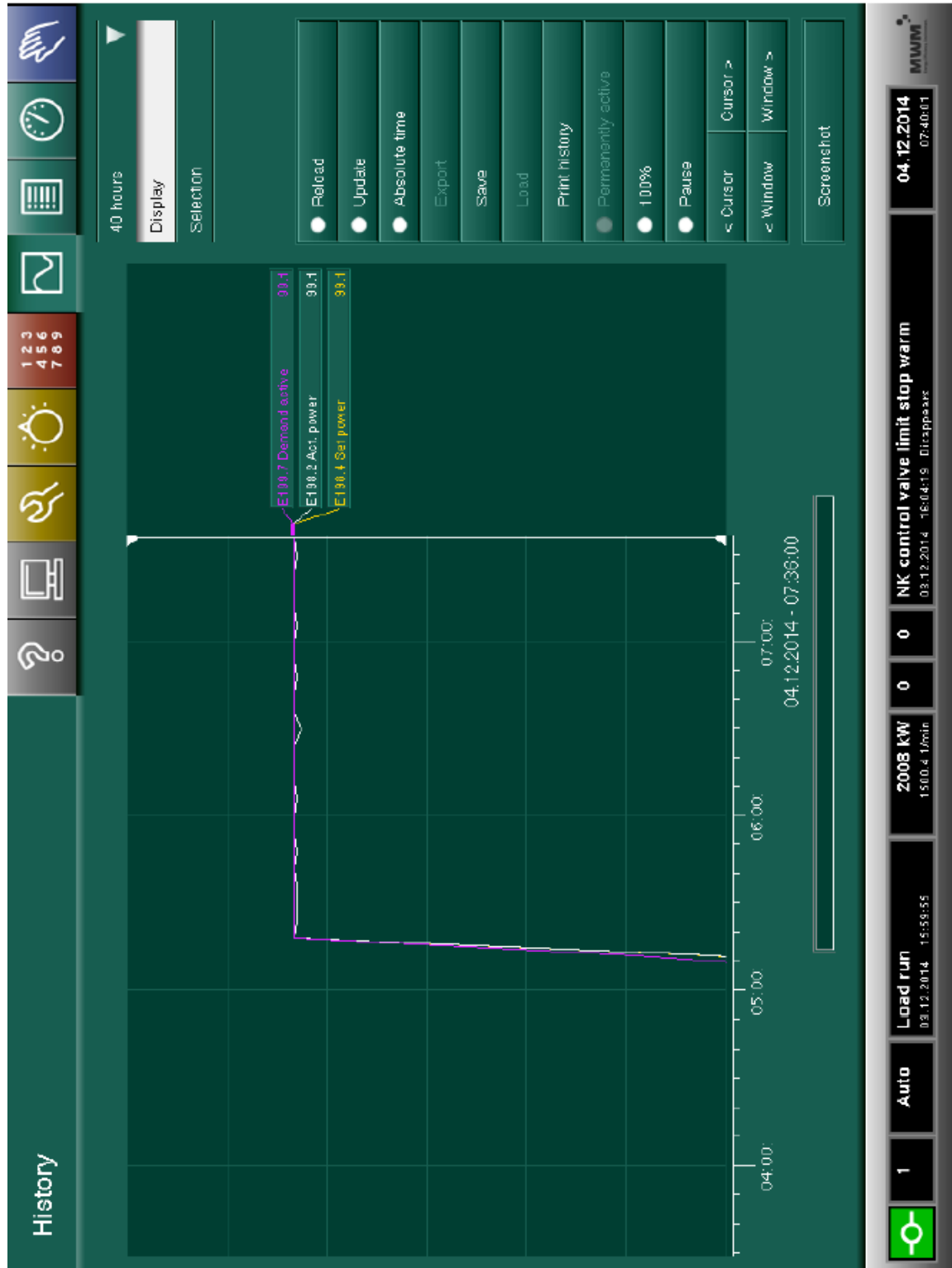
APPENDIX D – PRODUCTION DATA

Screenshot

12/06/2010 - 2nd eng 09/2014
PLC-date = 04.12.2014 07:40:01

PLC release = 2.29.43
Comment: Toohey's
Number of faults = 0
Number of alarms = 0
Operation hours = 23354

Number: 9296876
Engine type: TCG2020V20
Actual load = 2008 kW
Actual speed = 1500.4 1/min
Starts = 1623



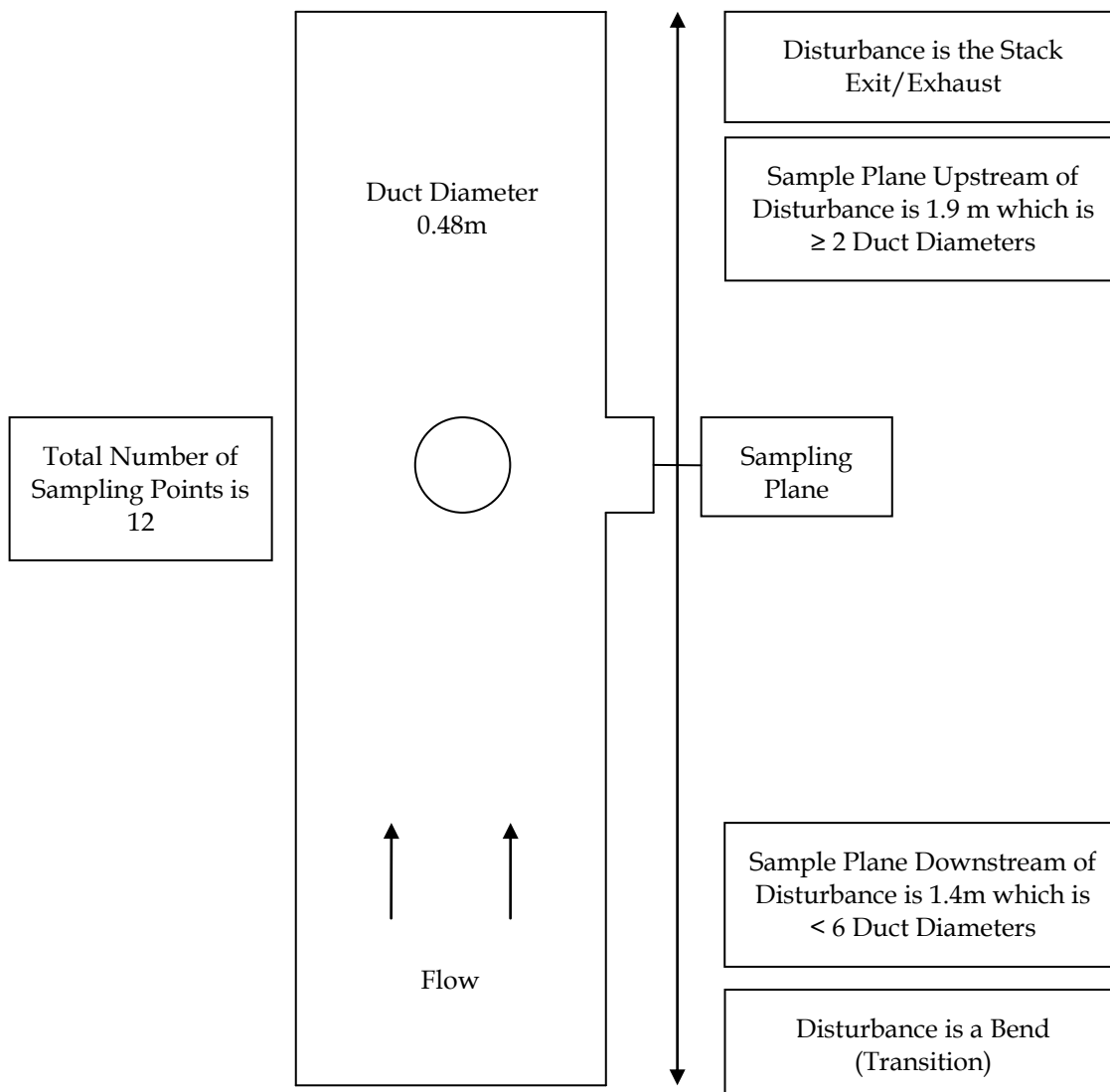
APPENDIX E – INSTRUMENT CALIBRATION DETAILS

TABLE E-1 INSTRUMENT CALIBRATION DETAILS

| SEMA Asset No. | Equipment Description | Date Last Calibrated | Calibration Due Date |
|---|---|-----------------------------|---|
| 859 | Digital Temperature Reader | 20-Aug-2014 | 20-Feb-2015 |
| 863 | Thermocouple | 20-Aug-2014 | 20-Feb-2015 |
| 885 | Digital Manometer | 14-Mar-2014 | 14-Mar-2015 |
| 726 | Pitot | 19-Jun-2014 | 19-Jun-2015 Visually inspected On-Site before use |
| 928 | Balance | 23-Apr-2014 | Response Check with SEMA Site Mass |
| 705 | Field Mass For Calibration | 20-Aug-2014 | 20-Aug-2015 |
| 932 | Personal Sampler | 16-Oct-2014 | 16-Oct-2015 |
| 846 | Stopwatch | 28-Mar-2014 | 28-Mar-2015 |
| 811 | Flue Gas Analyser | 11-Sep-2014 | 11-Mar-2015 |
| Gas Mixtures used for Analyser Span Response | | | |
| Conc. | Mixture | Cylinder No. | Expiry Date |
| 1080ppm 10.0% 10.2% | Carbon Monoxide Carbon Dioxide Oxygen In Nitrogen | 454288 | 13-Jul-2016 |
| 441ppm 443ppm | Nitric Oxide Total Oxide Of Nitrogen In Nitrogen | 437883 | 4-Apr-2017 |
| 243 ppm 247 ppm | Nitric Oxide Total Oxide Of Nitrogen In Nitrogen | ALTN1892 | 20-Aug-2019 |

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.

APPENDIX G – OEH – CO-GENERATION AND TRI-GENERATION DOCUMENT

1. Cogeneration and tri-generation

Cogeneration is the simultaneous generation in one process of thermal energy and electrical and/or mechanical energy¹. Cogeneration is also referred to as combined heat and power (CHP) and makes productive use of the heat that is normally rejected as waste in conventional generators.

Trigeneration is the simultaneous production of electrical and/or mechanical energy, heat and cooling from a single heat source. It can also be referred to as combined heat, cooling and power (CHCP).

¹ Source: *DIRECTIVE 2004/8/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC*

2. Interim NO_x policy for cogeneration

OEH released the [Interim NO_x Policy for Cogeneration in Sydney and the Illawarra](#) which sets out a framework for how we are currently dealing with emissions from cogeneration and tri-generation proposals.

One of the concepts introduced in the interim policy is best available techniques (BAT) emission performance. The interim policy does not define what emission performance is consistent with BAT for cogeneration and tri-generation.

3. What do we define as BAT?

BAT covers all aspects of a proposal including fuel source, technology selection and controls. The concept of BAT is a key principle in the European Union Directive on Integrated Pollution Prevention and Control.

Best available techniques shall mean the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole:

Best shall mean most effective in achieving a high general level of protection of the environment as a whole.

Available techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.

Techniques shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

Source: *DIRECTIVE 2008/1/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 January 2008 concerning integrated pollution prevention and control*

4. What do we define as BAT for natural gas fired reciprocating internal combustion engines?

The NO_x emission standard considered by OEH to be BAT for natural gas fired reciprocating internal combustion engines with a capacity to burn less than 7 mega joules of fuel per second are outlined in Table 1. A financial analysis of NO_x controls on gas fired reciprocating engines was used to develop the BAT emission standards².

² Source: *SKM 2009, Department of Environment and Climate Change (NSW) Financial Analysis of NOX Controls on Gas Fired Reciprocating Engines, Sinclair Knight Merz, June 2009*

5. Table 1: NO_x BAT emission standard for natural gas fired reciprocating internal combustion engines with a capacity to burn less than 7 mega joules of fuel per second

| Activity or plant | Air impurity | Region | Emission standard |
|---|---|--|---------------------|
| | | | mg/m ³ * |
| Any natural gas fired stationary reciprocating internal combustion engine | Nitrogen dioxide (NO ₂) or nitric oxide (NO) or both, as NO ₂ equivalent | Sydney and Wollongong Metropolitan Area [#] and Wollondilly Local Government Area | 250 |

* Reference conditions: Dry, 273 K, 101.3kPa, 5% O₂

Defined in the *Protection of the Environment Operations (Clean Air) Regulation 2010*

6. Discussion of BAT emission standards

A NO_x emission standard of 250 mg/m³ applies to all natural gas fired reciprocating internal combustion engines with a capacity to burn less than 7 mega joules of fuel per second in the Sydney and Wollongong Metropolitan Area and Wollondilly Local Government Area. Controlling NO_x emissions to 250 mg/m³ has been found to have a minor impact on project financial performance and is unlikely to impact on project viability. The marginal reduction in financial performance is due to the slightly higher fuel consumption².

Outside of the Sydney and Wollongong Metropolitan Area and Wollondilly Local Government Area the NO_x emission standard is 450 mg/m³, as defined in the *Protection of the Environment Operations (Clean Air) Regulation 2010*. A more stringent NO_x emission standard is only needed in the Sydney and Wollongong Metropolitan Area and Wollondilly Local Government Area as air quality in these regions currently exceeds the National Environment Protection Measure for Ambient Air Quality (Air NEPM) goal for ozone.

A NO_x emission standard for natural gas fired reciprocating internal combustion engines with a capacity to burn greater than or equal to 7 mega joules of fuel per second has not been proposed. This will be determined on a case by case basis.

In cogeneration and tri-generation applications, the financial viability of post combustion controls to reduce NO_x emissions to less than 250 mg/m³ has been shown to improve as the capacity of the engine increases². In cogeneration applications, post combustion controls are likely to be financially viable at approximately 1,000 kW of electrical output (or a capacity to burn approximately 3 mega joules of fuel per second) whereas in tri-generation applications the financially viable minimum size for post combustion controls is likely to be in excess of 10,000 kW of electrical output (or a capacity to burn greater than approximately 30 mega joules of fuel per second).

OEH should be contacted for the specific requirements for natural gas fired reciprocating internal combustion engines with a capacity to burn greater than or equal to 7 mega joules of fuel per second.

² Source: SKM 2009, *Department of Environment and Climate Change (NSW) Financial Analysis of NOX Controls on Gas Fired Reciprocating Engines*, Sinclair Knight Merz, June 2009

7. Why has BAT only been defined for natural gas fired reciprocating internal combustion engines?

OEH has firstly defined BAT for natural gas fired reciprocating internal combustion engines due to the significant interest in its installation in cogeneration and tri-generation applications. BAT will be developed for other technologies and industries on a case by case basis.

8. Do local air quality impacts still need to be considered?

Yes, local air quality impacts still need to be considered even if emissions performance is consistent with BAT.

Emission standards do not take into account site-specific features such as meteorology, background air quality, and other influences such as terrain and building downwash and therefore do not necessarily protect against adverse air quality impacts in the surrounding area. Depending on the sensitivity of the local receiving environment, an item of plant may need to meet emission standards tighter than BAT.

The impact of emissions from activities and plant is determined through an air quality impact assessment which is to be conducted in accordance with the [Approved Methods for the Modelling and Assessment of Air Pollutants in NSW](#).

9. What's happening with the interim NO_x policy for cogeneration?

OEH is continuing to progress the broad framework introduced in the interim policy. Keep a look out for updates to the OEH website on progress with the interim policy and opportunities to provide comments.