

Your ref: 0
Our ref: 12548374

19 January 2022

John Studdert
Manildra Group
PO Box 123
Nowra NSW 2541

Modification 23: Response to NSW EPA comments relating to air quality

Dear John,

1. Introduction

Shoalhaven Starches Pty Ltd (Manildra) sought approval for a proposed modification to the approved Shoalhaven Starches Expansion Project (SSEP) (Modification 23 or Mod 23).

The New South Wales Environmental Protection Agency (NSW EPA) has reviewed the application and requests additional information be provided and outlines certain matters that are to be addressed prior to determination (refer to NSW EPA letter Shoalhaven Starches – MP06_0228 Mod 23 – Gas Fired Co-generation Plant – EPA Comments).

This letter has been prepared by GHD to provide a response to matters relating to air quality based on NSW EPA's review of the *Shoalhaven Starches Modification 23 Air Quality Assessment* (GHD, 2021) dated 01 September 2021 (2021 Mod 23 air quality assessment).

It is noted that further investigation (including emissions sampling) and scenario refinement was undertaken after preparation of the 2021 Mod 23 air quality assessment. Therefore discussion, details and results provided in this letter and the *Shoalhaven Starches Modification 23 Air Quality Assessment* (GHD, 2022) dated 17 January 2022 (2022 Mod 23 air quality assessment) supersede those presented in the 2021 Mod 23 air quality assessment.

Key updates included in the 2022 Mod 23 air quality assessment are outlined below:

- Inclusion of boiler Volatile Organic Compounds (VOC's) sampling results and estimation of VOCs from dryers using National Pollutant Inventory emissions factors (NPI factors)
- Addition of another pollutant modelling scenario (maintenance scenario)
- Minor variation to gas fuel consumption in dryers
- Updated cogeneration plant gas turbine emission data
- Adoption of PM₁₀/TSP and PM_{2.5}/PM₁₀ ratios to refine the estimation of particulate concentrations

This letter should be read in conjunction with the 2022 Mod 23 air quality assessment.

2. Response to air quality matters to be addressed prior to determination

Matter

a. Supporting evidence on change in emissions from current approved operations not provided

Section 3.11.2 of the AQIA states that “The proposal is expected to have a neutral impact on odour and a positive impact on combustion emission compared against the previous modification (Mod 21). The reduction in combustion emissions (compared with Mod 21) is attributed to conversion of boilers from coal to gas which typically has lower emissions”. Whilst, the conversion of boilers from coal to gas could reduce particular air pollution emissions, the proposed modification seeks approval for an increase in power generating capacity from current approved operations. The modification seeks approval for a 60 MW cogeneration plant to replace existing approved power generation plant with a combined capacity of 55 MW.

The EPA recommends the proponent provide supporting evidence to support the claim that combustion emissions would decrease from current operations. In providing this information a comparison of particulate, oxides of nitrogen (NOx) and volatile organic compounds (VOC's) emissions for current and proposed operations should be provided. Emission estimates must be robustly justified for the comparison.

Response

A comparison of combustion emissions from current operations to proposed future Mod 23 operations was undertaken based on the following methodology:

- The current and proposed future fuel consumption was listed (refer Table 1)
- Applicable emissions factors were gathered from Nation Pollutant Inventory emissions estimation manuals (refer Table 2)
- Site wide combustion emissions from current and proposed operation were estimated and compared (refer Table 3)

Table 1 Current and proposed fuel consumption

Combustion source	Fuel consumption	
	Current (2021 FY actual usage)	Proposed (Mod 23)
Coal in boilers (t/h)	12.8	0
Gas in boilers (GJ/h)	188.7	96.6
Gas in cogeneration turbine (GJ/h)	0	783.7
Steam generation (t/h)	181.9	245.0

A literature review of available emission factors for coal and gas fired boilers and gas cogeneration turbines provided by the National Pollutant Inventory is supplied in Table 2. Emission factors were sourced from:

- Coal fired boilers – Table 15 of *National Pollutant Inventory Emission estimation technique manual for Combustion in boilers Version 3.6 (2011)*
- Gas fired boilers – Table 21 of *National Pollutant Inventory Emission estimation technique manual for Combustion in boilers Version 3.6 (2011)*
- Gas cogeneration turbines – Table 11 of *National Pollutant Inventory Emission estimation technique manual for Fossil Fuel Electric Power Generation Version 3.0 (2012)*

Table 2 *Review of emission factors*

Pollutant	NPI emission factor		
	Coal fired boilers (kg/t)	Gas fired boilers(kg/GJ)	Gas cogeneration turbines (kg/GJ)
PM ₁₀	6.600	0.00360	0.00320
PM _{2.5}	2.3000	0.00360	0.00320
NO _x	4.400	0.0243	0.0720
VOC	0.03000	0.00268	0.00230 ¹

Based on the supplied fuel consumption rates and National Pollutant Inventory emission factors, combustion pollutant emission were estimated and are summarised in Table 3. A decrease in PM₁₀, PM_{2.5} and NO_x emissions is expected. It is noted that no VOC emission factor was available for gas cogeneration turbines and therefore an emission factor for TOC was adopted. This is considered conservative and may be contributing to the higher estimate of VOC emissions for the proposed operations.

The comparison identified a general reduction in combustion pollutant emissions noting steam generation would increase and therefore the statement in the 2021 Mod 23 air quality assessment is considered justified. The reduction in combustion emissions (excluding VOCs) while increasing steam generation is attributed to adoption of cleaner and more efficient steam generation methods (i.e. replacing coal boilers with gas boilers and gas cogeneration turbines).

Table 3 *Estimated combustion pollutant emission rates*

Source	Emission rate (g/s)		Change %
	Current	Proposed	
PM ₁₀	23.7	0.79	-97%
PM _{2.5}	8.39	0.79	-91%
NO _x	17.0	16.3	-4%
VOC	0.25	0.57	131%

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b. Assessment has not accounted for existing combustion sources

Section 8.1.1 of the AQIA states “Use of boilers 1, 2, 3 and 8 are on standby duty as part of Mod 23 only boiler 5/6 would be active”. The dispersion modelling for the proposed modification has considered emissions from existing boiler 5/6. As such the EPA interprets that the other boilers not included in the impact assessment (1, 2, 3 and 8) would be decommissioned and no longer utilised at the premises.

However, no further description of the proposed operating regime has been provided to confirm if this interpretation is accurate. If existing boilers are to remain and utilised at the premises, the quantitative assessment must take these sources into consideration. Additionally, Section 3.11.2 of the AQIA states that existing coal fired boilers will be converted to gas, however it does not describe which coal fired boilers will be converted to gas.

The EPA recommends the proponent provide further information on:

- i. *Which coal fired combustion units will be converted to gas, and clarify if all existing coal fired combustion units will be converted to gas*
- ii. *The proposed use of existing combustion units under the proposed modification*
- iii. *Where existing combustion units are proposed to remain and utilised at the premises, they must be accounted for in a revised Air Quality Impact Assessment.*

¹ Emission factor taken for Total Organic Compounds (TOC) as not applicable factor for VOC was available

Response

The site intends to rely primarily on the proposed gas-fired co-generation plant to fulfil the stream production requirements for site operations. Certain boilers would operate at reduced capacity to meet any unexpected peaks in stream demands whilst other boilers would be allocated to standby duty (offline and not operating) for use during maintenance of the co-generation plant.

The new gas-fired co-generation plant (consisting of two natural gas turbines which would replace the approved but not constructed gas fired co-generators) proposed as part of Modification 23 would provide the baseload energy requirements for the site and would contribute approximately 86% of site's steam production requirements.

The existing gas boilers (boilers 1, 3, 7 and proposed gas boiler 8) will continue to be maintained and the existing coal and mixed coal and woodchip fired boilers (boilers 2, 4, 5, 6) will be converted from coal to biogas / natural gas firing.

For typical operation conditions, boilers 1, 2, 3, 4, 7 and 8 would be on standby, while only boilers 5 and 6 are proposed to be used.

Boilers allocated to standby duty (i.e. Boilers 1, 2, 3, 4, 7 and 8 would) would not be operational (no fuel usage and no emissions) and would only be brought online during statutory maintenance periods while a gas turbine or boiler 5 and 6 is offline for inspection and maintenance or in emergency situations.

Boilers 5 and 6 are proposed to operate at reduced capacity at approximately 40% and 30% of their capacity respectively. Boilers would contribute approximately 14% of site's steam production requirements.

The boilers will operate to:

- Control steam header pressure by responding to short term changes to steam demand
- Utilise biogas produced by the waste water treatment facility
- Supply steam over and above the capacity of the cogeneration facility
- Provide future steam generation capacity

Further boiler details and the emissions estimation methodology adopted in the Mod 23 air quality assessment are provided in Table 4 for the following two scenarios:

- **Typical operations** – This is the typical scenario that Manildra intent to operate in accordance with. Both co-generation plant natural gas turbines would be operational to provide the baseload energy requirements for the site. Boilers 5 and 6 would operate at low capacity to cover short term changes to steam demand.
- **Maintenance scenario** – This is a rare operating scenario that would occur for 1 – 2 weeks a year when a gas turbine is brought offline for statutory maintenance and repairs. Boilers 5 and 6 would be increased in output and boiler 8 would operate to cover short term changes to steam demand.

It is noted that a boiler alternative to boiler 8 may be used in the maintenance scenario, however the gas consumption from all site boilers would remain constant and therefore emissions to air are expected to remain constant and corresponding changes to ground level air quality concentrations are expected to be negligible.

Table 4 **Modification 23 boiler and cogeneration operational details**

Plant	Purpose	Fuel type		Modification 23 fuel usage (GJ/hour)		Steam production (tonnes/hour)		Emission estimation methodology for active boilers
		Current	Mod 23	Typical operations	Maintenance scenario	Typical operations	Maintenance scenario	
Cogen plant (two gas turbines)	Provide baseload energy requirements	N/A	Gas	784	392	212	106	Manufacturer specifications and guarantees
Boiler 1	Standby duty (offline and not operating)	Gas	Gas	0	0	0	0	N/A
Boiler 2	Standby duty (offline and not operating)	Coal and woodchips	Gas	0	0	0	0	N/A
Boiler 3	Standby duty (offline and not operating)	Gas	Gas	0	0	0	0	N/A
Boiler 4	Standby duty (offline and not operating)	Coal and woodchips	Gas	0	0	0	0	N/A
Boiler 5	Active (approximately 40% capacity for typical operations)	Coal	Gas	48.3	131	17	45	NPI emission factors for natural gas (<30MW wall fired) for all pollutants except VOC's
Boiler 6	Active (approximately 30% capacity for typical operations)	Coal	Gas	48.3	174	17	60	NPI emission factors for natural gas (<30MW wall fired) for all pollutants except VOC's
Boiler 7	Standby duty (offline and not operating)	Gas	Gas	0	0	0	0	N/A
Boiler 8	Under construction – to be on standby duty (offline and not operating) for Mod 23	N/A	Gas	0	99	0	34	NPI emission factors for natural gas (<30MW wall fired) for all pollutants except VOC's
TOTAL				880	795	245	245	

Matter

c. **Basis for the discharge parameters and emission estimates for the proposed gas fired cogeneration plant not provided, described or justified**

Discharge parameters

Table 8.2 of the AQIA provides an emission inventory for combustion emissions and discharge parameters (stack height, velocity etc) for various sources. However, the AQIA does not describe or include supporting information on the basis for the discharge parameters adopted for the proposed gas fired cogeneration plant.

As per the Approved Methods for Modelling and Assessment of Air Pollutants in NSW (the Approved Methods), the EPA's preferred methods for assessing proposed sources is manufacture's design specifications. The AQIA does not include manufactures design specifications for the proposed gas fired cogeneration plant or describe the basis for the adopted discharge parameters for the gas fired cogeneration plant.

Emission estimates

Table 8.2 of the AQIA provides an emission inventory for combustion pollutants including emission estimates for the proposed gas fired cogeneration plant. However, the AQIA does not:

- i. Describe how emission estimates have been derived
- ii. Include supporting calculations for derivation of any emission estimates
- iii. Justify the adopted emission rates, including demonstration that emissions estimates represent reasonable worst-case emissions

As per the Approved Methods, the EPA's preferred methods for assessing proposed sources is manufacture's design specifications and/or emission guarantees.

The EPA recommends the proponent provide manufactures design specifications and/or emission guarantees for the proposed cogeneration plant and demonstrate that the AQIA is based on the proposed design.

Response

Source discharge properties and emissions to air from the proposed gas fired cogeneration plant were supplied by GE Power being the proposed supplier of the plant. Manufacturer design specifications, emissions estimates, and emissions guarantees for NO_x and CO provided by GE Power are supplied in Attachment 1.

Matter

d. **Assessment of compliance with the prescribed concentrations contained in the Clean Air Regulation not provided**

Table 8.2 of the AQIA presents an emission inventory for products of combustion. A NO_x emission rate of 7.2 g/s is presented in Table 8.2 for each of the natural gas cogeneration units. An exhaust flow at actual conditions of 103 m³/s is also presented.

Based on the discharge parameters (exhaust temperature, and exhaust flow) presented in Table 8.2 the EPA estimate an NO_x discharge concentration of 96 mg/m³. This estimate is significantly greater than the NO_x discharge concentration of 39 mg/Nm³ presented in Table 8. As such there appears to be potential errors in the emission estimate, and hence the EPA are not in a position to understand the quantum of emissions that have been accounted for in the dispersion modelling.

Additionally, the Protection of the Environment Operations (Clean Air) Regulation 2021 (Clean Air Regulation) prescribes maximum allowable discharge concentrations for specific plant and activities. The Clean Air Regulation specifies a NO_x discharge concentration of 70 mg/m³ for any turbine operating on gas, being a turbine, used in connection with an electricity generating system with a capacity of 30 MW or more.

The AQIA does not include a demonstration that the prescribed concentrations contained in the Clean Air Regulation can be achieved. The estimated NO_x discharge concentration of 96 mg/m³, discussed above, is greater than the prescribed concentration of 70 mg/m³ contained in the Clean Air Regulation.

The EPA recommends the proponent revise the AQIA to:

- i. transparently describe and demonstrate that emission estimates are correct and representative of the proposal.*
- ii. Demonstrate that compliance with the Clean Air Regulation will be achieved*

Response

Further investigation into gas turbine emissions rates as suggested by EPA and communications with GE Power have identified that the pollutant mass emission rates provided by GE Power were misinterpreted in the original Mod 23 assessment. Mass emission rates were interpreted to apply to each gas turbine when they should have been applied to the entire gas-fired co-generation plant. Therefore previous modelling effectively assumed double the mass emission rate of pollutants from the co-generation plant.

Further emission estimation details provided by GE Power are provided as Attachment 1.

The Mod 23 air quality assessment was updated to account for the change in mass emission rate from the co-generation plant.

Matter

e. Emission estimates for existing Coal fired boiler not described or justified

Air pollutant emissions for Boiler 5/6 have been included within the quantitative assessment, however the AQIA provides limited information on how emissions have been derived. Given the limited information, the AQIA does not justify that the quantitative assessment is representative of reasonable worst-case emission.

The EPA recommends the proponent provide further information on the derivation of emissions estimates for Boiler 5/6 and justify that the quantitative assessment is representative of reasonable worst-case emissions.

Response

Emission estimation based on site specific sampling data was prioritised where available, however sampling data for gas fired boiler was not available at the time the 2021 Mod 23 air quality assessment. Therefore, emissions factors from the *National Pollutant Inventory Emission estimation technique manual for Combustion in boilers Version 3.6 (December 2011)* (NPI factors) were used (emissions factors for natural gas (≤30MW wall fired)) along with proposed boiler gas throughput quantities provided by Manildra to estimate emissions from boiler 5 and 6.

Subsequent to preparation of the 2021 assessment and to aid response to EPA's comments, sampling of VOC's including speciation was undertaken on all boilers currently in operation (gas fired boilers 1, 3, 7, combined coal boilers 5 and 6 and coal boiler 2). The preliminary VOC sampling results are provided in Preliminary Report REF: R012021p supplied as Attachment 2.

Therefore boiler emissions to air in the 2022 Mod 23 air quality assessment were estimated based on NPI factors for all pollutants except VOC's which used site specific sampling data. VOC emissions from future gas fired boilers were estimated based on the maximum sampled VOC concentration of an existing gas fired boiler scaled based on gas consumption.

Refer to the 2022 Mod 23 air quality assessment for further details regarding boiler emissions estimation.

Matter

f. Robust assessment of VOCs not included

The AQIA includes emission estimates for VOC's and a quantitative assessment of VOCs, however the AQIA does not:

- i. *Include an assessment of speciated VOC's*
- ii. *Reference the impact assessment criteria for speciated VOCs, for conducting the assessment of potential impacts*
- iii. *Include emission estimates of speciated VOCs for the proposed cogeneration plant. Table 8.2 of the AQIA implies there are no VOC emissions from the proposed cogeneration plant*

The EPA recommends the proponent revise the AQIA to include a robust assessment of speciated VOCs.

Response

VOC sampling on boilers currently in operation was undertaken in response to NSW EPA comments and to inform the 2022 Mod 23 air quality assessment. As the proposed cogeneration plant is not yet constructed, VOC sampling and speciation data was not available for the proposed cogeneration plant. The preliminary VOC sampling results on boilers show speciation data for toluene and acetone (refer Attachment 2), with the other VOCs being below detection.

A refined assessment of VOC is provided in the 2022 Mod 23 air quality assessment. The dispersion model results show that total VOC concentrations predicted at sensitive receptors locations are below the assessment criteria of the speciated VOCs (toluene and acetone). If the total VOC concentration is below the toluene and acetone assessment criteria, then the speciated VOC pollutant (component of total VOC's) would also be below the assessment criteria.

This assessment methodology is considered conservative and therefore no further assessment of speciated VOCs is considered necessary.

Matter

g. Assessment of annual average particulates not included

The AQIA does not include an assessment of cumulative annual average impacts for TSP, PM₁₀ and PM_{2.5}. Only incremental results at sensitive receptors are presented in Table 8.3.

The EPA recommends the proponent revise the AQIA to include cumulative assessment of annual average particulate matter impacts at sensitive receptors. If exceedances of annual average impact assessment criteria are predicted, the assessment must be revised to include additional mitigation measures

Response

The 2021 Mod 23 air quality assessment assessed PM₁₀ and PM_{2.5} emissions by assuming the following ratios:

- a PM₁₀/TSP ratio of 1 and
- a PM_{2.5}/PM₁₀ ratio of 1.

This approach is considered conservative and provided an upper bound estimate of potential particulate matter concentrations.

The 2022 Mod 23 air quality assessment adopted a refined approach based on a review of particle size distribution data provided in *Appendix B.1 Particle Size Distribution Data and Sized Emission Factors for Selected Sources of United States Environmental Protection Agency Air Emissions Factors and Quantification AP-42: Compilation of Air Emissions Factors* (US EPA guidance).

The US EPA guidance provides the following relevant particle size distribution data:

- **Grain processing** – PM₁₀/TSP ratio of 0.61 and a PM_{2.5}/PM₁₀ ratio of 0.23 and
- **Grain handling** – PM₁₀/TSP ratio of 0.15 and a PM_{2.5}/PM₁₀ ratio of 0.01.

A refined assessment of particulate matter including assessment of annually averaged concentrations is provided in the 2022 Mod 23 air quality assessment.

Matter

h. Assessment predicts exceedances of 24-hour PM₁₀ and 24-hour PM_{2.5}

The AQIA predicts 3 additional exceedances of PM₁₀ (24 hour) and PM_{2.5} (24 hour) at commercial receptor C6. The AQIA does not provide further analysis on the predicted exceedances, including but not limited to source contribution analysis, and identification of additional mitigation measures.

The EPA recommends the proponent revise the AQIA to include additional analysis of the predicted exceedances and identification of additional mitigation measures.

Response

The 2022 Mod 23 air quality assessment adopted a contemporaneous approach (prediction were added to recorded background concentrations of the same 24 hour period) to assess particulate matter and predicted exceedances of the 24 hour PM₁₀ criteria at commercial receptor C6 for two 24 hour periods (0.5% of the time). No exceedances of other particulate matter fractions (TSP or PM_{2.5}) or annual PM₁₀ concentrations were predicted.

The 24 hour PM₁₀ exceedances were composed of relatively small incremental components (impacts due to site operation) and a relatively large background concentrations. The composition of the predicted 24 hour PM₁₀ exceedances at C6 is provided in Table 5 which shows incremental components account for 8% and 4% of the assessment criteria (50 µg/m³) respectively while background concentrations account for 94% and 97% of the assessment criteria respectively. Therefore, the exceedances were primarily attributed to high background concentrations and do not necessarily reflect site operations. Background particulate matter concentrations of this magnitude are likely driven by abnormal environmental events in the region such as bushfires and dust storms which are outside the control of Manildra.

Table 5 Composition of 24 hour PM₁₀ exceedances at C6

Rank	Exceedance date	Incremental prediction at C6 (µg/m ³)	Background component (µg/m ³)	Cumulative prediction at C6 (µg/m ³)
1	21/02/2004	3.8	47.0	50.8
2	27/11/2004	1.8	48.4	50.2

A source contribution analysis as provided in Table 6 (significant contributing values were highlighted) for the following cases:

- **Exceedance 1** – the rank 1 cumulative 24 hour concentration predicted at C6
- **Exceedance 2** – the rank 2 cumulative 24 hour concentration predicted at C6

It is noted that a contemporaneous methodology was adopted and therefore maximum predicted incremental concentration does not necessary coincide with the maximum predicted cumulative concentration.

The source contribution analysis identified the following sources as key contributors:

- Starch dryer No. 5
- Starch dryer No. 4
- Starch dryer No. 1

Table 6 24 hour PM₁₀ source contribution analysis at C6

Source	ID	PM ₁₀ contribution at C6 (ug/m ³)	
		Exceedance 1	Exceedance 2
Starch dryer No. 5 (Existing)	SD5C	0.55	0.23

Source	ID	PM ₁₀ contribution at C6 (ug/m ³)	
		Exceedance 1	Exceedance 2
Gluten dryer No. 6	GD6	0.05	0.02
Starch dryer No. 3	S18	0.13	0.04
Starch dryer No. 4	S19	0.27	0.08
Gluten dryer No. 1	S02	0.00	0.00
Gluten dryer No. 2	S04	0.01	0.01
Starch dryer No. 1	S01	0.21	0.23
Gluten dryer No. 4	S05	0.03	0.01
Gluten dryer No. 3	S03	0.06	0.02
Gluten Dryer No.7	GD7	0.04	0.02
Boiler No. 5/6	BOILR5	0.00	0.00
Spray dryer 5	S20	0.02	0.02
Flour Mill	FMP1	0.00	0.00
Flour Mill	FMP2	0.00	0.00
Ring Dryer No.5	SDR5	0.07	0.06
New Flour Mill B (MOD 10)	FMBA	0.00	0.00
New Flour Mill B (MOD 10)	FMBB	0.00	0.00
New Flour Mill B (MOD 10)	FMBC	0.00	0.00
New Flour Mill B (MOD 10)	FMBD	0.00	0.00
New Flour Mill B (MOD 10)	FMBE	0.00	0.00
New Flour Mill B (MOD 10)	FMBF	0.00	0.00
New Flour Mill B (MOD 10)	FMC1	0.00	0.00
New Flour Mill B (MOD 10)	FMC2	0.00	0.00
New Flour Mill B (MOD 10)	FMC3	0.00	0.00
Gluten Dryer No.8	GD8	0.07	0.03
No. 5 Starch Dryer (new)	SD5N	1.93	0.67
Product dryer 9	PD9	0.00	0.00
Silo source 1 (combined stack for 3 silos)	SILO1	0.02	0.01
Silo source 2 (combined stack for 6 silos)	SILO2	0.02	0.01
Silo source 3 (combined stack for 2 silos)	SILO3	0.14	0.05
Silo source 4 (combined stack for 6 silos)	SILO4	0.04	0.03
Packing Plant (MOD 9 approved)	PPS1	0.00	0.01
Packing Plant (MOD 9 approved)	PPS2	0.01	0.01
Packing Plant (MOD 9 approved)	PPM1	0.00	0.00
Packing Plant (MOD 9 approved)	PPM2	0.00	0.00
Packing Plant (MOD 9 approved)	PPM3	0.00	0.00
Packing Plant (MOD 9 approved)	PPL1	0.00	0.00
Packing Plant (MOD 9 approved)	PPL2	0.01	0.00
Co-generator turbine No. 1 (proposed)	TURB1	0.01	0.11
Co-generator turbine No. 2 (proposed)	TURB2	0.01	0.08
Silo source 5 (combined stack for 3 silos)	SILO5	0.10	0.05

Source	ID	PM ₁₀ contribution at C6 (ug/m ³)	
		Exceedance 1	Exceedance 2
Wheat silos	A04	0.01	0.00
Bulk bag aspiration fan	B46	0.01	0.00
Total		3.84	1.81

Site incremental contributions at C6 on the two predicted cumulative exceedances were considered relatively minor as they accounted for less than 10% of the assessment criteria.

It is understood that Manildra intend to purchase the land were C6 is situated for future expansion works. Once the land has been acquired, no offsite exceedances of the 24 hour PM₁₀ criteria are expected.

If however, Manildra wanted to reduce off site particulate impacts, additional review of the Starch Dryers could be undertaken which may include sampling to confirm emission rates.

3. Limitations

This letter has been prepared by GHD for Shoalhaven Starches Pty Ltd and may only be used and relied on by Shoalhaven Starches Pty Ltd for the purpose agreed between GHD and Shoalhaven Starches Pty Ltd as set out in section 1 of this letter.

GHD otherwise disclaims responsibility to any person other than Shoalhaven Starches Pty Ltd arising in connection with this letter. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this letter were limited to those specifically detailed in the letter and are subject to the scope limitations set out in the letter.

The opinions, conclusions and any recommendations in this letter are based on conditions encountered and information reviewed at the date of preparation of the letter. GHD has no responsibility or obligation to update this letter to account for events or changes occurring subsequent to the date that the letter was prepared.

The opinions, conclusions and any recommendations in this letter are based on assumptions made by GHD described in this letter. GHD disclaims liability arising from any of the assumptions being incorrect.

Regards,



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Attachments

Attachment 1

**GE Power manufacturer design
specifications and emissions
guarantees**

Property	Units	LM2500+ 100% GT Load	LM2500 + 100% GT Load	LM2500 + 94.3% GT Load	LM2500 + 70% GT Load	Fresh Air Firing
Gas Turbine Exhaust Flow	lb/hr	690,988	690,988	674,615	560,063	677,789
Stack Exhaust Flow	kg/s	87.82	87.82	85.89	71.80	87.18
Stack Exhaust Flow	lb/hr	-	696,996	681,678	569,851	691,916
Gas Turbine Exhaust Temperature	deg F	990.86	990.86	961.00	997.00	59.00
Stack Exhaust Temperature	deg C	532.80	101.72	101.92	98.73	100.91
		-	-	-	-	-
Actual exhaust flow at stack	m ³ /s	206.61	96.65	94.54	78.35	95.30
Stack exhaust velocity	m/s	37.74	16.88	16.51	13.68	16.64
Bypass/HRSG Stack Diameter	m	2.64	2.70	2.70	2.70	2.70
		-	-	-	-	-
Nitrogen Oxides, NO _x as NO ₂	mg/Sm ³ , dry @15%O ₂	30.84	38.74	38.91	38.86	135.67
Carbon Monoxides, CO	mg/Sm ³ , dry @15%O ₂	45.07	48.61	48.66	91.78	56.53
Non-Methane, VOC as CH ₄	mg/Sm ³ , dry @15%O ₂	2.19	3.26	3.33	3.32	5.65
Sulfur Dioxide, SO ₂	mg/Sm ³ , dry @15%O ₂	3.21	3.21	3.28	3.28	3.20
Particulate	mg/Sm ³ , dry @15%O ₂	9.32	7.33	7.48	7.50	2.83
		-	-	-	-	-
Nitrogen Oxides, NO _x as NO ₂	mg/m ³ act.	10.01	38.73	38.06	37.99	98.78
Carbon Monoxides, CO	mg/m ³ act.	14.62	48.60	47.60	89.72	41.16
Non-Methane, VOC as CH ₄	mg/m ³ act.	0.71	3.26	3.26	3.25	4.12
Sulfur Dioxide, SO ₂	mg/m ³ act.	1.04	3.21	3.21	3.21	2.33
articulate	mg/m ³ act.	3.03	7.33	7.32	7.33	2.06
		-	-	-	-	-
O ₂ fraction in the exhaust	w/w	0.1529	0.1196	0.1218	0.1221	0.1524
H ₂ O fraction in the exhaust	w/w	0.0456	0.0629	0.0618	0.0616	0.0419

**GUARANTEE**

PROJECT: MANILDRA NOWRA COGENERATION PLANT
LOCATION: AUSTRALIA

UNIT NET, KW 27128
BTU/KW-HR, LHV 9530
(KJ/KW-HR, LHV) 10053

EMISSIONS ARE VALID FOR T2 WITHIN 41°F-100°F AND A
GTG LOAD DOWN TO 60% AS DEFINED IN STEADY STATE
CONDITIONS FOR EMISSIONS GUARANTEE PROVIDED
OPERATION IS IN ABC OR AB MODE ONLY

NOX: 15 PPMVD AT 15% O₂
(31 mg/Nm³)
CO: 36 PPMVD AT 15% O₂
(45 mg/Nm³)

Wacko, Kamil
Performance Engineer
Date: 06-30-21

NOT VALID WITHOUT SIGNATURE

VALID UNTIL 09-30-21

BASIS OF GUARANTEE:	GAS FUEL NOZZLE SYSTEM
	NO BLEED OR EXTRACTED POWER
ENGINE:	(1) GE LM2500+ DLE GAS TURBINE
FUEL:	19910 Btu/lb / (46312 kJ/kg) LHV
FUEL SPEC:	MID-TD-0000-1 LATEST REVISION
FUEL TEMP:	SITE FUEL TEMPERATURE OF 77.0°F (25.0°C)
FUEL PRESS:	520 PSIG+/-20 PSIG (3585 KPAG+/-138 KPAG)
GENERATOR:	BDAX 71-193 ER
GENERATOR OUTPUT	11.0 kV, 50 Hz
POWER FACTOR:	0.85
AMBIENT TEMP:	59.0°F / (15.0°C)
AMBIENT RH:	60.0%
INLET CONDITIONING:	NONE
ALTITUDE:	0.0 ft / (0.0 m)
INLET FILTER LOSS:	4.5 inH ₂ O / (114.3 mmH ₂ O)
EXHAUST LOSS:	16.5 inH ₂ O / (419.1 mmH ₂ O)
NOX CONTROL:	DLE
ENGINE CONDITION:	NEW AND CLEAN ≤ 200 SITE FIRED HOURS
FIELD TEST METHODS	
PERFORMANCE:	GE POWER SGTGPTM
NOX:	EPA METHOD 20
CO:	EPA METHOD 10

BASIS OF GUARANTEE IS NOT FOR DESIGN, REFER TO PROJECT DRAWINGS FOR DESIGN REQUIREMENTS.
SI VALUES ARE FOR REFERENCE PURPOSES ONLY.

THIS GUARANTEE SUPERSEDES ANY
PREVIOUS GUARANTEES PRESENTED

**GUARANTEE**

PROJECT: MANILDRA NOWRA COGENERATION PLANT
LOCATION: AUSTRALIA

NEAR FIELD NOISE:

85 DB(A) ARITHMETIC AVERAGE SOUND PRESSURE LEVEL (dB
REF 20 MICROPASCALS, RMS) OF LOCATIONS AROUND THE
PACKAGE (VERTICAL DISTANCE OF 5FT. (1.5M) ABOVE
PACKAGE BASE AT A HORIZONTAL DISTANCE OF 3FT. (1M)
FROM THE EXTERIOR PLANE OF EQUIPMENT AS TESTED IN A
FREE-FIELD CONDITION OVER A HARD REFLECTING GROUND
PLANE, OPERATING AT BASE LOAD)

Wacko, Kamil
Performance Engineer
Date: 06-30-21

NOT VALID WITHOUT SIGNATURE

VALID UNTIL 09-30-21

BASIS OF GUARANTEE:	GAS FUEL NOZZLE SYSTEM
	NO BLEED OR EXTRACTED POWER
ENGINE:	(1) GE LM2500+ DLE GAS TURBINE
FUEL:	19910 Btu/lb / (46312 kJ/kg) LHV
FUEL SPEC:	MID-TD-0000-1 LATEST REVISION
FUEL TEMP:	SITE FUEL TEMPERATURE OF 77.0°F (25.0°C)
FUEL PRESS:	520 PSIG+/-20 PSIG (3585 KPAG+/-138 KPAG)
GENERATOR:	BDAX 71-193 ER
GENERATOR OUTPUT	11.0 kV, 50 Hz
POWER FACTOR:	0.85
AMBIENT TEMP:	59.0°F / (15.0°C)
AMBIENT RH:	60.0%
INLET CONDITIONING:	NONE
ALTITUDE:	0.0 ft / (0.0 m)
INLET FILTER LOSS:	4.5 inH ₂ O / (114.3 mmH ₂ O)
EXHAUST LOSS:	16.5 inH ₂ O / (419.1 mmH ₂ O)
NOX CONTROL:	DLE
ENGINE CONDITION:	NEW AND CLEAN ≤ 200 SITE FIRED HOURS
NEAR FIELD NOISE:	GE ACOUSTIC TESTING PROCEDURE AND ASME PTC-36-2004

BASIS OF GUARANTEE IS NOT FOR DESIGN, REFER TO PROJECT DRAWINGS FOR DESIGN REQUIREMENTS.
SI VALUES ARE FOR REFERENCE PURPOSES ONLY.

THIS GUARANTEE SUPERSEDES ANY
PREVIOUS GUARANTEES PRESENTED



GE POWER

**Normal Operating Auxiliary and BOP Loads for 1xLM2500+ 6 Stage-DLE GAS
FUEL 50Hz on Gas Fuel
June 30, 2021**

STANDARD LOADS		
DESCRIPTION	QTY	KW
TURBINE ENCLOSURE VENT FAN A	1	45
TURBINE/GENERATOR LUBE OIL HEAT EXCHANGER FAN A	1	7.5
GENERATOR AC LUBE OIL PUMP	1	2.2
LIGHTING AND DISTRIBUTION PANEL	1	45
TOTAL STANDARD LOADS:		99.7
BOP ELECTRICAL LOADS		
DESCRIPTION	QTY	KW
FIN FAN COOLER	1	25
FIN FAN HEATER	1	12
GUILLOTINE WITH SEALING AIR FAN	1	10
DIVERTER DAMPER/BYPASS STACK	1	10
AIR COMPRESSOR WITH DRYER & RECEIVER	1	45
AIR CRAFT	1	3
CONTROLLER CABINET (RX3I / MARK VIE)	1	1
HMI	1	0.5
NETWORK RACK	1	0.5
HVAC PANEL IN CONTROL ROOM (PCM)	1	11
FIRE FIGHTING PANEL	1	1
ANTI CONDENSATION (HEATERS) FOR SWITCHGEAR	5	0.25
SPARE	1	5.5
SPARE	1	5.5
TOTAL BOP LOADS:		130.3

TOTAL LOADS: 230.0



GE POWER

Steady State Conditions for Emissions Guarantee

- | | |
|--|-------------------------------------|
| 1. Power Output (electrical) | $\pm 10.0\%$ / Min |
| 2. T2 Compressor Inlet air temperature | $\pm 2.5^{\circ}\text{F}$ / 5.0 Min |
| 3. Heat Value - gaseous fuel per unit volume | $\pm 0.25\%$ / Min |
| 4. Pressure - gaseous fuel as supplied to engine | ± 10 PSIG / 5.0 Min |



GE POWER

Conditions for Near Field Noise Guarantee

1. Based on arithmetic average of sound pressure levels at locations around the package.
2. Ancillary skids of the package must be located less than 6-ft of each other, and less than 6-ft of the main unit, measuring nearest edge-to-edge. If the package configuration requires the ancillary skids to be placed 6-ft or more from each other, then the ancillary skids must be located at least 10-ft apart.
3. If Fin Fan Cooler is to be located in front of the main unit (i.e. LM2X), then its location must be at least 10-ft away from the main unit, measuring nearest edge-to-edge. GE Power is to advise best location.
4. If Fin Fan Cooler is to be located broadside to the main unit, then its location must be at least 25-ft away from the main unit, measuring nearest edge-to-edge. GE Power is to advise best location.
5. If Fin Fan Cooler is to be located behind the generator end of the main unit, then its location must be at least 10-ft behind the generator end of the package, and off to one side, measuring nearest edge-to-edge, to avoid infringement on the rotor removal area. GE Power is to advise best location.
6. Ancillary skids of the package must be located at least 10-ft away from Fin Fan Cooler, measuring nearest edge-to-edge.
7. Per unit basis.
8. Base-load operation only.
9. GE Power GTG package scope of supply only, customer supplied equipment is not included.
10. GE Power GTG package scope of supply only, GE Power supplied BOP equipment is not included.
11. If GE Power supplies BOP equipment, then GE Power is to advise best location.

Estimated Average Engine Performance NOT FOR GUARANTEE, REFER TO PROJECT F&ID FOR DESIGN



GE Power

Performance By: **Wacko, Kamil**
Project Info: **Manildra Nowra Cogeneration Plant, Australia**

Engine: **LM2500+ 6 Stage-DLE 15 GAS FUEL (PR)**
Deck Info: **8pc.pip**
Generator: **BDAX 71-193ER 50Hz, 11.0kV, 0.85PF (EffCurve#: 32368; CapCurve#: 32366)**
Fuel: **Site Gas Fuel, 19910 Btu/lb, LHV**

Date: 6/30/2021
Time: 8:23:48

Case #	100	
Ambient Conditions		
Dry Bulb, °F	59.0	
RH, %	60.0	
Altitude, ft	0.0	
Ambient Pressure, psia	14.696	
Engine Inlet		
Comp Inlet Temp, °F	59.0	
RH, %	60.0	
Conditioning	None	
Tons(Chilling) or kBtu/hr(Heating)	0	
Pressure Losses		
Inlet Loss, inH2O	4.50	
Exhaust Loss, inH2O	16.50	
Partload %	94.94	UNIT NET
kW, Gen Terms	27358	27128
Est. Btu/kW-hr, LHV	--	9501
Guar. Btu/kW-hr, LHV	--	9530
Auxiliary Loads, kW	230.0	
Fuel Flow		
MMBtu/hr, LHV	257.7	
lb/hr	12960	
NOx Control	DLE	
Control Parameters		
T3 (Comp. Discharge), °F	907.7	
T48 (LPT Inlet), °F	1480.8	
PS3 (Comp. Disch), psia	326.4	
T25 (HPC Inlet), °F	59.0	
Exhaust Parameters		
Temperature, °F	971.5	
lb/sec	187.8	
lb/hr	676080	
Energy (Ref 0R), MMBTU/hr	246.8	
Emissions (ESTIMATED, NOT FOR GUARANTEE)		
NOx ppmvd Ref 15% O2	15.0	
CO ppmvd Ref 15% O2	36.0	
EXHAUST ANALYSIS % VOL.		
Argon	0.8900	
Nitrogen	74.8700	
Oxygen	13.8000	
Carbon Dioxide	3.2700	
Water	7.1600	
Fuel Composition (Volume %) for Stream		
Methane - CH4	91.6026	
Ethane - C2H6	4.6628	
Propane - C3H8	0.3776	
i-Butane - C4H10	0.0408	
n-Butane - C4H10	0.0453	
i-Pentane - C5H12	0.0121	
n-Pentane - C5H12	0.0099	
n-Hexane - C6H14	0.0325	
n-Heptane - C7H16	0.0010	
Carbon Dioxide - CO2	1.9583	
Nitrogen - N2	1.2650	
Oxygen - O2	0.0006	
n-Octane - C8H18	0.0003	
n-Nonane - C9H20	0.0003	
Fuel LHV, BTU/lb	19910.7	
Fuel Temperature, deg F	77.0	
Molecular Weight, lb/lbmol	17.6	
HHV, BTU/lb	22076.9	
NOx Scalar	0.98	
Specific Gravity	0.61	
MWI, (Btu/SCF)/SQRT(R)	48.925	

Estimated Average Engine Performance NOT FOR GUARANTEE, REFER TO PROJECT F&ID FOR DESIGN



GE Power

Performance By: **Wacko, Kamil**
Project Info: **Manildra Nowra Cogeneration Plant, Australia**

Engine: **LM2500+ 6 Stage-DLE 15 GAS FUEL (PR)**
Deck Info: **8pc.pip**
Generator: **BDAX 71-193ER 50Hz, 11.0kV, 0.85PF (EffCurve#: 32368; CapCurve#: 32366)**
Fuel: **Site Gas Fuel, 46312 kJ/kg, LHV**

Date: 6/30/2021
Time: 8:23:48

Case #	100	
Ambient Conditions		
Dry Bulb, °C	15.0	
RH, %	60.0	
Altitude, m	0.0	
Ambient Pressure, Bars	1.013	
Engine Inlet		
Comp Inlet Temp, °C	15.0	
RH, %	60.0	
Conditioning	None	
Tons(Chilling) or kBTu/hr(Heating)	0	
Pressure Losses		
Inlet Loss, mmH2O	114.30	
Exhaust Loss, mmH2O	419.10	
Partload %	94.94	UNIT NET
kW, Gen Terms	27358	27128
Est. kJ/kW-hr, LHV	--	10023
Guar. kJ/kW-hr, LHV	--	10053
Auxiliary Loads, kW	230.0	
Fuel Flow		
GJ/hr, LHV	271.9	
kg/hr	5879	
NOx Control		
	DLE	
Control Parameters		
T3 (Comp. Discharge), °C	486.5	
T48 (LPT Inlet), °C	804.9	
PS3 (Comp. Disch), kPa	2247.7	
T25 (HPC Inlet), °C	15.0	
Exhaust Parameters		
Temperature, °C	522.0	
kg/sec	85.3	
kg/hr	307000	
Exhaust Energy, GJ/hr - Ref T2	169.2	
Emissions (ESTIMATED, NOT FOR GUARANTEE)		
NOx mg/Nm3 Ref 15% O2	31	
CO mg/Nm3 Ref 15% O2	45	
Exhaust Analysis % vol. (NOT FOR USE IN ENVIRONMENTAL PERMITS)		
Argon	0.89	
Nitrogen	74.87	
Oxygen	13.80	
Carbon Dioxide	3.27	
Water	7.16	
Fuel Composition (Volume %) for Stream		
Methane - CH4	91.6026	
Ethane - C2H6	4.6628	
Propane - C3H8	0.3776	
i-Butane - C4H10	0.0408	
n-Butane - C4H10	0.0453	
i-Pentane - C5H12	0.0121	
n-Pentane - C5H12	0.0099	
n-Hexane - C6H14	0.0325	
n-Heptane - C7H16	0.0010	
Carbon Dioxide - CO2	1.9583	
Nitrogen - N2	1.2650	
Oxygen - O2	0.0006	
n-Octane - C8H18	0.0003	
n-Nonane - C9H20	0.0003	
Fuel LHV, kJ/kg	46312	
Fuel Temperature, deg C	25.0	
Molecular Weight, kg/kgmol	17.57	
HHV, kJ/kg	51351	
NOx Scalar	0.98	
Specific Gravity	0.61	
MWI, (kJ/Nm3) /SQRT(K)	51.281	

Attachment 2

Boiler VOC sampling report

TO: John Studdert
COMPANY: Manildra Group
EMAIL: john.studdert@manildra.com.au
DATE: 22 December 2021
PAGE: 1 of 11
FROM: Zoe Parker
OUR REF: R012021p

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Template Version: 160621

RE: Preliminary Report

This is a preliminary report and the results contained herein should be used as an indication only. A final report will be issued subsequent to the results being verified.

LICENCE COMPARISON

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 883 (last amended on 9 November 2021).

EPA No.	Pollutant	Units	Limit	Detected values	Detected Values (corrected to 7% O2)
Gas Fired Boiler 1	Volatile organic compounds (as n-propane equivalent)	mg/m ³	NA	8.2	NA
Gas Fired Boiler 3	Volatile organic compounds (as n-propane equivalent)	mg/m ³	NA	71	NA
Gas Fired Boiler 7	Volatile organic compounds (as n-propane equivalent)	mg/m ³	NA	0.18	NA
EPA ID 35 - Combined Boiler 5 & 6	Volatile organic compounds (as n-propane equivalent)	mg/m ³	40	<4	<4
EPA ID 45 - Boiler 2	Volatile organic compounds (as n-propane equivalent)	mg/m ³	40	0.12	0.18

Regards

Zoe Parker
 Zoe.parker@ektimo.com.au

RESULTS

Gas Fired Boiler 1

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	Gas Fired Boiler 1
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

Sampling Plane Details	
Sampling plane dimensions	2500 x 1600 mm
Sampling plane area	4 m ²
Sampling port size, number	1 x 10mm hole
Access & height of ports	Stairs 11 m
Duct orientation & shape	Horizontal Rectangular
Downstream disturbance	Change in diameter 0 D
Upstream disturbance	Change in diameter 0 D
No. traverses & points sampled	0 0
Sample plane compliance to AS4323.1 (1995)	Non-compliant

Comments
Velocity could not be measured due to inadequate access for the sampling gear and surrounding infrastructure prohibited access.
Sampling plane dimensions are estimations only due to access constraints.
The number of traverses sampled is less than the requirement
The number of points sampled is less than the requirement
The discharge is assumed to be composed of dry air and moisture
The sampling plane is deemed to be non-compliant due to the following reasons:
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane
The stack or duct does not have the required number of access holes (ports)

Total VOCs (as n-Propane)	Results	
	Concentration	
	ppm	mg/m ³
C1-C4	10	7.5
C5-C20	0.18	0.68
Total	11	8.2

VOC's C1-C4	Results	
Sampling time	1419-1422	
	Concentration	
	ppm	mg/m ³
Methane	3.8	2.7
Ethane	<1	<1
Ethylene	<1	<1
Acetylene	<1	<1
Propane	<1	<2
Cyclopropane	<1	<2
Propylene	<1	<2
Propadiene	<1	<2
Isobutane	<1	<3
n-Butane	<1	<3
1-Butene	<1	<3
Propyne	<1	<2
trans-2-Butene	<1	<3
cis-2-Butene	<1	<3
1,3-Butadiene	<1	<2

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	Gas Fired Boiler 1
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

VOC (speciated)	Sampling time	Results	
		1317-1418	
		Concentration	
		ppm	mg/m ³
Detection limit ⁽¹⁾		<0.009	<0.04
Toluene		0.28	1.2
Acetone		0.063	0.16

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

Dichloromethane, Ethanol, Isopropanol, 1,1-Dichloroethene, 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, Pentane, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, Isopropyl acetate, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Heptane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methylcyclohexane, Methyl Isobutyl Ketone, 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

Gas Fired Boiler 3

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	Gas Fired Boiler 3
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211208

Sampling Plane Details

Sampling plane dimensions	2140 x 630 mm
Sampling plane area	1.35 m ²
Sampling port size, number	1 x 15mm hole
Access & height of ports	Stairs 0 m
Duct orientation & shape	Horizontal Rectangular
Downstream disturbance	Change in diameter 0 D
Upstream disturbance	Change in diameter 0 D
No. traverses & points sampled	1 6
Sample plane compliance to AS4323.1 (1995)	Non-compliant

Comments

Sampling plane dimensions are estimations only due to access constraints.
The number of traverses sampled is less than the requirement
The number of points sampled is less than the requirement
The discharge is assumed to be composed of dry air and moisture

The sampling plane is deemed to be non-compliant due to the following reasons:

The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane
The stack or duct does not have the required number of access holes (ports)

Stack Parameters

Moisture content, %v/v	4.3	
Gas molecular weight, g/g mole	28.5 (wet)	29.0 (dry)
Gas density at STP, kg/m ³	1.27 (wet)	1.29 (dry)
Gas density at discharge conditions, kg/m ³	0.63	

Gas Flow Parameters

Flow measurement time(s) (hhmm)	1325 & 1435
Temperature, °C	283
Temperature, K	556
Velocity at sampling plane, m/s	24
Volumetric flow rate, actual, m ³ /s	32
Volumetric flow rate (wet STP), m ³ /s	16
Volumetric flow rate (dry STP), m ³ /s	15
Mass flow rate (wet basis), kg/hour	72000
Velocity difference, %	-1

Total VOCs (as n-Propane)

	Results		
	Concentration ppm	Concentration mg/m ³	Mass Rate g/min
C1-C4	99	71	64
C5-C20	0.064	0.17	0.15
Total	99	71	64

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	Gas Fired Boiler 3
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211208

VOC's C1-C4		Results		
Sampling time		1429-1432		
		Concentration		Mass Rate
		ppm	mg/m ³	g/min
Methane		36	26	23
Ethane		<1	<1	<1
Ethylene		<1	<1	<1
Acetylene		<1	<1	<1
Propane		<1	<2	<2
Cyclopropane		<1	<2	<2
Propylene		<1	<2	<2
Propadiene		<1	<2	<2
Isobutane		<1	<3	<2
n-Butane		<1	<3	<2
1-Butene		<1	<3	<2
Propyne		<1	<2	<2
trans-2-Butene		<1	<3	<2
cis-2-Butene		<1	<3	<2
1,3-Butadiene		<1	<2	<2

VOC (speciated)		Results		
Sampling time		1327-1428		
		Concentration		Mass Rate
		ppm	mg/m ³	g/min
Detection limit ⁽¹⁾		<0.009	<0.04	<0.03
Acetone		0.085	0.22	0.2

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

Dichloromethane, Ethanol, Isopropanol, 1,1-Dichloroethene, 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, Toluene, 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, Pentane, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, Isopropyl acetate, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Heptane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methylcyclohexane, Methyl Isobutyl Ketone, 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

Gas Fired Boiler 7

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	Gas Fired Boiler 7
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211208

Sampling Plane Details

Sampling plane dimensions	2140 x 600 mm
Sampling plane area	1.28 m ²
Sampling port size, number	1 x 10mm hole
Access & height of ports	Stairs 13 m
Duct orientation & shape	Horizontal Rectangular
Downstream disturbance	Change in diameter 0 D
Upstream disturbance	Change in diameter 0 D
No. traverses & points sampled	1 6
Sample plane compliance to AS4323.1 (1995)	Non-compliant

Comments

Sampling plane dimensions are estimations only due to access constraints.

The number of traverses sampled is less than the requirement

The number of points sampled is less than the requirement

The discharge is assumed to be composed of dry air and moisture

The sampling plane is deemed to be non-compliant due to the following reasons:

The downstream disturbance is <1D from the sampling plane

The upstream disturbance is <2D from the sampling plane

The stack or duct does not have the required number of access holes (ports)

Stack Parameters

Moisture content, %v/v	4.3	
Gas molecular weight, g/g mole	28.5 (wet)	29.0 (dry)
Gas density at STP, kg/m ³	1.27 (wet)	1.29 (dry)
Gas density at discharge conditions, kg/m ³	0.63	

Gas Flow Parameters

Flow measurement time(s) (hhmm)	1413 & 1522
Temperature, °C	284
Temperature, K	557
Velocity at sampling plane, m/s	40
Volumetric flow rate, actual, m ³ /s	51
Volumetric flow rate (wet STP), m ³ /s	25
Volumetric flow rate (dry STP), m ³ /s	24
Mass flow rate (wet basis), kg/hour	120000
Velocity difference, %	-2

Total VOCs (as n-Propane)	Results		
	Concentration ppm	Concentration mg/m ³	Mass Rate g/min
C1-C4	<5	<4	<6
C5-C20	0.057	0.18	0.27
Total	0.057	0.18	0.27

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	Gas Fired Boiler 7
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211208

VOC's C1-C4		Results		
	Sampling time	1517-1520		
		Concentration		Mass Rate
		ppm	mg/m ³	g/min
Methane		<2	<1	<2
Ethane		<1	<1	<2
Ethylene		<1	<1	<2
Acetylene		<1	<1	<2
Propane		<1	<2	<3
Cyclopropane		<1	<2	<3
Propylene		<1	<2	<3
Propadiene		<1	<2	<3
Isobutane		<1	<3	<4
n-Butane		<1	<3	<4
1-Butene		<1	<3	<4
Propyne		<1	<2	<3
trans-2-Butene		<1	<3	<4
cis-2-Butene		<1	<3	<4
1,3-Butadiene		<1	<2	<3

VOC (speciated)		Results		
	Sampling time	1415-1516		
		Concentration		Mass Rate
		ppm	mg/m ³	g/min
Detection limit ⁽¹⁾		<0.009	<0.04	<0.05
Toluene		0.052	0.21	0.31
Acetone		0.042	0.11	0.16

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

Dichloromethane, Ethanol, Isopropanol, 1,1-Dichloroethene, 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, Pentane, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, Isopropyl acetate, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Heptane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methylcyclohexane, Methyl Isobutyl Ketone, 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

EPA ID 35 – Combined Boiler 5 & 6

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	EPA ID 35 - Boiler 5 & 6 Combined Stack
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211207

Sampling Plane Details

Sampling plane dimensions	1985 mm
Sampling plane area	3.09 m ²
Sampling port size, number & depth	4" BSP (x4), 100 mm
Access & height of ports	Stairs & ladders 40 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit >6 D
Upstream disturbance	Junction 4 D
No. traverses & points sampled	2 20
Sample plane compliance to AS4323.1 (1995)	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, %v/v	7.4	
Gas molecular weight, g/g mole	29.5 (wet)	30.4 (dry)
Gas density at STP, kg/m ³	1.32 (wet)	1.36 (dry)
Gas density at discharge conditions, kg/m ³	0.92	
% Oxygen correction & Factor	7 %	1.14

Gas Flow Parameters

Flow measurement time(s) (hhmm)	1035 & 1240
Temperature, °C	120
Temperature, K	393
Velocity at sampling plane, m/s	14
Volumetric flow rate, actual, m ³ /s	42
Volumetric flow rate (wet STP), m ³ /s	29
Volumetric flow rate (dry STP), m ³ /s	27
Mass flow rate (wet basis), kg/hour	140000
Velocity difference, %	-8

Date	8/12/2021	Client	Manildra Group
Report	R012021	Stack ID	EPA ID 35 - Boiler 5 & 6 Combined Stack
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211207

Total VOCs (as n-Propane)	Results			
	Concentration		Corrected to 7% O ₂	Mass Rate
	ppm	mg/m ³	mg/m ³	g/min
C1-C4	<5	<4	<4	<6
C5-C20	<0.02	<0.03	<0.04	<0.06
Total	<5	<4	<4	<6

VOC's C1-C4	Sampling time	Results			
		Concentration		Corrected to 7% O ₂	Mass Rate
		ppm	mg/m ³	mg/m ³	g/min
Methane		<2	<1	<2	<2
Ethane		<1	<1	<2	<2
Ethylene		<1	<1	<1	<2
Acetylene		<1	<1	<1	<2
Propane		<1	<2	<2	<3
Cyclopropane		<1	<2	<2	<3
Propylene		<1	<2	<2	<3
Propadiene		<1	<2	<2	<3
Isobutane		<1	<3	<3	<4
n-Butane		<1	<3	<3	<4
1-Butene		<1	<3	<3	<4
Propyne		<1	<2	<2	<3
trans-2-Butene		<1	<3	<3	<4
cis-2-Butene		<1	<3	<3	<4
1,3-Butadiene		<1	<2	<3	<4

VOC (speciated)	Sampling time	Results			
		Concentration		Corrected to 7% O ₂	Mass Rate
		ppm	mg/m ³	mg/m ³	g/min
Detection limit ⁽¹⁾		<0.009	<0.04	<0.04	<0.06
Acetone		<0.01	<0.04	<0.04	<0.06

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

Dichloromethane, Ethanol, Isopropanol, 1,1-Dichloroethene, 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, Toluene, 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, Pentane, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, Isopropyl acetate, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Heptane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methylcyclohexane, Methyl Isobutyl Ketone, 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

EPA ID 45 – Boiler 2

Date	7/12/2021	Client	Manildra Group
Report	R012021	Stack ID	EPA ID 45 - Boiler 2
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211203

Sampling Plane Details

Sampling plane dimensions	1070 mm
Sampling plane area	0.899 m ²
Sampling port size, number & depth	4" Flange (x2), 180 mm
Access & height of ports	Ladders 20 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit >2 D
Upstream disturbance	Change in diameter 5 D
No. traverses & points sampled	2 16
Sample plane compliance to AS4323.1 (1995)	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, %v/v	5.9	
Gas molecular weight, g/g mole	29.3 (wet)	30.0 (dry)
Gas density at STP, kg/m ³	1.31 (wet)	1.34 (dry)
Gas density at discharge conditions, kg/m ³	0.75	
% Oxygen correction & Factor	7 %	1.47

Gas Flow Parameters

Flow measurement time(s) (hhmm)	1055 & 1245
Temperature, °C	201
Temperature, K	474
Velocity at sampling plane, m/s	8.8
Volumetric flow rate, actual, m ³ /s	7.9
Volumetric flow rate (wet STP), m ³ /s	4.5
Volumetric flow rate (dry STP), m ³ /s	4.3
Mass flow rate (wet basis), kg/hour	21000
Velocity difference, %	-9

Date	7/12/2021	Client	Manildra Group
Report	R012021	Stack ID	EPA ID 45 - Boiler 2
Licence No.	883	Location	Bomaderry
Ektimo Staff	Zoe Parker & Ahmad Ramiz	State	NSW
Process Conditions	Please refer to client records.		

211203

Total VOCs (as n-Propane)	Results			
	Concentration		Corrected to 7% O ₂	Mass Rate
	ppm	mg/m ³	mg/m ³	g/min
C1-C4	<5	<4	<6	<1
C5-C20	0.048	0.12	0.18	0.032
Total	0.048	0.12	0.18	0.032

VOC's C1-C4	Sampling time	Results			
		Concentration		Corrected to 7% O ₂	Mass Rate
		ppm	mg/m ³	mg/m ³	g/min
Methane		<2	<1	<2	<0.4
Ethane		<1	<1	<2	<0.3
Ethylene		<1	<1	<2	<0.3
Acetylene		<1	<1	<2	<0.3
Propane		<1	<2	<3	<0.5
Cyclopropane		<1	<2	<3	<0.5
Propylene		<1	<2	<3	<0.5
Propadiene		<1	<2	<3	<0.5
Isobutane		<1	<3	<4	<0.7
n-Butane		<1	<3	<4	<0.7
1-Butene		<1	<3	<4	<0.6
Propyne		<1	<2	<3	<0.5
trans-2-Butene		<1	<3	<4	<0.6
cis-2-Butene		<1	<3	<4	<0.6
1,3-Butadiene		<1	<2	<4	<0.6

VOC (speciated)	Sampling time	Results			
		Concentration		Corrected to 7% O ₂	Mass Rate
		ppm	mg/m ³	mg/m ³	g/min
Detection limit ⁽¹⁾		<0.008	<0.03	<0.05	<0.008
Acetone		0.063	0.16	0.24	0.042

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

Dichloromethane, Ethanol, Isopropanol, 1,1-Dichloroethene, 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, Toluene, 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, Pentane, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, Isopropyl acetate, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Heptane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methylcyclohexane, Methyl Isobutyl Ketone, 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

