Application form for EPA works approval

1. APPLICANT

1.1 Company details

Company name	ACN
AGL Energy Limited	115 061 375

Registered address
Level 22, 101 Miller Street, North Sydney, NSW 2060 Australia

1.2 Contact details

Name	Position
Evan Carless	Manager Power Development AGL Energy Limited

Phone	Email
(02) 9921 2214 (03) 8699 7641	ecarless@agl.com.au timothy_routley@urscorp.com

1.3 Premises details

Premises address	Municipality
Tarrone North Road, Tarrone, VIC, 3283 Lot 2 on Plan of Subdivision 218923A. Volume-9933 Folio-939	Moyne Shire

2. PROPOSAL

2.1 Project description

Provide a simple, one-line explanation of the project. Attach a site and location plan.

An open-cycle gas turbine peaking power station, comprising up to four turbines, at Tarrone, Victoria. *Further information is provided in Section 2.1 of the attached Works Approval Application report.* *A Locality Map is provided in Figure 1 of the Works Approval Application report.* *A Location Plan is provided in Figure 2 of the Works Approval Application report.* *A Site Plan is provided in Figure 3 of the Works Approval Application report.*

2.2 Cost of works and application fee

Cost of works	Application fee
$600 Million	$52,605

2.3 Proposed dates

Start construction: Month, Year	Start operation: Month, Year
Investment Decision - Stage 1 – Q4 2010 Start Construction – Stage 1 - 2011	Commission Power Station – Stage 1 - Q3 2012 Power Station Completion – Stage 1 - Q4 2012

The proposed Tarrone power station is planned to be built in two stages, the first stage will consist of two or three E or two F class gas turbines and an associated capital cost of approximately $400M. The EPA Works Approval Application is for four E or three F class gas turbines, which will be achieved on completion of stage two of construction.	The timing of stage 2 construction and completion will depend on the economic viability in accordance with national electricity market demands.

3. APPROVALS

3.1 Need for works approval

Schedule type	Act section that applies
K01 premises (Power stations) which generate electrical power from the consumption of a fuel at a rated capacity of at least 5 Megawatt electrical power. L01 premises which discharge or emit, or from which it is proposed to discharge or emit, to the atmosphere: - at least 100 kilograms a day of nitrogen oxides. - at least 100 kilograms a day of sulphur oxides. - at least 100 kilograms a day of particles. - at least 500 kilograms a day of carbon monoxide. [With respect to descriptions L01, it should be noted that the proposed Tarrone power station is a peak load power station and will not operate continuously. However, on days when it does operate, it may exceed the specified emissions threshold.]	Environment Protection Act, Sections: 19A (1)(a), pertaining to *an increase or alteration in the waste discharged or emitted from, deposited to, or produced at, the premises*; 19A (1)(b), pertaining to *an increase or alteration in the waste which is, or substances which are a danger or potential danger to the quality of the environment or any segment of the environment which are, reprocessed, treated, stored, contained, disposed of or handled, at the premises*; 19A (1)(c), pertaining to *a change in any method or equipment used at the premises for the reprocessing, treatment, storage, containment, disposal or handling of waste, or of substances which are a danger or potential danger to the quality of the environment or any segment of the environment*; 19A (1)(d) pertaining to *a significant increase in the emission of noise*

List any exemptions that apply: section of the Regulations

No exemptions were identified.

3.2 Planning and other approvals

Planning Zone	Type of approval required
Currently Farming Zone (FZ) To be rezoned to Special Use Zone (SUZ4)	Planning Scheme Amendment

Approving authority	Approval received or pending
Minister of Planning	Pending

Details of other approvals are provided in Section 3.2 of the Works Approval Application report.

3.3 Existing EPA approvals (if any)

List any EPA documents held

Somerton Gas-fired Peaking Power Station
An EPA licence (EA51148) is held for AGL's gas-fired peaking power station at Somerton.
AGL is registered for and submits annual EREP reports for its operations at Somerton
Symex Holdings
AGL is registered for and submits annual EREP reports for its operations at a gas-fired cogeneration plant on the site of Symex Holdings in Port Melbourne.
Western Treatment Plant at Werribee
An EPA licence (EA42348) is held for AGL's joint "biogas" generation project with Melbourne Water at Werribee.
Works are currently underway under a formal Works Approval Exemption for the installation of two additional engine generators.
Bogong Power Development
A Memorandum of Understanding (MOU) exists between the EPA and what was Southern Hydro.
AGL holds an EPA licence (SW4097) for a sewerage treatment plant at Bogong Village.

4. ENVIRONMENT AND COMMUNITY

4.1 Track record

Summarise the company's recent environmental performance

Information is provided in Section 4.1 of the Works Approval Application report.

Report any relevant offences; e.g. indictable and summary offences

AGL Energy Limited has not been prosecuted for a "relevant offence", as defined in Section 20C of the *Environment Protection Act 1970*, in the past 10 years.

List any enforcement actions related to this site

The EPA has not taken any environmental enforcement action against AGL Energy Limited or its subsidiaries over the past 3 years.

4.2 Key environmental considerations

List the main environmental aspects of your proposal

The key environmental considerations for the proposed Tarrone power station are:
- emissions to the air environment and greenhouse gas emissions arising from gas combustion in the turbines;
- noise arising from turbine operation;
- management of wastewater arising from water treatment and operation of evaporative turbine inlet air coolers; and
- stormwater management.

Further information is provided in Section 4.2 of the Works Approval Application report.

4.3 Community engagement

Summarise any public consultation that has been undertaken or planned

AGL has developed and implemented a consultation program for the proposed Tarrone power station project. Consultation activities that have occurred for the project to date include the following:

State Government

On-going consultation by AGL has occurred with the Victorian Government and their representative departments since 2008.

Moyne Shire Council

The Moyne Shire Council (including senior council officers) has been briefed by AGL on the progress of the project in December 2008, January 2010 and March 2010 in order to discuss the development and assess support for the project.

Community

A Community Information Day was conducted at the Willatook Community Hall on 28 February 2009. The Community Information Day provided information to the community and identified the key issues the community had with the proposed Tarrone power station. A brochure was also distributed to over 300 members of the community within 5 km of the proposed site outlining the project and addressing key issues.

Further community consultation phases are proposed for the project. Landowners will be contacted through either/or both of the following ways:

- an additional project brochure will be mailed out to address key concerns that were identified from the Community Information Day and the outcomes of the Commonwealth / State Government(s) decisions; and
- consultations will be conducted with individual landowners/occupiers of the site.

AGL will continue to consult with the community and relevant stakeholders as the project progresses.

Additional information on community and other stakeholder consultation is provided in Section 4.3 of the Works Approval Application report.

Indicate any issues that have been raised

Key Community Issues identified at the Community Information Day (Willatook 28-2-09) included:

Issue	No. of Community Households Concerned[1]
Noise emissions	2
Air emissions	5
Property value	2
Traffic safety	3
Fire risk	2
Groundwater	1
Visual impact	1

Notes:
[1]. Written comments were received from a total of 5 households.

5.1 Process and technology

AGL proposes to build a gas-fired peaking power station comprising of either four E class turbines or three F class turbines operating in open cycle mode. Once developed, either turbine configuration, including substation and associated infrastructure, will have a development envelope that is contained within an area of approximately 15 hectares. Electricity will be fed into an associated substation to connect to the high voltage transmission network that crosses the site. The gas turbines will be fuelled by natural gas from an 8 to 10 kilometre long underground gas pipeline connected to the nearby SEA Gas pipeline.

Key process steps	Key inputs	Key outputs	Key Controls
Gas Turbine Generators	Natural Gas Air Cooling Water (air intake evaporative coolers) Electricity (for startup)	Combustion gases Noise Wastewater bleed from the air intake evaporative coolers	Generator acoustic enclosure Exhaust silencer Dry-Low-NOx (DLN) combustion controls Generator controls. Turbine bunding.
Substation	Electricity	Electricity	Switchyard controls Transformer bunding.
Water Treatment (if required) for pretreatment of air intake evaporative coolers and/or other power augmentation systems.	Groundwater or potable water (yet to be decided) Electricity Other inputs depend upon the process selected but may include acids and alkalis for membrane cleaning and/or ion-exchange resin regeneration.	Treated water Waste streams type and composition depends upon the process selected, but may include a concentrate or regeneration wastewater stream and prefilter backwash.	Treatment plant controls – specifics will depend upon final plant details Bunding of any chemicals required for water treatment plant operation. Evaporation pond liner system, freeboard and level control systems.

Additional information is provided in Figure 4 and Section 5.1 of the Works Approval Application report.

5.2 Environmental best practice

The key aspects of the power station which are considered particularly important in the adoption of best practice are air emission controls and generator energy efficiency.

Indicate steps taken to determine industry best practice

Industry best practice was determined through AGLs industry experience, consultation with generator manufacturers, and review of information and literature pertaining to gas fired peaking plants in Australia and overseas.

This is discussed in more detail Section 5.2 of the Works Approval Application report.

Explain why waste generation and resource use cannot be avoided or minimised

Natural gas combustion is fundamental to electricity production using gas turbine generators and cannot be avoided. Gas turbine generators are appropriate for peaking plants as they have relatively rapid turn on and off capabilities. Combustion gases generation cannot be avoided but can be minimised by optimising generator performance. In addition the composition of the combustion gases can be controlled to some extent through combustion controls.

This is discussed in more detail Section 5.2 of the Works Approval Application report.

Explain options considered and why this process is considered best practice

No alternative processes, other than gas turbine generators, were considered for this peaking plant project, as no other processes are considered suitable.
In order to improve generator efficiency by increasing inlet air density, cooling of the turbine inlet air was considered and is proposed to be implemented.
A range of options were considered to control the composition of combustion gases, specifically the nitrogen oxides (NOx) concentration. Options considered were:
- water steam injection
- dry low NOx (DLN)
- catalytic combustion; and
- selective catalytic reduction (SCR)

DLN was assessed as best practice and is proposed to be implemented. SCR and catalytic combustion could theoretically achieve lower NOx concentrations but the technology is not commercially available for generators of the size proposed, they could significantly reduce generator efficiency, and in the case of SCR, require the use of significant quantities of the hazardous material ammonia.

This is discussed in more detail Section 5.2 of the Works Approval Application report.

5.3 Integrated environmental assessment

Indicate any areas where there are competing environmental demands

The improvement of generator efficiency through inlet air cooling (predominately in summer) requires a high quality cooling water supply. The majority of this water humidifies the turbine inlet air and is lost, however a cooling water bleed stream will be generated. This would be discharged to an onsite lined evaporation pond for concentration, prior to ultimate disposal as a prescribed industrial waste. Depending upon the quality of the water supply ultimately selected for the plant (from groundwater, road tankered potable water, or recycled water), the cooling water supply may require pretreatment, which would use some electricity and produce additional wastewater/sludge streams, to be discharged to the evaporation pond. Some treatment chemicals may also be required. The options that would be considered include pre-filtration and reverse osmosis, electrodialysis reversal (EDR), or ion-exchange.

Details are provided in Section 5.3 of the Works Approval Application report.

Indicate how you will determine net environmental benefit in these areas

No reasonable basis was identified for comparing reduced gas usage per unit energy output against increased water consumption (and associated treatment), so the decision will ultimately be made on a cost benefit basis.

Information is provided in Section 5.3 of the Works Approval Application report.

5.4 Choice of process and technology

Process or technology	Advantages	Disadvantages
Gas turbine generators for peaking plant.	Can be relatively rapidly started and stopped Evolved reliable technology suitable for many starts/stops. Not reliant upon climatic conditions Lower greenhouse gas emission per unit energy production than coal.	Consume hydrocarbon fuel, consequently producing combustion and greenhouse gases. Generate noise, which requires control.

Details are provided in Section 5.4 of the Works Approval Application report.

5.5 Choice of location and layout

Location or layout	Advantages	Disadvantages
Tarrone, in Moyne Shire	Proximal to gas supply and electricity distribution infrastructure. The gas can be supplied at the pipeline pressure without the need for additional compression. The substation will also service the proposed Macarthur wind farm (should that project proceed). The site is relatively isolated providing adequate buffers, with the nearest residence approximately 1500 metres to the north-east	No significant disadvantages identified

Additional information is provided in Figures 1, 2 and 3 and Section 5.5 of the Works Approval Application report.

6. RESOURCES

6.1 Carbon

Type of energy use or greenhouse gas emission	Amount in GJ/yr or tCO_2e
Natural Gas use Carbon Dioxide emission	At a 5% usage rate, the expected gas and electricity consumption would result in the emission of between 150,000 - 200,000 tonnes of carbon dioxide equivalent per year for the amount of gas consumed.

Additional information is provided in Figures 1, 2 and 3 and Section 6.1 of the Works Approval Application report.

6.2 Water use

The water usage: ML per year

It is anticipated that the proposed Tarrone power station will require approximately 10 - 15 ML of water per year. The source of the water is yet to be confirmed but will be selected from groundwater, road tankered potable water, or recycled water from Port Fairy (this source is dependant upon Shaw River Power Station Project proceeding).

Additional information is provided in Section 6.2 of the Works Approval Application report.

6.3 Solid waste

Type of solid waste	Amount t/yr	Destination
Solid waste in the form of metal scrap, rags, spent air and oil filters, domestic waste, and paper has been proposed for the Tarrone power station.	Approximately 5 tonnes per annum	All solid wastes generated on site will be collected by maintenance personnel or contractors for disposal. Waste will be segregated and recycled where appropriate (e.g. paper, metal etc) and non-recyclable wastes will be transported to municipal landfill.

Additional information is provided in Section 6.3 of the Works Approval Application report.

6.4 Prescribed industrial waste

Type of prescribed waste	Amount t/yr	Destination
Liquid and solid prescribed waste that may be generated at the site include: • Oil and oily waste; • Possible water treatment waste; • Turbine wash water; • Evaporation pond waste; and • Septic and/or sewage sludge; and • Chemical/oil containers.	Approximately 3 tonnes per year of solid and oily liquid prescribed waste. Approximately 37 kL per year of turbine wash water	Appropriately Licensed industrial waste receival facilities.

7. EMISSIONS

7.1 Air emissions

Type of air emissions	Rate or scale of emissions	List any class 3 indicators
Natural gas combustion emissions from the gas turbines, including the following principal components: • nitrogen (N_2); • oxygen (O_2); • carbon dioxide (CO_2); • water vapour; • oxides of nitrogen (NO_x); • sulphur dioxide (SO_2); and • carbon monoxide (CO).	*Refer to Section 9.5 and Appendix A of the Works Approval Application report*	No Class 3 Indicators are expected to be emitted.

Additional detail is provided in Sections 7.1 and 9.5 and Appendix A of the Works Approval Application report.

7.2 Discharge to surface water

Provide reasons for any discharge to water (rather than to sewer or to land)
Stormwater currently flows onto and across the site and will continue to be allowed to do so. The stormwater system will be designed to manage impacts on stormwater discharge quality. There is no sewerage system available in reasonable proximity to the site. Sewage waste will be discharged to an onsite septic system or other appropriate onsite sewage treatment/collection system (septic and/or sewage sludge will be tankered offsite for appropriate waste disposal). Process wastewater will be collected, concentrated by evaporation and disposed of to an appropriately licensed facility as prescribed waste. Impacted stormwater (that might occasionally be collected in bunded areas) will be educated and disposed of offsite to an appropriately licensed facility as prescribed waste.

Additional details are provided in Sections 7.2, 9.2, 9.4, 9.6 and 9.7 of the Works Approval Application report.

Rate of discharge to water; litres per day	Indicate water quality or treatment level
Refer to Sections 7.2 and 9.6 of the Works Approval Application report.	*Refer to Sections 7.2 and 9.6 and Figure 6 of the Works Approval Application report.* - Runoff from areas with low or no potential to impact on stormwater quality are expected to pass through a retarding basin prior to offsite discharge. - Runoff from hardstand areas are expected to be

	discharged to a sedimentation pond prior to offsite discharge. - Turbines and transformers will be bunded and stormwater will only be discharge to the sedimentation pond if confirmed to be unimpacted (ie oil free), otherwise the water will be educated and disposed of offsite to an appropriately licensed facility as prescribed waste.

7.3 Discharge to land

Rate of discharge or deposit to land, litres/or tonnes per day	Types of waste and level of treatment e.g. secondary or tertiary
None proposed	

For reuse, demonstrate that the proposal will meet EPA guidelines

No surface water irrigation will occur on-site and no solid waste will be discharged to an on-site landfill. The only water reuse that will be considered is collection of roof runoff for direct industrial water use.

Provide the reasons for any discharge to groundwater and indicate segment

Discharge to groundwater is not proposed. A wastewater evaporation pond will be appropriately lined, and all turbines, transformers and chemical storages will be within appropriately designed concrete bunds. There have been no groundwater investigations at the site. A review of the regional hydrogeology indicates that the groundwater segment, under the *State Environment Protection Policy (Groundwaters of Victoria)* is most likely B, but may be A2.

Addition details regarding management of land and groundwater discharges at the site are provided in Sections 7.3, 9.2, 9.4, 9.6, and 9.7 of the Works Approval Application report.

7.4 Noise emissions

Hours of operation	Noise sources	Are they audible at nearby residences?
Intermittent operation based on peaking power demand. Generators could be called on to operate at any time of the day, at any time of the year.	Turbine generators, including the exhaust stack Electrical transformers Electrical motors (pumps, etc)	*Refer to Sections 7.4 and 9.8, and Appendix B of the Works Approval Application report.*

Additional information is provided in Sections 7.4 and 9.8, and Appendix B, of the Works Approval Application report.

8. ENVIRONMENTAL MANAGEMENT

8.1 Non-routine operations

List process upsets that could impact on the environment

Process upsets causing impacts on the environment are not anticipated.
Chemicals and oils will all be stored in appropriately bunded areas.
The wastewater evaporation pond will be appropriately lined and have adequate freeboard.
Potential impacts arising from a potential gas leak were subject to a Quantitative Risk Assessment (QRA). The QRA reports that the risk to the community does not extend beyond the power station site boundary.

8.2 Separation distances

Proposed buffer distances, in metres	Recommended buffer distance, in metres
The location of the proposed Tarrone power station is approximately 1500m from the nearest sensitive receivers. In addition, the operational systems in place at the proposed Tarrone power station are expected to minimise the risk of any unintended or accidental emissions, and as such there will be no off-site effects associated with the operation of the power station.	Buffer distances are required to safeguard sensitive receivers from the potential effect of air discharges from unintended or accidental emissions (e.g. spills, equipment failure). The *Recommended Buffer Distances for Industrial Residual Air Emissions published by the EPA (AQ 2/86, July 1990)* provides buffer distances for a number of industry types. A recommended buffer distance for gas-fired power generation sites, like that proposed at Tarrone, is not provided in the guidelines.

8.3 Management system

Explain the system that will be used to manage environmental risk

AGL will manage and operate the Tarrone facility under its own management system. If required by EPA, as a condition of the Licence or Works Approval, AGL will prepare an Environmental Improvement Plan (EIP).

8.4 Construction

Identify any environmental risks that will need to be managed during installation

Construction phase environmental hazards that may require management include:

- dust control;
- noise emissions from vehicular and plant activity;
- stormwater management;
- sediment control;
- spill control and management;
- waste management; and
- management of onsite fuels, oils and chemicals.

Identify any existing site contamination issues

Not assessed as no contamination issues expected. The only known prior use of the site is as pasture land for livestock grazing.

Explain how construction will be managed to prevent environmental impacts

AGL will ensure that all contractors involved in the construction and pre-commissioning phase of the project will operate in accordance with an environmental management plan (EMP). The Principal Contractor will be required to develop a construction phase EMP in accordance with the conditions prescribed by AGL. The Principal Contractor's EMP will be subject to approval by AGL prior to commencement. It will also be provided to the EPA for approval if required by the Works Approval. AGL will establish an audit program to monitor compliance with the plan. The EMP will provide a framework of policies and procedures to assist in the "day to day" management of environmental issues during construction of the facility.

Additional information is provided in Sections 8.3 and 8.4 of the Works Approval Application report.

A. CARBON

A1. Energy use and greenhouse gas emissions

Note any existing energy use and greenhouse gas emissions

Refer to Section 9.1.1 of the Works Approval Application report.

Process step	Type of energy use or greenhouse gas	Amount (TJ/year) or tCO_2e/year
Refer to Section 9.1.1 of the Works Approval Application report.	*Refer to Section 9.1.1 of the Works Approval Application report.*	*Refer to Section 9.1.1 of the Works Approval Application report.*

Basis for numbers

Refer to Section 9.1.1 of the Works Approval Application report.

A2. Best practice carbon management

Outline the steps taken to identify best practice carbon management

Refer to Section 9.1.2 of the Works Approval Application report.

Summarise the options considered to avoid or minimise carbon emissions

Refer to Section 9.1.2 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 9.1.2 of the Works Approval Application report.

B. WATER

B1. Water use

Note any existing water use

Refer to Section 9.2 of the Works Approval Application report

Process step	Type of water use	Amount (ML/year)
Refer to Section 9.2 of the Works Approval Application report	*Refer to Section 9.2 of the Works Approval Application report*	*Refer to Section 9.2 of the Works Approval Application report*

Basis for numbers

Refer to Section 9.2 of the Works Approval Application report

B2. Best practice water management

Outline the steps taken to identify best practice for saving water

Refer to Section 9.2.8 of the Works Approval Application report.

Summarise the options considered to avoid or minimise water usage

Refer to Section 9.2.8 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 9.2.8 of the Works Approval Application report.

C. SOLID WASTE

C1. Solid waste generation

Note any existing solid waste generation

Refer to Section 6.3 of the Works Approval Application report.

Process step	Type of waste generated	Amount (t/year)
Refer to Section 6.3 of the Works Approval Application report.	*Refer to Section 6.3 of the Works Approval Application report.*	*Refer to Section 6.3 of the Works Approval Application report.*

Basis for numbers

Refer to Section 6.3 of the Works Approval Application report.

C2. Best practice solid waste management

Outline the steps taken to identify best practice for solid waste management

Refer to Section 6.3 of the Works Approval Application report.

Summarise the options considered to avoid or minimise solid waste

Refer to Section 6.3 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 6.3 of the Works Approval Application report.

Indicate where these wastes will go

Refer to Section 6.3 of the Works Approval Application report.

D. PRESCRIBED INDUSTRIAL WASTE

D1. Prescribed industrial waste generation

Information is provided in.

Note any existing prescribed industrial waste generation

Refer to Section 9.4.1 of the Works Approval Application report.

Process	Type of waste	Waste category	Amount (t/year)
Refer to Section 9.4.1 of the Works Approval Application report.	*Refer to Section 9.4.1 of the Works Approval Application report.*	*Refer to Section 9.4.1 of the Works Approval Application report.*	*Refer to Section 9.4.1 of the Works Approval Application report.*

Basis for numbers

Refer to Section 9.4.1 of the Works Approval Application report.

D2. Best practice prescribed waste management

Outline the steps taken to identify best practice for prescribed waste

Refer to Section 9.4.2 of the Works Approval Application report.

Summarise the options considered to avoid or minimise prescribed waste

Refer to Section 9.4.2 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 9.4.2 of the Works Approval Application report.

Indicate where these wastes will go

Refer to Section 9.4.2 of the Works Approval Application report.

E. AIR

E1. Air emissions

Note any existing air emissions

Refer to Section 9.5.1 of the Works Approval Application report.

Process step	Type of air emission*	Amount (g/min)
Refer to Section 9.5.1 of the Works Approval Application report.	*Refer to Section 9.5.1 of the Works Approval Application report.*	*Refer to Section 9.5.1 of the Works Approval Application report.*

*Identify any class 3 indicator emissions

Basis for numbers

Refer to Section 9.5.1 of the Works Approval Application report.

E2. Best practice air emissions management

Outline the steps taken to identify best practice# for air emissions

Refer to Section 9.5.2 of the Works Approval Application report.

Summarise the options considered to avoid or minimise air emissions

Refer to Section 9.5.2 of the Works Approval Application report.

Explain why the chosen option is best practice#

Refer to Section 9.5.2 of the Works Approval Application report.

#For class 3 indicator emissions assess against maximum extent achievable

E3. Impact on air quality

Predicted maximum concentration (project)	Background concentration
Refer to Sections 9.5.3, 9.5.4 and 9.5.5 of the Works Approval Application report.	*Refer to Sections 9.5.3, 9.5.4 and 9.5.5 of the Works Approval Application report.*

Predicted maximum concentration (total)^	Design criteria (mg/m³)
Refer to Sections 9.5.3, 9.5.4 and 9.5.5 of the Works Approval Application report.	*Refer to Sections 9.5.3, 9.5.4 and 9.5.5 of the Works Approval Application report.*

^Where any predicted concentrations are above the design criteria, provide a risk assessment. Assess any emissions that could impact on regional air quality.

F. WATER

F1. Water discharges

Note any existing water discharges

Refer to Section 9.6.1 of the Works Approval Application report.

Process step	Type of water discharge	Flowrate (L/day)
Refer to Section 9.6.1 of the Works Approval Application report.	*Refer to Section 9.6.1 of the Works Approval Application report.*	*Refer to Section 9.6.1 of the Works Approval Application report.*

Basis for numbers

Refer to Section 9.6.1 of the Works Approval Application report.

F2. Best practice water management

Outline the steps taken to identify best practice for discharge to water

Refer to Section 9.6.2 of the Works Approval Application report.

Summarise the options considered to avoid or minimise water discharges

Refer to Section 9.6.2 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 9.6.2 of the Works Approval Application report.

F3. Impact on waterway

Indicator	Maximum concentration	Median concentration (mg/L)
Refer to Section 9.6.3 of the Works Approval Application report.	*Refer to Section 9.6.3 of the Works Approval Application report.*	*Refer to Section 9.6.3 of the Works Approval Application report.*

Water quality objective^

Refer to Section 9.6.3 of the Works Approval Application report.

^Where any predicted concentrations are above the objectives, provide a mixing zone assessment

G. LAND AND GROUNDWATER

G1. Discharge or deposit to land

Note any existing discharge or deposit to land

Refer to Section 9.7 of the Works Approval Application report.

Process step	Type of discharge	Flow rate (L/day)
Refer to Section 9.7 of the Works Approval Application report.	*Refer to Section 9.7 of the Works Approval Application report.*	*Refer to Section 9.7 of the Works Approval Application report.*

Or

Type of waste	Amount (t/year)
Refer to Section 9.7 of the Works Approval Application report.	*Refer to Section 9.7 of the Works Approval Application report.*

Basis for numbers

Refer to Section 9.7 of the Works Approval Application report.

G2. Best practice land and groundwater management

Outline the steps taken to identify best practice in discharge or deposit to land

Refer to Section 9.7 of the Works Approval Application report.

Summarise the options considered to avoid or minimise discharge to land

Refer to Section 9.7 of the Works Approval Application report.

For landfills, demonstrate best practice siting and design

Refer to Section 9.7 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 9.7 of the Works Approval Application report.

G3. Impact on land and groundwater

Provide a land capability assessment

Refer to Section 9.7 of the Works Approval Application report.

Groundwater Indicator	Predicted Concentration	Water quality objective^
Refer to Section 9.7 of the Works Approval Application report.	*Refer to Section 9.7 of the Works Approval Application report.*	*Refer to Section 9.7 of the Works Approval Application report.*

^Where any predicted concentrations are above the objectives, provide an attenuation zone assessment

Assess any impacts on the level of the water table

Refer to Section 9.7 of the Works Approval Application report.

H. NOISE EMISSIONS

H1. Noise emissions

Process step	Source/type of emission	Sound power level (dBA)
Refer to Section 9.8.1 of the Works Approval Application report.	*Refer to Section 9.8.1 of the Works Approval Application report.*	*Refer to Section 9.8.1 of the Works Approval Application report.*

Basis for numbers

Refer to Section 9.8.1 of the Works Approval Application report.

H2. Best practice noise management

Information is provided in Section 9.8.2 of the Works Approval Application report.

Outline the steps taken to identify best practice for noise emissions

Refer to Section 9.8.2 of the Works Approval Application report.

Summarise the options considered to avoid or minimise noise emissions

Refer to Section 9.8.2 of the Works Approval Application report.

Explain why the chosen option is best practice

Refer to Section 9.8.2 of the Works Approval Application report.

H3. Noise impact

Location of receptor(s)	Noise levels from project^	Existing noise levels (site)^	Background noise level^
Refer to Section 9.8.3 of the Works Approval Application report.	*Refer to Section 9.8.3 of the Works Approval Application report.*	*Refer to Section 9.8.3 of the Works Approval Application report.*	*Refer to Section 9.8.3 of the Works Approval Application report.*

Total noise level^	Noise limit^
Refer to Section 9.8.3 of the Works Approval Application report.	*Refer to Section 9.8.3 of the Works Approval Application report.*

^dBA for each of day, evening and night where relevant. Where existing site noise is above the limit, provide a noise reduction plan.

I. ENVIRONMENTAL MANAGEMENT

I1. Non routine operations

Outline the steps taken to identify potential process upsets or failures

Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.

Outline approach to identifying best practice in managing these environmental risks

Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.

Type of process upset	Potential environmental impact	Measures to reduce likelihood and impact
Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.	*Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.*	*Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.*

Explain why the buffer distance to residents is acceptable

Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.

I2. Monitoring

Information is provided in Section 8 of the Works Approval Application report.

Process	Indicator Measured	Monitoring type	Monitoring frequency	Use of monitoring
Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.	*Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.*	*Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.*	*Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.*	*Refer to Section 9.9 (which refers back to Section 8) of the Works Approval Application report.*

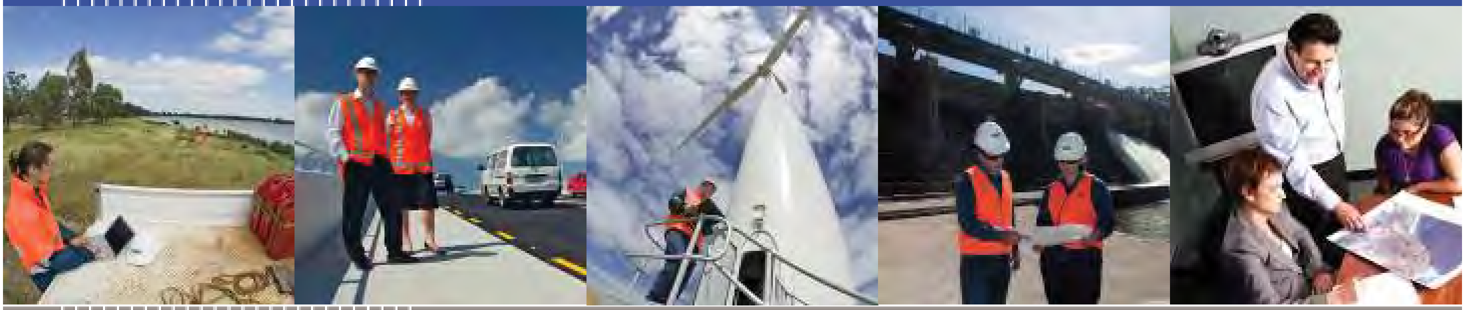
APPLICANT STATEMENT

I declare that to the best of my knowledge the information in this application is true and correct, that I have made all the necessary enquiries and that no matters of significance have been withheld from EPA.

Signed CEO or delegate

[signature] Michael Fraser CEO

25th JUNE 2010



Revised Final Report

Works Approval Application for Proposed AGL Peaking Power Station at Tarrone, Victoria

23 AUGUST 2010

Prepared for

AGL Energy Limited

Level 22, 101 Miller Street
North Sydney
NSW 2065

43283491

URS

Project Manager:	…………………………… Andrea McIntosh Environmental Planner		
Project Director:	…………………………… Sean Myers Senior Principal Environment and Planning		
Author:	…………………………… Dr Alison Radford Environmental Chemist		
Reviewer:	…………………………… Tim Routley Senior Principal Chemical Engineer	Date: Reference: Status:	**23 August 2010** 43283491/01/05 Revised Final

URS Australia Pty Ltd

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Australia
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Abbreviations

Abbreviation	Description
AGL	AGL Energy Limited
AMG	Australian Map Grid
ARI	Average Recurrence Interval
ARMC	Audit and Risk Management Board Committee
AQM	Air Quality Management
CASA	Civil Aviation Safety Authority
CPRS	Carbon Pollution Reduction Scheme
CO	Carbon Monoxide
CO_2	Carbon Dioxide
dB	Decibel
DLN	Dry Low NO_x
DSE	Department of Sustainability and Environment
EES	Environment Effects Statement
EIP	Environment Improvement Plan
EMP	Environment Management Plan
EPBC	Environment Protection and Biodiversity Conservation
EPA	Environment Protection Authority
EP Act	Environment Protection Act 1970
FFG	Flora and Fauna Guarantee
GDA	Geocentric Datum of Australia
GEL	Groundwater Extraction License
GHG	Greenhouse Gas
GMA	Groundwater Management Area
Ha	Hectares
HSE	Health, Safety and Environment
ISO	International Organisation fro Standardisation
IWMP	Industrial Waste Management Policies
kg	Kilogram
km	Kilometre
kV	Kilovolt
L	Litre
m	Metre
M	Million
ML	Megalitre

Abbreviations

Abbreviation	Description
MW	Megawatt
N_2	Nitrogen
NATA	National Association of Testing Authorities
NCO	Notifiable Chemical Orders
NO_x	Oxides of Nitrogen
NPI	National Pollution Inventory
O_2	Oxygen
PAH	Polycyclic aromatic hydrocarbons
PCV	Permissible Consumptive Volume
PIW	Prescribed Industrial Waste
PM	Particulate Matter
ppm	Parts per million
PRA	Plume Rise Assessment
QRA	Quantitative Risk Assessment
RET	Renewable Energy Target
SCR	Selective Catalytic Reduction
SEA Gas	South East Australia Gas
SEPP	State Environment Protection Policy
SO_2	Sulphur Dioxide
SRW	Southern Rural Water
SSCR	Safety, Sustainability and Corporate Responsibility
SWL	Sound Power Level
URS	URS Australia Pty Ltd
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WHO	World Health Organisation
WWTP	Wastewater Treatment Plant

1 Introduction

This Works Approval Application has been prepared by URS Australia Pty Ltd (URS) on behalf of AGL Energy Limited (AGL) for the proposed Tarrone power station. URS is an international multi-disciplinary professional services consulting company, with relevant experience in preparing and managing environmental approvals for industrial projects.

AGL is proposing to develop the Tarrone power station in southwest Victoria, approximately 300 km west of Melbourne (Figure 1). The proposed Tarrone power station will comprise an open-cycle gas-fired peaking power station located approximately 23 km north of Port Fairy and a dedicated 8 to 10 km underground gas pipeline from the existing South East Australia Gas Pty Ltd (SEA Gas) Port Campbell – Adelaide pipeline running from the south-east to the north-west. The proposed Tarrone power station will have a nominal capacity of approximately 720 – 920 MW of electricity generation and will be built adjacent to the Moorabool to Heywood 500 kV high-voltage transmission line. The power station and pipeline will have a minimum design life of 30 years.

AGL is proposing to develop the Tarrone power station in two phases. The first stage is expected to involve the installation of:

- two or three E class gas turbines; or
- two F class gas turbines.

Stage 1 construction activities will commence upon the execution of a construction contract, targeted for the fourth quarter of 2010, followed by mobilisation to site and completion, targeted by the fourth quarter of 2012. The timing and choice of turbine combination for the second stage of the project is yet to be determined. Completion of the second stage will result in a final facility configuration of:

- four E class gas turbines, or
- three F class gas turbines.

Under the *Environment Protection (Scheduled Premises and Exemptions) Regulations 2007*, the proposed Tarrone power station will be a scheduled premise and, as such, a Works Approval is required to develop the power station under the EP Act.

This application was prepared in accordance with the Environmental Protection Authority's (EPA) *Works Approval Guidelines Publication 1307 November 2009* and the draft Works Approval Application form.

1.1 Company Details

AGL's company details are listed in Table 1-1.

Table 1-1 Company Details

Company Name:	AGL Energy Limited
Registered Address:	Level 22, 101 Miller Street, North Sydney, NSW 2060 Australia
ACN:	115 061 375

AGL is Australia's largest energy retailer, which includes a significant customer base in Victoria. AGL owns and operates power stations across Australia including traditional energy sources (gas and coal) as well as renewable sources (hydro, wind, landfill gas and biogas).

1 Introduction

AGL owns and operates the Torrens Island power station (South Australia), the largest gas fired power station in Australia. AGL is also the largest private owner / operator of renewable energy assets in Australia. The AGL power development team is responsible for hydro, wind and gas fired power station developments, including the Somerton gas fired peaking power station and the Bogong hydro electric power station, both of which are located in Victoria.

1.2 Contact Details

Table 1-2 lists the contact details for authorised persons at AGL.

Table 1-2 Contact Details - AGL

Authorised person for proponent:	Evan Carless
Position:	Manager Power Development
Postal address:	Locked Bag 1837, St. Leonards, NSW 2065
Email address:	ecarless@agl.com.au
Phone number:	(02) 9921 2214
Facsimile number:	(02) 9921 2401

For any technical queries on the content of this Works Approval Application, refer to contact details for URS listed in Table 1-3.

Table 1-3 Contact Details - URS

Person who prepared application:	Tim Routley
Position:	Senior Principal Chemical Engineer
Organisation:	URS Australia Pty Ltd
Postal address:	Level 6, 1 Southbank Boulevard, Southbank, VIC, 3006
Email address:	timothy_routley@urscorp.com
Phone number:	(03) 8699 7641
Facsimile number:	(03) 8699 7550

1.3 Premise Details

The proposed Tarrone power station is located in the rural locality of Tarrone, in the Moyne Shire Local Government Area, in south-west Victoria (Table 1-4). Refer to Figure 1 for details.

Table 1-4 Premise Details

Premises Address:	Tarrone North Road, Tarrone, VIC, 3283
	Lot 2 on Plan of Subdivision 218923A. Volume-9933 Folio-939
Municipality:	Moyne Shire

Proposed Works

2.1 Project Description

The proposal description is summarised in Table 2-1.

Table 2-1 Proposal Description

Proposal Description
An open-cycle gas turbine peaking power station, comprising up to four turbines, at Tarrone, Victoria.

The project includes the development of the Tarrone power station, an open-cycle gas turbine peaking power plant ultimately consisting of three or four turbines, with an associated substation to connect to the high voltage transmission lines that cross the site, and onsite infrastructure.

The proposed Tarrone power station will be located on Tarrone North Road, approximately 23 km north of Port Fairy, on an approximately 75 hectare battle-axe shaped land parcel that is crossed by the 500kV high-voltage Moorabool – Heywood transmission line. The rural property, currently used for livestock grazing, is generally gently undulating with some evidence of stony rises in the northwest portion of the site. Remnant pine tree plantings are scattered throughout the open pasture. The site is clearly visible from Riordans Road and Landers Lane, as these road reserves are largely bereft of any vegetation apart from grasses.

The proposed Tarrone power station will be supplied with natural gas from the nearby SEA Gas pipeline, a high pressure gas pipeline supplying gas from the Otway Basin to South Australia. There are two underground gas pipeline investigation corridors under consideration to provide a gas supply from the SEA Gas Pipeline to the proposed Tarrone power station:

- an approximately ten kilometre long north-south corridor; and
- an approximately eight kilometre long east-west corridor.

Refer to the Locality Map (Figure 1), Location Plan (Figure 2) for the layout of the proposal and the Site Plan (Figure 3) for details on surrounding land uses.

2.2 Cost of Works and Application Fee

The estimated capital and installation costs for the proposed works (including land purchase) are approximately $600 million for the final facility (Stage 1 costs are estimated to be approximately $400M). The cost of works and associated application fee are outlined in Table 2-2.

Table 2-2 Cost of Works and Application Fee

Cost of Works	Application Fee
$600 million	$52,605

2.3 Proposed Dates

The indicative timetable is provided for the development of the proposed Tarrone power station in Table 2-3.

2 Proposed Works

Table 2-3 Development Timetable

Development Schedule	Earliest Proposed Dates
Finalisation of Concept Design	2009
Approvals	Q2-3 2010
Investment decision – Stage 1	Q4 2010
Commission Power Station – Stage 1	Q3 2012
Power Station Completion – Stage 1	Q4 2012

The proposed Tarrone power station is planned to be built in two stages, the first stage will consist of two or three E or two F class gas turbines and an associated capital cost of approximately $400M. The EPA Works Approval Application is for four E or three F class gas turbines, which will be achieved on completion of stage two of construction. The timing of stage 2 construction and completion will depend on the economic viability in accordance with national electricity market demands.

Approvals

3.1 Need for Works Approval

3.1.1 Environment Protection (Scheduled Premises and Exemptions) Regulations 2007

Under Section 19A of the *Environment Protection Act 1970* ('the EP Act'), a Works Approval is required to construct or install plant or equipment at a scheduled premise where such activity is likely to cause an increase in the waste or noise emitted from the premise or potential danger to the environment. "Scheduled premises" are listed in the *Environment Protection (Scheduled Premises and Exemptions) Regulations 2007.* Under Schedule 1 of these regulations, the proposed Tarrone power station is classified as a scheduled premise as it meets the following descriptions:

K01 premises (Power stations) which generate electrical power from the consumption of a fuel at a rated capacity of at least 5 Megawatt electrical power.

L01 premises which discharge or emit, or from which it is proposed to discharge or emit, to the atmosphere…at least 100 kilograms a day of nitrogen oxides.

L01 premises which discharge or emit, or from which it is proposed to discharge or emit, to the atmosphere…at least 100 kilograms a day of sulphur oxides.

L01 premises which discharge or emit, or from which it is proposed to discharge or emit, to the atmosphere…at least 100 kilograms a day of particles.

L01 premises which discharge or emit, or from which it is proposed to discharge or emit, to the atmosphere…at least 500 kilograms a day of carbon monoxide.

With respect to descriptions L01, it should be noted that the proposed Tarrone power station is a peak load power station and will not operate continuously. However, on days when it does operate, it may exceed the specified emissions threshold.

3.1.2 Works Approval Exemptions

Exemptions from obtaining a Works Approvals are set out in Part 3 of the *Environment Protection (Scheduled Premises and Exemptions) Regulations 2007*. The exemptions state that a premises is excluded from being a scheduled premises and requiring a Works Approval under the following circumstances (only if exempt against all descriptions):

Air Emissions

With respect to emissions to air for a source, other than an incinerator or an afterburner, a works approval is not required for a premises discharging or emitting less than:

- 100kg per day Oxides of Nitrogen; or
- 10kg per day Oxides of Sulphur; or
- 100kg per day Carbon Monoxide; or
- 10kg per day particles (except asbestos and heavy metals); or
- 5kg per day volatile organic compounds except for the emissions of odorous compounds or particles: or
- 0·1 gram per minute of any substance classified as a class 3 indicator in State environment protection policy (Air Quality Management).

3 Approvals

As shown in Section 7.1, and summarised in Table 3-1 emissions to atmosphere are above the criteria and therefore, are not exempt.

Table 3-1 Estimated emissions to atmosphere and works approval emission rate thresholds

Emitted Substance	Source	Emission Rate (kg/day)[1, 2]	Works Approval Emission Rate Threshold (kg/day)[1]	Exempt
Oxides of Nitrogen	Stack	1802 – 2646	100	No
Oxides of Sulphur	Stack	101 - 193	10	No
Carbon Monoxide	Stack	221 - 790	100	No
Particulate Matter	Stack	185 – 260	10	No
Volatile organic compounds	Stack	17.5 – 33.3	5	No
Polychlorinated dioxins and Furans	Stack	0.024 – 0.048[3]	0.1[3]	Yes

Notes:
1. Unless otherwise specified
2. When all generators are operating
3. Expressed in grams per minute

Noise Emissions

With respect to emissions of noise, a Works Approval is not required for a premises that:

- emits less than 80dB(A) sound power level; or
- does not otherwise require a Works Approval.

The sound power level of equipment proposed on site is expected to generate noise emissions greater than 80 dB(A). Therefore, the proposed Tarrone power station is not exempt from the Works Approval process under the *Environment Protection (Scheduled Premises and Exemptions) Regulations, 2007*.

Assessments have been undertaken for noise and emissions to atmosphere to ensure compliance with the Policy Framework.

3.2 Planning and other Approvals

Table 3-2 lists the decisions / approvals required for the proposed Tarrone power station at the Local, State and Commonwealth levels and the status of these approvals.

Table 3-2 State and Commonwealth Approvals

Planning Zone	Act	Type of Approval Required	Approving Authority	Approval / Decision received or pending
Commonwealth	*Environment Protection and Biodiversity Conservation Act 1999*	EPBC Referral - If the project is deemed to be a controlled action, it will require an EPBC Act approval. Otherwise, no approval is required.	Commonwealth Department of Environment, Water, Heritage and the Arts / Minister for Environment	Decision – not a controlled action

3 Approvals

Planning Zone	Act	Type of Approval Required	Approving Authority	Approval / Decision received or pending
State	*Environment Effects Act 1978*	EES Referral - If the Minister for Planning considers the project will have a significant effect on the environment, an EES may be required.	Minister for Planning	Decision – No EES required, subject to one condition
State / Local	*Planning and Environment Act 1987*	Planning Scheme Amendment	Minister for Planning	Pending Decision
State	*Pipelines Act 2005*	Pipeline Licence Application (Alteration to an authorised route)	Department of Primary Industries	Pending Submission
State	*Environment Protection Act 1970*	Works Approval Application	EPA Victoria	Approval Pending
State	*Water Act 1989*	Works on Waterways Permits	Glenelg – Hopkins CMA	Pending Submission
State	*Native Vegetation Management Framework*	Native Vegetation Offset Management Plan and Flora and Fauna Management Plan	Department of Planning and Community Development / Department of Sustainability and Environment	Pending Submission

EPBC Act Referral

A referral was submitted to the Commonwealth Department of Environment, Water, Heritage and the Arts in December 2009 under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*.The Commonwealth Minister for Environment determined on the 5th February 2010 that the proposed action is not a controlled action.

Environment Effects Statement Referral

The Environment Effects Statement (EES) referral process is a statutory process under the *Victorian Environment Effects Act 1978* (EE Act). The EES referral was submitted to the Minister for Planning in December 2009 to determine the need for assessment under the EE Act. The Minister determined on the 2nd February 2010 that an EES is not required for the proposed Tarrone power station project. This decision was subject to the preparation of both a native vegetation offset management plan and a flora and fauna management plan, prior to removal of any native vegetation. The two management plans must be prepared in consultation with the Department of Sustainability and Environment (DSE) and must be to the satisfaction of the Department of Planning and Community Development (DPCD).

Planning Scheme Amendment

The proposed Tarrone power station site is zoned Farming Zone under the provisions of the Moyne Planning Scheme. A planning scheme amendment is required so that the land can be developed and used for power station purposes. The amendment of the Moyne planning scheme to change the Tarrone power station site from Farming Zone to a Special Use Zone (SUZ4) has commenced through consultation with Moyne Shire Council and the Department of Planning and Community Development.

Pipeline License Application

The proposed Tarrone power station project will require an eight to ten kilometre underground gas pipeline lateral to connect the power station to the existing South East Australia Gas Pty Ltd (SEA Gas) Port Campbell to Adelaide gas pipeline. The proponent of the gas pipeline lateral is SEA Gas. Sea Gas is in the process of making an application to the Department of Primary Industries (DPI) for an alteration of an authorised route under the provisions of Division 6, Section 68 of the *Pipelines Act 2005* associated with the existing gas pipeline licence (239).

Works Approval Application

This document constitutes a Works Approval Application and will be submitted to the Statutory Facilitations Department of the EPA.

Works on Waterways Permit

Under the *Water Act 1989*, works or waterways permits will be submitted to Glenelg-Hopkins Catchment Management Authority for the crossing of waterways associated with the east-west gas pipeline alignment, if the east-west alignment is selected.

3.3 Existing Approvals

3.3.1 Tarrone Substation Planning Permit

It is proposed that the Tarrone power station and the Macarthur wind farm will share the same electrical connection point (the 500kV substation) located on the proposed Tarrone site (neither project is contingent on the other). The 500kV substation has already received planning approval (Planning Permit No: PL-SP/05/0283) as part of the Macarthur wind farm project. The limitation of this is that the substation may only be available to the proposed Tarrone power station provided the Macarthur wind farm is developed ahead of the Tarrone power station. However, in the event the Macarthur wind farm does not proceed or is developed after the Tarrone power station, AGL is considering seeking a separate planning permit for the substation so that it doesn't matter which project proceeds and is completed first.

3.3.2 EPA Approvals

AGL currently holds a number of approvals granted by the EPA. These are set out below.

Somerton Gas-fired Peaking Power Station

An EPA licence (EA51148) is held for AGL's gas-fired peaking power station at Somerton.

AGL is registered for and submits annual EREP reports for its operations at Somerton

Symex Holdings

AGL is registered for and submits annual EREP reports for its operations at a gas-fired cogeneration plant on the site of Symex Holdings in Port Melbourne.

3 Approvals

Western Treatment Plant at Werribee

An EPA licence (EA42348) is held for AGL's joint "biogas" generation project with Melbourne Water at Werribee.

Works are currently underway under a formal Works Approval Exemption for the installation of two additional engine generators.

Bogong Power Development

A Memorandum of Understanding (MOU) exists between the EPA and what was Southern Hydro.

AGL holds an EPA licence (SW4097) for a sewerage treatment plant at Bogong Village.

Environment and Community

4.1 Track Record

Environmental Performance Summary

AGL's operations are subject to various Commonwealth, State and Territory environmental laws in relation to energy development, construction and operations. This includes exploration, extraction and production of coal seam methane, liquid petroleum gas production and storage and power generation (natural gas, hydro electricity, biogas, landfill gas, bagasse and agricultural waste).

The AGL Safety, Sustainability and Corporate Responsibility (SSCR) Board committee meets quarterly in order to review the effectiveness of the health, safety and environmental management program. The Audit and Risk Management Board Committee (ARMC) receives 6 monthly reports on environmental compliance matters from across the business. Environmental management and safety performance is audited annually by external auditors. In 2008/2009 the focus in the environmental area was environmental licence compliance. Local health, safety and environment (HSE) LifeGuard committees provide the operational review of HSE matters in the business.

Environmental licence and planning conditions in New South Wales, Victoria, South Australia and Queensland govern all aspects of the management of generation assets.

The AGL goal for excellence in environmental management and performance is underpinned by the management systems, organisational structures and expertise in place to manage its business for sustainable growth.

Therefore, AGL's strategies to reach its environmental goal are to:

- Strengthen and maintain the environmental aspects of the HSE management system;
- Improve employee's capabilities in environmental management; and
- Monitor and manage its impact on land, air and water.

AGL's company values, environmental principles and health, safety and environment (HSE) management system are the main tools used to guide environmental management.

Community Concerns

AGL has a portfolio of approximately 35 power generation assets including wind farms, hydroelectric plants, gas-fired power stations, cogeneration plants and landfill gas capture. In addition, AGL hold exploration and production licences for coal seam gas extraction in New South Wales and Queensland.

From time to time, the communities in the locations where AGL operates have concerns about the impacts of its operations. In the power generation part of the business, this may include general opposition to the construction of wind farms, or noise issues associated with power generation plants. In the upstream gas business, concerns typically centre around noise from well drilling and concern about the impact on aquifers associated with coal seam gas extraction.

AGL is committed to complying with its legal obligations and working with the local communities to co-exist harmoniously. When AGL becomes aware of community concerns in relation to its operations, it works with its stakeholders to try and resolve those issues.

Relevant Offences and Enforcement Actions

The EPA has not taken any environmental enforcement action against AGL or its subsidiaries over the past 3 years.

Further, AGL has not been prosecuted for a "relevant offence", as defined in section 20C of the EP Act, in the past 10 years.

4.2 Key Environmental Considerations

The key environmental considerations for the proposed Tarrone power station are air, noise, and greenhouse gas emissions, surface water and wastewater management.

Air Emissions

The potential emissions to air from the proposed Tarrone power station are the products of natural gas combustion. The major emissions from natural gas combustion in turbines are nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), water vapour, oxides of nitrogen (NO_x), sulphur dioxide (SO_2) and carbon monoxide (CO). The potential impact of air emissions has been assessed and is discussed in Section 7.1.

Noise Emissions

Noise sources associated with the proposed power plant include the main gas turbine generator unit, the stack exit points, the electrical transformers (associated with the generators and substation) and the air inlet ducts. The most significant of these sources will be the gas turbine generator units however noise attenuation measures will be incorporated into the units. The potential impact of noise during plant operation has been assessed and is discussed in Section 7.4.

Greenhouse Gas Emissions

The overall level of energy use and energy related greenhouse gas emissions for the proposed Tarrone power station are linked to the proposed gas consumption, which will occur during the operating hours. Given that peak loading power plants are used at times when additional electricity is required by the grid, the distribution of operating hours can vary significantly from year to year. Based on 440 operating hours per year (5%), emissions to atmosphere of greenhouse gases from the generators have been estimated and are detailed in Section 6.1.

Stormwater Management

Stormwater management will be incorporated into the site EIP that will be developed for the proposed Tarrone power station. Stormwater run-off collected from the hardstand areas will be directed to a retarding basin for regulated discharge to a natural drainage system. Any stormwater impacted by oil from the turbines or transformers will be collected in the bund and transported off-site as prescribed industrial waste. Stormwater run-off from the generator and substation areas will be directed to a sedimentation pond and after settling, water will be discharged to a natural drainage system. Further details on the stormwater management plan are available in Section 9.6.

Wastewater Management

The volume of wastewater that would be generated by the peaking power station will vary depending upon the plant runtime. The main sources of wastewater will be the blowdown from the turbine air inlet cooling system and potentially brine stream from a groundwater desalination plant. The wastewater is proposed to be stored in an on-site evaporation pond, suitably lined to prevent adverse impacts on surface water and underlying soil and groundwater. Wastewater management on-site is detailed in Section 7.2.

4.3 Community Engagement

AGL has developed and implemented a consultation program for the proposed Tarrone power station project. Consultation activities that have occurred for the project to date include the following:

Victorian Government

On-going consultation by AGL has occurred with the Victorian Government and their representative departments since 2008.

Moyne Shire Council Consultation

The Moyne Shire Council (including senior council officers) has been briefed by AGL on the progress of the project in December 2008, January 2010 and March 2010 in order to discuss the development and assess support for the project.

Community Consultation

A Community Information Day was conducted at the Willatook Community Hall on 28 February 2009. The Community Information Day provided information to the community and identified the key issues the community had with the proposed Tarrone power station (Table 4-1). A brochure was also distributed to over 300 members of the community within 5 km of the proposed site outlining the project and addressing key issues.

Table 4-1 Key Community Issues

Issue	No. of Community Households Concerned[1]
Noise emissions	2
Air emissions	5
Property value	2
Traffic safety	3
Fire risk	2
Groundwater	1
Visual impact	1

Notes:

1. Written comments were received from a total of 5 households.

4.3.2 Proposed Community Consultation – Power Station

The following outlines the remaining community consultation phases for the project:

Landowners will be contacted through either/or both of the following ways:

- An additional project brochure will be mailed out to address key concerns that were identified from the Community Information Day and the outcomes of the Commonwealth / State Government(s) decisions; and
- Consultations will be conducted with individual landowners/occupiers of the site.

AGL will continue to consult with the community and relevant stakeholders as the project progresses.

4.3.3 Proposed Community Consultation – Gas Pipeline

In addition to AGL's consultation activities for the proposed Tarrone power station, a separate consultation plan has been prepared by SEA Gas (under the provisions of the *Pipelines Act 2005*) for the gas pipeline lateral. This plan aims to demonstrate how SEA Gas will consult with landowners and occupiers of land prior to and during the construction and operation of the gas pipeline.

The Consultation Plan was approved by DPI on the 17^{th} May, 2010.

4.3.4 Stakeholder Consultation

The proposed Tarrone power station has been discussed with the following agencies:

- Aboriginal Affairs Victoria;
- Commonwealth Department of Environment, Water, Heritage and the Arts;
- Department of Planning and Community Development;
- Department of Primary Industries;
- Environment Protection Authority;
- Moyne Shire Council;
- Department of Sustainability and Environment;
- Glenelg – Hopkins Catchment Management Authority;
- Southern Rural Water; and
- VicRoads.

Process and Best Practice

5.1 Process and Technology

AGL proposes to build a gas-fired peaking power station comprising of either four E class turbines or three F class turbines operating in open cycle mode. Once developed, either turbine configurations will have a development envelope that is contained within the approximately 6 hectare plant area. Electricity will be fed into an associated substation to connect to the high voltage transmission network that crosses the site. The gas turbines will be fuelled by natural gas from an 8 to 10 kilometre long underground gas pipeline connected to the nearby SEA Gas pipeline. The generation plant, substation and associated infrastructure will be contained in an area with a total area of approximately 15 hectares.

The national electricity market is extremely volatile and complex and as a result, the distribution of operating hours can vary significantly from year to year and is difficult to predict. However, the expected operating profile will involve operating for short periods for 200 days per year. On any day that the power station operates, run hours could be less than an hour and up to 24 hours, however will more likely be in the order of 2 – 6 hours. During summer, operation is more likely to occur during the heat of the day, whilst in winter operation is more likely to occur during morning and evening peak periods. Overnight running will be rare and will likely only be required for security of electricity supply. Table 5-1 summarises the key processes and technologies involved with the proposed Tarrone power station.

Table 5-1 Key Processes and Technologies

Inputs	Processes	Technologies	Outputs
Evaporative Cooler			
Water	Groundwater extraction Iron removal / desalination[1]	Iron removal / desalinisation	Low TDS water Brine and Treatment chemicals Iron sludge
	Deliver water to site by road tanker	Depends on supply water quality	
	Evaporative Cooler cycle	Recycle water	Water loss from evaporation
			“Blow down” wastewater to evaporation pond
Air			Cooled air to compressor
Gas Turbine Unit			
Compressor			
Cooled air from evaporative cooler	Compress air prior to combustion		Compressed air
Combustion			
Compressed air	Combustion of gas in air	DLN combustion technology	Exhaust gases
Gas			
Turbines			
Exhaust gases	Expansion of exhaust gases to drive turbines	Exhaust gases pass through silencer unit	Air emissions
			Electricity

5 Process and Best Practice

Notes:
1. Options for water treatment include:
   - iron removal / reverse osmosis desalination,
   - iron removal / demineralisation (ion-exchange),
   - iron removal / EDR desalination, and
   - iron removal

A flow diagram of the key processes, inputs, outputs and controls are illustrated in Figure 4.

The proposed Tarrone power station will consist of the following key components (refer to Figure 3):

Gas Turbine Units

Each gas turbine unit consists of a main engine enclosure housing the turbine and generators, an exhaust stack, and high-voltage electrical transformer. To facilitate combustion conditions, the air is cooled via evaporative cooling and compressed prior to entry into the combustion chamber of the gas turbine. In each gas turbine generator, air is drawn in through filters to remove particulate matter and passes into the compressor section of the gas turbine. In each compressor, multiple rows of rotating blades will raise the temperature and pressure of the air. Following compression, the air is at a pressure of approximately 15 atmospheres. After the compressor, the air flows into combustion chambers arranged around each gas turbine. In these combustors, natural gas is injected and burnt, increasing the temperature to approximately 1200 degrees Celsius.

The combustion gases from the combustion chambers enter the turbine section of the gas turbines and expand to atmospheric pressure, reducing in temperature to around 550^{o}C. As the gas expands, the gases drive the turbine, which in turn drives the compressor and an electrical generator. From the turbine, the heated exhaust gases pass through a silencer unit and are discharged through a stack. The combustors feature Dry Low NO_x technology to produce very low NO_x emissions.

Two open cycle plant configurations are being considered for the ultimate power station layout comprising either four E class turbines or three F class turbines. Exchange rate fluctuations and the availability of new or up-rated models means that selection of the manufacturer and model of plant to be installed is best made at the time it is required and under competitive tender arrangements (Table 5-2).

Table 5-2 Potential Generator Manufacturers and Turbine Models under consideration

Generator Class	E Class		F Class	
Manufacturer	Model	Approximate Power Output (MW/unit)	Model	Approximate Power Output (MW/unit)
Siemens	SGT5-2000E	168	SGT5-4000F	292
GE	9E	126	9FA	256
Ansaldo	V94.2	170	V94.3	294
Alstom	AE13E2	167		
Mitsubishi			M701F4	307

Gas Turbine Generation Components

The individual components within the gas turbine generation units are:

- Main Engine Building containing:
  - Air Intake Filter and Duct, incorporating evaporative cooler;
  - Gas Turbine;
  - Generator; and
  - Auxiliary Block (containing electrical modules and other equipment)
- Exhaust Gas Stack;
- Oil coolers;
- Auxiliary coolers;
- High-Voltage Transformer Enclosure containing:
  - Unit Auxiliary Transformer;
  - Step-up transformer;
  - Generator Bus Duct;
  - Firewall/fence; and
  - Approximately 130 metre internal 132kV transmission line / cable to the 500 / 132 kV electrical sub-station
- Ancillary Plant including:
  - Fuel Gas Skid;
  - Fire fighting Container; and
  - Drain Tank.

Auxiliary Buildings and Plant

The site will include the following ancillary buildings and plant:

- administration building;
- control building;
- security building;
- workshop and store;
- water tanks;
- water treatment facilities;
- balance of plant; and
- gas receiving facility.

The gas supply pipeline discharges into the gas receiving facility that regulates the gas entering the facility. The gas receiving facility is likely to contain the following equipment:

- Gas filtration, heating and pressure regulation equipment, custody transfer, flow control and metering;
- Over pressure protection and emergency venting systems;
- Process control and communications equipment; and
- Header pipeline connecting the gas receiving facility to the power station.

Safety features at the gas receiving facility include automatic shutdown due to low pressure. There will also be manual shutdown at the pipeline off take. The facility will incorporate safety equipment to vent gas from the connecting pipeline if required for maintenance or in an emergency situation.

Gas supply pressure is sufficiently high that an on-site compressor prior to combustion is not required.

Water Tanks

Water tanks will be installed on site including tanks for domestic water (for storing water received from rainwater harvesting), process water (for use in the evaporative cooling system), and fire protection (to supply any fire protection testing or action). Depending on the water source for the process water, water treatment infrastructure may also be present on site, inclusive of additional tanks for pre and post treatment water.

Wastewater Infrastructure

The wastewater infrastructure on site will include a stormwater retarding basin, a stormwater sedimentation pond and an evaporation pond to store and concentrate process water. Sewage will be stored on-site and then transferred and treated off-site. Portable toilets will be transferred to the site for periods of major maintenance.

Hardstand Area

The hardstand areas of the site will include areas for staff and visitor parking, internal access road from Tarrone North Road and equipment laydown areas.

500 kV Substation

The 500 /132 kV substation at the existing 500 kV Moorabool-Heywood transmission line steps up the voltage to 500 kV and feeds the energy into the major transmission line. The substation is to be located immediately beside the transmission line. It contains the necessary equipment to manage supplying the electrical energy into the State's electricity transmission system. The 500 kV transmission line is carried on large lattice towers, approximately 70m above the ground

The substation will include a control building, transformer(s), circuit breaker(s), tubular buswork, landing structures and ancillary equipment for measurement and protection. The 500kV substation will include an earthing system in accordance with IEEE 60080, AS2067 and AS3000. Lightning protection for the substation will be insured using masts and overhead earth wires.

5.1.2 Associated aspects of the project

Gas Pipeline

The proposed Tarrone power station will require a gas lateral pipeline to source natural gas from the nearby SEA Gas Port Campbell to Adelaide pipeline. There are two investigation corridors under consideration for the underground gas pipeline:

- an approximately ten kilometre long north-south corridor that runs adjacent to Landers Lane, crossing Woolsthorpe-Heywood Road and Kangertong Road, terminating at the SEA Gas pipeline approximately 500 metres north of Kangertong Road; and
- an approximately eight kilometre long east-west corridor that follows the site east, then north along Tarrone North Road for approximately 500 metres, then east, north-east to the Willatook Valve Station on the SEA Gas pipeline, crossing Back Creek, Coomete Road and Willatook-Warrong Road.

Upgraded Local Roads

Tarrone North Road from Woolsthorpe-Hamilton Road (C176) to the entrance to the power station site (a distance of approximately six kilometres) may be widened by approximately two metres to accommodate construction traffic.

5.2 Environmental Best Practice

The key aspects of the power station which are particularly important in their adoption of best practice are air emission controls and generator energy efficiency. These are discussed below.

5.2.1 Emission Control Options

The primary pollutants from gas turbines are oxides of nitrogen (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). The gas turbine operating load has a significant effect on the emissions levels of the primary pollutants of NO_x, CO, and VOCs. Gas turbines typically operate at high loads. Consequently, gas turbines are designed to achieve maximum efficiency and optimum combustion conditions at high loads. Controlling all pollutants simultaneously at all load conditions is difficult. At higher loads, higher NOx emissions occur due to peak flame temperatures. At lower loads, lower thermal efficiencies and more incomplete combustion occurs resulting in higher emissions of CO and VOCs.

Other pollutants such as oxides of sulphur (SO_x) and particulate matter (PM) are primarily dependent on the fuel used. The sulphur content of the fuel determines emissions of sulphur compounds, primarily SO_2. SO_x control is thus a fuel purchasing issue rather than a gas turbine technology issue. Particulate matter is a marginally significant pollutant for gas turbines using liquid fuels. Ash and metallic additives in the fuel may contribute to PM in the exhaust. Gas turbines using gas as the fuel filter the gas at the inlet to the combustion chamber. Gas is a cleaner burning fuel producing lower sulphur dioxide, particulates and VOCs compared to coal or liquid hydrocarbons.

The air emissions proposed from the gas turbines are discussed in detail in Section 9.5. The discussion of emission control options in this section focuses on NO_x control technology as NO_x is a potential precursor to the production of photochemical smog. Uncontrolled NO_x emissions from gas turbines are approximately 99 – 430 ppmv[1]. Various emission control technologies to reduce NO_x emissions are discussed below.

5.2.2 NO_x Emission Controls

Water / Steam Injection

This technology involves the injection of steam or water into the flame area of the combustor to lower the flame temperature and reduce thermal NO_x formation. Emissions of NO_x can be reduced to 42 ppm using water or steam injection. In general, water steam injection achieves NO_x emissions of 25 ppm or more. However, this method requires the use of significant quantities of purified water in a climate of water conservation. Considering water conservation and purification costs with the limited NO_x reduction of water / steam injection and the application of this technology for the proposed Tarrone power station is not proposed.

[1] Alternative Control Techniques Document— NOx Emissions from Stationary Gas Turbines. Emission Standards Division. U.S. Environmental Protection Agency. EPA-453/R-93-007. January 1993.

Dry Low NOx (DLN) Combustors

In conventional combustors, fuel is injected into the combustor and ignited in compressed air. No opportunity exists for generation of a complete homogenous air-fuel mixture before combustion. DLN combustor technology involves premixing of air and a lean fuel mixture that significantly reduces peak flame temperature and thermal NO_x formation. NO_x emissions from power stations that have implemented DLN technology range from 9 ppm to 25 ppm depending on the plant and operating conditions. Gas turbine manufacturers guarantee emissions of 25 ppm when power stations are operating above a specified minimum load. DLN technology will be implemented at the proposed Tarrone power station. This is the nominal level of NO_x control applied to open cycle gas power stations in Victoria and Australia.

Catalytic Combustion

In catalytic combustion, fuel oxidises under lean conditions in the presence of a catalyst. Catalytic combustion is a flameless process, allowing fuel oxidation to occur at temperatures where NO_x formation is low. Catalytic combustion reduces NO_x emissions to 3 ppm however the development of catalytic combustion for gas turbines greater than 15 MW has not yet been commercialised. This technology would not be suitable for the proposed Tarrone power station as each of the turbines would be well in excess of 100 MW.

Selective Catalytic Reduction (SCR)

Selective catalytic reduction (SCR) is a post-combustion NO_x control method. Ammonia is injected into the flue gas and reacts with NO_x in the presence of a catalyst to produce N_2 and H_2O. The SCR system is located in the exhaust path where the temperature of the exhaust gas matches the operating temperature of the catalyst. SCR reduces between 80 to 90% of the NO_x in the gas turbine exhaust, depending on the degree to which the chemical conditions in the exhaust are uniform. When used in series with water / steam injection or DLN combustion, SCR can result in low single digit NO_x levels (2 to 5 ppm). However, ammonia can “slip” through the process unreacted (known as ammonia slip) and requires on-site storage of ammonia, a hazardous chemical.

When operated in simple cycle mode, the use of high temperature SCR or dilution to air is required to reduce exhaust temperature. SCR is generally not applied to the large frame turbines in open cycle mode due to the high temperature mode of operation. It is technically feasible to use high temperature SCR technology but to date this has only been successfully implemented on turbines less than 50 MW in size, with exhaust temperatures of approximately 350 degrees Celsius. This is achieved by mixing the high temperature exhaust with fan forced cool air and often water to reduce the temperature at the SCR to within the operating limit of the catalyst used. Given these limitations to SCR, the technology would not be suitable for implementation at the proposed Tarrone power station.

5.2.3 Energy Efficiency

Effects of Ambient Conditions on Performance

The ambient conditions under which a gas turbine operates have a noticeable effect on the power output. At elevated inlet air temperatures, the power decreases. The power decreases due to the decreased air flow mass rate (the density of air declines as temperature increases). Conversely, the power increase when the inlet air temperature is reduced. At inlet air temperatures of near 38°C, power output can drop to as low as 90% of ISO-rated power for typical gas turbines.

At cooler temperatures of about 4 to 10°C, power can increase to as high as 105% of ISO-rated power. ISO-rated power refers to the power rating of the turbine at an ambient temperature of 15 °C, relative humidity of 60% and ambient pressure at sea level.

The density of air decreases at altitudes above sea level. Consequently, power output decreases with an increase in altitude. The Tarrone site is approximately 80m above sea level.

The region encompassing the proposed Tarrone power station experiences moderately warm summers with average daytime temperatures around 25°C, with occurrences of hot conditions to a maximum recorded temperature of 46°C. Average daytime winter temperatures are approximately 13°C with recorded night time minimums reaching lows of approximately -5°C. Therefore, in summer during peak electricity demand, high day time temperatures would reduce the power output of the gas turbines.

The Tarrone site is considered to be an appropriate site for gas turbine performance and efficiency. The site is close to sea level and is not dissimilar with respect to temperature ranges to other locations with access to suitable gas supplies and electricity transmission.

Performance and Efficiency Enhancements

Inlet Air Cooling

The decreased power of gas turbines at high ambient temperatures means that gas turbine performance is at its lowest at the times power is often in greatest demand and most valued (in the local context). Cooling the air entering the turbine by 4 to 10°C on a hot day can increase power output by approximately 1 to 3%. The decreased power resulting from high ambient air temperatures can be mitigated by inlet-air cooling, including evaporative cooling.

Water flows over baffles and air is drawn into the gas turbine inlet through the baffles. The air is cooled by evaporation as it passes over the baffles. Evaporation of the water reduces the temperature and increases the density of the air, allowing the gas turbine to operate at a higher output. After traversing the baffles the remaining water is collected in a sump and then recycled to the top of the baffles. Water is continually added to replace the evaporated water.

As water evaporates there is an increase in the concentration of dissolved salts. To control the salt concentration and to prevent scaling of the system (precipitation of salts), some water is continually bled off or ‘blown down’ from the sump. The blow down rate is adjusted to keep the concentration of dissolved salts below the threshold for scaling to occur. The blow down water is collected in a pond and left to evaporate.

The water requirements for evaporative cooling of E and F Class generators are presented in Table 5-3. These figures demonstrate the maximum quantities of water required, which would coincide with maximum operating capacity during hot summer weather with low humidity. Actual water consumption would vary based on actual weather conditions.

Table 5-3 Water Demand Requirement for E and F Class Generators

Water Demand Source	Approximate Water Demand Requirement for Operation at Maximum Capacity (kL/hr)[3]			
	Per E Class turbine[1]	Total (4 E Class Turbines)	Per F Class turbine[2]	Total (3 F Class Turbines)
Evaporation	7.5	30	8.8	26.4
Blow down	1.9	7.6	2.2	6.6
Make up	9.4	37.6	11	33
Recirculated	13.1	52.4	15.3	45.9

Notes:
1. Sourced from Leafs Gully water demand requirements
2. Make up volume sourced from GT Pro software package with the remaining water demand amounts calculated as a ratio from the E Class data.
3. The above water consumption only applies at times when evaporative cooling is in operation. The evaporative cooling typically runs during times of high temperature and low humidity.

Evaporative cooling of inlet air to the gas turbine will enable increased power generation output at the proposed Tarrone power station.

During the tendering process, some additional/alternative energy enhancement options including wet compression and fogging will also be considered.

5.2.4 Noise Mitigation

Noise emissions from turbine generators are inherently relatively high, and are generally attenuated to reduce noise levels. An appropriately high level of noise mitigation has been adopted by AGL for this project to ensure that the operating plant does not degrade the existing acoustic environment, nor cause annoyance to the community surrounding the plant.

Noise mitigation measures for the primary components of the proposed gas turbines are:

- acoustic enclosure of turbine compartments consists of two layers of 2 mm thick steel outer plate, 75 mm thick rockwool insulation and perforated steel inner plate
- acoustic enclosure of exhaust diffusers consists of two layers of 4 mm thick steel outer plate, 150 mm thick rockwool insulation and 4 mm thick steel inner plate
- silencing on the inlet system via an 8 foot long parallel acoustic baffle

These noise mitigation measures exceed the default ‘standard measures’ and are considered best practice for peaking turbine generators.

5.2.5 Systems and Procedures

AGL has strong operating systems and procedures in place through its health, safety and environment (HSE) management system and over-arching set of environmental principles based on continual improvement. These systems and procedures enable AGL to achieve best practice in environmental management.

5 Process and Best Practice

HSE Management System

AGL's HSE management system is based on ISO 14001 and assists AGL to proactively manage environmental risks and compliance issues, define environmental responsibilities, and measure and benchmark our environmental performance.

AGL's Environmental Principles

Compliance

AGL will meet or exceed statutory obligations and relevant codes of conduct and its internal standards.

Monitoring, Reporting and Communication

AGL's environmental performance measurement and reporting will be consistent with recognised national and global reporting standards.

AGL will apply the assurance and verification principles of materiality and completeness and responsiveness when measuring, monitoring and reporting environmental performance.

Impact Minimisation

AGL will reduce risk to the environment and minimise our environmental impact, by integrating considerations of environmental sustainability in all activities.

Key considerations for AGL and its stakeholders in minimising environmental impact include pollution prevention, promotion of waste minimisation, reuse and recycling, the efficient use of resources such as water and energy and protecting cultural heritage.

AGL will provide products, services and information to help customers make informed energy choices to benefit their home, business and the environment.

Contractors and suppliers are expected to demonstrate consistency with AGL's approach by fulfilling their environmental responsibilities.

Climate Change and Renewables

Consistent with business objectives and AGL's Greenhouse Gas Policy, AGL will work in consultation with its external stakeholders to improve greenhouse gas emission outcomes.

Stakeholder Engagement

AGL will provide leadership and actively participate in the policy debate on energy and environmental matters. AGL will engage with government, industry and community, its employees and other stakeholders about how to achieve sustainability in the energy sector.

AGL's employees are encouraged to contribute to improving AGL's environmental performance.

AGL will aim to build knowledge, capability and understanding of environmental management issues for its employees.

5.3 Integrated Environmental Assessment

Water Sources

The three potential options available to AGL for the supply of process water to the proposed Tarrone power station are set out below. In considering each option, it should be noted that the process water that will be used for the evaporative cooling system must be of a certain quality (refer to Section 9.2.2).

Options

- extracting and treating groundwater;
- road tankering in water (the quality of which will dictate pre-treatment needs); or
- connecting to the Port Fairy recycled water treatment plant which has been proposed as part of the Shaw River power station project (this option will be subject to that project proceeding). The indicated quality of this recycled water[2] is such that it is unlikely to require further treatment at Tarrone Power Station prior to use.

All three options are currently being considered by AGL and have been addressed in this Works Approval Application.

Extracting and Treating Groundwater

Groundwater extracted from a bore on-site is expected to contain elevated levels of total dissolved solids (TDS) and iron, rendering it of insufficient quality to be utilised directly in the evaporative cooling system without prior treatment. Treatment options for groundwater include:

- Iron removal via aeration, coagulant / flocculant dosing and multimedia filtration, followed by:
- Electrodialysis reversal (EDR); or
- Reverse osmosis (RO); or
- Ion-exchange.

Each of these water treatment systems is considered “best practice”. Notwithstanding, each will generate a waste stream that requires management. Given that the evaporative cooling system is estimated to require about 8.3 ML/annum of water (assumed 220 hr annual runtime for evaporative coolers), of the order of 12, ML/annum of groundwater would require treatment, which may involve iron removal and desalination.

Under this treatment system 4.8 ML/annum of wastewater would be generated and directed to an evaporation pond on-site for concentration. Periodically, the evaporation pond residue would require transportation off-site as prescribed waste for appropriate further treatment and/or disposal.

Treatment of groundwater on-site would increase the complexity of the plant design and layout, specifically to the design of the evaporation pond and to the storage and use of chemicals on-site.

Road Tankering in Water

Tankering in water would eliminate or reduce the need for and/or complexity of pre-treatment, depending upon the quality of the water available relative to that required for direct use in the evaporative cooling system. The additional environmental issues (i.e. air / noise emissions, road maintenance and safety) associated with increased traffic to the site from regular water deliveries would need to be considered.

[2] Wannon Water 2010, *Works Approval Application Port Fairy Recycled Water Treatment Plant (To Supply the Proposed Shaw River Power Station)*, prepared by GHD for Wannon Water

Supply from the Port Fairy Recycled Water Treatment Plant

The use of piped recycled water from the Port Fairy recycled water treatment plant is dependent on the Shaw River power station project proceeding. It is likely that the water from this source would be suitable for direct use at Tarrone.

Evaporative coolers

At high ambient temperatures there is a proportional decrease in the power and efficiency of gas turbines. This means that gas turbine performance is generally at its lowest at the times power is often in greatest demand and most valued. Cooling the air entering the turbine by 4 to 10°C on a hot day can increase power output by approximately 1 to 3%. The decreased power resulting from high ambient air temperatures can be mitigated by inlet-air cooling through evaporative cooling.

This increase in energy output during times of high ambient temperatures is gained through an increase in water consumption. To gain approximately 1 – 3% more power output, 4 E Class or three F Class turbines would consume 33 – 38 kL/hour of water (excluding additional water that might be consumed in possible pre-treatment, respectively. Throughout the cycle of evaporative cooling, 26.4 - 30 kL/hour is lost to evaporation and 6.6 – 7.6 kL/hour is removed via “blow down”, to reduce the concentration of dissolved salts in the circulating water. This is considered best practice.

In addition (or as alternatives) to evaporative coolers, other power augmentation technologies will be considered that use water to increase gas turbine power output, such as wet compression and fogging. The use of these technologies will require water, though the amount has not been quantified at this stage however it is expected to be of the same order as for evaporative coolers, with a similar quality requirement.

NO_x Emission Control

DLN combustor technology involves premixing of air and a lean fuel mixture that significantly reduces peak flame temperature and thermal NO_x formation. DLN technology can be implemented with no additional water use requirements and provides superior NO_x control. This is an application of best practice.

5.4 Choice of Process and Technology

Plant size, frame size, MW per area of footprint, energy efficiency and capital cost per MW were determined by:

- analysing the requirement for total installed capacity in the market;
- the availability of gas at site;
- the availability of electricity transmission capacity; and
- the economic unit size.

Gas turbines are generally the sole technology used for peaking applications where power is required at short notice for limited periods. The only other technology that is commonly used for peaking is hydro electricity for which there is little or no additional capacity potential in mainland Australia. AGL’s recently commissioned 140 MW Bogong hydro peaking plant is the largest hydro installation to be constructed in mainland Australia during the past 25 years. Gas turbines are used for peaking power in all Australian mainland states.

5.4.1 Gas Turbines

Open cycle gas turbines using natural gas as the main fuel source were selected as the best option for the proposed Tarrone power station as they represent the best practice technology for peak load operations. Industrial or frame (E Class and F Class) are the preferred options for the proposed Tarrone power station given their ability to meet peak load demand. The turbines are required to be placed in service rapidly, handle intermittent operation, tolerate a high number of starts and stops, and be reliable. E Class and F Class turbines will meet these requirements and are therefore suitable for the proposed Tarrone power station.

5.4.2 Emissions Technology

As discussed in Section 5, dry low NO_x emission control is the preferred technology as it is regarded as current best practice[3] for controlling NO_x emissions from gas-fired power stations. Continual development of the E and F Class gas turbines has resulted in further improvement in the energy efficiency of modern gas turbines, particularly in regard to heat rate. Modern and efficient E and F Class gas turbines have been selected from several market-leading manufacturers for consideration.

5.5 Choice of Location and Layout

5.5.1 Location of Proposed Works

The proposed Tarrone power station will be located in the rural locality of Tarrone, in the Moyne Shire Local Government Area, in south-west Victoria. The site has been nominated for the proposed Tarrone power station due to its proximity to critical electricity and gas infrastructure and the suitable distance of the site from the nearest residences.

It is proposed that a 500kV electrical sub-station will be located on the Tarrone power station site to connect the power station to Victoria's electricity grid through the high-voltage Moorabool-Heywood transmission line that crosses the site. The substation will also service the proposed Macarthur wind farm (should that project proceed).

An underground gas pipeline will provide a connection to the nearby high-pressure SEA Gas pipeline (Port Campbell – Adelaide). The gas can be supplied at the pipeline pressure without the need for additional compression.

The site is relatively isolated providing adequate buffers, with the nearest residence approximately 1500 metres to the north-east. The site plan is located in Figure 3.

Power Station Site

The power station site is located within an approximately 75 hectare battle axe land parcel with a western frontage to Landers Lane, Tarrone and a southern frontage to Riordans Road, Tarrone. A narrow on title access (battle axe handle) extends from the north-east corner, east to Tarrone North Road. The Australian Map Grip (AMG) (Geocentric Datum of Australia (GDA) 94) coordinates of the power station site are listed in Table 5-4.

[3] Environment Protection Authority Western Australia. *Guidance for the assessment of environmental factors. Guidance Statement for Emissions of Oxides of Nitrogen from Gas Turbines*. No.15. May 2000.

Table 5-4 Coordinates of the Power Station Site

Point	Easting	Northing
North-west corner	602889	5773985
South-west corner	603697	5773979
South-east corner	603692	5773158
North-east corner	602863	5773159
Eastern end of battle axe handle	604623	5773956

Development within the power station site will consist of the power station area, a 500 kV substation and auxiliary onsite infrastructure with a total developed area of approximately 15 hectare, as shown in Figure 3 and described below.

Power Station Plant Area

The main power station plant would be developed within an approximate 5 hectare development footprint in the north-west corner of the overall site area. The AMG coordinates of the plant area are listed in Table 5-5.

Table 5-5 Coordinates of the Power Station Plant Area

Point	Easting	Northing
North-west corner	602879	5773928
South-west corner	602956	5773761
South-east corner	603099	5773684
South corner	602956	5773683
North-east corner	603099	5773928
West Corner	602881	5773761

500kV Substation

The 500kV substation will be developed within an approximate 7 hectare footprint adjacent to the power station plant area and the high voltage transmission line that crosses the site. The AMG coordinates of the substation are listed in Table 5-6.

Table 5-6 Coordinates of the Substation Area

Point	Easting	Northing
North-west corner	603226	5773681
South-west corner	603258	5773573
South-east corner	603469	5773636
North-east corner	603433	5773740

Auxiliary Infrastructure

Auxiliary infrastructure including an access road from Tarrone North Road, site buildings (including office, control room, workshop, amenities), water treatment facilities, stormwater and evaporation ponds and construction laydown areas will be developed on the site as shown on Figure 3 with a total footprint of approximately 3.6 hectares.

5.5.2 Land Ownership

The proposed Tarrone power station site and majority of the gas pipeline corridors are privately owned freehold land. The gas pipeline investigation corridors associated with the Tarrone power station cross the road reserves of Heywood-Woolsthorpe Road, Kangertong Road, Tarrone North Road, Coomete Road and Willatook-Warrong Road, which are Crown land. The east-west gas pipeline investigation corridor crosses Tarrone North Road, Coomete Road and Willatook-Warrong Road. The north-south gas pipeline investigation corridor crosses Heywood-Woolsthorpe Road and Kangertong Road.

An easement associated with the Moorabool-Heywood high-voltage transmission lines crosses the site. The easement would be modified to allow for the 500kV electrical sub-station. There are currently no native title claims on the site at the date of this application.

AGL intends to purchase the freehold power station site after obtaining the necessary government approvals.

5.5.3 Existing Site Land Use

The proposed power station plant area is located in the north-west corner of the rural site, which is currently used for livestock grazing, between the substation to the east and Landers Lane to the west. The 5 hectare power station plant area is approximately 225 metres long (north to south) and approximately 210 metres wide (west to east) located close to the northern and western site boundaries.

The only existing development on the site is the pylons associated with the Moorabool-Portland high-voltage transmission line.

5.5.4 Land Zoning

The site is currently used for livestock grazing and is categorised as a Farming Zone (FZ) under the provisions of the Moyne Planning Scheme. Adjoining land is also classified as a Farming Zone.

5.5.5 Surrounding Land Use

Adjoining Land Use

The land use adjoining the proposed power station site and pipeline corridors is agricultural, mainly used for grazing cattle and sheep.

Proximity to Residences and Urban Centres

There are seven houses within approximately two kilometres of the peaking power station site, the closest being approximately 1500 metres to the north-east.

The proposed Tarrone power station site is located approximately seven kilometres north-east of Orford, seven kilometres west of Willatook, 15 kilometres south-west of Hawkesdale, 16 kilometres north-west of Kirkstall. The residences are identified on the location plan in Figure 2.

Road Access

The proposed Tarrone power station site adjoins Landers Lane on the western boundary, Riordans Road on the southern boundary and has on title access to Tarrone North Road to the east. Tarrone North Road is a sealed road that provides access to Heywood-Woolsthorpe Road (C176). Road access to the site would be from Tarrone North Road.

Infrastructure

The proposed Tarrone power station site has been chosen due to its proximity to the junction of the high-voltage Moorabool-Heywood transmission line and the high pressure SEA Gas pipeline, with electricity and gas connections from the Tarrone power station being included within the project. However, there is currently no water supply or sewerage infrastructure in the area that could be utilised by the peaking power station for water supply.

5.5.6 Site Selection

AGL has selected the Tarrone site due its proximity to the SEA Gas Pipeline and the Moorabool-Heywood high-voltage transmission line.

The chosen site will allow AGL to access gas from the existing SEA Gas Port Campbell to Adelaide gas pipeline. Minimising extensions to gas pipelines is a key consideration due to cost and environmental impact, and therefore a site within close proximity to the pipeline was selected. Minimising the length of gas lateral required to connect to the site is another key consideration.

The power station development area within the site has been selected because it offers the greatest buffers to the nearest residences and is adjacent to the high voltage Moorabool-Heywood transmission line. Furthermore, there is the potential for the proposed Tarrone power station to share the 500 kV substation infrastructure with the Macarthur wind farm.

Prior to selecting the Tarrone site, AGL considered various other locations in Victoria. However, the only existing transmission line in Victoria with capacity to accommodate the requirements of the proposed power station is the Moorabool-Heywood transmission line.

Resources

6.1 Carbon

6.1.1 Greenhouse Gas Emissions

The annual operating hours for gas fired peaking power stations can vary significantly from year to year as they are used at times when additional electricity is required by the grid. The national electricity market is extremely volatile and complex. Peak loading power plants are used at times when additional electricity is required by the grid, such as during hot summer days or cold winter mornings and evenings. As a result the distribution of operating hours can vary significantly from year to year. It is difficult therefore to predict with certainty when the plant will be operating and for how many hours. Typically, however, the annual operating hours are expected to be approximately 5% (440 hours).

At a 5% usage rate, the expected gas and electricity consumption would result in the emission of between 150,000 - 200,000 tonnes of carbon dioxide equivalent per year for the amount of gas consumed. From time to time, it is possible that the power station may operate in excess of this level due to circumstances such as drought years where availability of electricity generated from hydro and coal generators are reduced. In future years, it is also possible that operating hours may increase due to the introduction of climate change legislation. However, sustained increases in demand for gas fired generation would likely be met by newly built combined cycle gas turbine power stations at other locations. In any event, increased operation of the gas fired peaking power station will most likely be displacing generation from a generator with higher intensity carbon emissions (e.g. Victorian brown coal fired power stations).

Refer to Section 9.1 for additional details on greenhouse gas emissions and carbon management.

6.1.2 Electricity Usage

Peaking power stations are significant net electricity generators, but also use a relatively small amount of grid electricity, and a very small proportion of the electricity generated. The grid electricity is required for a range of plant and equipment operating when the turbines aren't generating including general lighting, control systems, building heating (if electric) and cooling, gas turbine starter motors, oil recirculation pumps, compartment ventilation fans and lighting, water treatment plant power and water distribution pumping. The small proportion of generated electricity that is consumed is associated solely with generator equipment including gas turbine shell exhaust blowers, cooling fans, and cooling water recirculation pumps. Based on the electricity usage of the similar Somerton Peaking Power Station, the total electricity consumed by the plant (grid and self-generated) would be expected to represent of the order of 2% (or less) of the net electricity generated.

Refer to Section 9.1 for additional details on electricity usage.

6.2 Water

It is anticipated that the proposed Tarrone power station will require approximately 10 - 15 ML of water per year. During operation water will be used on site for:

- process water;
- maintenance of equipment;
- fire services;
- domestic use; and
- landscaping.

Three options for the provision of water supply are being investigated, including:

- groundwater extraction;
- transport of water by licensed carrier and water tanker to site; and
- use of recycled water piped to site.

Refer to Section 9.2 for additional details on water usage and water management on-site.

6.3 Solid Waste

During operation small quantities of solid wastes may be generated during maintenance activities, primarily metal scrap, rags, air and oil filters. A very small amount of solid office waste may also be generated. Quantities of domestic / office waste have been estimated based on the number of operators on site. The site will typically by manned 8 hours per day Monday to Friday by up to five permanent staff on site. During minor maintenance periods up to 10 contractors may be present for 5 days every 2-3 years and during major maintenance periods up to 50 contractors may be present for 2 months every 6-7 years.

All solid wastes generated on site will be collected by maintenance personnel or contractors for disposal. Waste will be segregated and recycled where appropriate (e.g. paper, metal etc) and non-recyclable wastes will be transported to municipal landfill. Based on the above information an estimate of 5 tonnes per annum of solid waste in the form of metal scrap, rags, air and oil filters, domestic waste, paper has been proposed for the Tarrone power station. Given the amount of solid waste estimated will not exceed the 100 tonne/year threshold solid waste will not be addressed in more detail in this application.

6.4 Prescribed Industrial Waste

It is anticipated that the proposed Tarrone power station will produce approximately 3 tonne of solid / oily prescribed waste and 37 kL of liquid prescribed waste per year. Liquid and solid prescribed waste produced during operation can be classified as:

- Oil and oily waste;
- Possible water treatment waste;
- Turbine wash water;
- Evaporation pond waste; and
- Septic sludge and chemical containers.

Refer to Section 9.4 for additional details on solid and liquid prescribed waste production and management on-site.

Emissions

7.1 Air

The majority of emissions to air arising from the proposed Tarrone power station will originate from the combustion of natural gas in the gas turbines for the purposes of electricity generation. The major emissions from natural gas combustion in turbines are:

- nitrogen (N_2);
- oxygen (O_2);
- carbon dioxide (CO_2);
- water vapour;
- oxides of nitrogen (NO_x);
- sulphur dioxide (SO_2); and
- carbon monoxide (CO).

Water vapour will be the only visible emission. Small quantities of polyaromatic hydrocarbons (PAHs) and Volatile Organic Compounds (VOCs) will also emitted by the turbines.

Refer to Section 9.5 for additional details on air emissions, air emissions management and impacts on air quality.

7.2 Discharge to Surface Water

7.2.1 Stormwater

Ultimately, the site resides within the catchment of the Moyne River, as verified by the Glenelg Hopkins Catchment Management Authority (CMA) catchment mapping[4]. Existing onsite drainage consists of sub-catchments that feed into open drains. Water drains from the north and north-east towards the south-west, and is collected in an open drain, that flows from the north-west corner of the site to the south and exiting the site in a culvert (2 x 600 RCP) under Riordans Road. This drain also collects water from the catchments to the north of the site. An additional drain exists in the south-east corner of the site directing water from east to west, to the same culvert under Riordans Road. Runoff from the site beyond Riordans Road is expected to flow towards the Moyne River most likely via the ephemeral stream Back Creek, passing about 1.1 km to the east of the site (as shown in Figure 2). Back Creek flows south into the Moyne River at a point about 7.5 km to the south of the site. Other than in significant storm events, it is unlikely that stormwater runoff from the site would reach this receiving water, and would normally be lost by infiltration and evaporation.

To the extent practicable, the proposed stormwater management regime for the Tarrone Power Station will be designed to maintain the existing stormwater flow regime on the site, whilst manage potential impacts on stormwater discharge quality. Once the power station is developed, the site runoff will consist of:

- Runoff from areas with low or no potential to impact on stormwater quality are expected to pass through a retarding basin prior to offsite discharge;
- Runoff from hardstand areas are expected to be discharged to a sedimentation pond prior to offsite discharge;
- Turbines, transformers and chemical storages will be bunded and stormwater will only be discharge to the sedimentation pond if confirmed to be un-impacted (i.e. oil free), otherwise the water will be educated and disposed of offsite to an appropriately licensed facility as prescribed waste; and
- Some building roof water that may be collected for use on site.

[4] http://www.glenelg-hopkins.vic.gov.au/?id=onlinemapping

The catchment runoff will be diverted around the site using perimeter swale drains and directed into the existing drain. Swale drains are proposed as they provide treatment for runoff. The proposed stormwater management system is shown in Figure 6.

The site is located in the Murray and Western Plains Segment of the *State Environment Protection Policy (Waters of Victoria)* [SEPP(WoV)]. The protected beneficial uses of waters in the Murray and Western Plains Segment are nominated in the SEPP(WoV). The corresponding water quality objectives and indicators nominated in the SEPP(WoV) for " lowlands of the Glenelg & Hopkins catchments, & Portland, Corangamite and Millicent Coast Basins" are the applicable quality criteria for the receiving environment.

Refer to Section 9.6 for additional details on stormwater management.

7.3 Discharge to Land

No discharge to land and/or groundwater is proposed at the site. A wastewater evaporation pond will be appropriately lined and all turbines, transformers and chemical storages will be within concrete bunds to prevent discharge of any wastes to land/groundwater. No surface water irrigation will occur on-site and no solid waste will be discharged to an on-site landfill. The only water reuse that will be considered is collection of roof runoff for direct industrial water use.

There have been no investigations of soil and/or groundwater quality beneath the site. A review of the regional hydrogeology, discussed in Section 9.2.7, indicates that the total dissolved solids (TDS) concentration of the groundwater beneath the site would be expected to be in the range 850 mg/L to 2000 mg/L (refer to Table 9-4). The corresponding groundwater segments of the applicable *State Environment Protection Policy (Groundwaters of Victoria)* SEPP(GoV) are B (most likely) or A2. The protected beneficial uses of waters in these segments are nominated in the SEPP(GoV). The corresponding groundwater quality objectives and indicators nominated in the SEPP(GoV) for the relevant segment are the applicable quality criteria.

Refer to Section 9.7 for additional details on proposed measures to prevent impacts on land and/or groundwater.

7.4 Noise Emissions

The sound power levels (SWL) of equipment that have been identified as the primary on-site noise sources have been provided by AGL in octave frequency bands (between 31.5 Hz and 8 kHz). These levels for the F Class plant configuration option represent the noisiest types of engine and transformer/substation configuration which could be selected for each of the two different facility configuration options (namely the E and F Class options) and thus represent worst case scenario. The noise modelling has been conducted based on likely maximum operating conditions. All pre-defined sources were positioned according to the proposed site layout in the respective noise model. The precise positioning of the sources was not found to cause any significant uncertainty.

Refer to Section 9.8 for additional details on noise emissions, noise emissions management and noise impacts on the surrounding environment.

Environmental Management

8.1 Non-routine Operations

A Quantitative Risk Assessment (QRA) was prepared by Planager (2010) for the proposed Tarrone power station to identify potential process upsets or failures and determine the risk associated with handling potentially hazardous material.

The main hazard associated with the proposed Tarrone power station is the handling of natural gas, which is a flammable gas held under pressure. Hazards may arise within the plant area. The incidents likely to occur on-site have been derived from historical incidents at similar facilities. From this information it was determined that a leak is the predominant mode in which a hazardous incident may occur. This would generally only have the potential to cause injury or damage if there was ignition, which resulted in a fire or explosion incident.

The QRA reports that the risk to the community does not extend beyond the power station site boundary. Therefore, there are no requirements for restriction to residential development outside of the site. The risk associated with the transport of dangerous goods and potentially hazardous material to the site is negligible.

8.1.1 Monitoring

AGL proposes to conduct environmental monitoring when the plant is first operational (i.e. during commissioning). The purpose of this monitoring is to confirm that the generators are operating as claimed, particularly with respect to air and noise emissions.

Air emissions from each generator will be monitored under standard operating conditions. Sampling and analysis of stack emissions will be undertaken twice, by a NATA accredited laboratory. Sampling points installed in each stack will be in accordance with the requirements of EPA Publication No. 440. The actual emissions will be modelled to confirm the conclusions of the air impact assessment (refer to Section 9.5). The proposed analyte suite will comprise many of the parameters that are required to be reported under Category 2b of the National Pollution Inventory (NPI) reporting requirements.

The proposed analyte list is as follows:

- temperature;
- moisture;
- carbon dioxide;
- carbon monoxide;
- oxides of nitrogen;
- sulphur dioxide;
- particulate matter (less than 10 μm);
- total VOC's; and
- PAH's.

Noise monitoring will be conducted twice to confirm the predictions of the noise impact assessment (refer to Section 9.8).

AGL does not believe that any further or ongoing monitoring for either air or noise is necessary since once commissioned, the emission characteristics of gas turbine generators typically do not change significantly.

8.2 Separation Distances

Buffer distances are required to safeguard sensitive receivers from the potential effect of air discharges from unintended or accidental emissions (e.g. spills, equipment failure). The *Recommended Buffer Distances for Industrial Residual Air Emissions published by the EPA (AQ 2/86, July 1990)* provides buffer distances for a number of industry types.

A recommended buffer distance for gas-fired power generation sites, like that proposed at Tarrone, is not provided in the guidelines. The location of the proposed Tarrone power station is approximately 1500m from the nearest sensitive receivers. In addition, the operational systems in place at the proposed Tarrone power station are expected to minimise the risk of any unintended or accidental emissions, and as such there will be no off-site effects associated with the operation of the power station.

8.3 Management System

8.3.1 Construction Phase Environmental Management

AGL will ensure that all contractors involved in the construction and pre-commissioning phase of the project will operate in accordance with an environmental management plan (EMP). The Principal Contractor will be required to develop a construction phase EMP in accordance with the conditions prescribed by AGL. The Principal Contractor's EMP will be subject to approval by AGL prior to commencement. It will also be provided to the EPA for approval if required by the Works Approval. AGL will establish an audit program to monitor compliance with the plan. The EMP will provide a framework of policies and procedures to assist in the "day to day" management of environmental issues during construction of the facility.

For the Tarrone site, these environmental issues will include:

- dust control;
- noise emissions from vehicular and plant activity;
- stormwater management;
- sediment control;
- spill control and management;
- waste management; and
- management of onsite chemicals.

The construction phase EMP will ensure application of the EPA's *Environmental Guidelines for Major Construction Sites (Pub 480 Feb 1996)* and other relevant EPA guidelines. A temporary Concrete Batching Plant may be operated on site during the construction phase. This will be operated in accordance with the EPA's *Environmental Guidelines for the Concrete Batching Industry (Publication 628, June 1998).*

8.3.2 Operations Phase Environmental Management

AGL will manage and operate the Tarrone facility under its own management system. If required by EPA, as a condition of the licence or Works Approval, AGL will prepare an Environmental Improvement Plan (EIP).

8.4 Construction

Construction activities associated with the proposed Tarrone power station will commence with the execution of a construction contract targeted for the fourth quarter of 2010 followed by mobilisation to site and completion targeted by the fourth quarter of 2012. Construction will be separated into five phases as follows:

Site Mobilisation

Initially, a construction compound (including offices, amenities, workshop, material laydown and storage area) will be established on-site with facilities and equipment to execute the construction phase.

Site Preparation and Earthworks

The site preparation and construction phase of the project will begin with land clearing required for the approved site layout and the removal of topsoil. Removed topsoil will be stockpiled for reuse in landscaping following the completion of construction. A platform level will be established by earthworks with a slight grade to assist site drainage.

Concrete Foundation Works

Once site preparation and earthworks have been completed, concrete foundation works will be established for major plant equipment and structures. This phase will include the installation of internal underground piping and other internal infrastructure.

Building Construction

The major building construction phase will include the transport of pre-fabricated plant equipment to site, the installation of plant equipment and the construction of building enclosures. Electrical equipment and wiring will be installed to connect the plant to the electricity grid.

Roadworks

Tarrone North Road may need to be widened by approximately two metres from a four metre wide seal to a six metre wide seal within the existing road reserve and be to the satisfaction of the Council. Intersection improvements may also be made to the Heywood-Woolsthorpe Road to the satisfaction of VicRoads and the Council. Sections of the Heywood-Woolsthorpe Road may require widening works, subject to further investigations and consultation with VicRoads.

8.4.2 Environmental Management during Construction

The environmental issues that are of importance during construction of the facility and the management of these issues are discussed below:

Solid Waste

Construction waste may include scrap metal, off-cuts of piping, wiring, sheet metal and excess soil. These waste materials will be categorised as either solid inert waste, clean fill or recyclable metal scrap. Some excess soil may be required to be disposed of off-site as a result of excavation for the installation of foundations and footings, although this is not anticipated at this stage.

In-situ soil removed on site could be relocated on site for purposes such as landscape mounds or as foundation for the access road. Alternatively it may be suitable for offsite disposal as clean fill material.

No spoil quality investigations have been conducted at the site as no contamination is expected. The only known prior use of the site is as pasture land for livestock grazing.

It is conceivable that small quantities of contaminated soil or absorbent could be generated during the construction phase as a result of a hydraulic or lubricating oil leaks from vehicles and heavy equipment. This material would be classified as a Prescribed Waste. If generated, it will be collected and disposed of accordingly. An appropriate spill management procedure will be incorporated within a proposed construction phase EMP.

Air

Emissions to the atmosphere during the construction phase will be predominately dust generated during earthworks and exhaust emissions from construction vehicles. These emissions will be controlled to ensure health and amenity of the surrounding areas is not impacted. Due to the separation distance between the site and the nearest residence (approximately 1500 m), airborne emissions, and their potential to impact on the health or amenity of local residents, will be negligible. While the first stage of the construction phase will last approximately 24 months, the peak potential for dust generation is during the stripping of topsoil and prior to the establishment of the construction pad on the site. The necessary dust mitigation measures will be employed to reduce dust generation including water carts on an as-needs basis.

Stormwater

During construction, any water produced from dewatering activities, and stormwater runoff from the construction site will be treated and managed on site in accordance with EPA guidelines.

Noise

Victoria EPA Interim Guidelines N3/89

The EPA's *Interim Guidelines for Control of Noise from Industry in Country Victoria N3/89* sets out the daytime construction noise limit, which is 10 dB above the lowest permissible daytime noise limit, except where this would result in a limit greater than 68 dB(A). The construction noise limit applicable to the site is the lowest permissible daytime noise limit of 45 dB(A) plus 10 dB(A) which is 55 dB(A) L_{Aeq}.

The EPA *Noise Control Guidelines (Publication 1254, 2008) also provide guidelines* for construction noise during normal working hours, weekends and evenings, and during the night. As the total construction period is expected to be approximately 24 months, it is considered appropriate to adopt the operational noise limits for evening and night-time period, and N3/89 for daytime period. Site specific noise limits are presented in Table 8-1.

Table 8-1 Noise Limits during Construction

Time of Day	Noise Limit (L_{Aeq}), dB(A)
Normal working hours[1]	45 + 10 = **55**
Weekend & Evening working hours[2]	37
Night period[3]	32

Notes:
1. 7.00 am – 6.00 pm on Monday to Friday / 7.00 am – 1.00 pm on Saturdays
2. 6.00 pm – 10.00 pm on Monday to Friday / 1.00 pm – 10.00 pm on Saturdays / 7.00 am – 1.00 pm on Sundays and public holidays
3. 10.00 pm – 7.00 am on All days

Construction Noise

The main construction activities would involve the following stages:

- Stage 1: Removing the layer of vegetation and levelling;
- Stage 2: Bulk earthworks including site grading and excavation work;
- Stage 3: Establishing concrete foundations for plant and buildings; and
- Stage 4: Construction of buildings and installation of equipment and machinery.

Construction Equipment and Associated Noise Levels

Typical construction equipment expected on the Tarrone site and noise levels are summarised in Table 8-2. The sound power levels presented in the table are indicative and should be used only as a guide.

Table 8-2 Sound Power Levels – Construction Equipment

Scenario	Proposed Activities	Equipment / Plant Item	Sound Power Level L_{Aeq} dB(A)
1	Site preparation & Earthworks	Excavator Bulldozer Grader Roller Loader Dump truck	108 – 112 102 – 114 114 – 118 103 – 112 103 – 111 102 – 107
2	Concrete Foundation Works	Concrete truck Concrete mixer Compactor Crane	103 – 113 107 – 111 113 – 115 104 – 108
3	Building Construction	Crane Delivery trucks Pneumatic tools Electric tools Power generators Hammers	104 – 108 102 – 110 110 – 115 100 – 108 100 – 106 101 – 112

Predicted Construction Noise Levels

The noise levels generated by the construction activities listed above have been predicted at each receptor location. Noise generated by construction activities will vary as construction progresses.

The noise modelling has been carried out considering the adverse meteorological conditions. The results for the predicted noise levels during construction of the power station are presented in Table 8-3.

Table 8-3 Predicted Construction Noise Levels

Location	Predicted Noise Level under Adverse Meteorological Conditions L_{Aeq} dB(A)	Day Noise Criterion L_{Aeq} dB(A)	Evening Noise Criterion L_{Aeq} dB(A)	Night Noise Criterion L_{Aeq} dB(A)	Exceedance		
	Power Station Construction				Day	Evening	Night
A	28 – 35	55	37	32	No	No	No
B	32 – 39	55	37	32	No	Possible	Possible
C	34 – 40	55	37	32	No	Possible	Possible*
D	32 – 39	55	37	32	No	Possible	Possible
E	29 – 36	55	37	32	No	No	Possible
F	< 30	55	37	32	No	No	No
G	30 – 37	55	37	32	No	No	Possible
H	22 – 29	55	37	32	No	No	No

* Although the corresponding predicted noise level (lower end of the range) exceeds the night noise criteria, the construction scenario modelled would be considered a reasonable "worst case" daytime construction scenario. It would be still be feasible to conduct some selected construction activities at night whilst still achieving the noise criteria.

The predicted construction noise levels presented in Table 8-3 show that no exceedance of the noise limit is predicted at any location for the construction of the power station during the day. Specific construction activities undertaken during the evening may lead to an exceedance at receptors B, C and D. Construction activities will be scheduled to be undertaken at an appropriate time of the day for the activity in question. The construction activities generating the most noise will be conducted during the day. It should be noted that the predicted noise levels presented above result from a conservative noise modelling approach where it has been assumed that all equipment would operate continuously and simultaneously during the assessment period.

Off-site Traffic Noise

As the specific duration and start/finish times of construction shifts have not been determined, it is assumed that that all movements would take place during the peak periods for the region. This would produce a conservative worst-case scenario in the event that shifts commence 7.00 am - 8:00 am and conclude 4.00 pm - 5.00 pm and that all personnel, material and equipment deliveries would occur in those periods.

It is expected that the number of construction personnel during the peak construction period would reach 250 personnel per day. The vehicle movements associated with construction personnel assumes a vehicle occupancy rate of 1.2 persons per vehicle. All construction personnel are assumed to arrive to the site in the morning and leave in the afternoon.

The Victorian legislation and guidelines (Section 4.1 in Appendix B) do not include any criteria to assess off-site traffic noise associated with construction. It is assumed that off-site traffic noise with the proposed construction is minimised as much as is practically possible by limitations on construction hours and Australian Design Rules which apply to road-registered vehicles.

Noise Mitigation Measures

Physical construction noise mitigation measures are not considered necessary. While the proposed construction activities have limited potential for impact on the local ambient noise environment, the following noise management strategies can be applied which would further reduce the potential for noise issues during the proposed construction period:

- Carrying out all construction works with consideration of the appropriate noise levels for the respective times of day;
- Scheduling construction to minimise multiple use of the noisiest equipment or plant items near noise sensitive receptors where practicable;
- Strategic positioning of plant items to reduce the noise emission to noise sensitive receptors, where possible;
- Carrying out maintenance work away from noise sensitive receptors, where practicable;
- Ensuring engine covers are closed, maintenance of silencers and mechanical condition. Maintenance for major items of construction equipment that are significant contributors to construction noise levels;
- Awareness training for staff and contractors in environmental noise issues including;
  - Minimising the use of horn signals and maintaining to a low volume. Alternative methods of communication should be considered;
  - Avoiding any unnecessary noise when carrying out manual operations and when operating plant; and
  - Switching off any equipment not in use for extended periods during construction work;
- Restricting heavy vehicles' entry to site and departure from site to the nominated construction hours;
- Where noise level exceedances cannot be avoided, consideration should be given to applying time restrictions and/or providing quiet periods for nearby residents;
- Community consultation with local residents and building owners to assist in the alleviation of community concerns. Previous experience on similar projects has demonstrated that affected noise sensitive receptors may be willing to endure higher construction noise levels for a shorter duration if they have been provided with sufficient warning in the place of intermittent but extended periods of construction noise at lower levels; and
- Maintaining a suitable complaint register. Should noise complaints be received, undertake noise monitoring at the locations concerned. Reasonable and feasible measures would need to be implemented to reduce noise impacts.

With the implementation of the mitigation measures above, construction noise at all receptor locations is expected to comply with the noise limit.

EPA Application Sections A to I

9.1 A - Carbon

9.1.1 A1 - Energy Use and Greenhouse Gas Emissions

Generation

The national electricity market is extremely volatile and complex. Peak loading power plants are used at times when additional electricity is required by the grid, such as during hot summer days or cold winter mornings and evenings. As a result the distribution of operating hours can vary significantly from year to year. It is difficult, therefore, to predict with certainty when the plant will be operating and for how many hours. Typically however, in Victoria the expected operating profile for a peak loading power station of the size of the proposed Tarrone power station is approximately 200 days per year, with daily run times varying from less than 1 hour and up to 24 hours, although the likely daily rate is within the range of 2 to 6 hours per day. Overnight running is rare. Typically, however, the annual operating hours are expected to be approximately 5% (440 hours).

At a 5% usage rate, the expected gas and electricity consumption would result in Scope 1 and 2 greenhouse gas emissions for the considered engine types as shown in Table 9-1.

Table 9-1 Scope 1 and 2 Greenhouse Gas Emissions

Generator Class	E Class				F Class			
Manufacturer	Model	Tonnes CO_2-e per year			Model	Tonnes CO_2-e per year		
		Scope 1	Scope 2	Scope 1 & 2		Scope 1	Scope 2	Scope 1 & 2
Siemens	SGT5-2000E	156,612	6,908	163,521	SGT5-4000F	178,001	9,005	187,006
GE	9E	120,711	5,181	125,892	9FA	168,207	7,883	176,090
Ansaldo	V94.2	157,700	6,990	164,690	V94.3	179,815	9,067	188,882
Alstom	AE13E2	141,593	6,867	148,460				
Mitsubishi					M701F3	177,346	8,327	185,673

Notes:
1. Engines modelled for local air quality assessment have been highlighted.

National Greenhouse Accounts (NGA) factors provide data on the emissions of CO_2-e (carbon dioxide equivalent) generated through the combustion of gaseous fuels for power generation taking account of emissions of the three main greenhouse gases – CO_2, CH_4 (methane) and N_2O (nitrous oxide)[5]. Scope 1 emissions from electricity generation have been calculated using the NGA factors to provide data on the emissions of CO_2-e generated through the combustion of gaseous fuels for power generation. Scope 2 emissions from electricity use have been calculated using the NGA factors to provide data on the emissions of CO_2-e generated through the use of electricity from the national grid.

[5] Department of Climate Change, 2009. 'National Greenhouse Accounts (NGA) Factors'. Australian Government.

9 EPA Application Sections A to I

The maximum annual Scope 1 and 2 CO_2-e emissions for the proposed E and F class engines is 164,690 tonnes CO_2-e and 188,882 tonnes CO_2-e respectively. This represents 0.2% and 0.23%, for E and F class engines respectively, of 2006 Victorian emissions from stationary energy sources[6].

Emissions to atmosphere of greenhouse gases are likely to be in the range of 150,000 to 200,000 tonnes CO_2-e per annum.

Power Station Electricity Consumption

Peaking power stations are clearly significant net electricity generators, but also use a relatively small amount of grid electricity, and a very small proportion of the electricity generated.

The grid electricity is required for a range of plant and equipment operating when the turbines aren't generating including general lighting, control systems, building heating (if electric) and cooling, gas turbine starter motors, oil recirculation pumps, compartment ventilation fans and lighting, water treatment plant power and water distribution pumping. Some of this usage is a function of the plant run time (i.e relatively proportional eg water treatment plant operation), but some usage is not directly related to the plant operation (eg general lighting, and building heating and cooling)

The small proportion of generated electricity that is consumed is associated solely with generator equipment including gas turbine shell exhaust blowers, cooling fans, and cooling water recirculation pumps. This electricity usage is, to a larger extent, a function of the plant runtime.

The power station design is not yet sufficiently progressed to indicated and assess individual electricity demands (including water treatment, etc), but some indication can be provided on the order of the amount of electricity used relative to generation by comparison with other peaking plants. The AGL Somerton Peaking Power Station is significantly smaller than the proposed Tarrone facility (nominal capacity 150 MW compared to the proposed 720 – 920MW). It also differs in one significant aspect of configuration in that water injection is used for NOx control, rather than the proposed DLN for Tarrone, which has the effect of creating a significantly higher water demand relative to energy generated (in 2007/08 and 2008/09 Somerton Power Station used approximately 23ML per annum, whilst it is proposed that Tarrone will use only 10-15 ML per annum, despite it being approximately 5 times greater capacity). However, other than this aspect Somerton provides a reasonable indication of the types and relative proportions of grid electricity and self-generated electricity consumption. In 2007/08, grid electricity use was 1.15 % of the net electricity generated from the power station (1.36 GWhr used of 117.57 GWhr net generated), and in 2008/09 it was 1.93%. The self generated electricity consumed at the power station relative to the net electricity generated was 0.45% (0.52 GWhr used compared to 117.57 GWhr net generated) in 2007/08 and 0.27% in 2008/09. The electricity usage relative to electricity generated at Tarrone Power Station would not be expected to be greater than at Somerton, and may be lower due to economies of scale.

9.1.2 A2 - Best Practice Carbon Management

In the absence of renewable technology to meet the rising demand in Victoria, the best alternative is to implement low emission technology for energy production. Burning natural gas in an open cycle gas turbine produces between 50% and 60% less greenhouse gas (GHG) emissions than brown coal.

[6] EPA Victoria; 2010. 'Australia and Victoria's greenhouse gas emissions'. Available online at http://www.epa.vic.gov.au/greenhouse/australia-victoria-emissions.asp. Last accessed 30/3/10.

Open cycle gas turbines are ideal for responding to peak load demand and generally represent best practice for this type of use.

Under normal circumstances, it is unlikely that the proposed Tarrone power station will extend its operating hours given that its operating cost is relatively higher than other technologies. However, the capital cost per megawatt generated for open cycle turbines is lower than that for combined cycle gas turbines or coal fired generators, making it more cost effective for short periods of operation during peak times.

In addition, greenhouse gas emissions will also somewhat reduced by the installation of an evaporative cooling system on the proposed Tarrone power station. Evaporative cooling of the inlet air into the compressors increases the efficiency of the power generation process by increasing the power output per volume of gas burnt (Section 5.2.3).

In relation to electricity usage by the power station, from the grid and also self generated electricity, the level of design detail is insufficient at this time to consider the energy efficiency of individual plant items. However, AGL commits that best practice energy efficiency of individual equipment items will be significant consideration in the equipment selection.

This consideration will apply to a possible water treatment plant. If desalination is required three very broad technology options have been nominated for consideration, There is insufficient definition (capacity, unit processes, etc) at this time to consider the relative energy efficiency of the options, and there will be other factors including water usage efficiency, wastewater quality and quantity, chemical consumption, waste disposal costs, evaporation pond size and cost, ease of operation, reliability and maintenance demands that will all be taken into account. Energy efficiency will be a significant factor in making a decision between the options based on the overall cost benefit analysis.

9.2 B - Water

9.2.1 B1 - Water Use

It is anticipated that the peaking power station will require approximately 10 - 15 ML of water per year. During operation water will be used on site for:

- process water;
- maintenance of equipment;
- fire services;
- domestic use; and
- landscaping.

Table 9-2 presents the estimated proportion of water use for the major water using equipment or processes for the proposed Tarrone power station. It excludes the additional water demand if groundwater and desalination is required, up to approximately 4 ML.

Table 9-2 Proposed Water Use Areas

Major water using equipment/processes	Estimated water volume (kL/year)	Estimated % water consumption
Evaporative cooling system	7,300 – 8,300	98.5
Turbine wash water	40	0.5
Fire services	N/A	0
Domestic water usage	80	1
Landscaping	N/A	0
Total	7,420 – 8,420	100

9.2.2 Process Water Requirements

The process water is utilised in the evaporative inlet air coolers as part of the operation of the proposed power station. The estimated requirements for E Class turbine and F Class turbines operating are presented in Table 5-3. Actual water consumption could vary based on actual weather conditions, particularly the temperature and humidity, and the degree to which the coolers are operated when the generators are operated (expected to be predominately in summer).

The process water demand is based on maximising the recycling of water in the coolers. The evaporation rate (and hence the total flow rate) would decrease as relative humidity increases. The blowdown volumes assume water and air are clean and uncontaminated entering the system. The water usage data presented in Table 5-3 are also based on the assumption that the power station is operating during hot, dry periods when water consumption would be highest. However, the evaporative cooler system would not be operated during times of lower ambient temperatures. Therefore, the water usage of the evaporative coolers for three F Class or four E Class gas-turbines, assuming a total evaporative cooler run time of 220 hours in the year is about 7,300 kL/annum and 8,300 kL/annum respectively. If groundwater is the water source, then an additional 3 – 4 ML/annum of water might be required to account for the water losses through pre-treatment processes.

The water used for evaporative cooling would typically need to meet the water quality criteria outlined in Table 9-3.

Table 9-3 Typical Water Quality Criteria for Evaporative Cooling

Designation	Unit	Lower	Upper
Conductivity	µS/cm	50	450
Calcium Hardness (as $CaCO_3$)	ppm	45	170
Chlorides (as Cl)	ppm		<50
Total Alkalinity (as $CaCO_3$)	ppm	45	170
pH	-	7	8.5
Silica (as SiO_2)	ppm		<25
Iron (as Fe)	ppm		<0.2
Oil and grease	ppm		<2
Total dissolved solids	ppm		<550
Suspended solids	ppm		<5

9.2.3 Maintenance of Equipment

A small volume of water will be required for maintenance and cleaning of equipment (including turbine wash water). Up to 40 kL/annum is estimated to be required for this purpose however potable water will not be required.

9.2.4 Fire Services

A water tank will be present on-site to store water for fire fighting purposes. The volume of the tank will be determined as part of the detailed design process and will meet regulatory requirements. The water is not required to be of potable quality however, it would need to be low in suspended solids. The fire water tank may be combined with a raw / process water tank.

9.2.5 Domestic Uses

Water will be required for staff facilities, including drinking water and general amenities. Water for domestic use will be brought to site by tanker or will be collected from the roof of the amenities building and stored in tanks on-site. It is estimated that up to 80 kL/annum will be required for the 5 permanent staff. During minor and major maintenance periods additional domestic water may be required.

9.2.6 Landscaping

To minimise the potential for soil erosion and enhance local ecology, all disturbed areas will be planted at the end of the construction process. In order to minimise water usage, the disturbed areas would be planted with species that are both local to the area and whose water requirements can be supplied by rainfall alone. Some supplementary irrigation water may be required during establishment.

9.2.7 Possible Water Sources

Three options for the provision of water supply are being investigated, including:

- groundwater extraction;
- transport of water by licensed carrier and water tanker to site; and
- use of recycled water piped to site.

As discussed in Section 5.3, the first two of these options may result in a requirement for onsite water treatment to facilitate process water supply (turbine inlet air evaporative coolers).

Groundwater Extraction

The preferred option for water supply is groundwater extraction through the transfer of an existing groundwater licence in accordance with the regulatory and administrative requirements of Southern Rural Water (SRW). The site lies with the Hawkesdale GMA, which currently has exclusion of issuing any new groundwater extraction licences. This is due to the current understanding that the allocation licences for aquifer(s) in the GMA are likely to have reached or exceeded a sustainable volume. As a result, SRW is currently re-assessing the Permissible Consumptive Volume (PCV). Until a decision has been made on the PCV no new Groundwater Extraction Licences (GEL) will be issued by SRW. In order to obtain a licence to extract groundwater for use at the site a permanent transfer from an existing licence would be required.

The geology beneath the site incorporates the Newer Volcanic Basalt and Port Campbell Limestone, with the basalts believed to be in the order of 40m thick in the local area.

The upper most aquifer is within the Newer Volcanic Basalt, with depth to groundwater reported[7] to be between 10 to 20m below surface. The yields from the basalt aquifer in the region are highly variable, but it is likely that the facility's water requirements of up to 15 ML/year (max rate of 175kL/day) could be met with extraction from one bore.

The groundwater quality from the basalt aquifer is relatively consistent in the region, but does have some variability both vertically and horizontal. Table 9-4 presents the likely range of water quality values for a number of parameters that would be expected from the basalt aquifer at the site.

Table 9-4 Water Quality Parameters

Parameter	Water Quality Values (mg/L)	
	Likely Lower	Likely Upper
Total Dissolved Solids	850	2,000
Chloride as Cl	180	650
Sulphate as SO_4	<20	60
Iron (dissolved)	0.1	5.0
Total Alkalinity as $CaCO_3$	250	500
pH	7.0	7.5
Silica	Unknown	

The capacity for water storage on site will be determined following completion of engineering design and confirmation of which water supply will be used.

Recycled Water

The recycled water under consideration would involve connecting to the Port Fairy recycled water treatment plant which has been proposed as part of the Shaw River power station project. This option will be subject to the Shaw River Power Station project proceeding. The indicated quality of this recycled water[8] is such that it is unlikely to require further treatment at Tarrone Power Station prior to use.

9.2.8 Wastewater

The volume of wastewater that would be generated by the peaking power station will vary depending upon the plant runtime. The main wastewater source will be the blowdown from the turbine air inlet cooling system. Wastewater generated at the facility can be divided into:

- Process wastewater – generated through operations associated with electricity generation;
- Maintenance cleaning water; and
- Domestic sewage.

[7] SKM. Preliminary Groundwater Resource Appraisal for the Hawkesdale Groundwater Management Area. 20 December 2007.

[8] Wannon Water 2010, *Works Approval Application Port Fairy Recycled Water Treatment Plant (To Supply the Proposed Shaw River Power Station)*, prepared by GHD for Wannon Water

The process wastewater will be directed to the evaporation pond for concentration, and ultimately disposal as a prescribed waste (refer to Section 9.4). The maintenance cleaning water will be treated as prescribed waste, removed from site and treated elsewhere. The domestic sewage will be discharged to a septic system or appropriate onsite wastewater collection system (depending on site conditions) for periodic offsite collection and disposal.

9.2.9 B2 - Best Practice Water Management

Three options have been tabled for water supply to the proposed Tarrone power station, these include:

- groundwater extraction;
- transport of water by licensed carrier and water tanker to site; and
- use of recycled water piped to site.

On completion of further investigations into the water quality of the groundwater on-site, a triple bottom line assessment will indicate the best practice water supply (see also Section 5.3).

If water pretreatment is determined to be required, the design will focus on maximising treated water yield and minimising unnecessary wastewater generation.

Water harvesting from building rooves to supplement the industrial water supply will be considered as part of the detailed facility design, once the water supply arrangement has determined.

9.3 C - Solid Waste

The type and amount of solid waste estimated to be generated on-site is described in Section 6.3.

9.4 D - Prescribed Industrial Waste

9.4.1 D1 - Prescribed Industrial Waste Generation

The relevant state policy that establishes the framework for minimisation of industrial waste is the *Environment Protection (Industrial Waste Resource) Regulations 2009.* There will be no wastes discharged from the site that are classified as Priority Wastes in Schedule 2 of the *Environment Protection (Industrial Waste Resource) Regulations 2009*. Under the policy therefore, the minimum acceptable level of waste minimisation that is required to be applied at the site is that which is commonly available and appropriate to the industry.

Oil and Oily Waste

Prescribed wastes generated on the site include waste oils from the transformers and gas turbine generators. Gas turbine generator lubricating oil and transformer oil are changed infrequently but will be disposed of by a contractor in accordance with the *Environment Protection (Industrial Waste Resource) Regulations 2009*. Waste oil may also be recycled where appropriate.

Five transformers are proposed for the site, comprised of one 600 MVA transformer with an oil capacity of approximately 90,000 L and either three 330 MVA transformers (F Class configuration) or four 200 MVA transformers (E Class configuration) with approximately 70,000 L capacities each.

Another potential source of oil from site is to be oily bund water. It is estimated that 2 tonne of oily bund water may be captured per annum and disposed of as prescribed waste.

Evaporation Pond Waste

The blowdown water from the evaporative coolers will be discharged to an evaporation pond. Should groundwater be used for cooling, iron sludge, brine and membrane treatment chemicals may also be discharged to an evaporation pond. The residuals in the pond will be disposed of as prescribed waste to an appropriate facility. The residual quantity will ultimately depend on the feed water quantity, the evaporation pond design and climatic conditions. The worst case predicted annual evaporation pond feed volume is up to 5 ML/annum.

Turbine Wash Water Waste

It is anticipated that up to 40 kL per annum of wastewater could be generated from turbine wash water, cleaning and maintenance of the power station. This wastewater would be collected in washing bays in a bunded area, collected and then disposed of off-site by a licensed contractor to an appropriately licensed facility as prescribed industrial waste.

Other Wastes

Septic tank sludge produced on-site is estimated to be less than 1 tonne per annum based on the number of staff. The sludge will be treated as prescribed industrial waste and removed from the site.

Empty oil and chemical containers will also be treated as prescribed industrial waste and removed from the site.

9.4.2 D2 - Best Practice Prescribed Waste Management

The amount of Prescribed Industrial Waste (PIW) will be minimised from the proposed Tarrone power station through effective waste minimisation practices and policies. AGL have a waste minimisation policy and procedures that qualify that the generation of PIW will be minimised and opportunities for reuse and recovery (e.g. waste oils) will be implemented.

9.5 E - Air

9.5.1 E1 - Air Emissions

The majority of emissions to air arising from the proposed Tarrone power station will originate from the combustion of natural gas in the gas turbines for the purposes of electricity generation. The major emissions from natural gas combustion in turbines are nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), water vapour, oxides of nitrogen (NO_x), sulphur dioxide (SO_2) and carbon monoxide (CO). Small quantities of polyaromatic hydrocarbons (PAHs) and Volatile Organic Compounds (VOCs) will also emitted by the turbines. The type of gas turbines proposed for the Tarrone power station feature Dry Low NO_x technology to produce very low NO_x emissions. This technology is recognised as best practice in terms of emissions of NO_x.

Two plant configurations are considered for the proposed Tarrone power station comprising of either four E class turbines or three F class turbines operating in open cycle model. At this stage in the design process, the final choice of engine manufacturer has not been determined however five prospective manufacturers are being considered (Table 9-6).

In order to provide flexibility in the final choice of supplier, URS has considered the local air quality impact from the use of two engines representing typical emissions and impacts resulting from the use of E-Class and F-Class engines.

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The two proposed site designs considered for this assessment are:

- 4 X Alstom 13E2 M; or
- 3 X GE Energy 9FA.

An analysis of the representativeness of the Alstom 13E2 M and GE Energy 9FA engines modelled with respect to potential ground level concentrations of NO_2 was undertaken (Appendix A). It was determined that whilst there is potential for ground level concentrations to be higher than modelled (up to 1.3% for E class engines and 7.3% for F Class engines), relative to the Alstom 13E2 M and GE Energy 9FA engines modelled, this does not present potential for harm to the beneficial use of the atmosphere given:

- Concentrations determined by the dispersion modelling, undertaken for the Alstom 13E2 M and GE Energy 9FA engines, are significantly below criteria (Appendix A); and
- The assessment conservatively assumes all NO_X is NO_2 (Appendix A).

Emission Estimation under Start-up and Normal Operating Conditions

Start-up and normal operating conditions were modelled for the E Class and F Class engines. Emission estimation for the proposed power station was completed using manufacturer data and where manufacturer data was unavailable emission estimation was completed using techniques provided in the National Pollutant Inventory (NPI) and the USEPA emission estimation technique manual AP-42. Emissions of oxides of nitrogen were conservatively considered to be fully converted to nitrogen dioxide upon reaching the atmosphere (NO_X as NO_2). The emission rates under normal operating conditions for the Alstom 13E2 and GE 9FA are listed in Table 9-5.

Table 9-5 Modelled emission rates for normal operating conditions for Alstom 13E2 and GE 9FA engines

Species	Alstom 13E2 (M) (g/s)	GE 9FA (PG9351) (g/s)
NO_X	20.86	30.62
SO_2	1.17	2.23
CO	2.56	9.14
$PM_{2.5}$	3.00	2.14
Benzene	0.003	0.005
Toluene	0.03	0.05
Ethylbenzene	0.01	0.01
Xylene	0.01	0.03
Formaldehyde	0.15	0.29
Total PAH	0.0004	0.0008

Start up emissions for a peak loading power plant have potentially higher mass rates for a short durations due to lower efficiency of the engine during these conditions. The only species with a higher mass rate during start up than during normal operation is oxides of nitrogen (NO_X). Time varying NO_X emissions during the start up period were calculated for each engine type and used to determine the potential ground level impacts at start-up. Due to the different type of information provided by each manufacturer the method of calculation for start up NO_X emissions was varied slightly with each engine (refer to Appendix A).

Table 9-6 Potential Gas Turbine Generator Manufacturers under consideration

Generator Class	E Class		F Class	
Manufacturer	Model	Power Output (MW/unit)	Model	Power Output (MW/unit)
Siemens	SGT5-2000E	168	SGT5-4000F	292
GE[1]	9E	126	9FA	256
Ansaldo	V94.2	170	V94.3	294
Alstom[1]	AE13E2	167		
Mitsubishi			M701F4	307

Notes:
1. Shaded engines were modelled.

9.5.2 E2 - Best Practice Air Emissions Management

Representative Gas Turbine Modelling

The provision of generators will be subject to a tendering process and the additional potential suppliers and engine models identified are listed in Table 9-6. To ensure that the emissions from the Alstom AE13E2 and GE 9E are suitably representative of other possible engine configurations, a comparison of calculated plume rise heights and emissions rates was undertaken (Refer to Appendix A). To account for the potential use of other engines, start-up and normal operational mass emission rates for the GE 9FA engine were increased by 10%.

9.5.3 E3 - Impact on Air Quality

A local air quality study was undertaken to assess the impact on ambient air quality with respect to regulatory emission limits and ground level design criteria, specified in the *State Environmental Protection Policy for Air Quality Management* (SEPP (AQM)) of the primarily gaseous emissions from the proposed gas-fired power station. The SEPP (AQM) defines design criteria (Schedule A) that are used to assess the impact for new or modified sources. Table 9-7 shows design criteria relevant to emissions from the proposed peak load power station.

Table 9-7 SEPP (AQM) design criteria for relevant emitted substances

Substance	Averaging Period	Design Criteria (µg/m^3)
Nitrogen dioxide	1-hour	190
Carbon monoxide	1-hour	29,000
Sulphur dioxide	1-hour	450
Particles as PM_{10}	1-hour	80
Particles as $PM_{2.5}$	1-hour	50
Ammonia	3-minute	600
Formaldehyde	3-minute	40
Xylenes	3-minute	350
Acetaldehyde	3-minute	76
Acrolein	3-minute	0.77
Ammonia	3-minute	600
Benzene	3-minute	53
Ethylbenzene	3-minute	14,500
Polycyclic aromatic hydrocarbons (PAH) as BaP	3-minute	0.73
Toluene	3-minute	650

The local air quality assessment involved atmospheric dispersion modelling using CALPUFF and was conducted in accordance with the SEPP (AQM), where the assessment of the impact of local air quality used a largely conservative approach.

9.5.4 Background Air Quality

Local air quality monitors indicate the existing air quality. In order to ascertain the impact the proposed Tarrone power station may have on the existing air quality of the region, the background concentrations of air quality indicators must be added to the predicted ground level concentrations of the proposed Tarrone power station to indicate overall air quality. However, the area has no permanent background monitors in place for the measurement of ambient air quality.

Background air quality has been measured in Warrnambool by the EPA and Mount Gambier by the South Australian EPA. However, monitoring undertaken in Warrnambool by the EPA does not provide data on species likely to be emitted from the proposed power station, and data collected by the South Australian EPA in Mount Gambier is not considered to be representative of the project site.

In these circumstances, the EPA recommends the use of the 70th percentile of available monitored data and provides a table of appropriate background levels for proponents to use in dispersion modelling. URS has used the background data, provided by the EPA, from areas where data exists and is likely to be representative. It should be noted that this monitoring is based on an area with a higher residential population and a high number of vehicle movements, than the model domain. The background concentrations used in this assessment are therefore considered to be conservative. Table 9-8 shows the background concentration used in this assessment for each species, the source of the data and a comment on the appropriateness of the selection.

Table 9-8 Background concentrations for common species provided by EPA as representative background values

Species	Background Concentration (µg/m³)	Location of Background Measurement	Comment
NO_2	11.3	Point Cook	Suburban area with little industrial activity or residential population at the time of monitoring (2000). Considered representative.
$PM_{2.5}$	7.5	Brighton	Urban area with high residential population. Large number of vehicle movements. Considered appropriate but likely to be conservative compared to modelled area.
CO	229	Geelong	Low density residential surrounding monitoring point at time of monitoring (2000). Considered representative.
SO_2	0	Geelong	Low density residential surrounding monitoring point at time of monitoring (2000). Considered representative.

Shaw River Power Station

URS is aware that Shaw River Power Station Pty Ltd, a wholly owned subsidiary of Santos, proposes the construction of a base load power station in close proximity to the proposed AGL site at Tarrone. URS has used the data contained in the Environment Effects Statement for the Shaw River facility to undertake a cumulative impact assessment.

URS has adopted the emission rates and stack parameters provided in the Shaw River EES, associated with the operation of three closed cycle turbines, as this provides the most conservative assessment of cumulative impact Table 9-9.

Table 9-9 Emissions of NO_X and CO from the proposed Shaw River Development (Shaw River EES)

Species[1]	SGT5-4000F (g/sec/turbine)
NO_X	30.6
CO	7.5

Notes:
1. The results for NO_2 presented in the Shaw River EES adopt a conversion factor of 0.3 to estimate NO_2 from modelled NO_X concentrations, whilst this assessment has conservatively assumed that all NO_X is NO_2 for both Tarrone and Shaw River emissions.

9.5.5 Air Quality Modelling Results

Modelling was undertaken to predict ground level concentrations during start-up and operation of the E Class and F Class turbine options both separate from and in combination with a proposed nearby combined-cycle gas power station at Shaw River.

Start-up emissions vary over the first hour. CALPUFF, the model used in this assessment to predict ground level concentrations from the proposed Tarrone power station, allows input of sub-hourly emission rates and hence start-up emission rates can be modelled as varying emission rates over the hour. Consequently, the maximum modelled ground level concentration for start-up was lower than the maximum modelled ground level concentration for normal operations.

For all modelled scenarios and emissions, the maximum modelled ground level concentration, including a conservatively selected background and emissions from the proposed Shaw River power station development, are predicted to be below the SEPP (AQM) design criteria. Table 9-10 shows the maximum predicted ground level concentrations, within the modelled area, for common products of combustion, and considered scenarios. The full results, including volatile organic compounds, polycyclic aromatic hydrocarbons and formaldehyde may be found in the technical report (Appendix A).

Table 9-10 Maximum modelled (99.9th percentile) ground level concentrations for considered scenarios (without background)

Species	NO_X as NO_2	SO_X as SO_2	CO	$PM_{2.5}$
Units	ug/m^3	ug/m^3	ug/m^3	ug/m^3
Averaging Period	1 hour	1 hour	1 hour	1 hour
Alstom 13E2 Steady State	16.11	0.86	1.97	2.31
GE 9FA Steady State	14.23	0.86	4.25	0.996
Alstom 13E2 Start up	3.15			
GE 9FA Start up	4.8			
Alstom 13E2 Steady State Plus Shaw River	55.1		13.5	
GE 9FA Steady State Plus Shaw River	55.1		13.5	
Background Concentration	11.3	0	229	7.5
SEPP (AQM) Design Criteria	**190**	**450**	**29,000**	**50**
Exceed SEPP (AQM) Design Criteria	No	No	No	No

9.5.6 Aviation Safety

A Plume Rise Assessment (PRA) will be carried out and the resulting report forwarded to the Civil Aviation Safety Authority (CASA) prior to construction.

9.6 F - Discharges to Surface Water

9.6.1 F1 - Water Discharges

Existing environment

The site occupies an approximately 75 hectare battle-axe shaped land parcel. It is bordered by Landers Land on the west and Riordans Road on the south, inclusive of a wetland area (shown in Figures 3 and 6).

The topography of the rural property, currently used for livestock grazing, remains similar to surrounding areas, being generally gently undulating with some evidence of rock outcrops in the northwest portion of the site. Remnant pine tree plantings are scattered throughout the open pasture. No natural watercourses run through the site. The north and north-eastern portion of the site is bounded by more of the same terrain. The site receives runoff from these areas.

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Existing drainage

In describing the existing site drainage, there are a number of catchments and sub-catchments to be considered. The main catchments are the:

- North catchment: Approximately 30.5 hectares, draining from the north to south, entering the north-west corner of the site.
- North-East Catchment: Approximately 33.9 hectares, draining from the north to south, entering the north-east corner of the site.
- Wetland Catchment: Approximately 4.3 hectares and draining from east to west. The catchment is quite small compared with the total surface area of the wetland itself.

Onsite drainage consists of sub-catchments that feed into open drains. Water drains from the north and north-east towards the south-west, and is collected in an open drain, that flows from the north-west corner of the site to the south and exiting the site in a culvert (2 x 600 RCP) under Riordans Road. This drain also collects water from the catchments to the north of the site. An additional drain exists in the south-east corner of the site directing water from east to west, to the same culvert under Riordans Road. There is also a concrete pipe running from the wetland under Landers Lane that appears to be in a poor state of repair, and may not effectively pass water. Refer to Figure 6 for details of existing surface flows.

Ultimately, the site resides within the catchment of the Moyne River, as verified by the Glenelg Hopkins Catchment Management Authority (CMA) catchment mapping[9]. Runoff from the site beyond Riordans Road is expected to flow towards the Moyne River most likely via the ephemeral stream Back Creek, passing about 1.1 km to the east of the site (as shown in Figure 2). Back Creek flows south into the Moyne River at a point about 7.5 km to the south of the site. Other than in significant storm events, it is unlikely that stormwater runoff from the site would reach this receiving water, and would normally be lost by infiltration and evaporation.

Changes to Local and Regional Hydrology

The proposed site for development is currently grazing land. The construction of tracks and hardstand areas has the potential to alter the hydrologic regime of the site. Generally when the land's surface cover is changed the quantity and timing of surface runoff during a rainfall event may change.

Compacted areas such as hardstands and tracks will have less permeability and consequently a higher runoff coefficient than grassed areas. This means that a larger proportion of rainfall will become surface runoff and the time it takes water to runoff (the time of concentration) will decrease. Any embankments that are created as a result of the track construction may alter the location of natural flow paths by diverting surface runoff. Both of these changes to the local hydrologic regime have the potential to detrimentally impact on the regional hydrologic regime if not managed adequately. A well designed stormwater management plan will ensure that there are no detrimental changes or impacts to the hydrologic regime.

Conceptual Stormwater Management

The proposed Tarrone power station has the potential to impact on the quality of surface runoff from the site and subsequently on the water quality of local receiving watercourses.

[9] http://www.glenelg-hopkins.vic.gov.au/?id=onlinemapping

Surface runoff from the proposed development site must comply with the *State Environmental Protection Policy (Waters of Victoria)* criteria for discharge to receiving watercourses. The conceptual stormwater management system detailed below deals with the expected types of runoff, and ensures that the hydrologic regime and surface water quality of the region is preserved, in particular that of the intermittent wetland.

Catchment Runoff

The off-site catchment runoff will be diverted around the site using perimeter swale drains and directed into the existing drain. Three different sized swale drains are proposed. Swale drains, comprising vegetated open channels, are proposed as they provide treatment for runoff, as the vegetation slows down the flow and improves water quality.

The 10 year and 100 year ARI design discharges were considered, however, 100 year ARI swale drains are proposed given there was little difference between the drain sizes to accommodate these design flows. Given limited information on catchments to the north of the site, these drains will have sufficient capacity to divert large flows.

The first swale will receive runoff from the majority of the north east catchment and the road. It will run along the north side of the road, from the north-east corner of the main site until the north-east edge of the site. Water picked up in this swale will drain to low points, and exit the site via culverts under the access road into the adjacent property. The first swale drain was designed to the 100 year ARI design discharge of 0.993 m^3/s. Swale dimensions (trapezoidal cross-section) are:

- Bed width 1 m,
- Top width of 4.4 m,
- Total depth of 0.60 m.

The second swale drain will receive runoff from a small section of north east catchment as well as a portion of the access road, and eastern sub-catchments. It will run along part of the northern boundary of the plant, before crossing the road in a culvert, and following the eastern boundary of the plant until it eventually discharges into the existing drain downstream of the plant. The second swale drain was designed to handle the 100 year ARI design discharge of 0.5 m^3/s. Swale dimensions (trapezoidal cross-section) are:

- Bed width of 1 m,
- Top width of 3.8 m,
- Total depth of 0.45 m.

The third swale drain will receive runoff from the north catchment, and the sub-catchments between access roads. The first section will run along the northern boundary of the plant, where it will discharge into the drain running within the floodway. The other section will run along the northern boundary, cross the road in a culvert, before following the road southwest (crossing in another culvert) and discharging into the drain running within the floodway. The third swale drain was designed to handle the 100 year ARI design discharge of 0.75 m^3/s. Swale dimensions (trapezoidal cross-section) are:

- Bed width of 1 m,
- Top width of 4.1 m,
- Total depth of 0.52 m.

Rock beaching would be considered in sections of the swale drains that may be subjected to concentrated flows with potential for erosion e.g. where swales run into existing drains.

Site runoff – Retarding Basin

The site runoff consists of stormwater from the hardstand areas (paved). It is expected that the runoff from these areas may not require any treatment, however, if after future consideration it is decided that treatment is desirable, the retarding basin could be designed to have the functionality of a sedimentation pond. At this stage only a retarding basin has been proposed. As the site will increase the runoff amount, the difference in discharge from pre- to post- construction shall be controlled to preserve the natural hydrologic regime. To achieve this, a retarding basin is proposed with an outlet that will be sized to control the discharge to be equivalent to pre-construction flow.

The runoff from the hardstand areas would be directed into the existing north-south drain until it reaches the retarding basin. The retarding basin would discharge into the existing north-south drain. It would be located to the south of the site (Figure 6). Ultimately, the requirement for location and design of a retarding basin will be reconsidered during further power station design stages.

The retarding basin would store rainfall runoff from the two hardstand areas, and have a discharge equivalent to pre-construction flow. The indicative retarding basin dimensions were based on a 10 year ARI discharge of 0.38 m^3/s. The following was determined:

- Dimensions: 20 x 10 x 1.5 m, including 0.5 m freeboard,
- Outlet size: 150 mm diameter pipe (based on a 10 year ARI discharge of 0.05 m^3/s).

Process Area Runoff – Sedimentation Pond

The process area includes the generators area, and substation. For conceptual stormwater draining system design, it has been assumed that this area is not roofed or paved, although the generators will actually be roofed and there will be small paved areas, including bunded areas. The surface is assumed to be a gravel hardstand area and may require some limited degree of treatment before it can be discharged. and a sedimentation pond is currently considered as an option to treat the water. The pond is indicatively proposed to be located to the south of the switchyard area and would discharge into the nearby swale drain (Figure 6), although the location may be adjusted following more detailed power station design. The need to the sedimentation pond will be considered in further design stages. A small onsite wetland may be considered as an alternative to a sedimentation pond following further assessment in future more detailed design.

Bunded process areas would be drained to the sedimentations pond by manual valve operation, following confirmation that the bund water was oil free. In the event the oily water was detected in the bunds, this would be removed offsite as prescribed waste.

The sedimentation pond would be designed with an outlet sized to give a detention time of 10 days to allow sediment to settle out. The 100 year ARI design discharge of 2.71 m^3/s was used to indicate the likely size of the pond. The following conceptual design is proposed:

- Dimensions: 65 x 35 x 1.5 m, including 0.5 m freeboard,
- Outlet size: 50 mm diameter pipe.

Bund to protect intermittent wetland

As the site is located in very close proximity to an intermittent wetland, shown in Figure 6, there is potential for site runoff to enter the wetland catchment and alter the hydrologic regime. To ensure that this does not occur, at further design stages of the project consideration will be given for the need for a bund to be constructed between the site and the wetland (Figure 6). The bund, if necessary, would ensure runoff is directed towards the existing drain and eventually into the retarding basin.

Potential localised flooding

In the event of a large storm (e.g. greater than 100 year ARI) there is a risk that flood waters from the north may enter the generator area. To mitigate this risk, a bund may be constructed with sufficient freeboard to direct the flood waters in between the generator area and the substation area. The construction of a floodway (i.e. unobstructed overland flow path) may be undertaken. This may require some surface reshaping. The floodway would then discharge into the existing drain south of the turbine area.

Stormwater Harvesting

It is proposed that the rainfall runoff from the site's office building may be collected into a rainwater tank and re-used for domestic water usage and / or evaporative cooling. There is sufficient rainfall per average year to allow for this.

The approximate rainfall that can be harvested is:

- Approximate Area of roof: 2000 m^2
- Conservative assumption of 80% runoff
- Rainfall: 662.9 mm/annum
- Approximate Runoff: 1 ML/annum.

The main water demand where recycled water could potentially be used are:

- Domestic water usage: 80kL/annum
- Turbine wash water: 40kL/annum; and
- Evaporative cooling process water (~8.3 ML/a)

9.6.2 F2 - Best Practice Water Management

The best practice water management proposed for the proposed Tarrone power station site involves:

- The separation and diversion of stormwater from off site around the site so it is unimpacted;
- The collection of potentially oil impacted stormwater and off site disposal as PIW to prevent off site impacts;
- The segregation of unimpacted stormwater and discharge via a retarding basin with controlled discharge to prevent hydraulic impacts;
- The treatment of potentially impacted stormwater in a sedimentation pond before discharge off site to minimise impacts from sediment;
- The potential use of roof water on site;
- The protection of the intermittent wetland;
- Worst case scenario for wastewater disposal addressed through a lined evaporation pond; and
- Evaporation ponds have been preferred for saline water disposal, other options are generally not economically or environmentally feasible.

The site stormwater systems design will be reconsidered in more detailed power station design states but it will be designed to meet the nominated objectives.

9.6.3 F3 - Impact on Waterway

The site will not impact the existing wetland as the development footprint is outside of the wetland catchment area. Furthermore, potential preventative measures in the form of bunding will be considered to if necessary divert any site runoff away from the wetland, preserving the natural inflow. .

The site is located in the Murray and Western Plains Segment of the *State Environment Protection Policy (Waters of Victoria)* [SEPP(WoV)]. The protected beneficial uses of waters in the Murray and Western Plains Segment are nominated in the SEPP(WoV). The corresponding water quality objectives and indicators nominated in the SEPP(WoV) for " lowlands of the Glenelg & Hopkins catchments, & Portland, Corangamite and Millicent Coast Basins" are the applicable quality criteria for the receiving environment.

The proposed best practice stormwater management system described in Section 9.6.1 and 9.6.2, and the significant distance to the identified receiving water (the Moyne River), should result in no impact on the protected beneficial uses of these waters.

9.7 G - Land and Groundwater

9.7.1 G1 - Discharge or Deposit to Land

There will be no intentional discharge or deposit of water or waste to land at the AGL Tarrone site, however, some oils, chemicals and wastewater will be stored on the site that will require appropriate storage to prevent impacts on land and/or groundwater.

Wastewater

Process wastewater is generated at the facility by the process of blow down from the evaporative inlet air coolers. The expected maximum volume of wastewater generated is 1.9 kL per hour per E Class turbine or 2.2 kL per hour per F Class turbine.

Water flows over baffles and air is drawn into the gas turbine inlet through the baffles. After traversing the baffles, the remaining water is collected in a sump and then recycled to the top of the baffles. Water is continually added to replace the evaporated water. As water evaporates there is an increase in the concentration of dissolved salts. To control this and to prevent scaling of the system (build-up of salts), some water is continually bled off or 'blown down' from the sump. The blow down rate is adjusted to keep the concentration of dissolved salts below the threshold for scaling to occur. The blow down water is collected in a pond and left to evaporate.

The volume of blow down water generated by the evaporative coolers depends on the number of hours the power station is operating, the number of turbines operating, operation of the evaporative cooling (as the turbines can operate effectively without the coolers on) and the ambient temperature and humidity. The annual volume of blow down water is therefore difficult to predict however, an estimate of 1,700 kL/year is estimated, based on 220 hrs turbine operation (all) with evaporative cooling on, to flow to the evaporation pond.

In addition, if pre-treatment of the evaporative cooler water supply is required, which is likely if groundwater is selected as the site water supply, then additional process wastewater streams will potentially discharged to the evaporation pond.

Pre-treatment may consist of iron removal and desalination (RO or EDR or ion-exchange), with effluent streams comprising filter backwash streams and desalination brines/concentrates/regeneration streams. An estimated additional 3,100 kL/a wastewater might be discharged to the evaporation pond in this case.

The process wastewater (cooling water blowdown, and should groundwater be used - brine, water treatment cleaning chemical solutions and sludge) will be piped from the plant into an evaporation pond. A water balance for water sourced from groundwater (Option 1) and water trucked/piped (recycled water via Shaw River) into site (Option 2) was undertaken to determine the indicative sizing. The pond was sized on rainfall data from a 90^{th} percentile (wet) year. The assumption was made that a wet year occurs only once every 10 years, and the other 9 years are of average rainfall. Thus the water in the pond at the end of the wet year would be evaporated over the following 9 years of average rainfall. The results are as follows:

Option 1:

- Inflow of 4752 kL/annum,
- Pond dimensions of 120 x 120 x 0.5 m, with an additional 1 m freeboard

Option 2:

- Inflow of 1664 kL/annum,
- Pond dimensions of 70 x 70 x 0.5 m, with an additional 1 m freeboard

The evaporation pond will not discharge to surface water, and discharge to land and groundwater will be prevented by use of an appropriate liner system, discussed in Section 9.7.2.

Sewage

A small amount of wastewater will be generated by personnel on-site. This is estimated to be less than 1 tonne per annum (estimates derived from Somerton peaking power station). Sewage from the amenities on-site may be directed to an on-site proprietary wastewater system. Alternatively, a storage and pump system could be used to dispose of domestic wastewater off-site at an appropriately licensed facility.

Oils and Chemicals

Oil containing equipment, namely the turbines and transformers will be present on site, as will some fuel and chemicals associated with water treatment.

In addition to the oil in the generators and transformers, a diesel fuel tank of 5,000 – 10,000 L capacity is proposed on site to supply diesel to the back-up generator set in the event of an interruption to the electricity supply from the grid. The diesel tank will be sufficiently bunded according to the EPA's *Bunding Guidelines.*

The type and quantity (package or bulk) of water treatment chemicals to be stored and used on the site has not been defied yet and will depend largely on the selected water treatment system (if any). The types of chemicals are most likely acids and alkalis.

Packaged chemicals will be stored within a storage room in the main onsite building.

9.7.2 G2 – Best Practice Land and Groundwater Management

The best practice land and groundwater management proposed for the proposed Tarrone power station site involves:

Evaporation Pond Liner:

A pond liner will be required to avoid contamination of surface water, soil and groundwater. A composite pond liner is proposed. The liner may consist of a High Density Polyethylene (HDPE) geomembrane placed over 1m of compacted clay, to achieve a minimum combined permeability of $1x10^{-9}$. This is a preferred choice over a solitary clay liner, to minimise the potential for cracking of the clay liner and to define the boundary between sediment and liner, thus assisting cleaning of sediments. The final liner design will be reconsidered in further design stages, understanding however that it will meet the EPA's permeability requirements.

The pond will be designed to have at least a 1m freeboard above pond top water level.

Sewage

An EPA onsite wastewater system suitable for site specific conditions will be installed.

Transformer, Fuel and Chemicals Bunding

The transformers and diesel fuel tank will be separately bunded in accordance with *AS1940: The Storage and Handling of Flammable and Combustible Liquids (Publication No 347),* consistent with the EPA *Bunding Guidelines*. The gas turbine generators have integral spillage control within the turbine enclosures. The bunds for both the transformers and gas turbines will be constructed of reinforced concrete with capacity sufficient to contain the entire oil inventory in addition to a suitable allowance for stormwater. Further, the bunds will be fitted with a level alarm that will indicate the presence of liquid in the bottom of the bund. This will be set at the level allowed for stormwater accumulation to ensure that the bund is drained of uncontaminated stormwater when required and there is always sufficient containment capacity in the event of an oil leak. The alarm will occur in the on-site control room, and also in a remote control room that is attended 24 hours a day. The bund drain valves will normally be locked closed. If bund water is deemed oily by visual inspection it will be removed by eductor truck and treated as prescribed waste.

The packaged chemicals storage room and any chemical storages associated with water treatment will all have appropriately concrete (and if necessary coated) bunds designed to be consistent with the EPA *Bunding Guidelines* and the relevant Australian dangerous goods storage and handling standards.

9.7.3 G3 - Impact on Groundwater

As identified previously, discharge to land or groundwater is not proposed, and therefore impact is not anticipated. The wastewater evaporation pond will have adequate freeboard and a suitable liner. Adequate and appropriate spillage control and secondary containment will be provided for all chemical and oil storage at the facility. Such measures will be consistent with the requirements of the EPA's *Bunding Guidelines (Publication No 347, 1992)*. Materials that are classified as Dangerous Goods will be stored and handled in accordance with the requirements of the *Dangerous Goods (Storage and Handling) Regulations 2000*.

There have been no investigations of soil and/or groundwater quality beneath the site. A review of the regional hydrogeology, discussed in Section 9.2.7, indicates that the total dissolved solids (TDS) concentration of the groundwater beneath the site would be expected to be in the range 850 mg/L to 2000 mg/L (refer to Table 9-4). The corresponding groundwater segments of the applicable *State Environment Protection Policy (Groundwaters of Victoria)* SEPP(GoV) are B (most likely) or A2. The protected beneficial uses of waters in these segments are nominated in the SEPP(GoV). The corresponding groundwater quality objectives and indicators nominated in the SEPP(GoV) for the relevant segment are the applicable quality criteria.

9.8 H - Noise Emissions

9.8.1 H1 - Noise Emissions

The sound power levels (SWL) of equipment that have been identified as the primary on-site noise sources have been provided by turbine manufacturers to AGL in octave frequency bands between 31.5 Hz and 8 kHz. These levels represent the noisiest type of engine which could be selected for each of the two different turbine configuration options and thus represent worst case scenario. This assumption is consistent for the associated transformer and substation configurations ie the F Class configuration of three 330 MVA transformers reactors and one 600MVA transformer is a reasonable worst case scenario relative to the alternate E Class configuration of four 200 MVA transformers and one 600MVA transformer configuration. The sound power levels presented in Table 9-11 have been input into the noise model.

Table 9-11 Sound Power Levels – Operational Equipment

Operational Noise Source		Estimated Overall Sound Power Level[1]	
		dB(Lin)	dB(A)
Inlet System (silencer included)	Inlet Ducting (filter house included)	107	95
	Inlet Filter Face	117	107
GT Power Train Package	Accessory Unit	111	103
	Inlet Plenum	104	103
	Turbine Compartment (acoustic enclosure)	113	107
	Exhaust Diffuser (acoustic enclosure)	119	106
	Load Compartment	114	105
	Liquid Fuel & Atomising Air (LF/AA) Module	111	103
Vent Fans	Turbine Compartment Vent Fans	112	104
	Exhaust Compartment Vent Fans	113	102
Transformers	330 MVA Transformers (3 of)	113	104
Exhaust Stack[1]	Stack Body	-	105
	Stack Opening	-	108
Substation (500 kV)	Reactors (4 of)	-	106[2]
	Transformer (1 x 600 MVA)	111	103

Notes:
1. Sound power level of the exhaust stack has been estimated based on the maximum cumulative sound power level the site can generate in order to met the noise limits. To ensure the compliance with the noise limit, the sound power level of exhaust stack opening and body combined should not exceed 110 dB(A).
2. Estimated based on AS/NZS 60076.10:2009 – Power Transformers: Determination of sound levels.
3. All manufacturer sound power levels were supplied to URS by AGL.

Table 9-12 shows the cumulative octave band sound power levels of the equipment listed in Table 9-11.

Table 9-12 Overall Sound Power Levels

Overall Level, L_{eq}		Octave Band Centre Frequency, Hz Sound Power Level, dB(Lin) L_{eq}								
dB(Lin)	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
128	118	123	124	120	115	113	110	113	109	105

Noise Sensitive Receptors

The nearest potentially affected noise sensitive receptor locations have been identified from examination of aerial photographs using Google Earth Pro (2009) and a site inspection conducted in December 2008 are detailed in Table 9-13.

Table 9-13 Nearest Potentially Affected Noise Sensitive Receptor Locations

Receptor	Address	Approx. Distance from Gas Turbines	Nearest Site Boundary
A	Riordans Road	2250 m	SW
B	386 Tarrone North Road	1750 m	NE
C	426 Tarrone North Road	1550 m	NE
D	473 Tarrone North Road	1700 m	E
E	573 Tarrone North Road	2050 m	SE
F	589 Tarrone North Road	2250 m	SE
G	574 Tarrone North Road	1950 m	SE
H	760 Tarrone North Road	3100 m	SE

Figure 2 shows the location of these receptors described above, together with a reference 2 kilometre radius circle from the centre of the site.

9.8.2 H2 - Best Practice Noise Management

The exhaust stack, air inlets and turbine acoustic enclosures will be designed to achieve overall compliance with the EPA requirements specified in Table 9-11. Noise mitigation measures for the primary components of the proposed gas turbines are:

- acoustic enclosure of turbine compartments consists of two layers of 2 mm thick steel outer plate, 75 mm thick rockwool insulation and perforated steel inner plate
- acoustic enclosure of exhaust diffusers consists of two layers of 4 mm thick steel outer plate, 150 mm thick rockwool insulation and 4 mm thick steel inner plate
- silencing on the inlet system is an 8 foot long parallel acoustic baffle

The sound power levels shown on Table 9-11 assume the application of the aforementioned mitigation measures. The details of the noise mitigation measures have been determined in consultation with AGL and suppliers. The mitigation measures proposed by AGL are considered to be best practice for the mitigation of noise from a peaker power station.

9.8.3 H3 - Noise Impact

A noise impact assessment was undertaken to determine likely noise issues pertaining to the operation of the proposed Tarrone power station. The assessment of potential noise impacts of the facility, on surrounding noise sensitive receptor locations, has been carried out in accordance with relevant Victoria EPA noise guidelines. In order to ascertain the appropriate guidelines for use in the noise assessment, the existing acoustic environment must be determined.

Existing Acoustic Environment

Noise measurements have been conducted by long-term unattended monitoring and short-term attended monitoring at selected noise sensitive receptors. Noise monitoring locations were chosen after examination of satellite imagery of the locality and a site inspection.

Consideration was given in selecting the monitoring locations to enable unattended long-term noise monitoring to establish the representative noise trend at the nearest receptors. The locations were also chosen so that the noise loggers would not have been affected by extraneous noise (e.g. cattle, pumps, etc) which could result in unrepresentative elevated background noise levels.

The two nearest noise sensitive receptor locations to the site were selected for the long-term noise monitoring, and several short-term attended locations were chosen to supplement the long-term noise monitoring. These locations are considered representative of the most potentially affected noise sensitive receptor locations near the site. The results of the background noise monitoring are presented in Section 3 of Appendix B.

Long term un-attended noise measurements were conducted at:

- Location D: 473 Tarrone North Road, located approximately 1,600 metres to the north-east of the proposed location of the gas turbines on site. This location was used for long-term unattended noise monitoring to obtain background noise levels representative of Locations B, C and D.
- Location G: 574 Tarrone North Road, located approximately 1,800 metres to the south-east of the proposed location of the gas turbines on site. This location was utilised for long-term unattended noise monitoring to obtain background noise levels representative of Locations A, E, F, G and H.

Short-term attended noise measurements were conducted at Locations A, B, C, E and F. Background noise levels at these locations have found to be similar to those at Locations D, G, and H.

Considering the sound sources in the vicinity of these receptors, background noise levels obtained from Locations D and G have been adopted to establish noise limits of the operation of the proposed Tarrone power station. Table 9-14 presents a summary of overall ambient and background noise levels and at each monitoring location.

Table 9-14 Summary of Measured Noise Levels

Location	Background Noise Level (BL) L_{A90} dB(A)		
	Day	Evening	Night
D: 473 Tarrone North Road	31	28	25
G: 574 Tarrone North Road	33	29	24

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Victoria EPA Interim Guidelines N3/89

Rural areas often have very low background noise levels. While ideally noise from new activities should not be significantly higher than the existing background, N3/89 recognises that this is often not practicable to achieve. The Guidelines provides the following minimum noise limits.

Table 9-15 N3/89 minimum noise limits

	Day	Evening	Night
Background noise level (L_{A90})	< 30 dB(A)	< 30 dB(A)	< 25 dB(A)
Noise limit (L_{Aeq})	45 dB(A)	37 dB(A)	32 dB(A)

Notes: See Appendix B for Time of Day

Given that the measured background noise levels were close or below to the "very low" threshold, it is appropriate to apply the minimum noise limits in all locations. SEPP N-1 provides a procedure for adjusting noise levels for special audible characteristics such as tonality and impulsiveness.

The Guidelines do not specify which acoustic descriptor (e.g. L_{Aeq}, L_{A10}, or L_{Amax}) should be used to describe the noise limits. However, use of the L_{Aeq} is consistent with the requirements set out in the Victoria EPA SEPP No.N-1.

Table 9-16 summarises the selected operational noise criteria applicable to all receptor locations.

Table 9-16 N3/89 Operational Noise Limit

Receptor Locations	Operational Noise Limit $L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night
A, B, C, D, E, F, G & H	45	37	32

Notes: See Appendix B for Time of Day

Victoria EPA Draft Guidelines – NIRV

SEPP N-1 is the statutory policy for industry noise in the Melbourne metropolitan region. It sets allowable noise levels based on the land zoning and the background sound levels in that area.

The EPA last released guidelines for rural industry noise in 1989 (N3/89), which set low noise levels to be met in very quiet rural areas and describe areas where the methodology of SEPP N-1 should be applied to set recommended levels. However, the guidelines have not provided certainty about the appropriate noise levels in other areas, such as industrial zones in smaller towns, or in the outskirts of Melbourne and major regional centres.

The draft NIRV addresses gaps in the existing Guidelines and will provide greater certainty and transparency in the setting of appropriate noise levels for industry. The draft NIRV will supersede the N3/89 when issued in its final form.

The noise limits for each period are 45 dB(A) for day, 37 dB(A) for evening and 32 dB(A) for night.

It also states that the recommended noise limits will become 3 dB less than the above limits if the industrial premises on an allotment greater than 10 ha in any zone where expansion of the industrial premises is likely to happen.

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Table 9-17 presents the NIRV noise limits according to the steps explained above.

Table 9-17 NIRV Operational Noise Limit

Receptor Locations	Operational Noise Limit $L_{Aeq,15min}$ dB(A) No Site Expansion in future			Operational Noise Limit $L_{Aeq,15min}$ dB(A) Site Expansion in future		
	Day	Evening	Night	Day	Evening	Night
A, B, C, D, E, F & G	45	37	32	42	34	29
Notes: See Appendix B for Time of Day						

Comparison of N3/89 and NIRV Noise Criteria

Table 9-18 presents comparison of noise criteria established in accordance with N3/89 and NIRV respectively.

It can be seen that, on the basis that AGL does not propose future expansion to the facilty, both N3/89 and NIRV criteria are identical,

Table 9-18 Noise Criteria: N3/89 and NIRV

Guideline	Day	Evening	Night
N3/89 Noise Criteria $L_{Aeq,15min}$ dB(A)	45	37	32
NIRV Noise Criteria $L_{Aeq,15min}$ dB(A) – No site expansion in future	45	37	32
NIRV Noise Criteria $L_{Aeq,15min}$ dB(A) – Site Expansion in future	42	34	29
Notes: AGL does not propose any expansion to the project site.			

Sleep Disturbance

An assessment of sleep disturbance for the potentially affected noise sensitive receptors has also been considered in this study. Where there exists the possibility that instantaneous, short-duration, high-level noise events may occur during night-time hours (10.00 pm – 7.00 am), consideration should be given to the potential for the disturbance of sleep within residences.

The relevant legislation suggests that the equivalent noise level (L_{eq}) and maximum noise level (L_{max}) inside bedroom should be limited to 30-35 dB(A) and 45 dB(A) respectively. To achieve the internal noise levels described above, the noise levels outside bedroom windows (given noise reduction through partially opened windows is estimated to be 10 dB(A)), should be limited to 45 dB(A) L_{Aeq} and 55 dB(A) L_{Amax} respectively. However, the 45 dB(A) L_{Aeq} noise limit is supplanted by the more stringent 32 dB(A) L_{Aeq} limit established above for the night-time period.

Noise Emission Modelling Results

Noise levels for the proposed operation of the site at the identified noise sensitive receptor locations have been predicted using an acoustic computer model created in SoundPLAN Version 6.5 which, is internationally recognised, including by regulators and authorities throughout Australia. The program allows the use of various noise prediction algorithms. To calculate noise emission levels under neutral and adverse meteorological conditions, the CONCAWE algorithm has been used. The CONCAWE method was especially designed for the requirements of large industrial facilities such as petroleum and petrochemical complexes, and is now the principal prediction method used in Australia and widely used for calculating noise emissions from all types of industrial facilities. CONCAWE, where prevailing winds and meteorological conditions do not fit normal conditions that are assumed in some other alternate calculation methods, provides complex calculation methods in predicting noise levels under the influence of wind and the stability of the atmosphere as well as ground effects.

The noise model took into account:

- sound power levels of each source;
- receptor locations;
- screening effects due to topography;
- meteorological effects and attenuation due to distance; and
- ground and atmospheric absorption.

The noise calculations have been carried out using the L_{Aeq} descriptor to assess the operational and construction noise impacts.

Additional noise modelling has been carried out using ISO9613 (Part 2) calculation method, available within SoundPLAN, for comparison with the results generated by CONCAWE method. A key difference between the CONCAWE method and the ISO method is that the later assumes source-to-receptor wind direction compared to the former which takes into account the area's prevailing wind conditions.

Throughout the assessment, typical and 'worst-case' factors have been taken into consideration. The noise modelling has been conducted based on likely maximum operating conditions for each turbine option.

In setting-up the noise model, all pre-defined sources were positioned according to the proposed site layout in the respective noise model. The precise positioning of the sources was not found to cause any significant uncertainty. The following assumptions were also made in the noise modelling:

- Each noise generating activity operates continuously; and
- All the activities (listed in Table 9-11) occur simultaneously.

The noise modelling results using the CONCAWE calculation method with neutral and adverse meteorological conditions are presented in Table 9-19 (refer to Appendix B Table 5-3 for a summary of each meteorological scenario).

Table 9-19 Predicted Operational Noise Levels (CONCAWE Calculation Method)

Receptor Location	Predicted Noise Levels (L_{Aeq}) dB(A)		Criterion (L_{Aeq}) dB(A)		Exceedance
	Neutral Met Conditions (Scenario 1 & 2)	Adverse Met Conditions (Scenario 3 & 4)	Day (Scenario 1 & 3)	Evening & Night (Scenario 2 & 4)	
A	24	19 (3) / 21 (4)	45	37 / 32	No
B	28	33 (3) / 28 (4)	45	37 / 32	No
C	29	33 (3) / 32 (4)	45	37 / 32	No
D	26	30 (3) / 31 (4)	45	37 / 32	No
E	24	21 (3) / 29 (4)	45	37 / 32	No
F	< 20	< 20	45	37 / 32	No
G	25	21 (3) / 30 (4)	45	37 / 32	No
H	< 20	15 (3) / 24 (4)	45	37 / 32	No

Notes:
Results in bold represent the exceedance of the respective noise limit.
Scenario 1: Daytime operation under neutral meteorological conditions.
Scenario 2: Evening & Night-time operation under neutral meteorological conditions.
Scenario 3: Daytime operation under adverse meteorological conditions.
Scenario 4: Evening & Night-time operation under adverse meteorological conditions.

The noise modelling results using the ISO9613 calculation method with neutral and adverse meteorological conditions are presented in Table 9-20

Table 9-20 Predicted Operational Noise Levels (ISO9613 Calculation Method)

Receptor Location	Predicted Noise Levels (L_{Aeq}) dB(A)		Criterion (L_{Aeq}) dB(A)		Exceedance
	ISO Conditions (Day - Scenario 5)	ISO Conditions (Evening/Night - Scenario 6)	Day	Evening & Night	
A	28	28	45	37 / 32	No
B	29	30	45	37 / 32	No
C	31	31	45	37 / 32	No
D	28	28	45	37 / 32	No
E	28	28	45	37 / 32	No
F	< 20	< 20	45	37 / 32	No
G	28	28	45	37 / 32	No
H	24	24	45	37 / 32	No

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The results presented in Table 9-19 and Table 9-20 show that the predicted noise levels generated by the proposed operation would be within the established noise criteria at all receptor locations under all conditions. Given that the power station is a peaking plant and the meteorological conditions that could adversely affect the noise levels are expected to occur less than 15 per cent of time, the operational noise levels would generally be below the levels predicted for Scenarios 3 and 4.

Comparing the results using the CONCAWE calculation method (Table 9-19) with the ISO results (Table 9-20), they predict similar noise levels (variation 1 to 3 dB) at all receptor locations, with the minor variations primarily due to the different wind direction settings used in each calculation method.

It should be noted that N3/89 and the draft NIRV are not mandatory and the application of noise limits is for guidance only. In very low background noise and adverse meteorological conditions, the site operation may just be audible at Locations C and D at night time, but as previously identified the predicted noise levels would be below the measured ambient noise levels and would not exceed the criteria.

Therefore, further noise mitigation measures beyond those already proposed by AGL (Appendix B) are not considered necessary.

Noise from the proposed operation is constant in nature and therefore, during the night-time period the levels are expected to be significantly below 55 dB(A) L_{Amax} at all receptor locations. Therefore, the operation is not predicted to give rise to sleep disturbance.

Off-Site Traffic Noise

The ongoing operation of the power station will generate significantly less traffic than the construction phase of the project. During the operational phase, staff levels are expected to average up to five full time persons on site generating approximately ten car trips per day. The increase in traffic from the daily operation of the power station is accounted for in the general growth in traffic for the region. An increase in traffic volumes is expected during periodic maintenance activities which would take place every 2 to 3 years.

Compared to the existing traffic volumes, the proposed traffic volumes generated by the development will be insignificant.

Low Frequency Noise

Low frequency noise is usually defined as sound between 20Hz and 200Hz (frequencies below 20Hz are considered to represent infrasound). In the absence of specific guidelines to assess low frequency noise for Victoria, a review was conducted of appropriate guidelines to assess potential low frequency noise impacts. A wide range of guidelines and references were reviewed including the *NSW Industrial Noise Policy* (INP, NSW EPA, 2000), *A Review of Published Research on Low Frequency Noise and its Effects* (Report for Department for Environment, Food and Rural Affairs [DEFRA] UK by Dr Geoff Leventhall, 2003) and *A Noise Limit on Low Frequency Noise Emission due to Power Plants* (N. Broner, 2008)

The NSW INP recommendations for low frequency noise involve an assessment to be conducted on the difference between C and A weighted levels. The most common frequency weighting in current use is “A-weighting” providing results usually denoted as dB(A), and approximates the response of the human ear at low sound levels. An alternative “C-weighting” curve is often used when evaluating loud or low-frequency sounds. The INP states that if a 15 dB difference exists between the A and C weighted levels, a correction of - 5 dB is to be applied to the noise limit. This approach provides an assessment for potential for low frequency noise.

However, recent international research has shown that the use of this difference approach is not suitable when the noise levels are tend towards the lower end of the range of low frequencies, since the low frequencies may then be below the threshold of hearing levels (Leventhall, 2003). Current research suggests that (dB(C) – dB(A)) difference should not be used as an annoyance predictor, but as a simple indicator of whether further investigation may be necessary (*Low Frequency Noise and Annoyance*, Noise & Health 2004, 6:23, 59-72). DEFRA developed a procedure to assess low frequency noise as follows:

- Take measurements of L_{eq}, L_{10} and L_{90} in third octave bands between 10 Hz and 160 Hz.
- If the L_{eq}, taken over a time when the noise is said to be present, exceeds the values in a specified low frequency reference curve (Table 4-5 of Appendix B), it may indicate a source of low frequency that could cause disturbance. The character of the sound should be checked if possible by playing back an audio recording at an amplified level.
- If the noise occurs only during the day, then 5 dB relaxation may be applied to all third octave bands.
- If the noise is steady, then a 5 dB relaxation may be applied to all third octave bands. A noise is considered steady if either of the conditions a) or b) below is met:
  - a). $L_{10} - L_{90} < 5$ dB
  - b). the rate of change of sound pressure level (Fast time weighting) is less than 10 dB per second

  where the parameters are evaluated in the third octave band which exceeds the reference curve values (Table 4-5 of Appendix B) by the greatest margin.

For protecting residential areas against potential low frequency noise issues caused by combustion turbine open cycle plants, Hessler (*Proposed Criteria for Low Frequency Noise from Combustion Turbine Power Plants*, Noise – Con 2004, Baltimore, Maryland, G. F. Hasseler Jr, 2005) proposed C-weighted levels supplementary to the A-weighted site criteria as follows:

- For intermittent daytime only or seasonal source operation:
  - 70 dB(C) for normal suburban/urban residential areas, where background level (L_{A90}) is higher than 40 dB(A),
  - 65 dB(C) for quiet suburban or rural residential areas, where background level (L_{A90}) is lower than 40 dB(A), and
- For extensive or 24/7 source operation:
  - 65 dB(C) for normal suburban/urban residential areas, where background level (L_{A90}) is higher than 40 dB(A),
  - 60 dB(C) for very quiet suburban or rural residential areas, where background level (L_{A90}) is lower than 40 dB(A),

9 EPA Application Sections A to I

Other identified guidelines relating to acceptable low frequency noise levels included:

- ANSI S12.9 – 2005/Part 4 indicates that annoyance is generally minimal when octave band sound levels are less than 67 dB(C) and less than 72 dB(C) to prevent the likelihood of noise-induced rattles.
- The US Oregon State Noise Control Regulations for industrial and commercial noise sources suggest the allowable low frequency noise level for the night-time period (10 pm – 7 am) to be 65 dB(C) and for the daytime period (7 am – 10 pm) to be 68 dB(C).
- In a review of recent international research, including some of the aforementioned papers, Dr. Broner (A Noise Limit on Low Frequency Noise Emission due to Power Plants, 2008) suggested a low frequency noise criterion of Leq 65 dB(C) – 70 dB(C) for residential locations.

The proposed Tarrone power station would operate intermittently, there will be a seasonal component (associated with peak electricity demand) to its operation, and it is proposed to be located in a rural area with background noise levels below 40 dB(A). Therefore, it is considered that L_{eq} 65 dB(C) is the most appropriate criterion to adopt for a low frequency noise assessment for this project. For practical purposes this is taken to be sound from the 25Hz third octave band to the 200Hz third octave band.

We note that this criterion is consistent with that imposed for AGL's most recently approved power station development in Leafs Gully, NSW. The Leafs Gully power station is to be located in a rural area where background noise levels are similar to those of Tarrone. As part of the impact assessment process, relevant overseas research related to assessment of the potential for low frequency noise impact was reviewed. As discussed previously within this section, the research indicated that the use of the approach provided in the NSW Industrial Noise Policy (INP) is not suitable when the predicted resultant noise levels are low. NSW Department of Planning was satisfied with AGL's assessment methodology proposed for the project that a noise level not greater than 65 dB(C) is unlikely cause low frequency noise annoyance impacts at sensitive receptors. Accordingly, the Department concluded that the 5 dB(A) adjustment to the noise criteria is only to be applied if the difference between the C and A-weighted noise levels is greater than or equal to 15 dB when the measured noise levels is greater than 65 dB(C).

To assess potential low frequency noise impacts, C-weighted noise levels of octave band frequency between 31.5 Hz and 8 kHz were predicted by noise modelling using SoundPLAN. The predictive noise modelling by SoundPLAN estimated the noise levels (C-weighed) at the receptors and a comparison with the assessment criteria is presented in Table 9-21.

It is noted that sound power levels of frequencies below 31.5 Hz were not available and are beyond the range of the modelling software. To address this, the contribution of sound at lower frequencies to the C-weighted noise levels at each receptor location, based on indicative turbine spectra, was estimated. Whilst attenuation of noise levels in 31.5 Hz to 8 kHz octave band frequencies are dependent upon some factors such as air absorption, ground absorption or screening, attenuation of noise levels in frequencies below 31.5 Hz would primarily be due to geometrical spreading, i.e. attenuation mostly due to distance, with little adjustment due to air/ground absorption or screening.

Table 9-21 presents C-weighted noise levels predicted using SoundPLAN for 31.5 Hz to 8 kHz octave band frequencies as well as the estimated levels considering lower frequencies (down to 20 Hz) based on indicative turbine spectra.

Table 9-21 Predicted Operational Noise Levels (C-weighted)

Receptor Location	Predicted Noise Levels (L_{eq}) dB(C)		Criterion (L_{eq}) dB(C)	Exceedance
	31.5 Hz – 8 kHz CONCAWE / ISO9613	20 Hz – 8 kHz ISO9613[1]		
A	37 / 50	60	65	No
B	45 / 45	62		
C	47 / 48	63		
D	45 / 48	62		
E	44 / 47	61		
F	28 / 36	60		
G	44 / 47	61		
H	38 / 45	57		

Note: 1. Noise attenuation below 31 Hz would primarily be due to geometrical noise propagation.

The analysis presented in Table 9-21 compared to the criteria indicates that low frequency noise would not be at a level to cause annoyance to the closest residential receivers. Accordingly, no adjustment to the A-weighted operational noise criteria is required.

Cumulative Noise Impacts – Shaw River Power Station

The predicted noise emission levels arising from the construction and operation of the proposed Shaw River Power Station (SRPS) and the Compressor Station (CS) presented in the Environmental Effects Statement [EES] Shaw River Power Station Project (March 2010) were reviewed for consideration of potential interactions between the proposals. The noise impact assessment present in the SRPS EES was undertaken by Sonus Pty Ltd (July 2009).

The SRPS site is to be located near Orford, approximately 4.5 kilometres to the west of the nearest receptor (Receptor A) considered in this assessment. The CS site is to be located approximately 8 kilometres to the south-east of the nearest receptor (Receptor F) considered in this assessment.

The noise levels estimated, based on the data present in the EES, due to the assumed concurrent operation of the SRPS and CS at the nominated receptors are as follows:

- Noise level at Receptor A is estimated to be less than 20 dB(A), and
- Noise level at Receptor F is estimated to be less than 15 dB(A).

The construction noise levels estimated due to SPRS and CS at the nominated receptors are as follows:

- Noise level at Receptor A is estimated to be less than 30 dB(A), and
- Noise level at Receptor F is estimated to be less than 25 dB(A).

Based on these estimated noise levels, it is concluded that the potential cumulative noise impact at the receptors A and F arising from construction or operation (at full load) of the AGL Tarrone Power Station (presented in Table 9-19, Table 9-20 and Table 8-3) at the same time as construction and/or operation of the proposed SRPS and CS would be negligible and not expected to increase the noise levels at these locations relative to the noise levels predicted to arise from operation of Tarrone Power Station alone.

Noise Assessment Findings

The assessment found that the adopted noise limits can be achieved with no further noise mitigation measures beyond those already proposed by AGL (including mitigation measures for the proposed stack).

No exceedances of the noise limit are predicted for activities relating to the construction of the power station that would occur during the day. The proposed operation of the facility is not expected to significantly degrade the existing acoustic environment nor generate community annoyance.

The predicted noise levels should be verified during commissioning, and in the unlikely event of any significant discrepancies from this assessment, there is scope to provide additional attenuation through measures such as acoustic enclosures and silencers with higher noise reduction rating.

On the basis of these conclusions, it is the finding of this assessment that the development should be acceptable with respect to noise generation.

9.9 I - Environmental Management

Non routine operations and monitoring requirements have been covered in Section 8.

10 Limitations

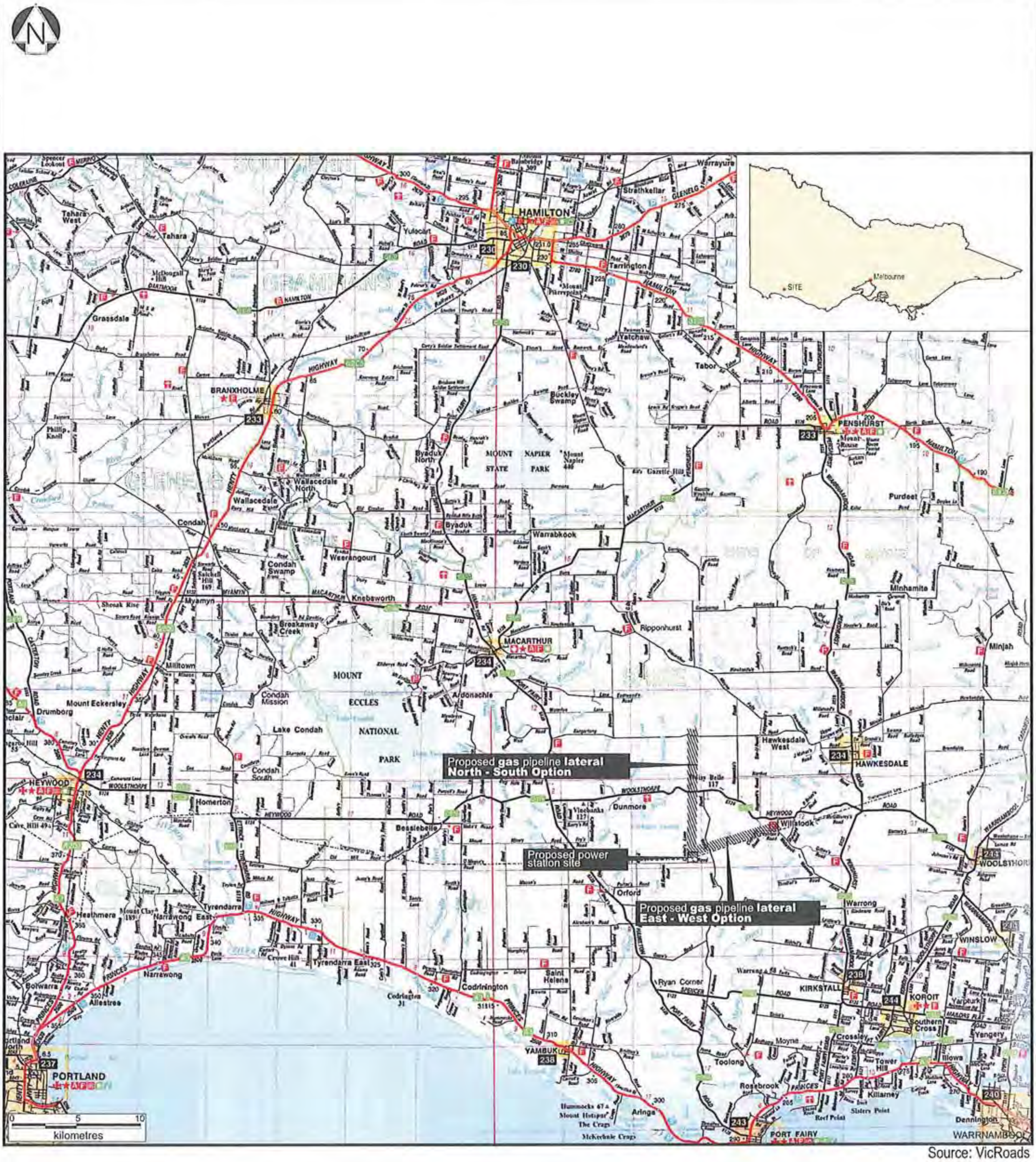
URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of AGL Energy Limited and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 20 October, 2008 and 18 February 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between March and August 2010 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Figures



Source: VicRoads

Client	Project	Title	
AGL ENERGY LIMITED	AGL TARRONE PROPOSED POWER STATION WAA	LOCALITY MAP	
URS	Designed: AR · Checked: · Date: June 2010 · File No. Fig1.cdr Drawn: LLB · Approved: · Status: Final · Job No.: 43283491	Figure: 1	Rev. A A4

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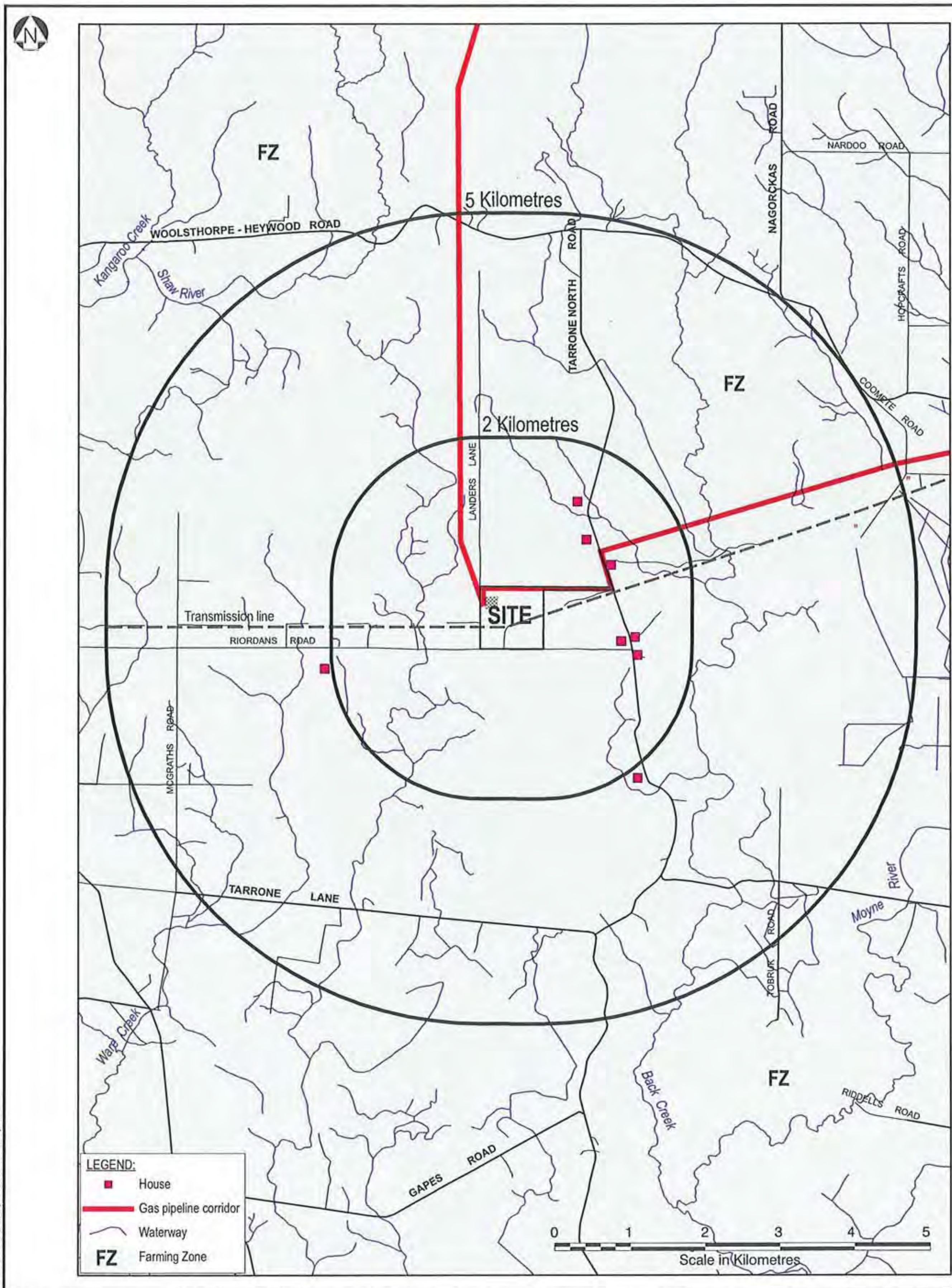

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AGL ENERGY LIMITED	AGL TARRONE PROPOSED POWER STATION WAA				LOCATION PLAN	
URS	Designed: AR	Checked:	Date: August 2010	File No. Fig 2.cdr	Figure: 2	Rev. A
	Drawn: LLB	Approved:	Status: Final	Job No.: 43283491		A4

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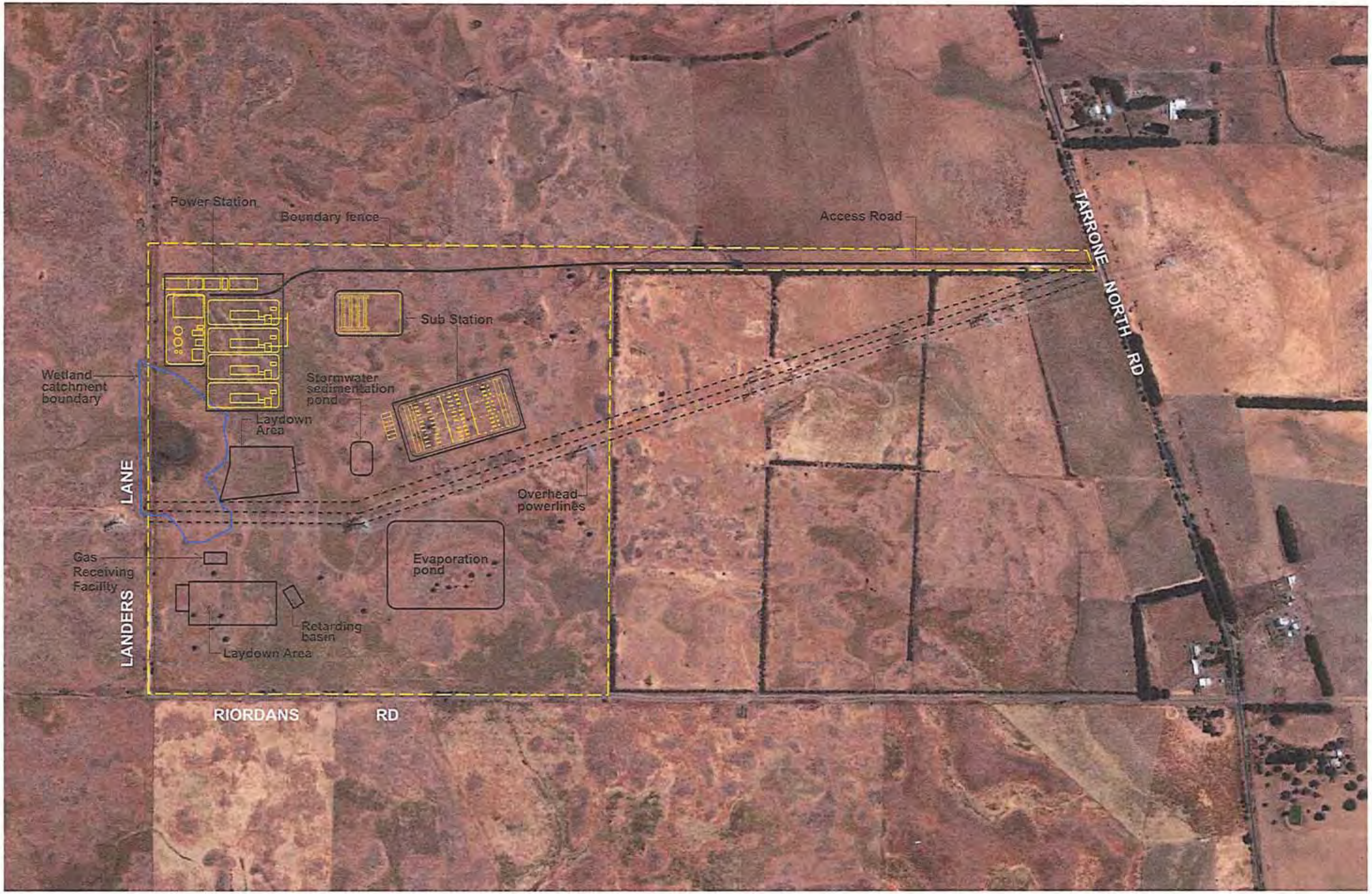

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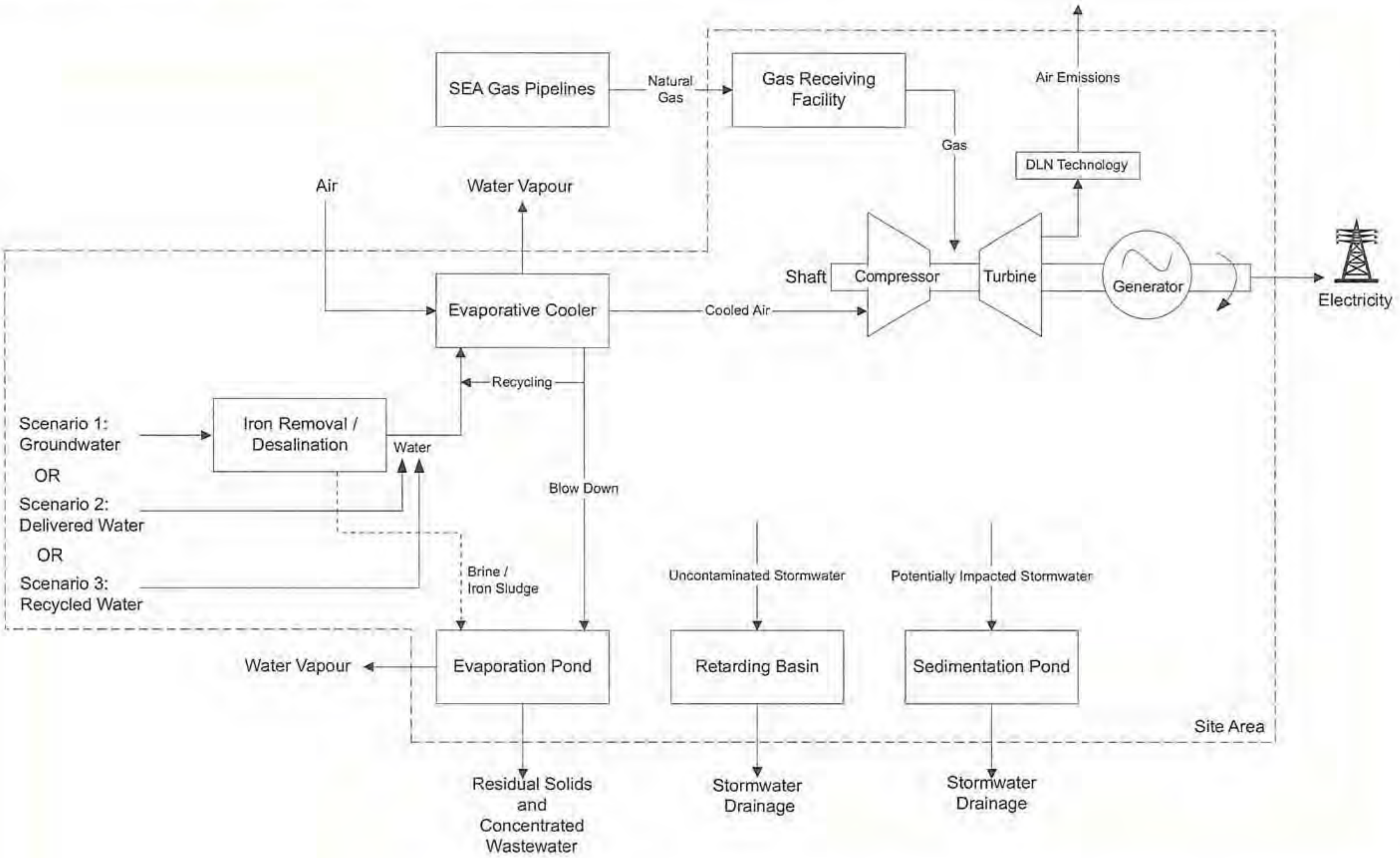
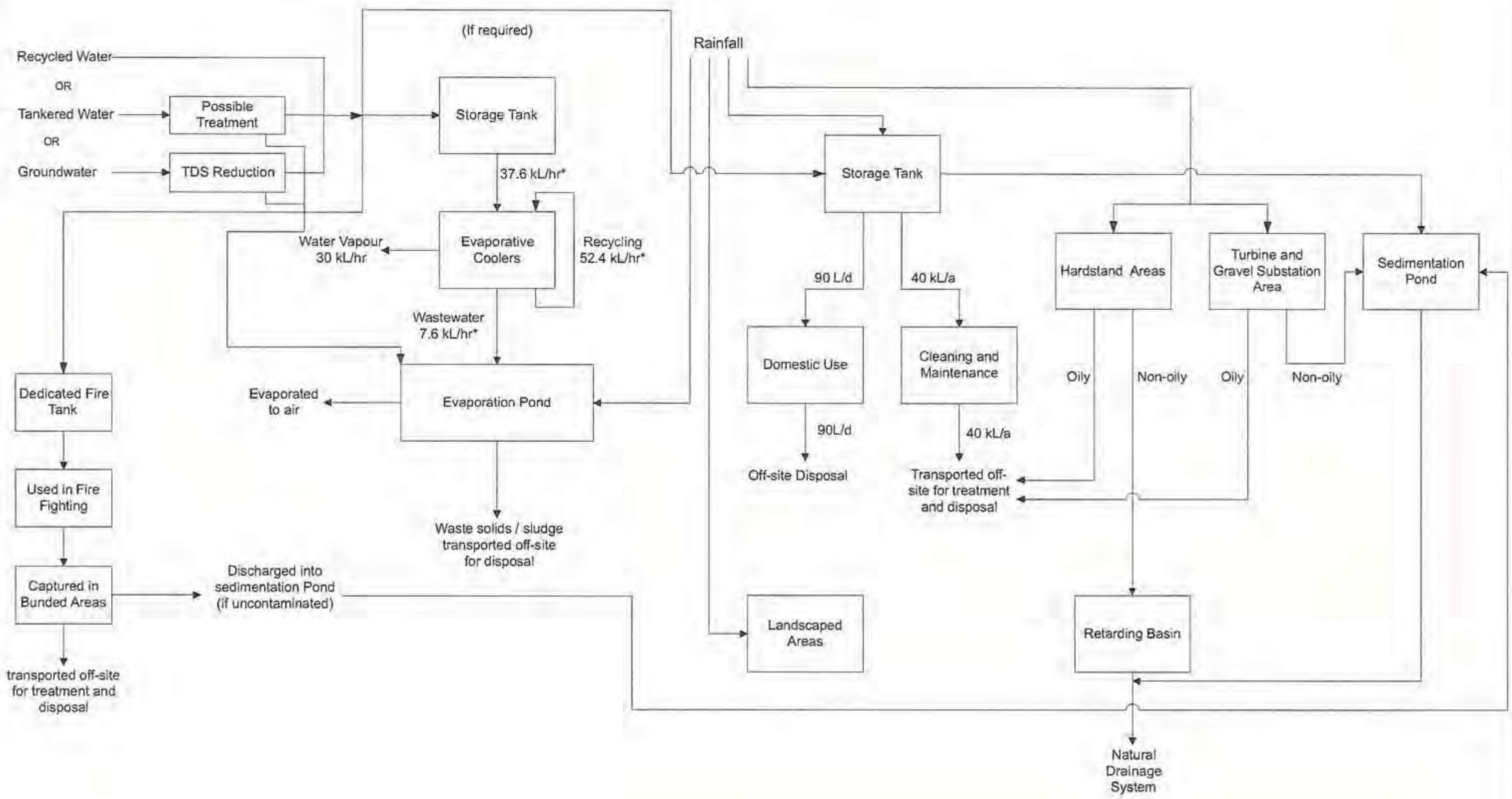
Scale in Metres

Client	Project				Title	
AGL ENERGY LIMITED	AGL TARRONE PROPOSED POWER STATION WAA				SITE PLAN	
URS	Designed: AR	Checked:	Date: June 2010	File No. Figure 3.cdr	Figure: 3	Rev. A
	Drawn: LLB	Approved:	Status: Final	Job No.: 43283491		A4

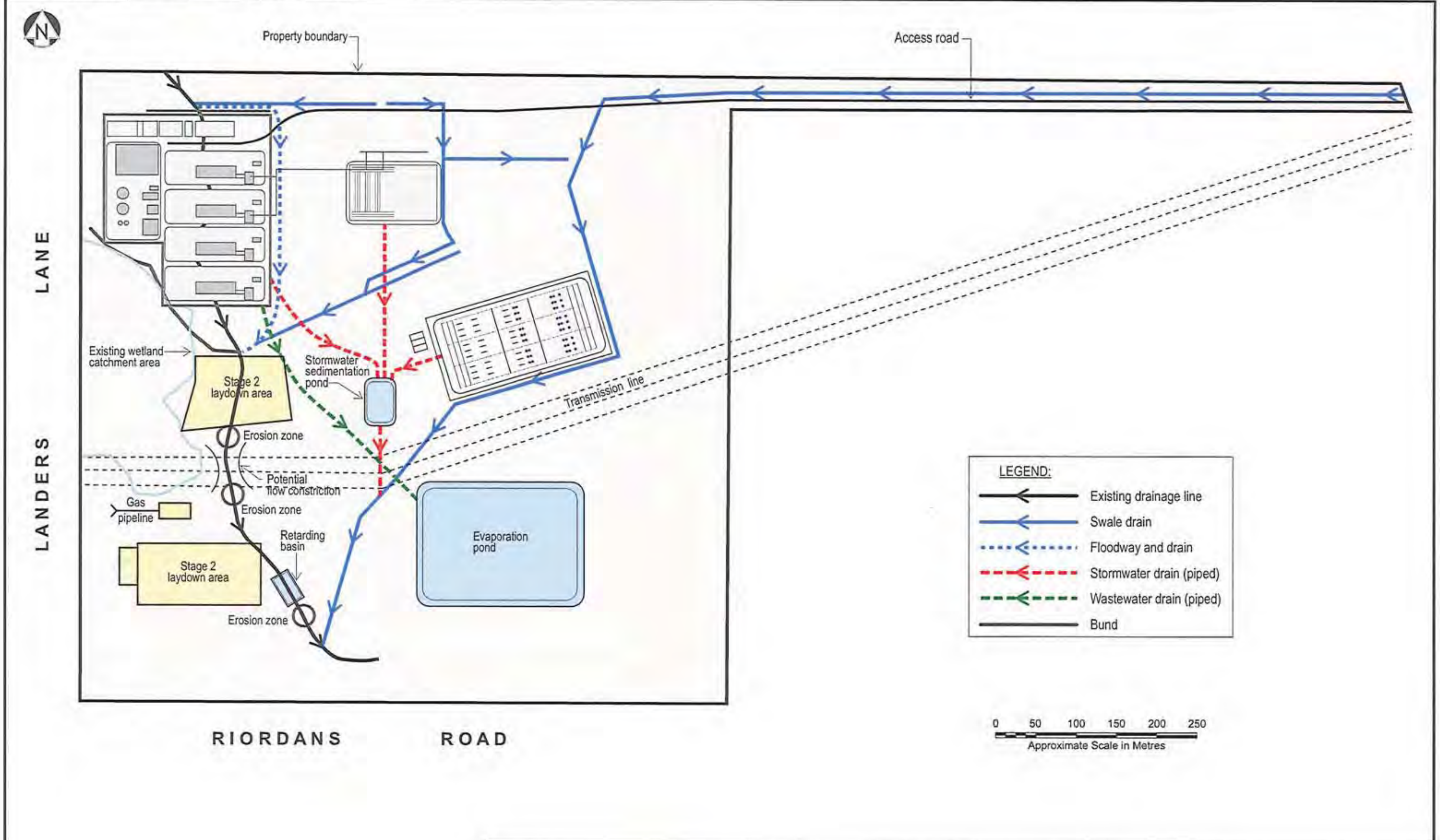


Client	Project	Title
AGL ENERGY LIMITED	AGL TARRONE PROPOSED POWER STATION WAA	**INDICATIVE PROCESS FLOW SCHEMATIC FULL DEVELOPMENT**
URS	Designed: AR; Checked: ; Date: June 2010; File No. Figure 4.cdr; Drawn: LLB; Approved: ; Status: Final; Job No.: 43283491	Figure: 4; Rev. A; A4



*Indicative flowrates when evaporative cooling operational

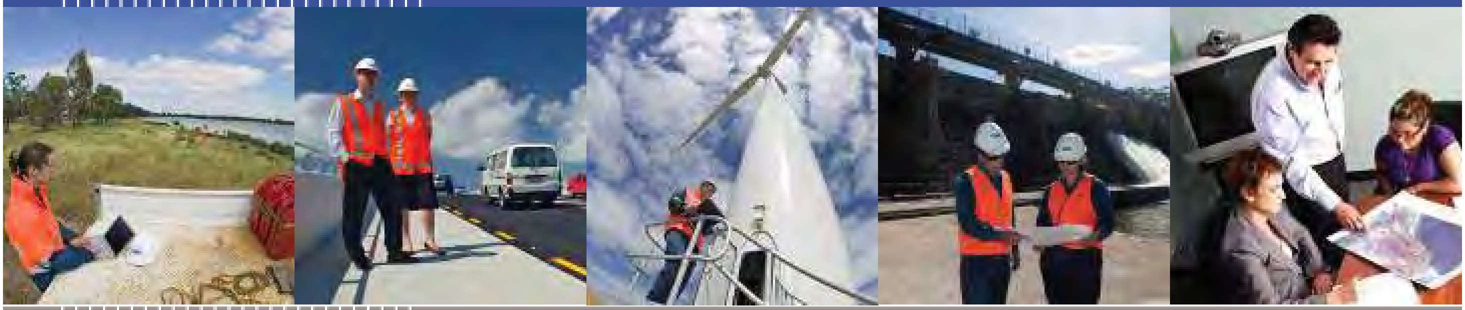
Client	Project	Title
AGL ENERGY LIMITED	AGL TARRONE PROPOSED POWER STATION WAA	WATER CYCLE
URS	Designed: AR; Checked: [signature]; Date: June 2010; File No. Figure 5.cdr; Drawn: LLB; Approved: [signature]; Status: Final; Job No.: 43283491	Figure: 5; Rev. A; A4



Client	Project	Title
AGL ENERGY LIMITED	AGL TARRONE PROPOSED POWER STATION WAA	STORMWATER MANAGEMENT PLAN
URS	Designed: AR; Checked:; Date: June 2010; File No. Figure 6.cdr; Drawn: LLB; Approved:; Status: Final; Job No.: 43283491	Figure: 6; Rev. A; A4

A

Appendix A Air Quality and Greenhouse Gas Assessment



Final Report

Local Air Quality and Greenhouse Gas

Tarrone Power Station

17 JUNE 2010

Prepared for

AGL Energy Limited

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43283491

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Introduction

AGL Energy Limited Pty Ltd (AGL) proposes the construction of a peak loading power plant near to Tarrone in south western Victoria. The proposed peak loading power plant will have a nominal operating capacity of approximately 720 MWh - 920 MWh, dependant on the final turbine configuration.

Two plant configurations are considered for the proposed Tarrone power station comprising of either four E class or three F class turbines operating in open cycle mode. At this stage in the design process, the final choice of engine manufacturer has not been determined, however five prospective manufacturers are being considered. In order to provide flexibility in the final choice of supplier, URS Australia Pty Ltd (URS), AGL's technical consultant has considered the:

- Local air quality impact; and
- Greenhouse gas emissions,

from the use of two engines representing typical emissions and impacts resulting from the use of E-Class and F-Class engines. The two proposed site designs considered by URS in this assessment are:

- 4 X Alstom 13E2 M; or
- 3 X GE Energy 9FA.

A discussion on the representativeness of the engines is provided in this assessment.

The impact on ambient air quality with respect to regulatory emission limits and ground level concentration criteria of the primarily gaseous emissions has been assessed by URS. The local air quality assessment involved atmospheric dispersion modelling and has been conducted in accordance with the *State Environment Protection Policy for Air Quality Management* (referred to herein SEPP(AQM)). The assessment of the impact of local air quality used a largely conservative approach, in accordance with the SEPP(AQM).

Local Environment

2.1 Site Location

The proposed Tarrone power station is located in the rural locality of Tarrone, in the Moyne Shire Local Government Area, in south-west Victoria. The site has been nominated as the proposed power station location due to its proximity to critical electricity and gas infrastructure, and the suitable distance of the site from the nearest residences.

A 500kV electrical sub-station would be located on the site to provide a connection to Victoria's electricity grid through the high-voltage Moorabool-Heywood transmission line that crosses the site and would service the Tarrone power station. The substation would also service the proposed Macarthur wind farm (should that project proceed).

An underground gas pipeline will provide a connection to the nearby high-pressure SEA Gas Pipeline (Port Campbell – Adelaide). The gas can be supplied at the pipeline pressure without the need for additional compression.

The site is relatively isolated providing adequate buffers, with the nearest residence approximately 1500 metres to the north-east.

2.2 Climate and Meteorology

Three Bureau of Meteorology sites are located close to the proposed site at:

- Mortlake Racecourse;
- Portland; and
- Warrnambool.

These data indicate that the region experiences moderately warm summers with average daytime temperatures around 25°C with occurrences of hot conditions to a maximum recorded temperature of 46°C. Average daytime winter temperatures are approximately 13°C with recorded night time minimums reaching lows of approximately -5°C.

Annual winds are found to occur from all directions, with northerly winds more frequent than other directions. During the summer, the afternoon is dominated by southerly winds indicative of a strong influence of sea breezes.

The area has an annual mean rainfall of approximately 550mm with, on average, 96 days of rain with greater than 1mm recorded.

2.3 Background Air Quality

To URS' knowledge, the area has no permanent background monitors in place for the measurement of ambient air quality. Background air quality has been measured in Warrnambool by EPA and Mount Gambier by the South Australian EPA.

2.3.1 Warrnambool Background Air Quality

EPA measured particulate concentrations and ozone in Warrnambool from October 2006 to October 2007. Warrnambool was found to have generally good air quality with high levels of particulate resulting in the objective for visibility being exceeded on 13 days and the PM_{10} objective on 3 days. The episodes of high particulate levels were attributed to bushfires in the north-east of Victoria and wood smoke from the use of domestic fires. Data on levels of $PM_{2.5}$, or other common anthropogenic species were not reported in this round of monitoring.

2.3.2 Mount Gambier Background Air Quality

The South Australian EPA measured background air quality in Mount Gambier at three sites from September 2001 to August 2002. Species monitored included:

- Nitrogen dioxide;
- Sulphur dioxide;
- Carbon monoxide;
- PM_{10};
- Formaldehyde; and
- Benzene.

Two of the sites were located adjacent to industrial areas, and the third site was located next to the main road through Mount Gambier. The monitoring locations were selected by the South Australian EPA to determine the impact from industry and the roads and to establish whether the emissions resulted in air pollution 'hot spots' in Mount Gambier. As such the data does not conform to the Australian Standard for the placement of background monitors required for compliance with NEPM, and URS does not, therefore, consider these results to be representative of background air quality surrounding the site.

2.3.3 Background Air Quality Used for Assessment

Monitoring undertaken in Warrnambool by EPA does not provide data on species likely to be emitted from the proposed power station, and data collected by the South Australian EPA in Mount Gambier is not considered to be representative of the project site.

In these circumstances, EPA recommends the use of the 70^{th} percentile of available monitored data and provides a table of appropriate background levels for proponents to use in dispersion modelling. URS has used the background data, provided by EPA, from areas where data exists and is likely to be representative. It should be noted that this monitoring is based on an area with a higher residential population and a higher number of vehicle movements, than the proposed site. The background concentrations used in this assessment are therefore considered to be higher than expected for the project site and are therefore conservative. Table 2-1 shows the background concentration used in this assessment for each species, the source of the data and a comment on the appropriateness of the selection.

Table 2-1 Background concentrations for common species provided by EPA as representative background values

Species	Background Concentration ($\mu g/m^3$)	Location of Background Measurement	Comment
NO_2	11.3	Point Cook	Suburban area with little industrial activity or residential population at the time of monitoring (2000). Considered representative.
$PM_{2.5}$	7.5	Brighton	Urban area with high residential population. Large number of vehicle movements. Considered likely to be conservative compared to modelled area.
CO	229	Geelong	Low density residential surrounding monitoring point at time of monitoring (2000). Considered representative.

Species	Background Concentration (µg/m³)	Location of Background Measurement	Comment
SO_2	0	Geelong	Low density residential surrounding monitoring point at time of monitoring (2000). Considered representative.

2.4 Other Sources

The region is mainly rural in nature with local industrial areas in and around the larger towns of Portland and Warrnambool (approximately 50km and 30km from the subject site respectively). Emissions from these industrial areas would not be expected to contribute significantly to local ambient air quality surrounding the project site.

The main roads in the local area are infrequently trafficked and not expected to result in significant contribution to local air quality. Impacts from the local road network have not been considered as part of this assessment.

URS is aware that Shaw River Power Station Pty Ltd (Shaw River Power) proposes the construction of a base load power station in reasonably close proximity to the proposed AGL site at Tarrone. URS has used the data contained in Shaw River Power's Environment Effects Statement (EES) for the Shaw River facility to undertake a cumulative impact assessment.

Criteria

3.1 Regulatory Framework

This section discusses the regulatory framework for managing air quality in Victoria. Only species that will be emitted to atmosphere from the peak load power station under normal operations are considered.

3.2 National Environmental Protection Measure (Ambient Air Quality)

The *National Environment Protection (Ambient Air Quality) Measure* (Ambient Air NEPM) provides the goals for ambient air quality that need to be achieved nationwide. Table 3-1 provides the Ambient Air NEPM goals for key air quality indicators relevant to the project. The NEPM standards are intended to be applied at monitoring locations that represent air quality for a region or sub-region of more than 25,000 people. The Ambient Air NEPM was released in 1998 and amended in 2003[1].

Table 3-1 NEPM (Ambient Air Quality) 2003, Clause 7 – Schedule 2 of Ambient Air NEPM

Pollutant	Averaging Time	Air Quality Standard		Goal within 10 years – Maximum Allowable Exceedances
		ppm	µg/m³	
Carbon Monoxide (CO)	8-hour	9	10,300	1 day a year
Nitrogen Dioxide (NO_2)	1-hour	0.12	226	1 day a year
	1-year	0.03	56	none
Sulphur Dioxide (SO_2)	1-hour	0.20	523	1 day a year
	1-day	0.08	209	1 day a year
	1-year	0.02	52	none

Note: Concentrations in µg/m³ are converted from ppm at 25°C and 1 atmosphere

3.3 State Environment Protection Policies

The State Environment Protection Policies (SEPPs) provide the framework for the protection of the environment in Victoria and have been enacted under Sections 16(1) and 16(2) of the *Environment Protection Act 1970* (Vic). For air quality, two SEPPs exist, including the *State Environment Protection Policy for Ambient Air Quality* (SEPP (AAQ)) and the *State Environment Protection Policy for Air Quality Management* (SEPP (AQM)).

3.3.1 SEPP(AAQ)

For common pollutants within the atmosphere such as nitrogen dioxide (NO_2), particulate matter (PM_{10}), carbon monoxide (CO) and lead (Pb) generated by the combustion of fossil fuels or wood, the SEPP (AAQ) is the prevalent applicable SEPP. The main aim of the policy is compliance with Ambient Air Quality NEPM, and as such it contains standards that are considered to apply to monitoring data and concentrations modelled over an airshed rather than being applicable to local air quality standards.

With regards to the protection of local air quality, the prevalent SEPP is the SEPP (AQM).

[1] National Environmental Protection Council, National Environment Protection Measure for Ambient Air Quality, 1988, with amendment in 2003

3.3.2 SEPP(AQM)

The SEPP(AQM) is the instrument which the State Government uses to achieve the Ambient Air Quality SEPP Goals. The SEPP(AQM) provides design criteria for ground level concentrations which new or modified industrial sources must attain in order to comply with the Policy and the *Environment Protection Act 1970* (Vic).

It is the policy intent of the SEPP(AQM) to manage the emissions to the air environment so that:

the beneficial uses of the air environment are protected, Victoria's air quality goals and objectives are met, our air quality continues to improve and we achieve the cleanest air possible, having regard to the State's social and economic development.

The protected beneficial uses of the air environment are defined as protection of the following:

- Life, health and well-being of humans;
- Life, health and well-being of other forms of life, including the protection of ecosystems and biodiversity;
- Local amenity and aesthetic enjoyment;
- Visibility;
- The useful life and aesthetic appearance of buildings, structures, property and materials; and
- Climate systems that are consistent with human development, the life, health and well-being of humans, and the protection of ecosystems and biodiversity.

The SEPP(AQM) defines design criteria (Schedule A) that are to be used in assessing the impact for new or modified sources on ground level concentrations of emitted species. Table 3-2 shows design criteria relevant to emissions from the proposed peak load power station.

Emissions of substances have been identified through turbine manufacture data (for NO_x inclusive of DLN control technology) and US-EPA emissions database AP-42 based on no control technology being used.

In addition to assessing ground level concentrations, the SEPP(AQM) defines 'in stack' concentrations that are to be used in assessing a new or modified source in locations outside of Air Quality Control Regions (Schedule D). Note: Concentrations in $\mu g/m^3$ are converted from ppm at 25°C and 1 atmosphere

Table 3-3 shows the criteria, relevant to emissions from the proposed peak load power station.

Table 3-2 SEPP (AQM) design criteria for relevant emitted substances

Substance	Averaging Period	Design Criteria	
		ppm	µg/m³
Nitrogen dioxide	1-hour	0.1	190
Carbon monoxide	1-hour	25	29,000
Sulphur dioxide	1-hour	0.17	450
Particles as PM_{10}	1-hour	-	80
Particles as $PM_{2.5}$	1-hour	-	50
Ammonia	3-minute	0.83	600
Formaldehyde	3-minute	0.033	40
Xylenes	3-minute	0.08	350
Acetaldehyde	3-minute	0.042	76
Acrolein	3-minute	0.00033	0.77
Ammonia	3-minute	0.83	600
Benzene	3-minute	0.017	53
Ethylbenzene	3-minute	3.3	14,500
Polycyclic aromatic hydrocarbons (PAH) as BaP	3-minute	-	0.73
Toluene	3-minute	0.17	650

Note: Concentrations in µg/m³ are converted from ppm at 25°C and 1 atmosphere

Table 3-3 SEPP(AQM) Emission limits for stationary sources in Victoria

Substance	Source to which emission limit is applicable	Emission Limit (g/m³)
Nitrogen dioxide	Fuel burning units (other than internal combustion engines and glass manufacturing plants) with maximum heat input rate greater than 150,000 MJ/hr	1.0
Total particulate matter	All stationary sources	0.5

3.4 Occupational Health and Safety

Schedule C, Part C, Section 2(b) of the SEPP(AQM) states that:

Design criteria for air quality indicators based on toxicity apply everywhere, except inside buildings. In cases where the design criteria can only be met beyond the property boundary, advice should be sought from the Authority in the assessment of the model simulation.

The intent of the SEPP(AQM) as stated in Part 1 (8) is that:

Emissions to the air environment will be managed so that beneficial uses of the air environment are protected…

3 Criteria

Given the intent of the SEPP(AQM), it is traditionally accepted by EPA that beneficial uses of the air environment are protected within the site boundary as long as ambient concentrations comply with exposure standards considered to represent a safe workplace as determined by Safe Work Australia.

Table 3-4 shows ambient concentrations expressed as a Time Weighted Average (TWA) and Short Term Exposure Limit (STEL) obtained from the Safe Work Australia website (Safe Work Australia, 2010). Safe Work Australia specifies the TWA as an eight hour average for a five day working week and the STEL as a fifteen minute average of peak concentration (National Occupational Health and Safety Commission. Worksafe Australia, 2001),

Table 3-4 TWA and STEL exposure concentrations as specified by Safe Work Australia adapted from the Hazardous Substances Information System (Safe Work Australia, 2010)

Substance	TWA		STEL	
	ppm	μg/m³	ppm	μg/m³
Nitrogen dioxide	3	5,600	5	9,400
Carbon monoxide	30	34,000	N/A	N/A
Sulphur dioxide	2	5,200	5	13,000
Ammonia	25	17,000	35	24,000
Formaldehyde	1	1,200	2	2,500
Xylenes	80	350,000	150	655,000
Acetaldehyde	20	36,000	50	91,000
Acrolein	0.1	230	0.3	690
Ammonia	25	17,000	35	24,000
Benzene	1	3,200	N/A	N/A
Ethylbenzene	100	434,000	125	543,000
Polycyclic aromatic hydrocarbons (PAH) as BaP	N/A	N/A	N/A	N/A
Toluene	50	191,000	150	574,000

Note: Concentrations in μg/m³ are converted from ppm at 25°C and 1 atmosphere

The concentrations specified in Table 3-4 are considered only to apply to on-site locations as workers in this location are likely to be exposed for the relevant averaging periods on which the criteria are based. For all other locations, the SEPP(AQM) design criteria have been used.

Methodology

4.1 Choice of Model

CALPUFF Version 6.263 was used as the atmospheric dispersion model for the assessment of the proposed AGL Power Plant at Tarrone in preference to the regulatory model, Ausplume Version 6.

Pursuant to Schedule C Part A of the SEPP (AQM), URS requested that the EPA approve the use of CALPUFF Version 6.263 in preference to the regulatory model on 19 January 2010 and received written approval for the use of CALPUFF on 16 June 2010.

The preference to use CALPUFF rather than Ausplume for this particular assessment was due to:

- the potential for sea breeze influences on plume behaviour; and
- the ability of CALPUFF to model sub-hourly emissions, which is a more accurate representation of the impacts from startup of the peak loading power plant.

4.1.1 Influence of Sea Breeze Circulation

Local meteorology was likely to be affected by sea breeze circulation at the proposed site location for the AGL power plant at Tarrone. URS considered it important that sea breezes be taken into account within the modelling assessment due to the potential for stack emissions to be transported out to sea in the morning and returned to areas over the land in the afternoon. URS believe Ausplume would have been unable to account for this circulation, as the model is based on Gaussian dispersion of emissions for each hour independently. As a puff model, CALPUFF was able to track the emissions as puffs within the grid domain, meaning that a more accurate model result was determined where recirculation of air occurred.

4.1.2 Sub-hourly Modelling

Peak loading power plants do not operate continuously, and there are a number of startup conditions of the plant throughout the year. During startup, which usually takes approximately 30 minutes to full load, emissions of species, exit temperature and discharge velocity vary significantly. The use of sub-hourly modelling allows a more accurate approach to assessing the impact of start-up conditions than the use of Ausplume which, like most dispersion models, allows one condition per hour to be modelled. The use of CALPUFF with sub-hourly modelling therefore affords more confidence in the modelled ground level concentrations for start up conditions compared to a single hourly condition using CALPUFF.

4.2 Meteorological Data

Meteorological data was prepared for the dispersion modelling using CALMET. CALMET is a meteorological pre-processor for the CALPUFF dispersion model that is able to take account of surface and upper air observations across a model domain and, using topographic and land use data, derive three dimensional meteorology across a model grid. The output from CALMET is then used in the dispersion modelling.

CALMET requires several datasets in order to resolve the surface and upper air meteorology occurring for each hour of the year:

- Surface observations;
  - Wind speed and direction;
  - Temperature;
  - Cloud cover amount;

  - Precipitation amount and type; and
  - Base cloud height.
- Upper air observations;
  - Height of observation;
  - Wind speed and direction at each height;
  - Temperature at each height; and
  - Barometric pressure at each height.
- Land use data; and
- Topographic data.

4.2.1 Observational Data

Observational data in the area surrounding the project site was available from:

- Mortlake Racecourse (surface);
- Portland (surface);
- Warrnambool (surface); and
- Mount Gambier (surface and upper air).

4.2.2 Land Use

In addition to topographic information, CALMET also requires land use information in order to estimate surface roughness over the grid. Land use information was obtained from version 2.0 of the Australia Pacific Land Cover Characteristics Database available from the United States Geological Survey that provides land use data at a 1km resolution.

Land use information for the model grid was extracted from the Land Cover Characteristics Database using a Geographic Information System. This information was then translated to CALMET format using a macro in Excel.

4.2.3 Topography

Meteorological modelling using CALMET requires topographic information for the model domain. Topographic information was taken from data available from the Shuttle Ray Topography Mission (SRTM) that provides topographic data at a spatial resolution of 90m for the entire surface of the Earth. Topographic information for the model grid was extracted for the SRTM dataset using a Geographic Information System. This information was then translated to CALMET format using a macro in Excel.

4.2.4 Model Domain

The area surrounding Tarrone, which the observational data covers, forms a domain of approximately 180 km by 120 km. The use of a domain this size would result in the use of a coarse grid resolution of approximately 5 km to allow the model to run efficiently. A grid resolution of 5 km has the potential to miss smaller terrain features that may have an effect on local meteorology.

To avoid the use of a coarse grid resolution in the final modelling, observational data was included in the CALMET meteorological run using a coarse grid of resolution 5km over the extent of the monitoring locations.

A second CALMET run was then used for a finer resolution grid (500m) to define the model domain. The output from the first CALMET run formed the initial wind fields for the final finer resolution model grid. This had the effect of using the observational data and taking account of large terrain features / land use to define a regional scale meteorological model. The regional meteorological model was then used to define the base conditions for a micro-meteorological model used in the dispersion modelling. Figure 1 in Appendix A shows the extent of the two modelling domains.

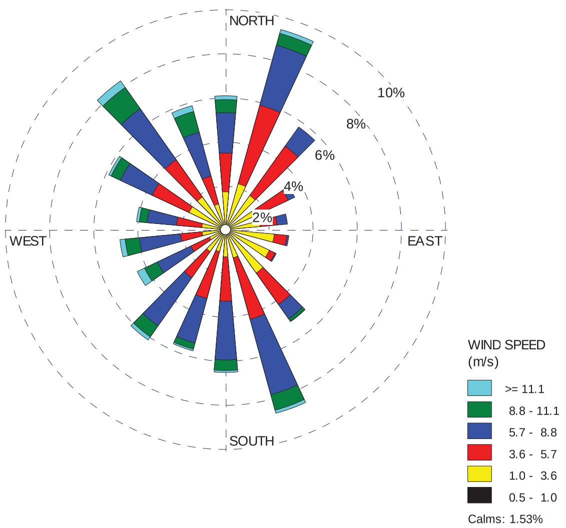
4.2.5 Verification of Meteorological Modelling

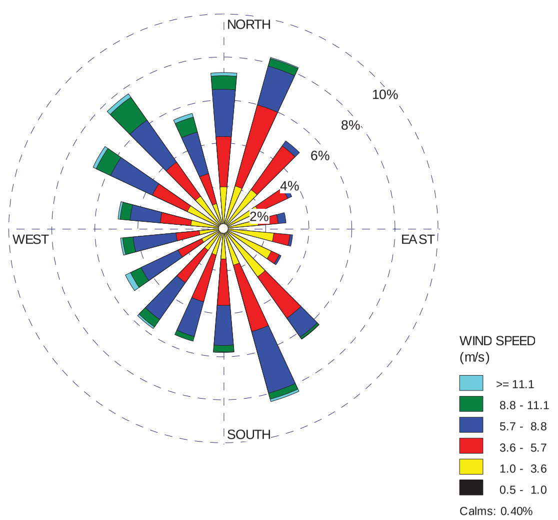
Verification of representativeness of the meteorological modelling was undertaken by comparing model output with observational data for wind speed / and direction and calculated stability categories for the nearest Bureau of Meteorology observation station

Wind Speed and Direction

Figure 4-1 shows a comparison of measured wind speed and direction at Warrnambool Airport with the same parameters produced by the CALMET for the site.

Figure 4-1 Measured wind speed / direction at Warrnambool Airport (Left) compared to modelled wind speed / direction for the Site using CALMET (Right)





A comparison of the wind roses shown in Figure 4-1 concluded that there was limited variation between the wind speed and direction observed at Warrnambool airport and the expected wind parameters at the site. As the terrain between Warrnambool and the site is relatively flat, this indicates a high degree of confidence in CALMET's ability to reflect meteorological conditions on site.

Stability Categories

Pasquil stability classes define whether there is turbulence in the lower atmosphere that is likely to affect dispersion. Turbulence in the lower atmosphere is affected by wind speed, land use type and degree of solar insolation.

4 Methodology

Atmospheric stability classes were estimated from measured data at Warnambool airport and Mount Gambier using Table 4-1. Where potential for two stability classes exist, the more stable of the two classes was selected.

Table 4-1 Pasquil stability class related to wind speed and insolation[2]

Wind Speed	Daytime Insolation			Night-time Cloud Cover	
m/s	**Strong**	**Moderate**	**Light**	**> 4/8**	**<3/8**
<2	A	A-B	B	-	-
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

The strength of daytime insolation was calculated using the Bird Model, with diffuse insolation incident on a horizontal surface[3]. Cloud cover from Mount Gambier was used to reduce the insolation value estimated by the Bird Model using Equation 4-1.

Equation 4-1 Calculation of Solar radiation reaching the Earth surface, taking in to account cloud cover

$$S_C = S_0 \times \left(1 - \left(\left(0.62 \times \frac{C}{10}\right) + (0.0019 \times SNA)\right)\right)$$

Where:

S_C is the solar radiation reaching the ground after cloud (Watts/m2/sec)

S_0 is the solar radiation reaching the ground without cloud (Watts/m2/sec)

C is the cloud cover (in tenths)

SNA is the Solar Noon Attitude obtained from the National Oceanographic and Atmospheric Administration (NOAA) (Radians)

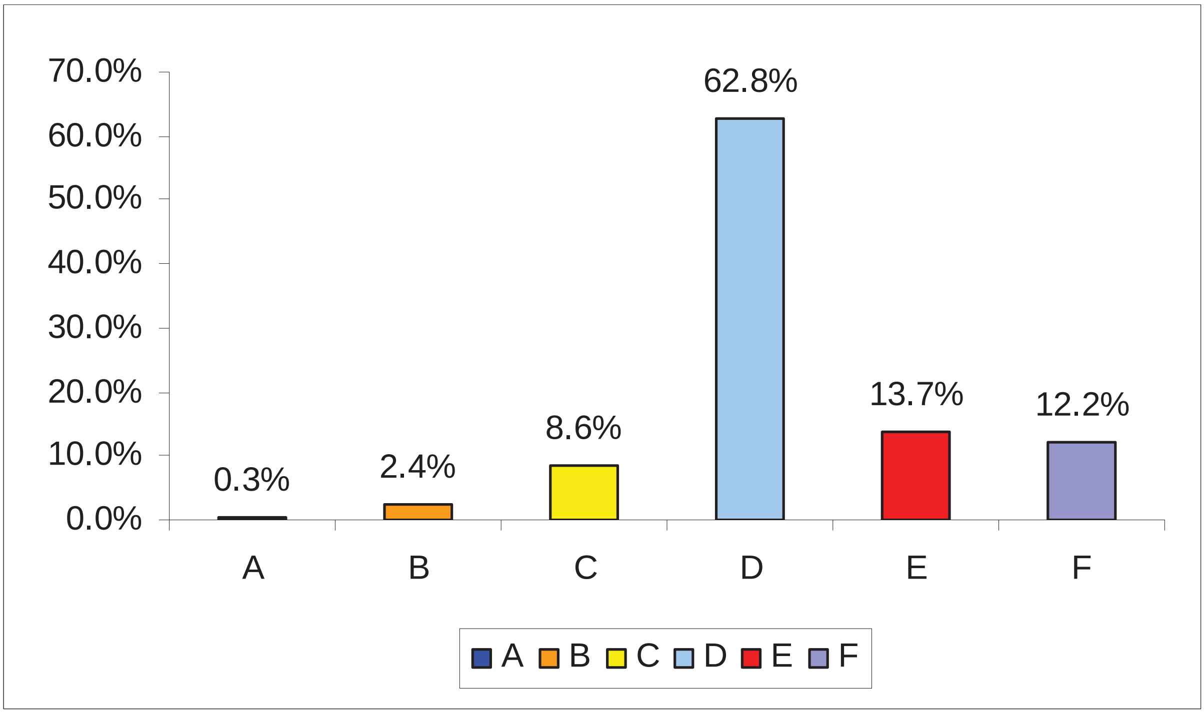
The strength of daytime insolation was defined as:

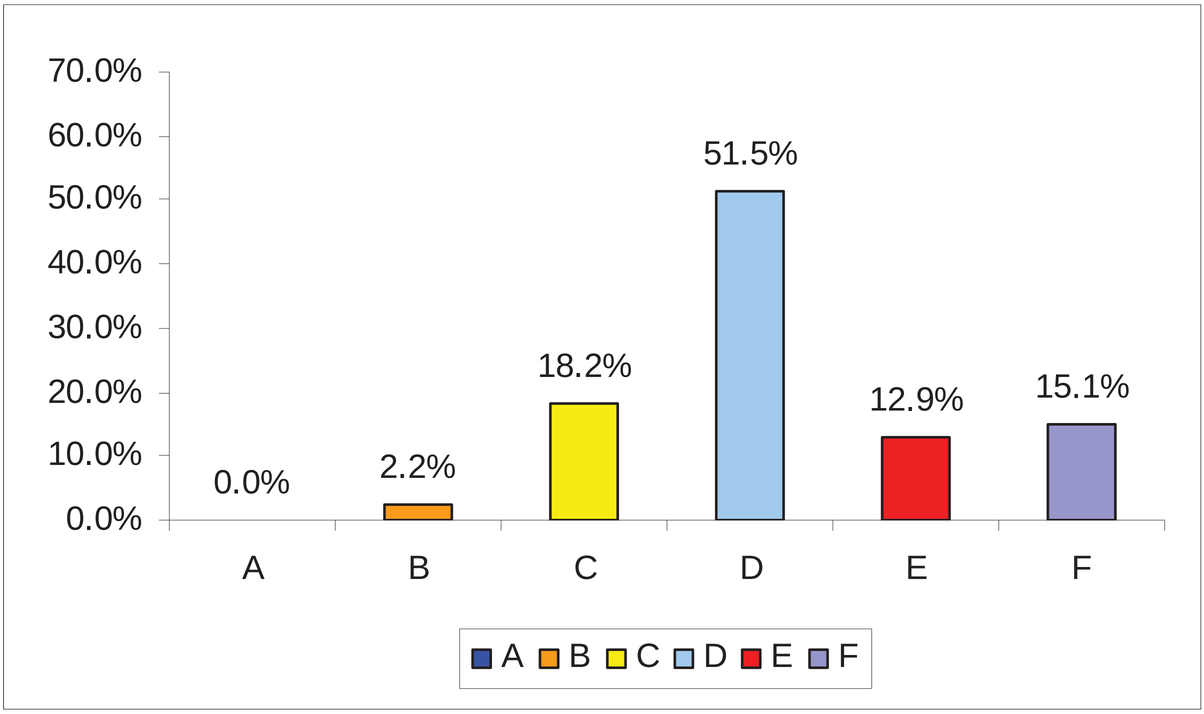
- Strong > 143 cal/m^2/sec;
- Moderate 72-143 cal/m^2/sec; and
- Slight < 72 cal/m^2/sec.

Figure 4-2 shows a comparison of the percentages of the atmospheric stability classes calculated by CALMET. The results show good agreement between the modelled data and estimations based on observations, indicating that the model provides a good representation of atmospheric stability at the site.

[2] Beychock, M.R., 2005. 'Fundamentals of Stack Gas Dispersion', Beychock.
[3] Solar Radiation Calculator available online at http://www.ecy.wa.gov/programs/eap/models.html last accessed 29/3/10

Figure 4-2 Comparison of modelled (top) and calculated from measurements (bottom) Pasquil Stability categories





The CALMET model provides a slightly higher distribution of D class stability categories than C class in comparison to the calculated values using the measured data. More stable categories (D to F) will result in less dispersion and higher ground level concentrations than more unstable categories (A to C), which tend to result in better mixing of emissions in the atmosphere. The modelled distribution of stability categories therefore presents a conservative assessment of impact.

4.3 Representativeness of Modelled Engines

The power station is proposed to be developed in two stages, with the initial stage comprising either two or three E-Class or two F-Class generators. Two plant configurations are considered for the proposed ultimate Tarrone power station configuration comprising of either four E class turbines or three F class turbines operating in open cycle model. At this stage in the design process, the final choice of engine manufacturer has not been determined however five prospective manufacturers are being considered (Table 4-2). In order to provide flexibility in the final choice of supplier, URS has considered the local air quality impact from the use of two engines representing typical emissions and impacts resulting from the use of E-Class and F-Class engines. The two proposed site designs considered for this assessment are[4]:

- Alstom AE13E2 – E-Class (Generation capacity 167 MW per engine); and
- GE 9FA – F-Class (Generation capacity 256 MW per engine).

Table 4-2 Potential generator manufacturers and models

Generator Class	E Class		F Class	
Manufacturer	Model	Power Output (MW/unit)	Model	Power Output (MW/unit)
Siemens	SGT5-2000E	168	SGT5-4000F	292
GE	9E	126	9FA	256
Ansaldo	V94.2	170	V94.3	294
Alstom	AE13E2	167		
Mitsubishi			M701F4	307

An analysis of the representativeness of the engines modelled, relative to the range of potential generator manufacturers and models nominated in Table 4-2, was undertaken with respect to potential ground level concentrations of NO_2 (Appendix B). It was determined that whilst there is potential for ground level concentrations to be marginally higher than modelled (up to 1.3% for E class engines and 7.3% for F Class engines), relative to those modelled in this assessment. It is concluded however that the assessment conducted is adequate to confirm that the nominated beneficial uses of the air environment will be protected given that:

- Concentrations determined by the dispersion modelling, undertaken for this assessment, are significantly below criteria (Section 5.1); and
- The assessment conservatively assumes all NO_X is NO_2 (Section 4.8).

4.4 Emission Rate Estimation

Emission estimation for the proposed power plant was completed using manufacturer data, and, where manufacturer data was unavailable, emission estimation was completed using techniques provided in the National Pollutant Inventory (NPI) and the USEPA emission estimation technique manual AP-42.

[4] The two site designs assessed were provided to URS by AGL.

4.4.1 AGL Start-Up Emissions

Start up emissions for a peak loading power plant have potentially higher mass rates for a short durations due to lower efficiency of the engine during these conditions. It was found that the only species with a higher mass rate during start up than during normal operation is oxides of nitrogen (NO_X). Start-up emissions for NO_X were therefore calculated for both engines.

CALPUFF allows the use of sub-hourly meteorological data, meaning that time varying emissions for the same time period can be used to determine the potential ground level impacts due to start-up conditions.

Emissions of NO_X during start up have been calculated for each engine type. Due to the different type of information provided by each manufacturer the method of calculation for start up NO_X emissions was varied slightly with each engine.

Alstom 13E2

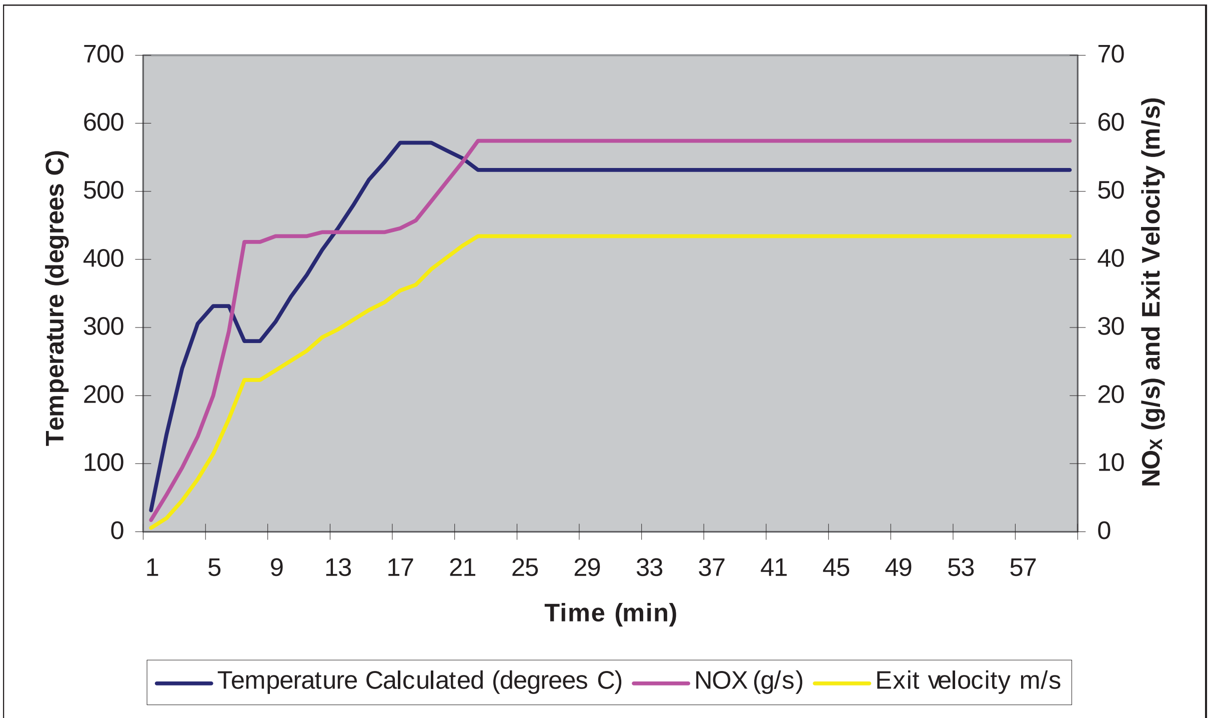
Start-up conditions for the Alstom 13E2 engines were based on start-up curves provided by the manufacturer that provided:

- Mass flow rate of stack emissions as a percentage of base load;
- Data on total emissions of NO_X over the start-up period (49 kg); and
- Variation in stack exit temperature.

In addition, an assumed gas density of 28.26g/mol, the same as provided by GE, was used with variation in mass flow rate and the stack diameter to calculate the variation in velocity.

Figure 4-3 shows the time varying emission estimates included in the dispersion modelling for each hour to simulate start up in that hour.

Figure 4-3 Variation of stack exit temperature, NO_X emissions and exit velocity during the start-up hour for the Alstom 13E2 engines



GE 9FA

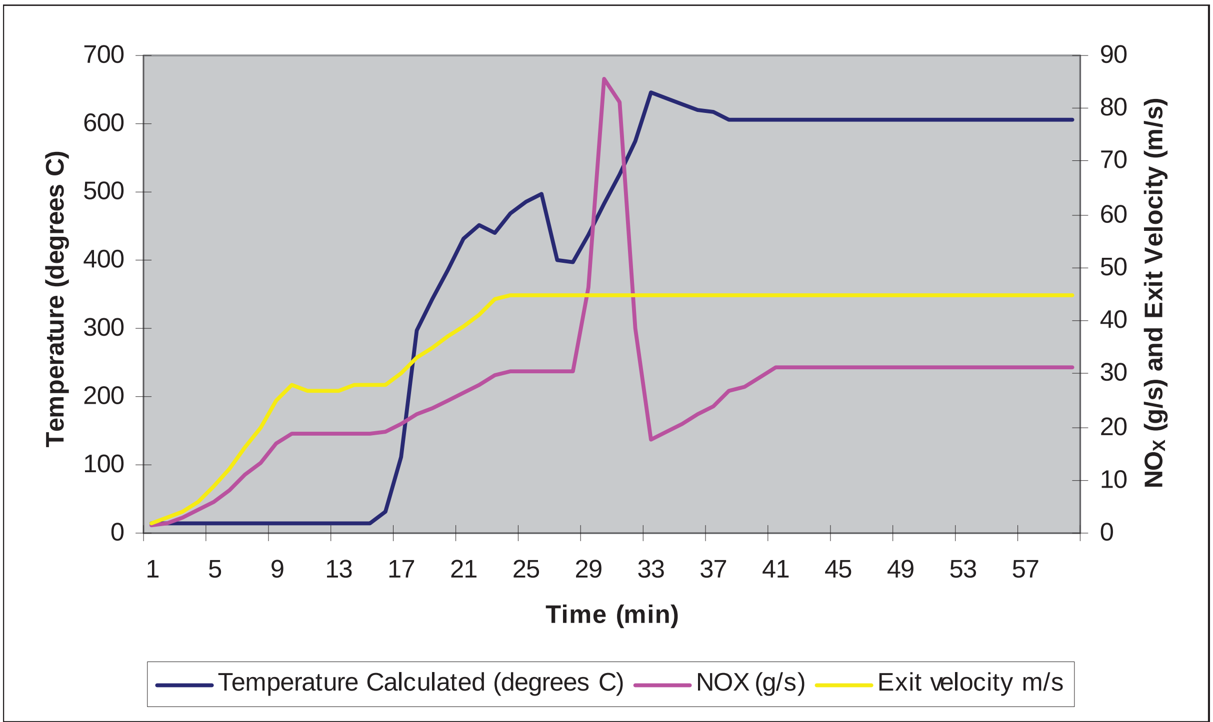
Start-up conditions for the GE 9FA engines were based on start-up curves provided by the manufacturer provide that:

- Percent load during start-up;
- Exhaust mass as a percentage of base load;
- NO_X emissions in relation to percentage load operation of the turbine; and
- Change of temperature over the start-up period.

In addition, a gas density of 28.26g/mol, provided by GE, was used with variation in mass flow rate and the stack diameter to calculate the variation in velocity.

Figure 4-4 shows the time varying emission estimates included in the dispersion modelling for each hour to simulate start up in that hour.

Figure 4-4 Variation of stack exit temperature, NO_X emissions and exit velocity during start-up hour of the GE 9FA engines



4.4.2 AGL Base Load

Emissions during normal operations have been calculated using a combination of data received from the manufacturers, NPI and AP-42 emission estimation techniques and this is shown in Table 4-3.

Table 4-3 Modelled emission rates for Alstom 13E2 and GE 9FA engines (g/s)

Species	Alstom 13E2 (M) (g/s)	GE 9FA (PG9351) (g/s)
NO_X [1]	20.86	30.62
SO_2 [2]	1.17	2.23
CO [3]	2.56	9.14
$PM_{2.5}$ [2]	3.00	2.14
Benzene [3]	0.003	0.005
Toluene [3]	0.03	0.05
Ethylbenzene [3]	0.01	0.01
Xylene [3]	0.01	0.03
Formaldehyde [3]	0.15	0.29
Total PAH [3]	0.0004	0.0008

Notes:
1. Sourced from manufacturers data. Provided to URS by AGL.
2. Sourced from NPI emission factors.
3. Sourced from AP-42 emission factors.

4.4.3 Shaw River Power Station

In order to account for cumulative effects from the Shaw River project, URS has modelled emissions from the Shaw River Power Station based on data provided in the EES for NO_X and CO (Table 4-4) in combination with emissions of the same species from the proposed AGL facility.

The Shaw River EES proposes the construction of one open cycle and two closed cycle turbines in a phased construction process. It is intended that once the two closed cycle turbines have been constructed that the open cycle turbine may be converted to closed cycle.

Dispersion modelling of the various development phases of the Shaw River Power Station showed that worst case ground level concentrations were obtained during operation of three closed cycle turbines operating at base load. This is likely the result of lower temperature exhaust gases (from closed cycle turbines compared to open cycle), which will result in less plume rise, and consequently higher ground level concentrations.

URS has therefore adopted the emission rates and stack parameters associated with the operation of three closed cycle turbines, as this provides the most conservative assessment of cumulative impact.

It should be noted, that the results for NO_2 presented in the Shaw River EES adopt a conversion factor of 0.3 to estimate NO_2 from modelled NO_X concentrations. This Tarrone Power Station assessment has conservatively assumed that all NO_X is NO_2 for the Shaw River emissions.

Table 4-4 Emissions of NO_X and CO from the proposed Shaw River Development (Shaw River EES)

Species	SGT5-4000F (g/sec/turbine)
NO_X	30.6
CO	7.5

4.5 In Stack Concentrations

Schedule D of the SEPP(AQM) requires assessment of in stack concentration against criteria for the following species likely to be emitted from AGL Tarrone:

- Oxides of Nitrogen; and
- Particulate matter.

In stack concentrations have been calculated using Equation 4-2.

Equation 4-2 Calculation of in stack concentration

$$S_C = \frac{S_M}{S_V}$$

Where:

S_C is the in stack concentration (g/m^3)

S_M is the mass flow rate of the species (g/sec)

S_V is the volumetric flow of exhaust gases (m^3/sec)

As the proposed peak loading power station is powered by gas, any particulate matter released will be of size 2.5µm in aerodynamic diameter or less. Consequently emission estimates of $PM_{2.5}$ are considered equivalent to emissions of total particulate matter.

4.6 CALPUFF Setup

The following settings were used in the CALPUFF setup:

- Grid of 81 X 79 points at 500m resolution with the south-west corner at 583000, 5754000 (AMG);
- Wind speed profile – ISC Rural;
- Stack tip downwash;
- Partial plume penetration;
- Building wake effects;
- Partial plume adjustment for terrain effects;
- Chemical transformation was not included; and
- Deposition was not included;

4.6.1 Stack Tip Downwash

Stack tip downwash was included as this can potentially result in high ground level concentrations where the wind is strong enough to ground plumes.

The emitted plumes from both the AGL and Shaw River facilities are very hot and therefore buoyant, with a high velocity the potential for partial plume penetration of the boundary layer when the layer is close to the ground exists. It is therefore considered necessary to include partial plume penetration in the modelling.

4.6.2 Building Wake Effects

Building wake effects have the potential to increase ground level concentrations when a plume becomes trapped in the recirculation zone generated by air flow over a building. Potential building wake effects were incorporated in the CALPUFF modelling by using output from the BPIP module of Ausplume for the buildings at the AGL Tarrone site and the building downwash parameters included in the Ausplume list files for the Shaw River facility.

4.6.3 Partial Plume Adjustment

Partial plume adjustment was included for any terrain effects. There is, however, no significant terrain in the model domain, and the use of partial plume adjustment is considered unlikely to result in a change to predicted concentrations had adjustment of the plume not been considered.

4.6.4 Chemical Transformation

Note that chemical transformation and deposition were not modelled, as this provides a conservative assessment of potential impacts.

4.6.5 Source Description

Table 4-5 shows the stack parameters used in conjunction with the emission estimates to define the sources within CALPUFF for steady state conditions. Start-up conditions were modelled using the same stack heights and diameters as shown in Table, but with varying emission temperatures and velocities through the start up period as shown in Figure 4-3 and Figure 4-4 respectively.

Table 4-5 Steady state source parameters used in the dispersion modelling

Parameters	AGL Tarrone		Shaw River
	Alstom 13E2	GE 9FA	SGT5 4000F
Stack Height (m)	30	45	50
Stack diameter (m)	6	6.7	6.4
Emission temperature (°C)	532	609	99
Emission velocity (m/s)	40	45	19.8

4.7 Cumulative Impact Assessment

To account for potential impacts on local air quality from both the AGL Tarrone and the Shaw River developments, URS has undertaken a cumulative assessment to quantify ground level predictions resulting from operation of both developments simultaneously.

Given the maximum ground level concentrations are predicted to occur during steady state operation of both AGL Tarrone and Shaw River facilities, the cumulative impact assessment has considered operation of all generators at both facilities for every hour of the year.

4.8 Calculation of Nitrogen Dioxide

During the combustion process, nitrogen from the air and fuel combines with oxygen in the air to form nitrogen oxide (NO) and nitrogen dioxide (NO_2) in the approximate ratio 90% NO to 10% NO_2.

In the atmosphere, NO_2 is broken down by sunlight to form NO and an oxygen radical. The oxygen radical is highly reactive and combines with oxygen (O_2) to form ozone (O_3). O_3 is unstable and readily combines with NO to form NO_2 and O_2 (Equation 4-3).

It may be seen from Equation 4-3 that the reaction series is circular, as such NO and NO_2 are often combined and termed oxides of nitrogen (NO_X).

Equation 4-3 Formation of Secondary NO_2

$$NO_2 \xrightarrow{hv(\lambda 295-430nm)} NO + O^{\bullet}$$
$$O_2 + O^{\bullet} \xrightarrow{M} O_3$$
$$NO + O_3 \longrightarrow NO_2 + O_2$$

Where:

NO_2 is nitrogen dioxide	NO is nitrogen oxide	$O^{\bullet}$ is an oxygen radical	hv is light
λ is wavelength	O_2 is Oxygen	M is any molecular form	O_3 is Ozone

Whilst NO is innocuous at concentrations commonly found in the atmosphere in urban areas and surrounding industrial facilities, concentrations of NO_2 are known to have an effect on human health at much lower levels. Ambient criteria for NO_2 have accordingly been set by EPA.

To account for potential conversion from NO to NO_2 total emitted NO_X is traditionally modelled and, in the first instance, all NO_X is considered to be NO_2. This is an over-estimation of the impacts, however if predicted concentrations are determined to be below criteria with this over-estimation, the beneficial use of the atmosphere is considered to be preserved.

In this assessment all emissions of NO_X, both from the AGL Tarrone and Shaw River facilities are considered to be NO_X as NO_2.

4.9 Greenhouse Gas Emissions

4.9.1 Regulatory Framework for Greenhouse Gas Emissions

State Environment Protection Policy (Air Quality Management)

The *State Environment Protection Policy for Air Quality Management* states that generators of emissions of greenhouse gases must manage their emissions in accordance with the provisions of Clause 18 and 19 of the SEPP (AQM). Any protocols for environmental management relating to greenhouse gas emissions developed in accordance with the SEPP (AQM) will be consistent with any measures developed by the Government of Victoria for the management of greenhouse gases and energy efficiency. These protocols will be applied to generators of emissions subject to works approvals and licenses, and in assessing the potential impacts of other development proposals.

Environment Protection (Environment and Resource Efficiency Plans) Regulations 2007

Environment and Resource Efficiency Plans (EREP) is an innovative regulatory program that helps Victorian businesses meet climate change and resource scarcity challenges.

Through EREP, industry can realise the business opportunities presented by resource efficiency by implementing actions that achieve environmental benefits and direct cost savings in a short timeframe. The EREP program applies to large energy and water using sites – those using more than 100 TJ of energy and/or 120 ML of water per annum.

National Greenhouse and Energy Reporting Act

A national approach to greenhouse gas (GHG) emission estimation and reporting has been established. *The National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a national framework for reporting greenhouse gas emissions, greenhouse gas emission abatement actions and energy consumption and production by Australian corporations.

The *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulations) provide the necessary details that allow compliance with, and administration of, the NGER Act.

To estimate greenhouse gas emissions for compliance with the NGER Regulations and the NGER Act, the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (NGER (Determination)) sets out methods, and criteria for methods, for the estimation of greenhouse gas emissions. It also sets out methods for estimating or calculating the production and consumption of energy. Facilities are required to report under the NGER Act if they exceed the GHG emission threshold of 25 kt CO_2-e/year (kilotonnes of carbon dioxide-equivalent per year) or the energy threshold (produced or consumed) of 100 TJ/year.

The document "*National Greenhouse and Energy Reporting System: technical guidelines for the estimation of greenhouse emissions and energy at facility level: energy, industrial process and waste sectors in Australia*", 2007 provides additional guidance to the NGER (Determination).

Also relating to GHG emissions, by way of energy consumption, is the Energy Efficiency Opportunities Program (EEO) and related Act and Regulations which requires that facilities using more than 500 TJ of energy participate in the program. The program is designed to encourage participants to develop a detailed knowledge of their energy consumption and develop actions to reduce consumption.

4.9.2 Emission Scope

The methodology described in NGER (Determination), used for the assessment, was employed with the concept of emission "scopes".

- Scope 1: Direct GHG emissions. Direct GHG emissions occur from sources that are owned or controlled by the company, for example emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc; and emissions from chemical production in owned or controlled process equipment.
- Scope 2: Electricity Indirect GHG emissions. This accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.

- Scope 3: Other Indirect GHG emissions. This is not a reporting class as required under the NGER Act and NGER Regulations. These emissions account for all other indirect GHG emissions resulting from a company's activities, but occurring from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Scope 1 and 2 emissions together are called "total" greenhouse gas emissions for a facility. Scope 3 is not required to be reported to NGER, and have not been estimated in this assessment

4.9.3 Scope 1 Emissions

Scope 1 emissions from electricity generation have been calculated using the National Greenhouse Accounts (NGA) factors to provide data on the emissions of CO_2-e (carbon dioxide equivalent) generated through the combustion of gaseous fuels for power generation (Table 4-6). The NGA factors take in to account emissions of the three main greenhouse gases, CO_2, CH_4 (methane) and N_2O (nitrous oxide) (Department of Climate Change, 2009).

For power generation, from natural gas distributed in a pipeline, an overall emission factor of 51.33 kg CO_2-e/GJ is provided by the NGA factors.

Manufacturer's specifications for the potential generators proposed for this site provide a heat rate in terms of kJ/kWh. This defines the amount of natural gas, in terms of the energy it contains, required by the engine type to produce 1 kWh of electricity. Scope 1 emissions have been calculated using Equation 4-4.

Equation 4-4 Calculation of Scope 1 emissions

$$E_{CO_2-e} = \frac{(Engines \times Output \times 1000) \times HR \times OpHours}{1 \times 10^6} \times EF$$

Where:

$E_{CO2\text{-}e}$ is the emission in kg/annum of CO_2-e

Engines is the number of engines operating on site;

Output is the output in MWh per engine

HR is the manufacturer specified Heat Rate in kJ/kWh

OpHours is the number of operational hours for the site per year (486 hours based on 5% operation)

EF is the emission factor provided by NGA (51.33 kg CO_2-e/GJ)

Table 4-6 Scope 1 Emissions from Electricity Generation

Manufacturer	Engine	Scope 1 CO_2-e (Tonnes)
Siemens	SGT5-2000E	156612
	SGT5-4000F	178001
GE	9E	120711
	9FA	168207
Ansaldo	V94.2	157700
	V94.3	179815
Alstom	AE13E2	141593
Mitsubishi	M701F4	177346

4.9.4 Scope 2 Emissions

Scope 2 emissions from electricity use have been calculated using the National Greenhouse Accounts (NGA) factors to provide data on the emissions of CO_2-e (carbon dioxide equivalent) generated through the use of electricity from the national grid. The NGA factors take in to account emissions of the three main greenhouse gases, CO_2, CH_4 (methane) and N_2O (nitrous oxide) generated through generation of electricity (Department of Climate Change, 2009).

For electricity use in Victoria an overall emission factor of 1.22 kg CO_2-e/kWh is provided by the NGA factors.

Projected electricity use for the AGL Tarrone facility has been estimated based on electricity consumption from grid by AGL Somerton peak loading plant in Victoria. In 2009, AGL Somerton used 2010.89 MWh of electricity from the grid and produced 104.5 GW of electricity. Using a linear relationship between grid electricity use and generating capacity (based on 5% operation) Table 4-7 shows the projected electricity consumption for each engine configuration. The electricity use has been used with the NGA factors for electricity use in Victoria to define the Scope 2 emissions.

Table 4-7 Grid Electricity Consumption (MWh) for each potential generator configuration

Generator Class	E Class		F Class	
Manufacturer	Model	Grid Electricity Consumption (MWh)	Model	Grid Electricity Consumption (MWh)
Siemens	SGT5-2000E	5662	SGT5-4000F	7381
GE	9E	4247	9FA	6461
Ansaldo	V94.2	5730	V94.3	7432
Alstom	AE13E2	5629		
Mitsubishi			M701F4	7761

Results

5.1 Local Air Quality

Figures 1 to 12 show predicted contribution to ground level concentrations during startup and operation of the Alstom 13E2 and GE 9FA engines both separate from and in combination with the proposed Shaw River site.

Table 5-1 shows the maximum modelled ground level concentration (99.9th percentile), excluding background, in comparison to the SEPP(AQM) design criteria.

For all modelled scenarios and species the maximum modelled ground level concentration is well below the SEPP(AQM) design criteria.

Table 5-2 and Table 5-3 show the maximum modelled ground level concentration (100th percentile), excluding background, for onsite locations in comparison to the TWA and STEL specified by Safe Work Australia.

For all modelled scenarios and air quality indicator species the maximum modelled on-site ground level concentration is below Safe Work Australia guidelines.

It is notable that the maximum modelled ground level concentration for startup is lower than the maximum modelled ground level concentration for normal operations. This is due to modelling using a sub-hourly data set that allows the lower emissions than normal operations for the first 21 minutes and 9 minutes for the Alstom 13E2 and GE9FA respectively, to be incorporated into the modelling. Over the hour, the emissions during start-up are lower than during normal operations, in addition, the variation in temperature and exit velocity means that the emission reaches varying final plume heights throughout the hour resulting in a lower ground level concentration as the plume is less well formed.

Results for species other than NO_X as NO_2 are not included in the results as emissions for these species are lower during startup than during normal operation. Only NO_X as NO_2 has a period when the emission rate is higher than during normal operation.

5 Results

Table 5-1 Maximum modelled (99.9th percentile) ground level concentrations for considered scenarios (without background)

Species	NO_X as NO_2	SO_X as SO_2	CO	$PM_{2.5}$	PAH as B(a)P	Benzene	Xylenes	Toluene	Ethyl-benzene	Formalde-hyde
Units	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
Averaging Period	1 hour	1 hour	1 hour	1 hour	3 minutes	3 minutes	3 minutes	3 minutes	3 minutes	3 minutes
Alstom 13E2 Steady State	16.11	0.86	1.97	2.31	0.001	0.003	0.018	0.037	0.009	0.203
GE 9FA Steady State	14.23	0.86	4.25	0.996	0.001	0.003	0.018	0.037	0.009	0.204
Alstom 13E2 Start up	3.15									
GE 9FA Start up	4.8									
Alstom 13E2 Steady State Plus Shaw River	55.1		13.5							
GE 9FA Steady State Plus Shaw River	55.1		13.5							
Background Concentration	11.3	0	229	7.5	0	0	0	0	0	0
SEPP (AQM) Design Criteria	**190**	**450**	**29,000**	**50**	**0.73**	**53**	**350**	**650**	**14,500**	**40**
Exceed SEPP (AQM) Design Criteria	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**

5 Results

Table 5-2 Maximum modelled on site ground level concentrations for considered scenarios (without background)

Species	NO_X as NO_2	SO_X as SO_2	CO	$PM_{2.5}$	PAH as B(a)P	Benzene	Xylenes	Toluene	Ethyl-benzene	Formalde-hyde
Units	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
Averaging Period	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes
Alstom 13E2 Steady State	2.18	0.12	0.27	0.31	0.00005	0.0003	0.0014	0.0028	0.0007	0.015
GE 9FA Steady State	1.85	0.11	0.55	0.129	0.00005	0.0003	0.0013	0.0027	0.0007	0.015
Alstom 13E2 Start up	0.0081									
GE 9FA Start up	0.23									
Alstom 13E2 Steady State Plus Shaw River	10.83		2.66							
GE 9FA Steady State Plus Shaw River	10.83		2.66							
Background Concentration	11.3	0	229	7.5	0	0	0	0	0	0
STEL Worksafe Criteria	**9,400**	**13,000**	**N/A**		**N/A**	**N/A**	**655,000**	**574,000**	**543,000**	**2,500**
Exceed SEPP (AQM) Design Criteria	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**

5 Results

Table 5-3 Maximum modelled ground level concentrations for considered scenarios (without background)

Species	NO_X as NO_2	SO_X as SO_2	CO	$PM_{2.5}$	PAH as B(a)P	Benzene	Xylenes	Toluene	Ethyl-benzene	Formalde-hyde
Units	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
Averaging Period	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours
Alstom 13E2 Steady State	12.85	0.69	0.16	1.84	0.00028	0.0015	0.016	0.008	0.004	0.089
GE 9FA Steady State	13.01	0.79	3.89	0.91	0.00032	0.0017	0.019	0.009	0.005	0.103
Alstom 13E2 Start up	4.12									
GE 9FA Start up	1.29									
Alstom 13E2 Steady State Plus Shaw River	0.66		0.16							
GE 9FA Steady State Plus Shaw River	1.07		0.26							
Background Concentration	11.3	0	229	7.5	0	0	0	0	0	0
TWA Worksafe Criteria	**5,600**	**5,200**	**34,000**		**N/A**	**3,200**	**350,000**	**191,000**	**434,000**	**1,200**
Exceed SEPP (AQM) Design Criteria	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**

5.2 In Stack Concentrations

Table 5-4 shows the estimated in stack concentrations based on the mass emission rates and volumetric flow for the turbines under base load conditions.

Table 5-4 In stack concentrations (g/m3) for species likely to emitted (Schedule D SEPP(AQM))

Substance	Alstom 13E2 (g/m³)	GE 9FA (g/m³)	Emission Limit (g/m³)	Exceedance
Nitrogen dioxide*	0.03	0.03	1.0	No
Total particulate matter	0.003	0.001	0.5	No

* - Based on reference oxygen of 7% with an in stack oxygen concentration of 12.5%

The in stack concentrations are at least an order of magnitude below the emission limits set within Schedule D of the SEPP(AQM).

5.3 Greenhouse Gas Emissions

The annual operating hours for gas fired peaking power stations can vary significantly from year to year as they are used at times when additional electricity is required by the grid. The national electricity market is extremely volatile and complex. Peak loading power plants are used at times when additional electricity is required by the grid, such as during hot summer days or cold winter mornings and evenings. As a result, the distribution of operating hours can vary significantly from year to year. It is difficult therefore to predict with certainty when the plant will be operating and for how many hours. Typically, however, the annual operating hours are expected to be approximately 5% (440 hours). At a 5% usage rate, the expected gas and electricity consumption would result in Scope 1 and 2 greenhouse gas emissions for the considered engine types, as shown in Table 5-5.

Table 5-5 Tonnes CO_2-e emitted to atmosphere through fuel combustion and grid electricity consumption. Engines modelled for local air quality assessment have been highlighted.

Generator Class	E Class				F Class			
Manufacturer	Model	Tonnes CO_2-e per year			Model	Tonnes CO_2-e per year		
		Scope 1	Scope 2	Scope 1 & 2		Scope 1	Scope 2	Scope 1 & 2
Siemens	SGT5-2000E	156,610	6,910	163,520	SGT5-4000F	178,000	9,005	187,010
GE	9E	120,710	5,180	125,890	9FA	168,210	7,880	176,090
Ansaldo	V94.2	157,700	6,990	164,690	V94.3	179,815	9,070	188,880
Alstom	AE13E2	141,590	6,870	148,460				
Mitsubishi					M701F4	177,346	9,468	186,814

5 Results

The annual Scope 1 and 2 CO_2-e emissions for the proposed E and F class engines is 164,690 tonnes CO_2-e and 188,882 tonnes CO_2-e respectively. This represents 0.2% and 0.23% for E and F class engines respectively of 2006 Victorian emissions from stationary energy sources[5].

[5] EPA Victoria; 2010. 'Australia and Victoria's greenhouse gas emissions'. Available online at http://www.epa.vic.gov.au/greenhouse/australia-victoria-emissions.asp. Last accessed 30/3/10.

Conclusion

AGL Energy Pty Ltd (AGL) proposes the construction of a peak loading power plant near to Tarrone in south western Victoria. The proposed peak loading power plant will have a nominal operating capacity of approximately 720 MWh - 920 MWh, dependant on the final turbine configuration.

Two plant configurations are considered for the proposed Tarrone power station comprising of either four E class turbines or three F class turbines operating in open cycle model. At this stage in the design process, the final choice of engine manufacturer has not been determined, however five prospective manufacturers are being considered. In order to provide flexibility in the final choice of supplier, URS has considered the:

- Local air quality impact; and
- Greenhouse gas emissions,

from the use of two representative E-Class and F-Class engines. The two proposed site designs considered in this assessment are:

- 4 X Alstom 13E2 M; or
- 3 X GE Energy 9FA.

An assessment of the representativeness of the engines for the prediction determined that modelling these engines would result in a reasonably conservative prediction of ground level concentration in comparison to the other considered engines.

The impact on ambient air quality with respect to regulatory emission limits and ground level concentration criteria of the primarily gaseous emissions has been assessed by URS. The local air quality assessment involved atmospheric dispersion modelling and has been conducted in accordance with the SEPP(AQM). The assessment of the impact of local air quality used a largely conservative approach, in accordance with the SEPP(AQM).

6.1 Background Data

Very little ambient monitoring has been undertaken in the area surrounding the proposed project site. URS understands that monitoring has been undertaken in industrial areas of Mount Gambier by the South Australian EPA and in Warrnambool for PM_{10} and TSP by the Victorian EPA. Data from Mount Gambier was considered not to be representative of the project site due to the industrial areas in which the data was collected. Monitoring in Warrnambool measured only PM_{10} and TSP. URS considers that any dust emissions from the power station are likely to be less than $PM_{2.5}$ due to the natural gas fuel source. Use of PM_{10} monitoring as background data for $PM_{2.5}$ would be an over estimate of background concentrations.

URS therefore selected appropriate locations from the 70^{th} percentile of monitored concentrations for common species provided by EPA.

URS is aware that Shaw River Power proposes the construction of a base load power station in close proximity to the proposed AGL site at Tarrone. URS has used the data contained in the Environment Effects Statement for the Shaw River facility to undertake a cumulative impact assessment.

6.2 Methodology

6.2.1 Emission Estimation

AGL Start-up

CALPUFF allows the use of sub-hourly meteorological data, meaning that time varying emissions for the same time period can be used to determine the potential ground level impacts due to start-up conditions.

Emissions of NO_X during start up have been calculated for each engine type. Due to the different type of information provided by each manufacturer the method of calculation for start up NO_X emissions was varied slightly with each engine.

Start-up conditions for the Alstom 13E2 engines were based on start-up curves provided by the manufacturer that provided:

- Mass flow rate of stack emissions as a percentage of base load;
- Data on total emissions of NO_X over the start-up period (49 kg); and
- Variation in stack exit temperature.

Start-up conditions for the GE 9FA engines were based on start-up curves provided by the manufacturer providing:

- Percent load during start-up;
- Exhaust mass as a percentage of base load;
- NO_X emissions in relation to percentage load operation of the turbine; and
- Change of temperature over the start-up period.

AGL Steady State

Emission estimation for the proposed power plant was completed using manufacturer data (Table 4-3), and where manufacturer data was unavailable emission estimation was completed using techniques provided in the National Pollutant Inventory (NPI) and the USEPA emission estimation technique manual AP-42.

Shaw River Steady State

Emissions from the Shaw River project have been extracted from the Environmental Effects Statement (EES) published as part of the approvals process for the development. The emission rates for NOX and CO detailed in the EES along with the source description, have been modelled in CALPUFF and the predicted ground level concentrations added to those predicted for the AGL Tarrone facility.

6.2.2 Modelling

URS used CALPUFF Version 6.263 as the atmospheric dispersion model for the assessment of the proposed AGL Power Plant at Tarrone in preference to the regulatory model, Ausplume Version 6.

The preference to use CALPUFF rather than Ausplume for this particular assessment was due to:

- The potential for sea breeze influences on plume behaviour; and
- The ability of CALPUFF to use sub-hourly meteorological data which is a more accurate representation of the impacts of startup conditions for the peak loading power plant.

6 Conclusion

Meteorological data was prepared for the dispersion modelling using CALMET. CALMET is a meteorological pre-processor for the CALPUFF dispersion model that is able to take account of surface and upper air observations across a model domain and, using topographic and land use data derive three dimensional meteorology across a model grid. The output from CALMET is then used in the dispersion modelling.

Observational data in the area surrounding the project site was available from:

- Mortlake Racecourse (surface);
- Portland (surface);
- Warrnambool (surface); and
- Mount Gambier (surface and upper air).

6.2.3 In Stack Concentrations

In stack concentrations have been estimated based on emission estimates (as detailed above) and volumetric flow of exhaust gases. In stack concentrations of NO_X and total particulate matter have been assessed against the criteria in Schedule D of the SEPP(AQM).

6.2.4 Greenhouse Gas Estimation

Emissions of CO_2-e (carbon dioxide equivalent) have been calculated for Scope 1 and Scope 2 activities and defined in the NGERS determination (See Section 4.9.2).

Accounts (NGA) factors to provide data on the emissions of CO_2-e generated through the combustion of gaseous fuels for power generation. The NGA factors take in to account emissions of the three main greenhouse gases, CO_2, CH_4 (methane) and N_2O (nitrous oxide) (Department of Climate Change, 2009).

Scope 1

Manufacturer's specifications for the potential generators proposed for this site provide a heat rate in terms of kJ/kWh. This defines the amount of natural gas, in terms of the energy it contains, required by the engine type to produce 1 kWh of electricity. Scope 1 emissions have been calculated using the gas energy required for each engine to generate at full load for 5% of the year and the NGA factors for the combustion of natural gas delivered by pipeline.

Scope 2

Scope 2 emissions from electricity use have been calculated using the National Greenhouse Accounts (NGA) factors to provide data on the emissions of CO_2-e (carbon dioxide equivalent) generated through the use of electricity from the national grid. The NGA factors take in to account emissions of the three main greenhouse gases, CO_2, CH_4 (methane) and N_2O (nitrous oxide) generated through generation of electricity (Department of Climate Change, 2009).

Electricity use of the proposed facility has been estimated based on grid electricity consumption by another AGL peak load power station in Victoria using a linear relationship between electricity produced and grid electricity consumed.

6.3 Results

6.3.1 Ambient Air Quality

Predicted ground level concentrations for all species and all considered engine designs were well below the relevant SEPP (AQM) design criteria at all locations in the model domain including with consideration of potential emissions from the proposed Shaw River Power Station.

6.3.2 On Site Concentrations

Predicted ground level concentrations for all species and all considered engine designs were below the relevant Safe Work Australia guidelines at all modelled on-site locations.

6.3.3 In Stack Concentrations

Estimated in stack concentrations for NO_X and total particulate matter are below the SEPP(AQM) emission limits for stationary sources in Victoria.

6.3.4 Greenhouse Gas Emission

At an assumed 5% usage rate, the annual Scope 1 and 2 CO_2-e emissions for the proposed E and F class engines are about 165,000 tonnes CO_2-e and 189,000 tonnes CO_2-e respectively. This represents 0.2% and 0.23% for E and F class engines respectively of 2006 Victorian emissions from stationary energy sources.

References

Department of Climate Change, 2009. 'National Greenhouse Accounts (NGA) Factors'. Australian Government

EPA Victoria, 2001. 'State Environment Protection Policy (Air Quality Management)'. Victoria Government Gazette No. S 240.

National Occupational Health and Safety Commission. Worksafe Australia, 2001. 'Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment NOHSC 3008(1995) 3rd Edition. Available at http://www.safeworkaustralia.gov.au/NR/rdonlyres/C5FA8374-318E-49AC-A1FB-5E75BEE5868C/0/GuidanceNoteontheInterpretationofExposureStandardsforAtmosphericContaminantsintheOccupa.pdf. Last accessed 20/04/2010

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Limitations

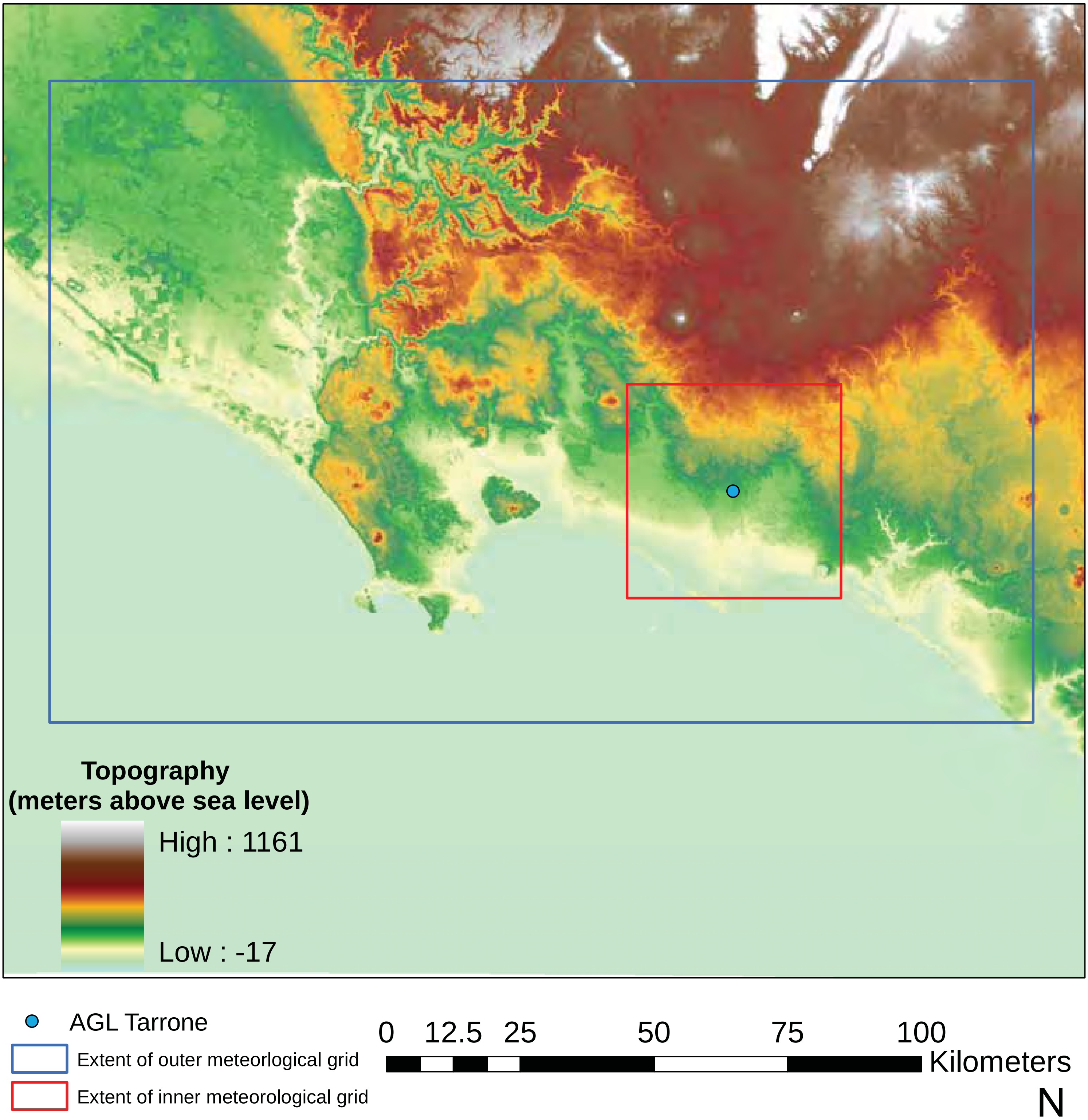
URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of AGL Energy Limited and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 12 September 2008.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between March 2009 and June 2010 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Figures



Source: Base map sourced USGS using Shuttle Ray Topography Mission (SRTM) data

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Works Approval Application

TITLE: Extent of outer and inner meteorlogical grids used in CALMET to derive meteorology for dispersion modelling with terrain data from the SRTM database

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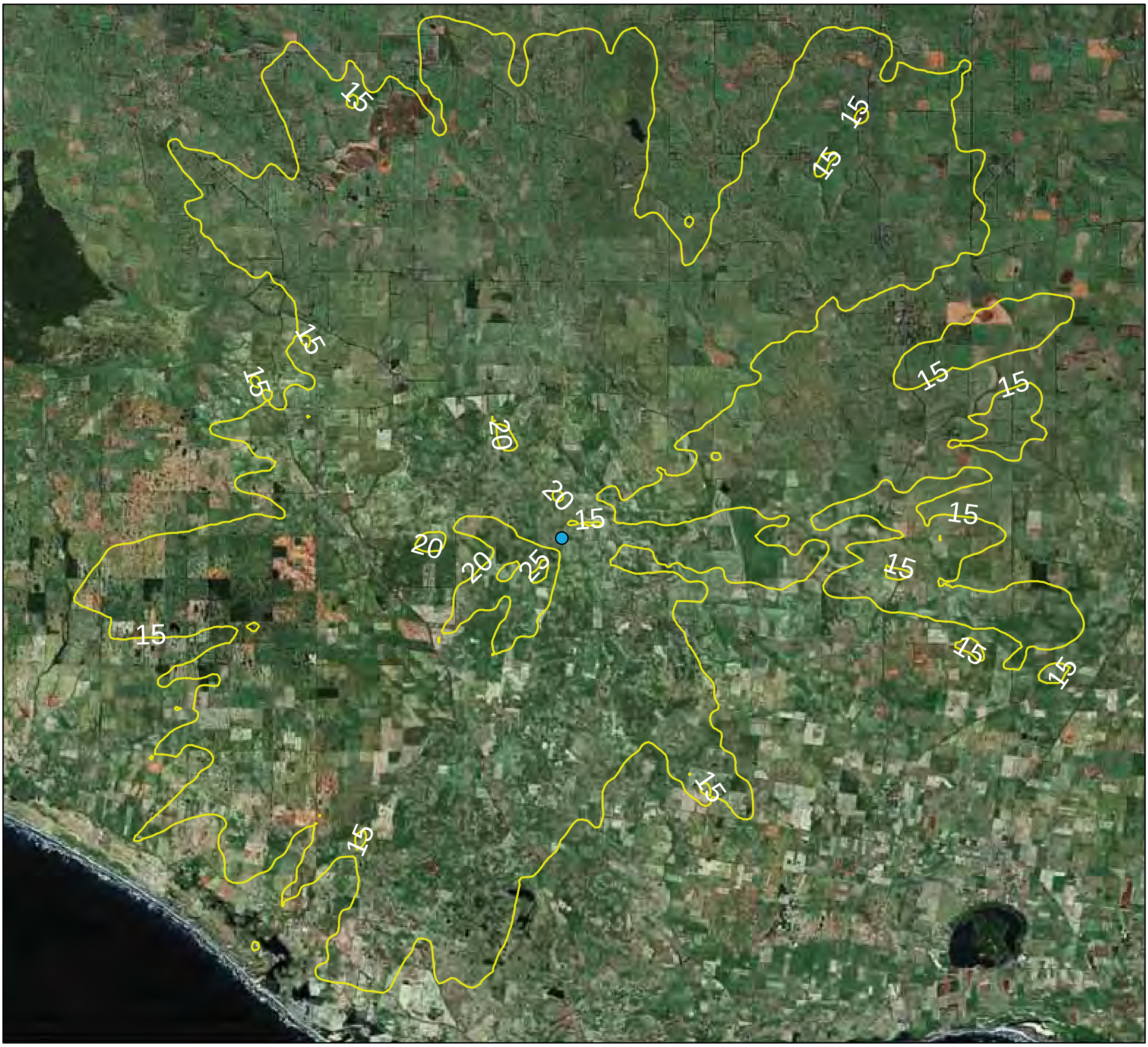


SEPP(AQM)
Design Criteria190 ug/m^3

Background Concentration 11.3 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_X as NO_2 Concentrations (ug/m^3), including background, for four Alstom AE13E2 engines operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_2.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 2

SEPP(AQM)
Design Criteria 450 ug/m^3

Background Concentration 0 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

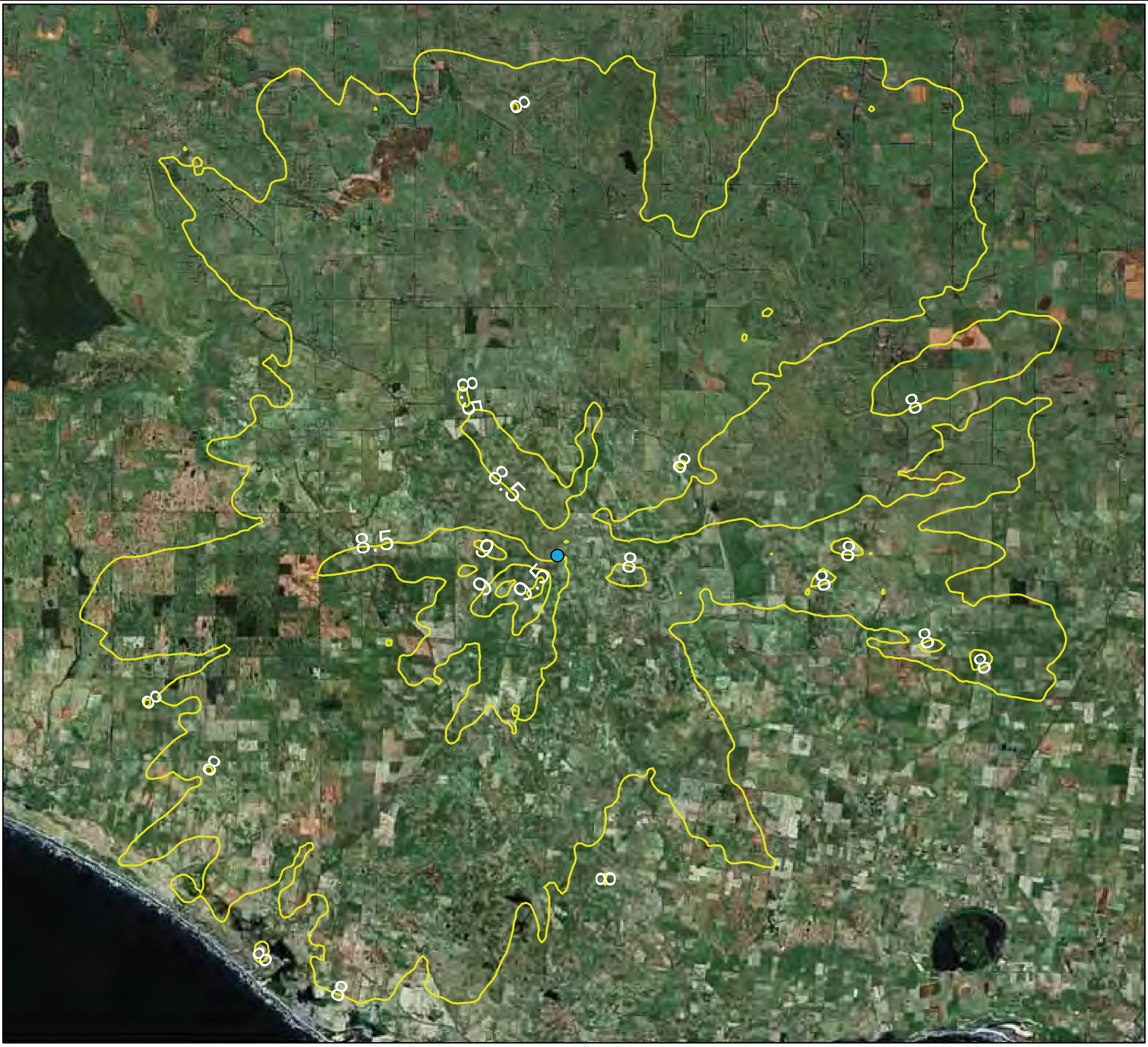
Source: Base map sourced from Bing Maps and Microsoft 2010
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average SO_X as SO_2 Concentrations (ug/m^3), including background, for four Alstom AE13E2 engines operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_3.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 3



SEPP(AQM)
Design Criteria 50 ug/m^3

Background Concentration 7.5 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

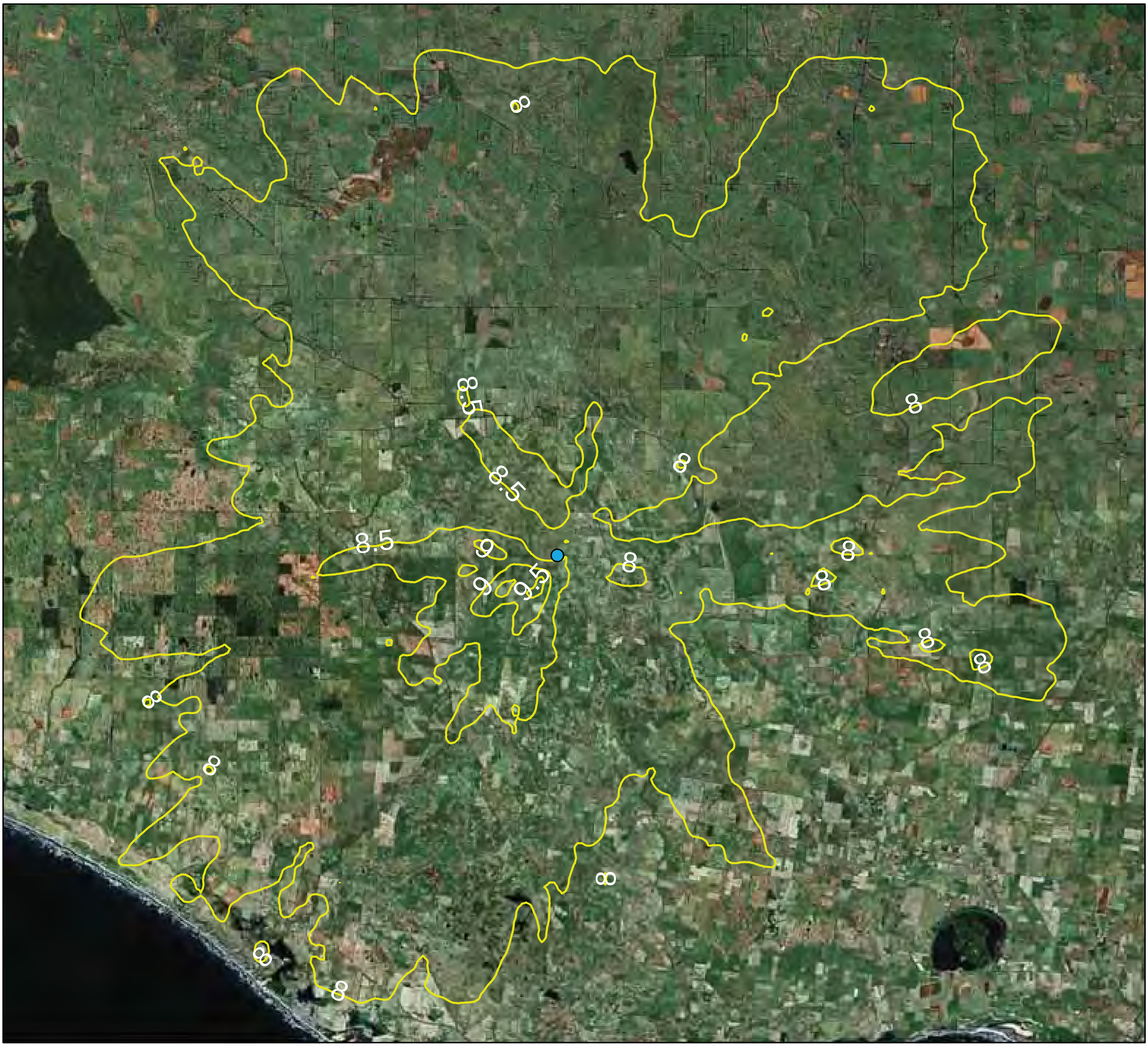
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ concentrations (ug/m^3), including background, for four Alstom AE13E2 engines operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_5.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 4



SEPP(AQM)
Design Criteria 50 ug/m^3

Background Concentration 7.5 ug/m^3

AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ concentrations (ug/m^3), including background, for four Alstom AE13E2 engines operating at full load**

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_5.mxd

MAP BY: IMC
CHECKED BY: HG

DATE: 19/08/10

URS

Figure:
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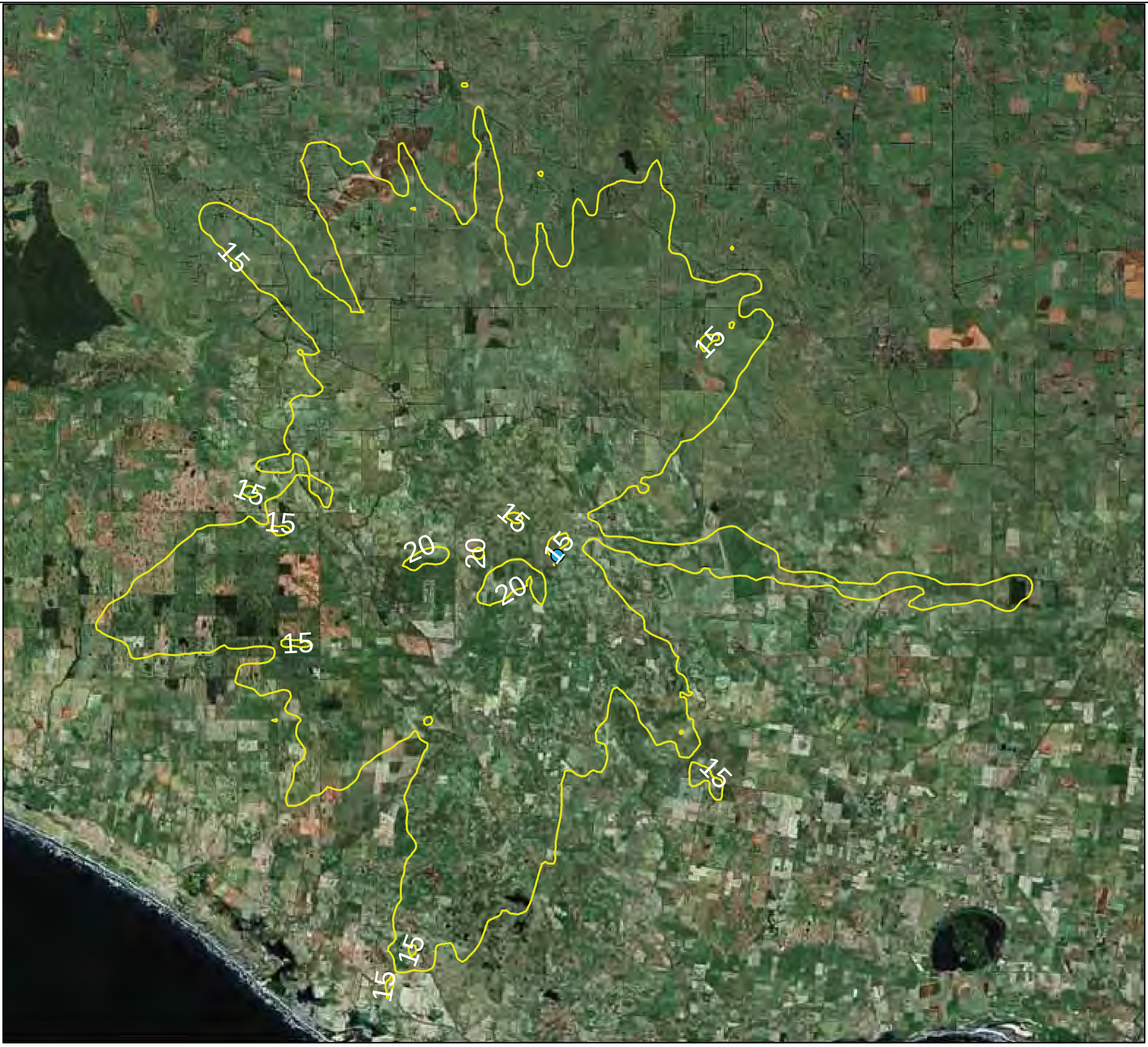


Source: Base map sourced from Bing Maps and Microsoft 2010

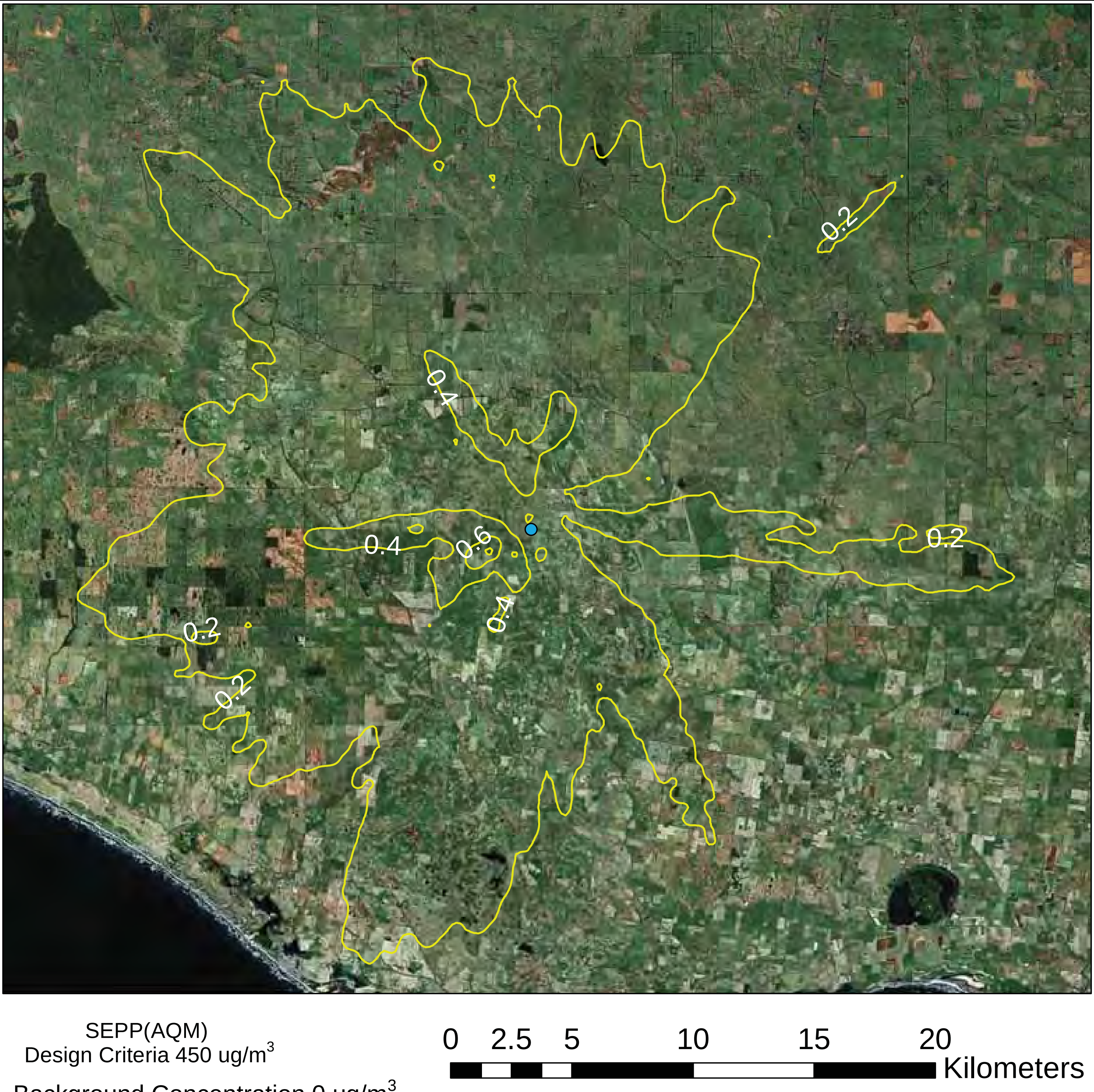
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_X as NO_2 concentrations (ug/m^3), including background, for three GE 9FA engines operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_6.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 6



Source: Base map sourced from Bing Maps and Microsoft 2010

Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average SO_X as SO_2 concentrations (ug/m^3), including background, for three GE 9FA engines operating at full load**

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_7.mxd

MAP BY: IMC
CHECKED BY: HG

DATE: 19/08/10

Figure:
7

Source: Base map sourced from Bing Maps and Microsoft 2010

Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Works Approval Application

TITLE: Predicted Maximum (99.9th Percentile) 1 hour average carbon monoxide concentrations (ug/m^3), including background, for three GE 9FA engines operating at full load

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_8.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 8

SEPP(AQM)
Design Criteria 50 ug/m^3

Background Concentration 7.5 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

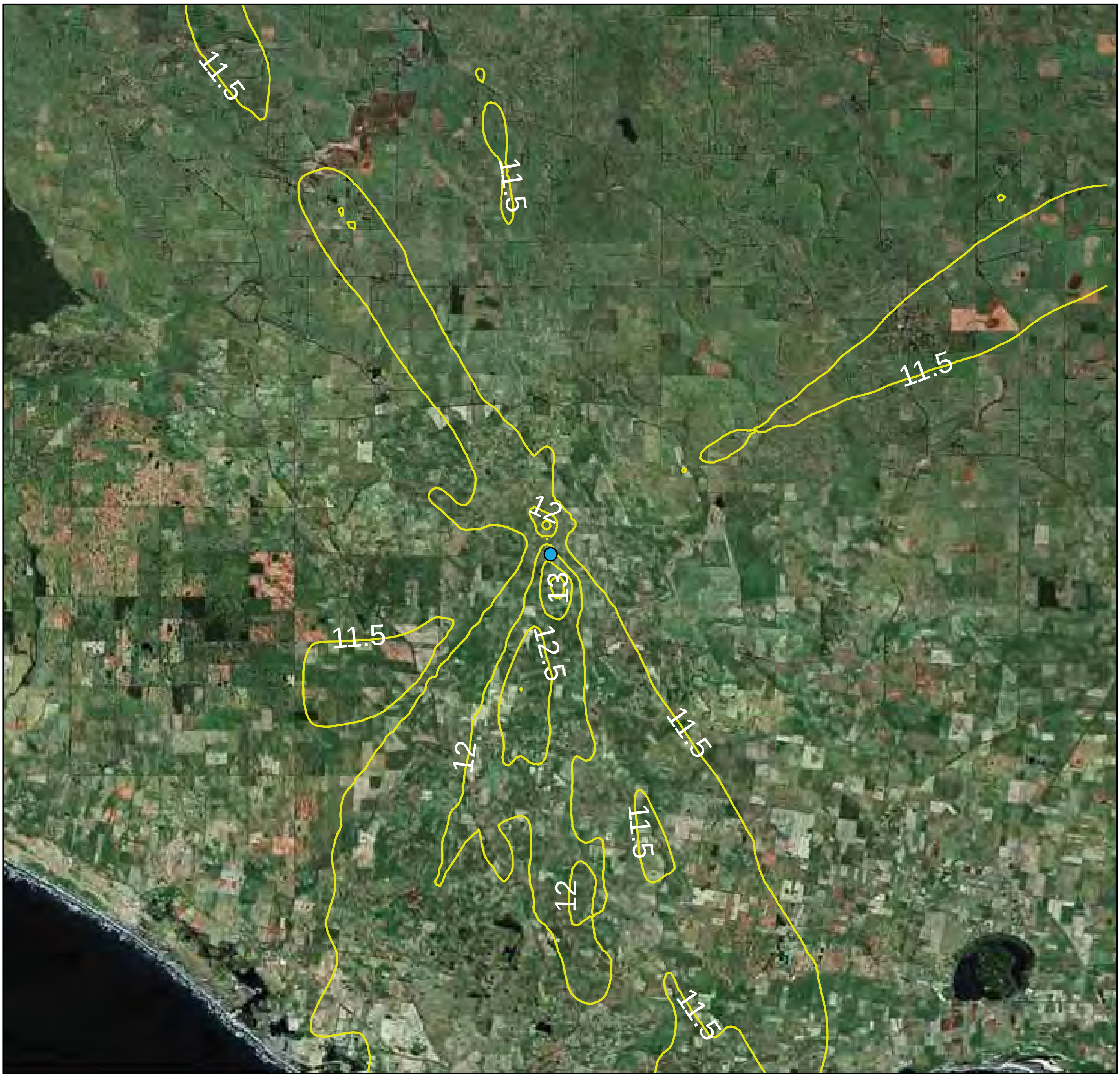
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Works Approval Application

TITLE: Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ concentrations (ug/m^3), including background, for three GE 9FA engines operating at full load

PROJECT: 43283491 MAP FILE: J:\Jobs\43283491\Works\Air Quality\GIS\Layouts WA\AGL_WA_9.mxd	MAP BY: IMC CHECKED BY: HG DATE: 19/08/10	URS	Figure: 9



SEPP(AQM)
Design Criteria 190 ug/m^3

0 2.5 5 10 15 20 Kilometers

Background Concentration 11.3 ug/m^3

● AGL Tarrone

N

Source: Base map sourced from Bing Maps and Microsoft 2010

Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_X as NO_2 concentrations (ug/m^3), including background, for four Alstom AE13E2 engines operating in startup**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_10.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 10

SEPP(AQM)
Design Criteria 190 ug/m^3

0 2.5 5 10 15 20 Kilometers

Background Concentration 11.3 ug/m^3

● AGL Tarrone

N

Source: Base map sourced from Bing Maps and Microsoft 2010

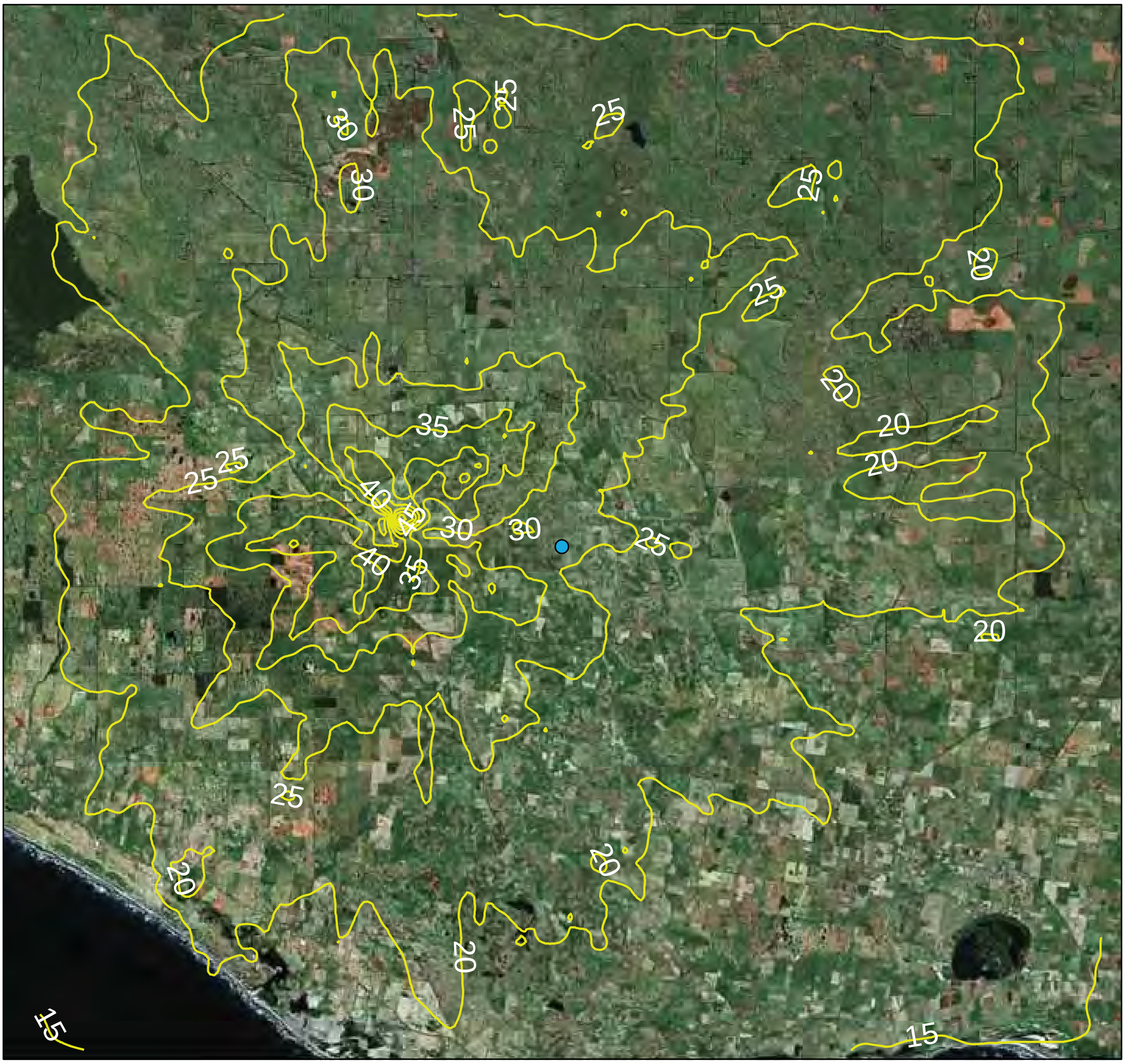
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_X as NO_2 concentrations (ug/m^3), including background, for three GE 9FA engines operating in startup**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_11.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 11



SEPP(AQM)
Design Criteria 190 ug/m^3

Background Concentration 11.3 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

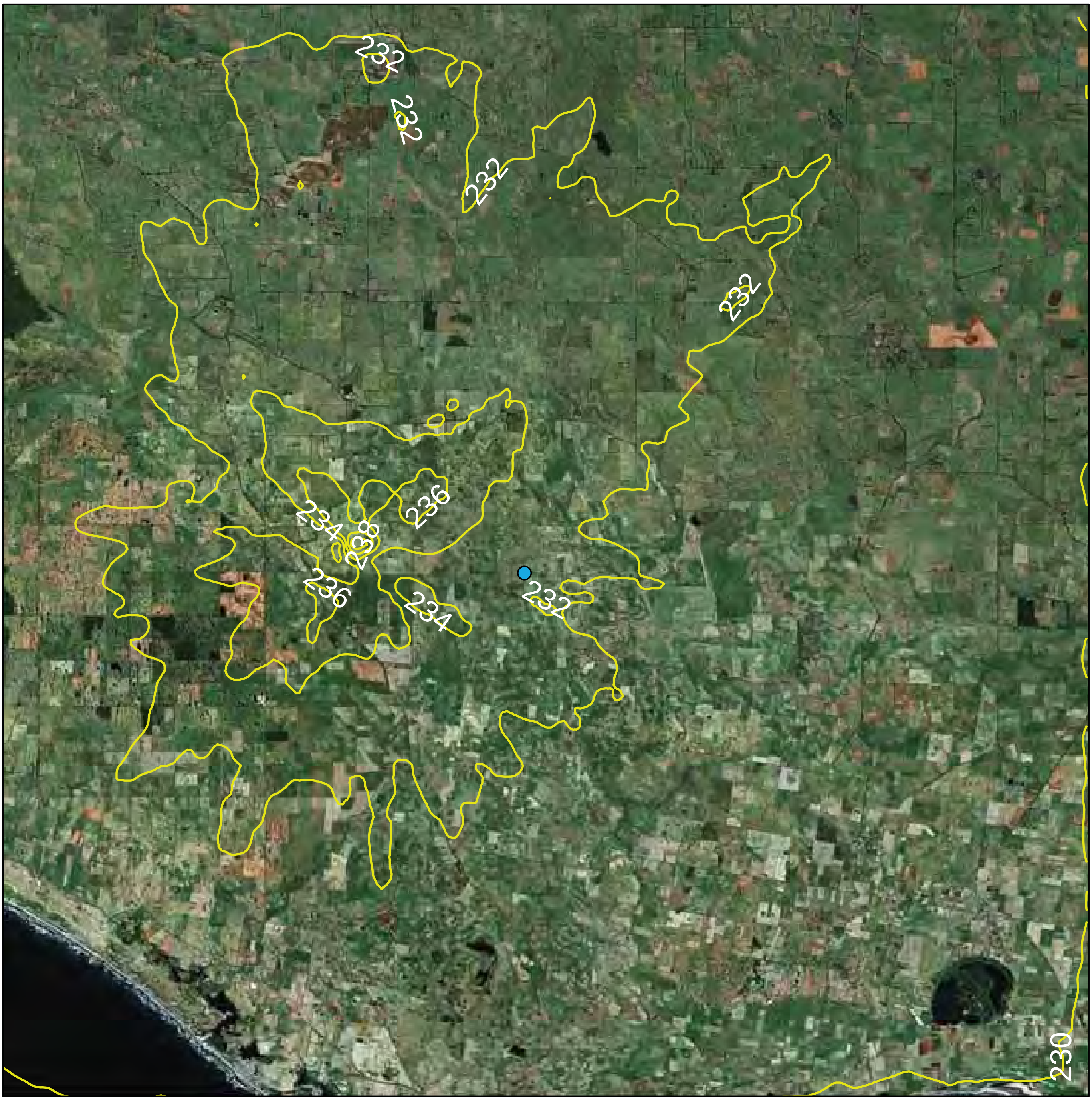
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_X as NO_2 concentrations (ug/m^3), including background, for four Alstom AE13E2 turbines at AGL Tarrone and three SGT5-4000F at Santos Shaw River operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_12.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 12



SEPP(AQM)
Design Criteria 29,000 ug/m^3

Background Concentration 229 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

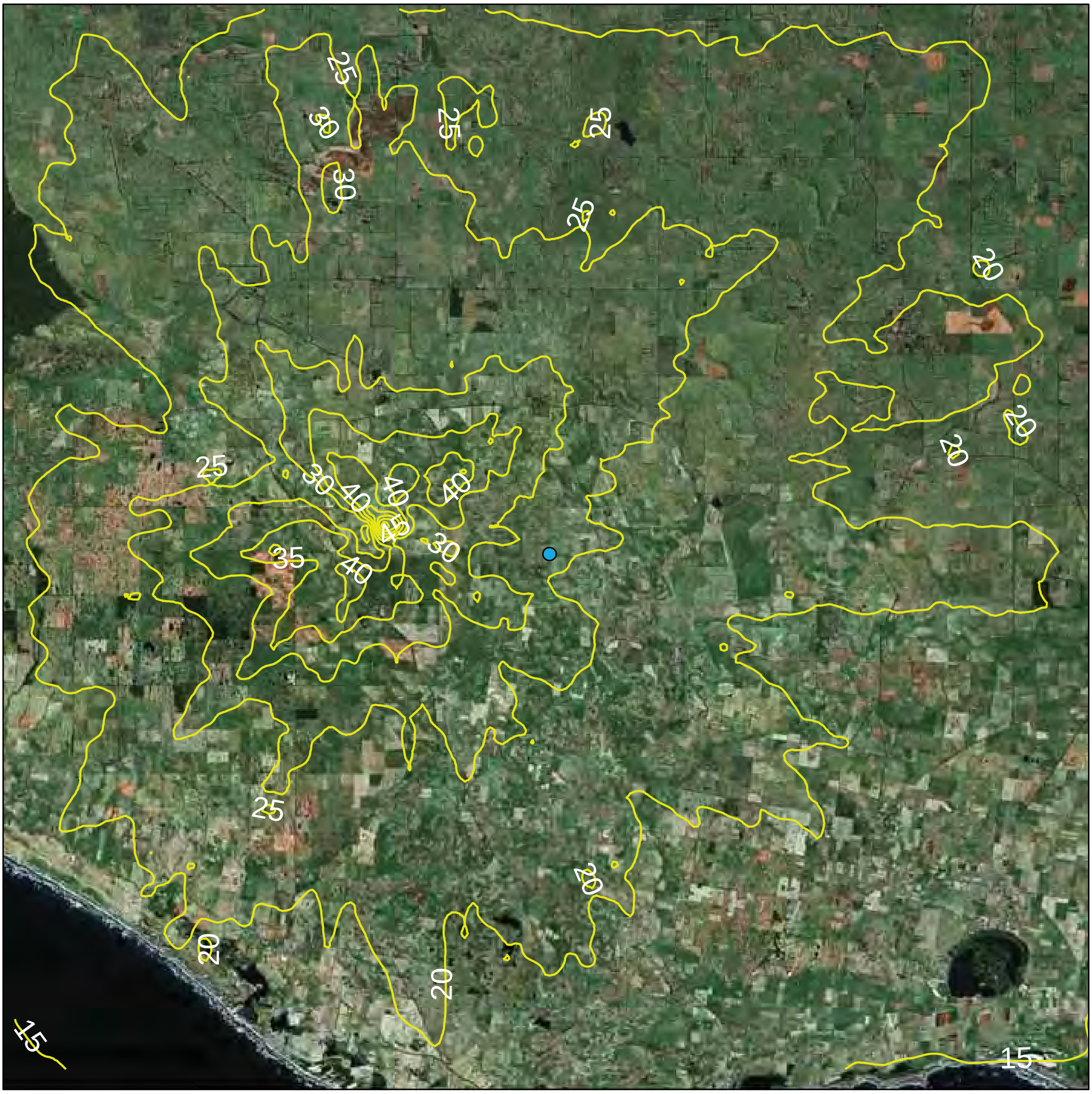
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average carbon monoxide concentrations (ug/m^3), including background, for four Alstom AE13E2 turbines at AGL Tarrone and three SGT5-4000F at Santos Shaw River operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491\Works\Air Quality\GIS\Layouts WA\AGL_WA_13.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 13



SEPP(AQM)
Design Criteria 190 ug/m^3

Background Concentration 11.3 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

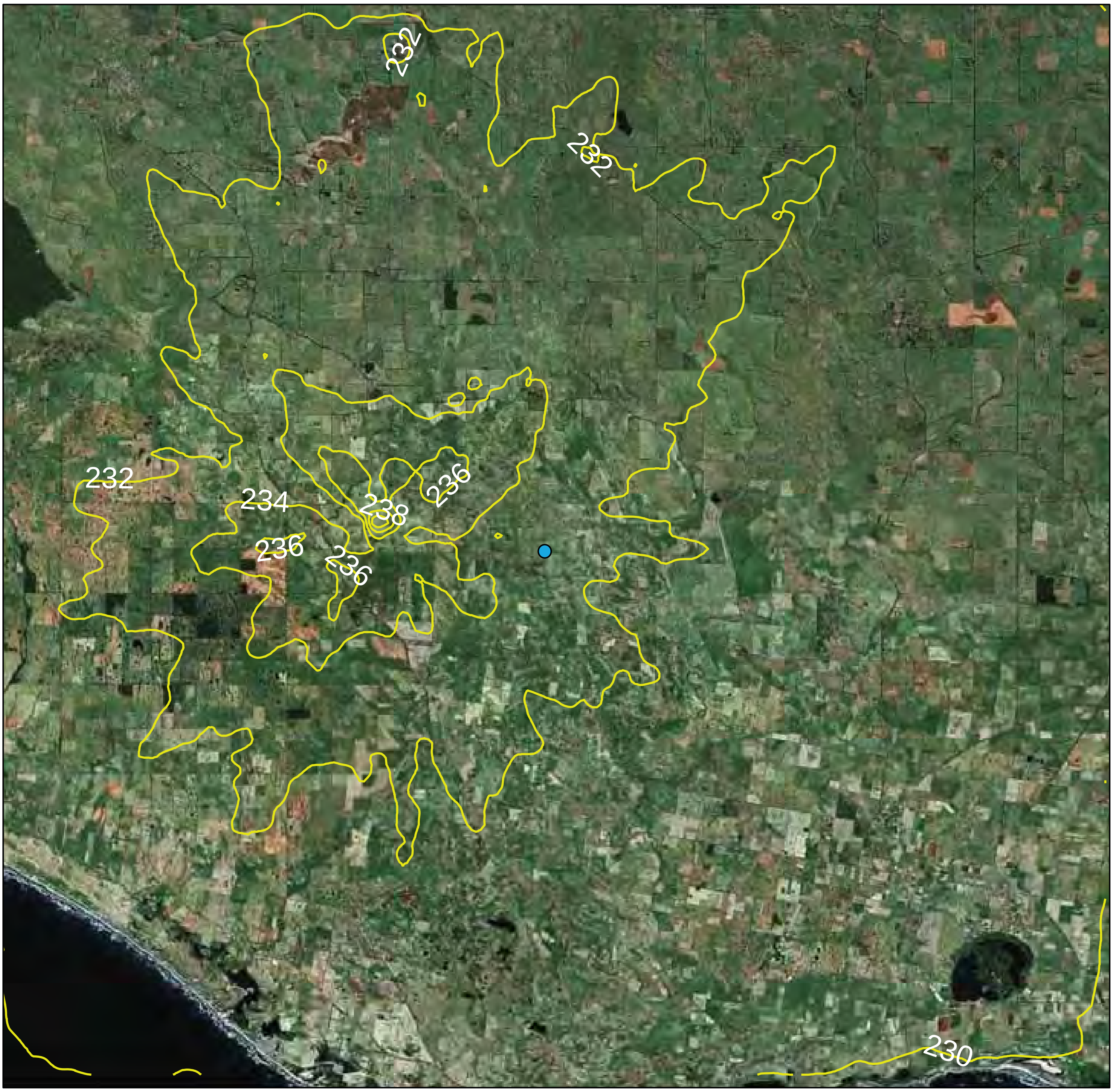
Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_X as NO_2 concentrations (ug/m^3), including background, for three GE9FA turbines at AGL Tarrone and three SGT5-4000F at Santos Shaw River operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_14.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 14



SEPP(AQM)
Design Criteria 29,000 ug/m^3

Background Concentration 229 ug/m^3

● AGL Tarrone

0 2.5 5 10 15 20 Kilometers

N

Source: Base map sourced from Bing Maps and Microsoft 2010

Contours generated by URS Australia Pty Ltd from dispersion modelling undertaking using CALPUFF

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Works Approval Application**

TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average carbon monoxide concentrations (ug/m^3), including background, for three GE9FA turbines at AGL Tarrone and three SGT5-4000F at Santos Shaw River operating at full load**

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts WA\AGL_WA_15.mxd**	**MAP BY: IMC** **CHECKED BY: HG** **DATE: 19/08/10**	URS	Figure: 15

Appendix B Representativeness of Modelled Engines

Appendix B

B.1 Comparison of Specifications

At this stage in the design process, the final choice of engine manufacturer has not been determined. In order to provide flexibility in the final choice of supplier, the local air quality impact from the use of two engines representing typical emissions and impact resulting from the use of E-Class and F-Class engines has been considered. To ensure that available specifications used in this application are suitably representative of other possible engine configurations, comparison of publically available documentation from manufacturer's websites has been undertaken (Table 4-3). Missing data for a particular parameter indicates that data on this particular parameter is not available in the product brochures / websites[6].

The key parameters with respect to influencing emission characteristics are:

- Power output;
- Heat rate;
- Exhaust gas temperature; and
- Gas consumption.

B.1.1 Buoyancy Flux

Upon release from the stack, the rise of emissions up into the atmosphere is governed by buoyancy flux. Buoyancy flux is driven by:

- Exhaust velocity;
- Exhaust gas temperature; and
- Ambient temperature.

Following emission from the stack and as it rises, the plume cools and slows down as a result of heat loss to the surrounding atmosphere and friction with the air. Final plume rise is reached when the temperature of the emissions is the same as the surrounding atmosphere, and the vertical velocity is zero.

The interaction of the stack exit velocity and stack exit temperature on plume rise was first described by Briggs in 1972[7], using the Briggs buoyancy flux parameter (Equation B-1). The higher the Briggs buoyancy flux parameter, the higher the plume will rise in to the atmosphere.

[6] http://www.energy.siemens.com/hq/en/power-generation/gas-turbines/
http://www.gepower.com/prod_serv/products/gas_turbines_cc/en/midrange/ms9001e.htm
http://www.gepower.com/prod_serv/products/gas_turbines_cc/en/f_class/ms9001fa.htm
http://www.ansaldoenergia.com/PDF/AnsaldoEnergia_GasTurbines_09_ING.pdf
http://www.mpshq.com/products_gasturbines.htm#M501FM701F
[7] Beychock, M.R., 2005, 'Fundamentals of Stack Gas Dispersion'.

8 Limitations

Table B-1 Comparison of manufacturers specifications for proposed E Class engines (modelled engine shaded)

Manufacturer	Engine	Class	Number Engines	Power Output (MW)	Heat Rate (kJ/kWh)	Exhaust Gas Temp	Gas Consumed m^3/hr	Guaranteed NO_X at 15% Oxygen (ppm)
Siemens	SGT5-2000E	E	4	168	10,366		45,849	25
GE	9E	E	4	126	10,653		35,339	
Ansaldo	V94.2	E	4	170		544		
Alstom	AE13E2	E	4	167	9,428	513	41,452	

Table B-2 Comparison of manufacturers specifications for proposed F Class engines (modelled engine shaded)

Manufacturer	Engine	Class	Number Engines	Power Output (MW)	Heat Rate (kJ/kWh)	Exhaust Gas Temp	Gas Consumed m^3/hr	Guaranteed NO_X at 15% Oxygen (ppm)
Siemens	SGT5-4000F	F	3	292	9,038		69,481	25
GE	9FA	F	3	256	9,757	609	65,658	
Ansaldo	V94.3	F	3	294		572		
Mitsubishi	M701F4	F	3	307[8]	8,565[8]		69,226	

[8] Current rating of the Mitsubishi M701F3 is 270 MW per engine with a heat rate of 9738 kJ/kWh. Technology is expected to improve over time resulting in the M701F4 claiming a reduced heat rate and greater efficiency of the engine to produce more power for the same volume of gas consumed.

Appendix B

Equation B-1 Calculation of Briggs buoyancy flux parameter[7]

$$F = g v_s r^2 \frac{(T_s - T_a)}{T_s}$$

Where:

F is the Briggs buoyancy flux parameter (m^4/sec^3)
g is the acceleration due to gravity (9.807 m/sec^2)
v_s is the stack exit velocity (m/sec)
r is the stack radius (m)
T_s is the stack exit temperature (K)
T_a is the ambient air temperature (K)

It should be noted that in Equation B-1, the product of stack velocity and the square of the stack radius are used. This term is equivalent to the volumetric flow of the stack. A narrowing of the stack diameter will result in an increase in velocity; however the volumetric flow will remain the same meaning that the buoyancy flux will not change.

Figure B-1 Impact of variation of temperature and emission velocity on Briggs buoyancy flux parameter

shows a comparison of the impacts of exit velocity and exit temperature on the Briggs buoyancy flux parameter (using Equation B-1). In this example, the following parameters have been used:

- Ambient temperature set to the annual mean temperature for Warnambool (18°C)[9];
- Stack diameter set to 7m (typical for peak loading power stations);
- Stack exit temperature varied between 500°C and 625°C (typical for peak loading power stations); and
- Stack exit velocity varied between 40 m/sec and 45 m/sec (typical for peak loading power stations).

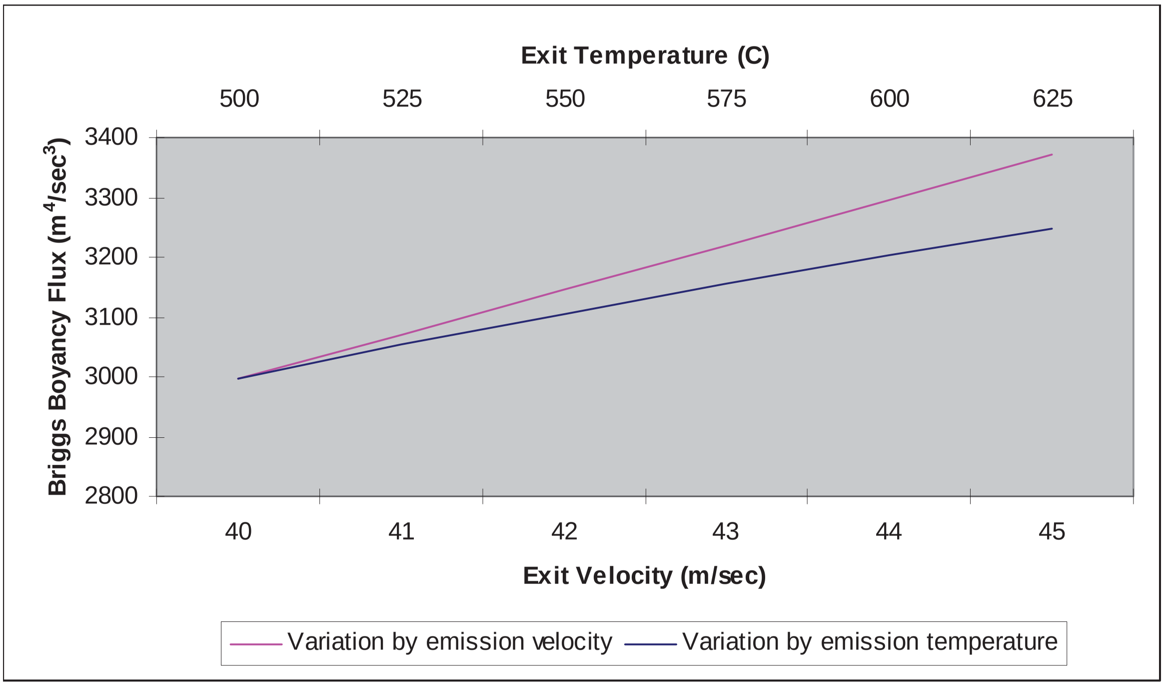
Figure 4-3 demonstrates that a small change in emission velocity, for a constant stack diameter, (which is effectively variable emission volumetric flow, as velocity is varied at a constant stack diameter) has a larger impact on the Briggs buoyancy flux parameter than a 100°C temperature change. Final plume rise height is determined by a combination of these parameters.

Both emission velocity and temperature are related to the engine efficiency, as this determines the energy contained in the emissions in terms of sensible heat emission. Briggs' equations also allow the calculation of buoyancy flux using the sensible heat emission as shown in Equation B-2. It should be noted that Equation B-1 and Equation B-2 are equivalent to each other.

[9] BOM, 2010. 'Climate Statistics for Australian Locations – Warnambool'. Available at http://www.bom.gov.au/climate/averages/tables/cw_090172.shtml, last accessed 3/3/2010

Appendix B

Figure B-1 Impact of variation of temperature and emission velocity on Briggs buoyancy flux parameter



Equation B-2 Calculation of heat flux using the stack sensible heat emission

$$F = \frac{gQ}{\Pi C_{pa} T_a \rho_a}$$

Where:

Q is the stack sensible heat emission (cal/sec)

C_{pa} is the specific heat of ambient air (1.012 cal/(gK) at 25°C)

ρ_a is the density of air (1184 g/m^3 at 25°C and standard pressure)

Using the efficiency of the engine to calculate energy directed to stack (in the form of heat) and Equation B-2, Table B-3 shows the calculated buoyancy flux of each engine.

Table B-3 Briggs buoyancy flux calculated based on engine efficiencies for each possible engine configuration (engines modelled in EES referral are highlighted)

Generator Class	E Class		F Class	
Manufacturer	Model	Buoyancy Flux (m^4/sec^3)	Model	Buoyancy Flux (m^4/sec^3)
Siemens	SGT5-2000E	659	SGT5-4000F	921
GE	9E	515	9FA	912
Ansaldo	V94.2	662	V94.3	932
Alstom	AE13E2	564		
Mitsubishi			M701F4	884

Appendix B

In general, higher buoyancy flux results in higher final plume rise. Theoretical final plume rise height may be calculated for the above buoyancy fluxes using Equation B-3.

Equation B-3 Calculation of final plume rise height using Briggs equation for bent-over buoyant plumes for stability categories A to D

$$\Delta h_{max} = 1.6F^{1/3} x_f^{2/3} u^{-1} = 38.7F^{0.60} u^{-1}$$

Where:

Δh_{max} is the maximum final plume rise height

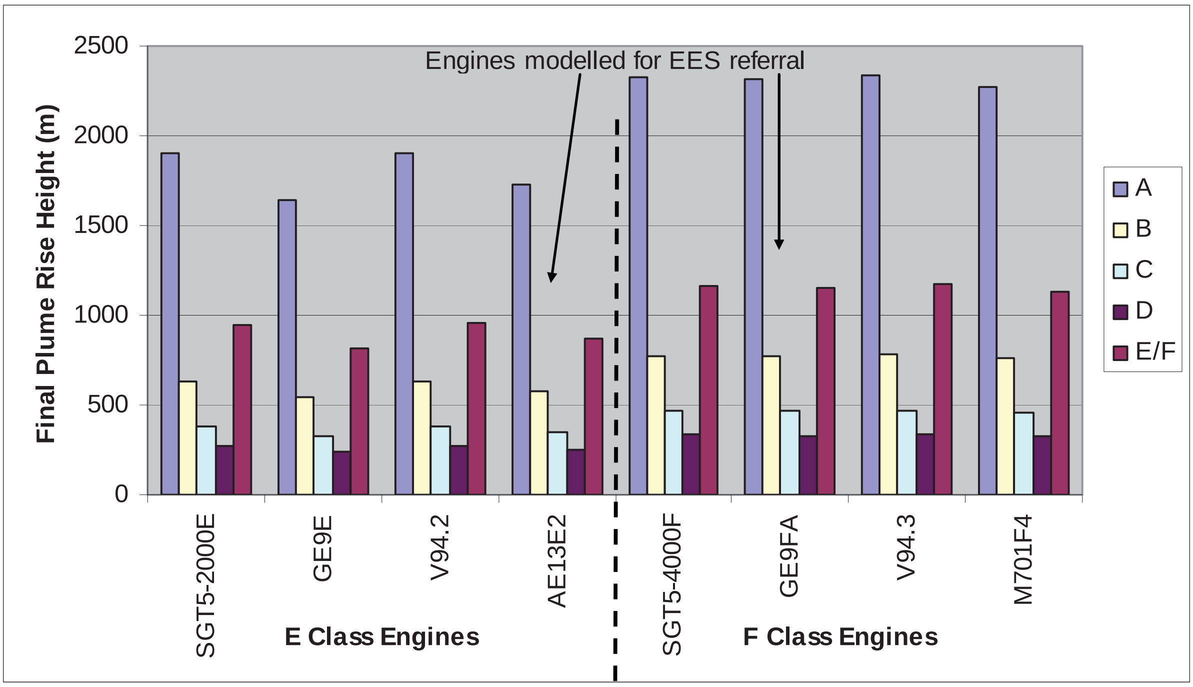
x_f is the downwind distance from the stack to maximum (final plume rise) calculated for the above buoyancy fluxes using $199F^{0.40}$

u is the wind speed

Error! Reference source not found. shows the final plume rise heights calculated for the atmospheric stability classes A to F for the proposed engines.

Table B-4 shows the percentage variation in final plume rise height of additional engines under consideration relative to the modelled engines for each of the two engine classes. It should be noted that a positive percentage difference refers to a higher final plume rise height and vice versa for a negative percentage difference.

Figure B-2 Final plume rise height for the proposed engines in each atmospheric stability category calculated using Equation B-3



Appendix B

Table B-4 Percentage change in final plume rise height from engines modelled in the EES referral (positive changes refer to a higher final plume rise height and vice versa)

Generator Class	E Class		F Class	
Manufacturer	Model	Percentage Change in Plume rise height	Model	Percentage Change in Plume rise height
Siemens	SGT5-2000E	9.76%	SGT5-4000F	0.54%
GE	9E	-5.31%	9FA	0.00%
Ansaldo	V94.2	10.04%	V94.3	1.29%
Alstom	AE13E2	0.00%		
Mitsubishi			M701F4	-1.90%

Theoretically (and generally), higher plume rise results in lower ground level concentrations due to a greater potential for dispersion and dilution. Conversely, lower plume rise will result in generally higher ground level concentrations.

Assuming a linear relationship between variation in plume rise and ground level concentrations, the GE 9E will result in approximately a 5% higher ground level concentration than the E Class engines modelled for the EES referral and the Mitsubishi M701F4 will result in approximately a 1.9% higher ground level concentration than the F Class engines modelled for the EES referral. All other engines will result in higher plume rise, and therefore lower ground level concentrations.

Whilst this assumption is considered reasonable (given that the air mass will typically rise as a column until near the top of its rise where it will disperse and fall) plume rise may vary under particular climatic conditions. These calculations are based on theoretical atmospheric stability and assume a homogenous atmosphere. Variations in upper atmospheric meteorology will result in variations to these assumptions, which may result in increased ground level concentrations despite higher plume rise. However, the variation in the calculated change in plume rise heights is not likely to be of sufficient magnitude to affect the validity of the assessment predictions.

B.1.2 Mass Emission Rates

For the same meteorological and stack release conditions, a doubling of the emission rate of species from the stack will result in a doubling of predicted ground level concentration, due to the conservation of mass principle.

Available data from engine manufacturers provides details of a guarantee of oxides of nitrogen (NO_X) maximum emission concentration. NO_X is considered by engine manufacturers to be the species of most concern when compared to regulatory limits. All the prospective engine manufacturers guarantee NO_X to 25ppm for the nominated engines.

NO_X is generated during combustion as nitrogen in the air and fuel combines with oxygen in the air to form nitrogen oxide (NO) and nitrogen dioxide (NO_2) in approximately the ratio 90:10. On emission, atmospheric chemistry transforms a portion of the NO to NO_2 through oxidation, whilst sunlight results in disassociation of NO_2, forming NO. As the exact ratio in released gases at any one time is not known, the two are summed and termed NO_X. Methods however exist for estimating the ground level concentrations of NO_2, using oxidant concentrations in the atmosphere.

Appendix B

Assuming that the ratio of air to fuel gas injected to the combustion chamber for each Class of engine is the same, the variant parameter in the amount of NO_X produced by an engine is the quantity of fuel used. NO_X emission rates are known for the two engines modelled for the EES referral; assuming a linear relationship between the fuel flow rate and the NO_X emissions, Equation B-4 may be used to estimate mass emission rate of NO_X for each engine.

Equation B-4 Calculation of NO_X emission rate using linear relationship with fuel usage

$$E_{NO_X} = \frac{F_{Engine}}{F_{EES}} \times E_{EES}$$

Where:

E_{NOX} is the emission rate of NO_X for a specific engine
F_{EES} is the fuel use rate used for the engine class in the EES referral (Calculated using Equation B-5)
F_{Engine} is the fuel use rate for the specific engine (Calculated using Equation B-5)
E_{EES} is the emission rate used for the engine class in the EES referral

Equation B-5 Calculation of fuel rate

$$F = \frac{P \times 1000 \times HR}{E_{Gas}}$$

Where:

F is the fuel rate (m^3/hr)
P is the power output of the engine (MWh)
HR is the heat rate of the engine (kJ/kWh)
E_{Gas} is the energy content of gas (37983 kJ/m^3 at 15°C)

Table B-5 provides a comparison of estimated mass emission rates for the different engines in comparison to the nominated engines. In the EES referral, the NO_X mass rate for the Alstom E-Class engine was modelled as provided by the manufacturer, whilst the NO_X mass emission rate for the GE F-Class engine was increased by 10%. This approach was used to provide a conservative upper estimate of potential emission rate, ensuring that any variation for the manufacture specifications would not result in an exceedance of regulatory criteria.

Comparison of the emission rates modelled in the EES referral with emission rates for other prospective engines shows that other engines may have a higher NO_X emission rate than modelled.

Appendix B

Table B-5 Comparison of the calculated NO_X mass rates for the other engines relative to the modelled NO_X mass rates used in EES referral. Engines modelled in the EES referral are highlighted

Generator Class	E Class		F Class	
Manufacturer	Model	Percentage Change in Modelled NO_X mass rate	Model	Percentage Change in Modelled NO_X mass rate
Siemens	SGT5-2000E	10.61%	SGT5-4000F	5.82%
GE	9E	-14.75%	9FA	0.00%
Ansaldo	V94.2	11.38%	V94.3	6.90%
Alstom	AE13E2	0.00%		
Mitsubishi			M701F4	5.43%

To provide an indication as to the impact on ground level concentrations from varying plume rise and differences in NO_X mass emission rates, the results provided in

Table B-4 and Table B-5 were combined to provide an indication of the relative impact on predicted ground level concentrations of emissions from the additional nominated engines compared to those two modelled in the EES referral (Table B-6).

This analysis indicates that there is potential for ground level concentrations to be marginally higher than modelled (up to 1.3% for E class engines and 7.3% for F Class engines), relative to those modelled in the EES referral and in this assessment. It is concluded however that the assessment conducted is adequate to confirm that the nominated beneficial uses of the air environment will be protected given that:

- Concentrations determined by the dispersion modelling, undertaken for the EES referral and this assessment, are significantly below criteria (Section 5.1); and
- The assessment conservatively assumes all NO_X is NO_2 (Section 4.8).

Consequently, it is considered that, the engines modelled represent a reasonable assessment of the engines under possible consideration.

Table B-6 Indicative comparison of the overall impact of the change in potential plume height coupled with the NO_X mass rate modelled for other engines under consideration relative to those modelled in the EES referral.

Generator Class	E Class		F Class	
Manufacturer	Model	Potential change in ground level NO_X concentrations	Model	Potential change in ground level NO_X concentrations
Siemens	SGT5-2000E	0.85%	SGT5-4000F	5.28%
GE	9E	-9.44%	9FA	0.00%
Ansaldo	V94.2	1.33%	V94.3	5.62%
Alstom	AE13E2	0.00%		
Mitsubishi			M701F4	7.33%

Appendix C Calpuff Model Input Files

```
AGL Tarrone Power Station
Scenario 1 - 4 Alstom 13E2
Continuous (steady state) operation
---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT =             *
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    * RSTARTB=             *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST =C:\URS-DATA\AGLTAR~1\CALPUFF\AGL1BSS.LST  !
CONC.DAT      output   ! CONDAT =AGL1BSS.CON     !
DFLX.DAT      output   * DFDAT  =             *
WFLX.DAT      output   * WFDAT  =             *

VISB.DAT      output   * VISDAT =             *
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =             *
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =             *
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
RISE.DAT      output   * RISDAT=             *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------
```



```
     Number of CALMET.DAT files for run (NMETDAT)
                                     Default: 1      ! NMETDAT =   6   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                     Default: 0      ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                     Default: 0      ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                     Default: 0      ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_JF.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_MA.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_MJ.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_JA.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_SO.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_ND.MET     !
!END!


--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR  =  2007  !
                       Month  (IBMO)  --    No default   ! IBMO  =  1  !
                       Day    (IBDY)  --    No default   ! IBDY  =  1  !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR  =  0  !
                       Minute (IBMIN) --    No default   ! IBMIN =  0  !
                       Second (IBSEC) --    No default   ! IBSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2007  !
                       Month  (IEMO)  --    No default   ! IEMO  =  12  !
                       Day    (IEDY)  --    No default   ! IEDY  =  31  !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR  =  23  !
                       Minute (IEMIN) --    No default   ! IEMIN =  0  !
                       Second (IESEC) --    No default   ! IESEC =  0  !

     (These are only used if METRUN = 0)

     Base time zone        (XBTZ) -- No default       ! XBTZ= -10.0  !
     The zone is the number of hours that must be
     ADDED to the time to obtain UTC (or GMT)
     Examples: PST = 8., MST = 7.
```

```
           CST = 6., EST = 5.

     Length of modeling time-step (seconds)
     Equal to update period in the primary
     meteorological data files, or an
     integer fraction of it (1/2, 1/3 ...)
     Must be no larger than 1 hour
     (NSECDT)                        Default:3600     ! NSECDT =  3600  !
                                     Units: seconds

     Number of chemical species (NSPEC)
                                     Default: 5       ! NSPEC =  10   !

     Number of chemical species
     to be emitted  (NSE)            Default: 3       ! NSE =  10   !

     Flag to stop run after
     SETUP phase (ITEST)             Default: 2       ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)      Default: 0       ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)        Default: 0       ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                     Default: 1       ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                     Default: 1       ! MPRFFM =  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                     Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                     Default: 60.0    ! PGTIME = 60. !


!END!
```



```
-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)              Default: 0     ! MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                              Default: 1     ! MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)            Default: 1     ! MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                     Default: 1     ! MRISE =  1  !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW =   2  !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                   Default: 0     ! MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)       Default: 1     ! MCHEM =  0   !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
```

```
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM =  0   !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modeled ? (MWET)          Default: 1     ! MWET =  0   !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  0   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                     Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
```



```
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 800


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion modeled for
point sources?
(MPARTL)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTLBA =  0  !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes
```

```
Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                      Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                        Default: 1     ! MREG =  0   !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
                  PGTIME   60. (min)
                  MGAUSS   1
                  MCTADJ   3
                  MTRANS   1
                  MTIP     1
                  MRISE    1
                  MCHEM    1 or 3 (if modeling SOx, NOx)
                  MWET     1
                  MDRY     1
                  MDISP    2 or 3
                  MPDF     0 if MDISP=3
                           1 if MDISP=2
                  MROUGH   0
```


AGL1BSS.INP

```
                  MPARTL   1
                  MPARTLBA 0
                  SYTDEP   550. (m)
                  MHFTSZ   0
                  SVMIN    0.5 (m/s)


!END!


-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          NOX !         !END!
! CSPEC =          SO2 !         !END!
! CSPEC =           CO !         !END!
! CSPEC =        PM2.5 !         !END!
! CSPEC =      BENZENE !         !END!
! CSPEC =      TOLUENE !         !END!
! CSPEC =     ETYLBENZ !         !END!
! CSPEC =       XYLENE !         !END!
! CSPEC = FORMALDEHYDE !         !END!
! CSPEC =    TOTAL_PAH !         !END!

                                                          Dry                 OUTPUT
GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,
(0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st
CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd
CGRUP,
    in length)                                       3=USER-SPECIFIED)     3=
etc.)

!          NOX  =         1,               1,           0,                 0   !
!          SO2  =         1,               1,           0,                 0   !
!           CO  =         1,               1,           0,                 0   !
!        PM2.5  =         1,               1,           0,                 0   !
!      BENZENE  =         1,               1,           0,                 0   !
!      TOLUENE  =         1,               1,           0,                 0   !
!     ETYLBENZ  =         1,               1,           0,                 0   !
!       XYLENE  =         1,               1,           0,                 0   !
! FORMALDEHYDE  =         1,               1,           0,                 0   !
!    TOTAL_PAH  =         1,               1,           0,                 0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
```

```
   for certain species are combined (added) prior to output.  The
   CGRUP name will be used as the species name in output files.
   Use this feature to model specific particle-size distributions
   by treating each size-range as a separate species.
   Order must be consistent with 3(a) above.


-------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  54   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0N  !
     (RLON0)                    No Default      ! RLON0 = 0E  !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 0N  !
     (XLAT2)                    No Default      ! XLAT2 = 0N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and
XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)
```



```
     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84  !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =  81   !
            No. Y grid cells (NY)      No default     ! NY =  79   !
         No. vertical layers (NZ)      No default     ! NZ =  12   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = .5 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE = .0, 20.0, 40.0, 80.0, 100.0, 200.0, 300.0, 400.0, 500.0, 1000.0,
              1500.0, 2000.0, 2400.0 !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM = 583.0 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = 5754.0 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1   !
```

```
             (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1   !
             (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP =  81   !
             (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP =  79   !
             (1 <= JECOMP <= NY)



SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)         Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP =  1   !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  1   !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP =  81   !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP =  79   !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN =  1  !
        (MESHDN is an integer >= 1)

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                                  *                          *
     FILE                          DEFAULT VALUE             VALUE THIS RUN
     ----                          -------------             --------------

   Concentrations (ICON)                 1                   !  ICON =  1   !
   Dry Fluxes (IDRY)                     1                   !  IDRY =  0   !
   Wet Fluxes (IWET)                     1                   !  IWET =  0   !
   2D Temperature (IT2D)                 0                   !  IT2D =  0   !
   2D Density (IRHO)                     0                   !  IRHO =  0   !
   Relative Humidity (IVIS)              1                   !  IVIS =  0   !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         ! LCOMPRS = T !
```



```
   *
    0 = Do not create file, 1 = create file


    QA PLOT FILE OUTPUT OPTION:

       Create a standard series of output files (e.g.
       locations of sources, receptors, grids ...)
       suitable for plotting?
       (IQAPLOT)                       Default: 1         !  IQAPLOT =  1   !
         0 = no
         1 = yes

    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported?
       (IMFLX)                         Default: 0         ! IMFLX =  0  !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported?
       (IMBAL)                         Default: 0         ! IMBAL =  0  !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)


    NUMERICAL RISE OUTPUT OPTION:

       Create a file with plume properties for each rise
       increment, for each model timestep?
       This applies to sources modeled with numerical rise
       and is limited to ONE source in the run.
       (INRISE)                        Default: 0         ! INRISE =  0  !
         0 = no
         1 = yes (RISE.DAT filename is
                  specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:

       Print concentrations (ICPRT)    Default: 0         ! ICPRT =  0   !
       Print dry fluxes (IDPRT)        Default: 0         ! IDPRT =  0   !
       Print wet fluxes (IWPRT)        Default: 0         ! IWPRT =  0   !
       (0 = Do not print, 1 = Print)

       Concentration print interval
       (ICFRQ) in timesteps            Default: 1         ! ICFRQ =  1   !
       Dry flux print interval
       (IDFRQ) in timesteps            Default: 1         ! IDFRQ =  1   !
       Wet flux print interval
       (IWFRQ) in timesteps            Default: 1         ! IWFRQ =  1   !

       Units for Line Printer Output
       (IPRTU)                         Default: 1         ! IPRTU =  3   !
                     for             for
                Concentration    Deposition
           1 =       g/m**3        g/m**2/s
           2 =      mg/m**3       mg/m**2/s
           3 =      ug/m**3       ug/m**2/s
           4 =      ng/m**3       ng/m**2/s
           5 =     Odour Units

       Messages tracking progress of run
```

```
       written to the screen ?
       (IMESG)                        Default: 2         ! IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------
WET FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   PRINTED?  SAVED ON DISK?
   -------       ------------------------   ------------------------
------------------------   ---------------
!         NOX =     0,          1,          0,          0,          0,
     0,           0  !
!          CO =     0,          1,          0,          0,          0,
     0,           0  !
!         SO2 =     0,          1,          0,          0,          0,
     0,           0  !
!       PM2.5 =     0,          1,          0,          0,          0,
     0,           0  !
!     BENZENE =     0,          1,          0,          0,          0,
     0,           0  !
!     TOLUENE =     0,          1,          0,          0,          0,
     0,           0  !
!    ETYLBENZ =     0,          1,          0,          0,          0,
     0,           0  !
!      XYLENE =     0,          1,          0,          0,          0,
     0,           0  !
! FORMALDEHYDE =    0,          1,          0,          0,          0,
     0,           0  !
!   TOTAL_PAH =     0,          1,          0,          0,          0,
     0,           0  !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                Default: 1     ! IPFDEB =  1  !

       Number of puffs to track
       (NPFDEB)                                Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                   Default: 1     ! NN1 =  1   !

       Met. period to end output
       (NN2)                                   Default: 10    ! NN2 =  10  !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
```



```
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                     1 **
     HILL information


HILL        XC       YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2
SCALE 1   SCALE 2   AMAX1    AMAX2
 NO.       (km)     (km)      (deg.)   (m)     (m)      (m)       (m)
(m)       (m)      (m)      (m)
----       ----     ----      ------  -----  ------    ------    ------
-------   -------   -----    -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
```

```
        SCALE 2 = Horizontal length scale along the minor axis
        AMAX    = Maximum allowed axis length for the major axis
        BMAX    = Maximum allowed axis length for the major axis

        XRCT, YRCT = Coordinates of the complex terrain receptors
        ZRCT    = Height of the ground (MSL) at the complex terrain
                  Receptor
        XHH     = Hill number associated with each complex terrain receptor
                  (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
    NOTE: DATA for each hill and CTSG receptor are treated as a separate
          input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)                                             (s/cm)
             (dimensionless)
      -------     -----------      ----------      ----------
--------------------     -----------------------


!END!

-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                   DEVIATION
                        (microns)                  (microns)
      -------      -------------------        ------------------

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                           Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                             Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                          Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
```



```
     evaluate effective particle deposition velocity
     (NINT)                            Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                            Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.      Frozen Precip.
       ---------      --------------      --------------

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =  0   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.
     !  BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                   Default: 0.2          ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0          ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0          ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)    Default: 1            ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
```

```
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                 Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------
```



```
     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP =
5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0
!

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                    Default: 0.1    ! CONK2 = .1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                      Default: 0.5    ! TBD = .5 !
        TBD < 0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                             Default: 10     ! IURB1 =  10  !
                                                         19     ! IURB2 =  19  !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                              Default: 20     ! ILANDUIN =  20
 !

        Roughness length (m) for modeling domain
        (Z0IN)                                  Default: 0.25   ! Z0IN = .25 !

        Leaf area index for modeling domain
        (XLAIIN)                                Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                Default: -999.  ! XLATIN =
-999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                Default: -999.  ! XLONIN =
-999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                Default: 10.    ! ANEMHT = 10.0
!

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
```

```
        (ISIGMAV)                              Default: 1      ! ISIGMAV =  1
!
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                             Default: 0      ! IMIXCTDM =  0
!
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                  Default: 1.0    ! XMXLEN = 1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                 Default: 1.0    ! XSAMLEN = 1.0
!

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                   Default: 99     ! MXNEW =  99
!

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                   Default: 99     ! MXSAM =  99
!

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                  Default: 2      ! NCOUNT =  2
!

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                   Default: 1.0    ! SYMIN = 1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                   Default: 1.0    ! SZMIN = 1.0  !

     Maximum sigma z (m) allowed to avoid
     numerical problem in calculating virtual
     time or distance.  Cap should be large
     enough to have no influence on normal events.
     Enter a negative cap to disable.
     (SZCAP_M)                                 Default: 5.0e06 ! SZCAP_M =
5.0E06 !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                     ----------  LAND  ----------       ---------  WATER
----------
        Stab Class :  A    B    C    D    E    F         A    B    C    D    E
 F
                     ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---
---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37,
.37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03,
.016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370,
0.370, 0.370, 0.370, 0.370!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120,
```



```
0.080, 0.060, 0.030, 0.016!

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                 Default: 0.0,0.0  ! CDIV = .0,
.0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                 Default: 4      ! NLUTIBL =  4
!

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                  Default: 0.5    ! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                  Default: 3000.  ! XMAXZI =
2400.0 !

     Minimum mixing height (m)
     (XMINZI)                                  Default: 50.    ! XMINZI = 50.0
!

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                      Default   :
                                     ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                          Wind Speed Class :  1     2     3     4     5
                                             ---   ---   ---   ---   ---
                                        ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                       Default   : ISC RURAL values
                                     ISC RURAL : .07, .07, .10, .15, .35, .55
                                     ISC URBAN : .15, .15, .20, .25, .30, .30

                           Stability Class :  A     B     C     D     E
F
                                             ---   ---   ---   ---   ---
---
                                         ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35,
0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                       Default: 0.020, 0.035
                                         ! PTG0 = 0.020,   0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                  Stability Class :  A     B     C     D     E
F
                                  Default  PPC : .50,  .50,  .50,  .50,  .35,
.35
                                             ---   ---   ---   ---   ---
```

```
---
                                       !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35,
0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                              Default: 10.       ! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                           Default:   3       ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                     Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                          Default: 100.      ! ZISPLIT = 100.0
!

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                          Default: 0.25      ! ROLDMAX = 0.25
!


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                          Default:   5       ! NSPLITH =  5  !

       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                         Default:  1.0      ! SYSPLITH = 1.0
!

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                         Default:  2.       ! SHSPLITH = 2.0
!

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                         Default:  1.0E-07   ! CNSPLITH =
1.0E-07 !

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
```



```
       (EPSSLUG)                          Default:   1.0e-04  ! EPSSLUG =
1.0E-04 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                          Default:   1.0e-06  ! EPSAREA =
1.0E-06 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                           Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                          Default:   500.     ! HTMINBC = 500.0
!

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                          Default:   10.      ! RSAMPBC = 10.0
!

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                           Default:   1        ! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =  4  !

     Units used for point source
     emissions below                (IPTU)  Default: 1  !  IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  !  NSPT1 =  0  !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  0  !

     (If NPT2 > 0, these point
```

```
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                      a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                             b
         c
  Source       X          Y       Stack    Base     Stack    Exit  Exit    Bldg.
Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
 Rates
              (km)       (km)       (m)      (m)       (m)  (m/s) (deg. K)

  ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------
   1 ! SRCNAM = GTS1 !
   1 ! X =  602.975, 5773.882,    30.0,  80.0,       6.0,  40.0, 805.15,
1.0,2.09E01, 1.12E00, 2.56E00,
       3.0E00, 2.45E-03, 2.65E-02, 6.52E-03, 1.3E-02, 1.45E-01, 4.48E-04 !
   1 ! ZPLTFM  =       .0 !
   1 ! FMFAC  =      1.0 !   !END!
   2 ! SRCNAM = GTS2 !
   2 ! X =  602.975, 5773.833,    30.0,  80.0,       6.0,  40.0, 805.15,
1.0,2.09E01, 1.12E00, 2.56E00,
       3.0E00, 2.45E-03, 2.65E-02, 6.52E-03, 1.3E-02, 1.45E-01, 4.48E-04 !
   2 ! ZPLTFM  =       .0 !
   2 ! FMFAC  =      1.0 !   !END!
   3 ! SRCNAM = GTS3 !
   3 ! X =  602.975, 5773.783,    30.0,  80.0,       6.0,  40.0, 805.15,
1.0,2.09E01, 1.12E00, 2.56E00,
       3.0E00, 2.45E-03, 2.65E-02, 6.52E-03, 1.3E-02, 1.45E-01, 4.48E-04 !
   3 ! ZPLTFM  =       .0 !
   3 ! FMFAC  =      1.0 !   !END!
   4 ! SRCNAM = GTS4 !
   4 ! X =  602.975, 5773.733,    30.0,  80.0,       6.0,  40.0, 805.15,
1.0,2.09E01, 1.12E00, 2.56E00,
       3.0E00, 2.45E-03, 2.65E-02, 6.52E-03, 1.3E-02, 1.45E-01, 4.48E-04 !
   4 ! ZPLTFM  =       .0 !
   4 ! FMFAC  =      1.0 !   !END!

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
```



```
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
             (Default: 0.0)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                      a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------

 1    ! SRCNAM  =   GTS1 !
 1    ! HEIGHT  =  14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   20.4,   20.4,   20.4,   14.0,   14.0,
                   20.4,   20.4,   14.0,   14.0,   14.0,   14.0!
 1    ! WIDTH   =  42.47,   42.62,   41.75,   39.25,   35.5,   30.5,
                   25.0,   19.0,   12.0,   19.0,   25.5,   31.0,
                   35.5,   39.0,   41.5,   42.75,   42.38,   41.0,
                   42.47,   42.62,   41.5,   39.0,   35.75,   30.5,
                   25.0,   13.5,   12.0,   13.0,   25.5,   31.0,
                   15.5,   14.5,   41.5,   42.75,   42.5,   41.0!
 1    ! LENGTH =   19.0,   25.5,   31.0,   35.5,   39.0,   41.5,
                   42.75,   42.38,   41.0,   42.47,   42.62,   41.5,
                   39.25,   35.5,   31.0,   25.5,   18.5,   12.0,
                   18.5,   25.0,   31.0,   35.5,   39.25,   41.5,
                   42.5,   10.0,   8.0,   9.97,   42.62,   41.5,
                   14.5,   15.25,   31.0,   25.0,   18.5,   12.0!
 1    ! XBADJ   =  -5.5,   -5.0,   -4.0,   -3.0,   -1.5,   -.5,
                   .75,   1.87,   3.0,   1.91,   .75,   -.25,
                   -1.5,   -2.75,   -4.0,   -5.0,   -5.0,   -6.0,
                   -13.5,   -20.5,   -27.0,   -33.0,   -37.5,   -41.0,
                   -43.25,   -52.25,   -52.0,   -52.25,   -43.38,   -41.0,
                   -76.5,   -77.25,   -27.0,   -20.5,   -13.5,   -6.0!
 1    ! YBADJ   =  -23.14,   -22.19,   -20.38,   -18.13,   -15.25,   -11.75,
                   -8.0,   -4.0,   .0,   4.5,   8.25,   11.5,
                   15.25,   18.0,   20.25,   22.13,   23.19,   23.5,
                   23.14,   22.06,   20.25,   18.0,   15.13,   11.75,
                   8.0,   8.25,   .0,   -8.5,   -7.75,   -12.0,
                   7.25,   -5.0,   -20.5,   -22.13,   -23.13,   -23.5!
!END!
 2    ! SRCNAM  =   GTS2 !
 2    ! HEIGHT  =  14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   20.4,   20.4,   14.0,
                   14.0,   20.4,   20.4,   20.4,   20.4,   14.0,
                   20.4,   20.4,   14.0,   14.0,   14.0,   14.0!
```

```
 2    ! WIDTH  =   43.78,   44.25,   43.5,   41.25,   37.75,   33.5,
                   27.5,   21.0,   14.0,   21.0,   27.5,   33.0,
                   37.5,   41.0,   43.5,   44.25,   43.75,   41.0,
                   42.47,   42.62,   41.5,   13.75,   14.25,   33.5,
                   27.5,   15.0,   14.0,   15.0,   15.5,   33.5,
                   16.5,   15.75,   43.25,   44.25,   43.75,   42.0!
 2    ! LENGTH =   21.0,   27.5,   33.0,   37.5,   41.25,   43.5,
                   44.25,   43.75,   42.0,   43.78,   44.25,   43.25,
                   41.25,   37.75,   33.0,   27.5,   21.0,   12.0,
                   18.5,   25.0,   31.0,   14.0,   13.75,   43.25,
                   44.25,   9.37,   7.0,   9.31,   11.37,   43.25,
                   15.75,   16.5,   33.5,   27.5,   21.0,   14.0!
 2    ! XBADJ  =   -7.5,   -6.5,   -5.5,   -4.0,   -3.0,   -1.5,
                   .0,   1.63,   3.0,   1.94,   .75,   -.25,
                   -1.5,   -2.75,   -4.0,   -5.0,   -5.5,   -55.0,
                   -61.5,   -66.5,   -69.5,   -75.5,   -75.0,   -41.75,
                   -44.25,   -52.25,   -52.0,   -52.59,   -51.63,   -42.75,
                   -78.5,   -79.25,   -29.5,   -23.0,   -15.5,   -8.0!
 2    ! YBADJ  =   -23.83,   -22.88,   -21.25,   -19.13,   -16.12,   -12.75,
                   -9.25,   -5.5,   -1.0,   3.0,   7.25,   11.0,
                   14.75,   17.75,   20.25,   22.13,   23.5,   23.5,
                   14.64,   5.31,   -4.25,   5.37,   -6.63,   12.75,
                   9.25,   9.5,   1.0,   -7.5,   -15.25,   -11.25,
                   7.25,   -5.12,   -20.38,   -22.38,   -23.38,   -24.0!
!END!
 3    ! SRCNAM  =   GTS3 !
 3    ! HEIGHT  =  14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   20.4,   20.4,   14.0,
                   14.0,   20.4,   20.4,   20.4,   20.4,   14.0,
                   20.4,   20.4,   14.0,   14.0,   14.0,   14.0!
 3    ! WIDTH  =   43.81,   44.38,   43.5,   41.0,   37.75,   33.0,
                   27.5,   21.0,   14.0,   21.0,   27.5,   33.0,
                   38.0,   41.25,   43.5,   44.25,   43.87,   42.0,
                   43.81,   44.25,   43.5,   14.25,   15.0,   33.0,
                   27.5,   15.0,   14.0,   15.5,   16.5,   33.0,
                   17.0,   16.0,   43.25,   44.25,   43.75,   42.0!
 3    ! LENGTH =   21.0,   27.5,   33.5,   38.0,   41.25,   43.5,
                   44.25,   43.87,   42.0,   43.81,   44.25,   43.25,
                   41.0,   37.75,   33.0,   27.5,   21.0,   14.0,
                   21.0,   27.5,   33.0,   15.0,   14.25,   43.25,
                   44.25,   11.25,   9.0,   11.28,   13.25,   43.25,
                   16.0,   16.5,   33.0,   27.5,   21.0,   14.0!
 3    ! XBADJ  =   -7.5,   -6.5,   -5.5,   -4.5,   -2.75,   -1.5,
                   .0,   1.5,   3.0,   1.91,   .75,   -.25,
                   -1.5,   -2.75,   -3.5,   -5.0,   -5.0,   -56.0,
                   -63.0,   -68.0,   -71.0,   -76.0,   -75.75,   -41.75,
                   -44.5,   -54.25,   -54.0,   -54.56,   -53.5,   -42.75,
                   -79.5,   -79.75,   -29.5,   -23.0,   -16.0,   -8.0!
 3    ! YBADJ  =   -23.81,   -22.94,   -21.25,   -19.0,   -16.12,   -13.0,
                   -9.25,   -5.0,   -1.0,   3.5,   7.25,   11.0,
                   14.5,   17.63,   20.25,   22.13,   23.44,   24.0,
                   15.13,   5.75,   -3.75,   5.62,   -6.25,   13.0,
                   9.25,   9.5,   1.0,   -7.75,   -15.75,   -11.0,
                   6.5,   -5.75,   -20.38,   -22.13,   -23.5,   -24.0!
!END!
 4    ! SRCNAM  =   GTS4 !
 4    ! HEIGHT  =  14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0,
                   14.0,   14.0,   14.0,   20.4,   20.4,   14.0,
                   14.0,   20.4,   20.4,   20.4,   20.4,   14.0,
                   14.0,   14.0,   14.0,   14.0,   14.0,   14.0!
 4    ! WIDTH  =   44.78,   45.25,   44.25,   42.0,   38.5,   33.5,
                   28.0,   21.0,   14.0,   21.5,   28.0,   33.5,
                   38.5,   41.75,   44.25,   45.0,   44.75,   42.0,
                   43.81,   44.25,   43.5,   16.0,   16.5,   33.5,
```



```
                   27.5,   15.5,   14.0,   15.5,   16.0,   33.5,
                   38.5,   41.75,   44.25,   45.25,   44.75,   43.0!
 4    ! LENGTH =   21.5,   27.5,   33.5,   38.5,   42.0,   44.25,
                   45.0,   44.75,   43.0,   44.78,   45.12,   44.25,
                   42.0,   38.25,   34.0,   28.0,   21.5,   14.0,
                   21.0,   27.5,   33.5,   16.5,   16.0,   44.25,
                   45.25,   11.37,   9.0,   11.28,   13.25,   44.25,
                   41.75,   38.5,   33.5,   27.5,   21.5,   14.0!
 4    ! XBADJ  =   -7.5,   -6.5,   -5.5,   -4.0,   -3.0,   -1.5,
                   .25,   1.5,   3.0,   1.91,   .75,   -.25,
                   -1.5,   -2.5,   -4.0,   -5.0,   -5.5,   -56.0,
                   -63.0,   -68.0,   -71.0,   -77.5,   -77.25,   -42.75,
                   -45.25,   -55.25,   -55.0,   -55.53,   -54.5,   -43.75,
                   -40.25,   -35.75,   -30.0,   -23.0,   -16.0,   -8.0!
 4    ! YBADJ  =   -24.3,   -23.38,   -21.63,   -19.25,   -16.5,   -13.25,
                   -9.5,   -5.5,   -1.0,   3.25,   7.5,   11.25,
                   15.25,   18.13,   20.63,   22.75,   24.0,   24.0,
                   15.13,   5.75,   -3.75,   6.5,   -5.75,   13.25,
                   9.25,   9.75,   1.0,   -7.75,   -16.0,   -11.25,
                   -14.75,   -18.13,   -20.88,   -22.63,   -23.87,   -24.5!
!END!

--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                                      a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                             Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------
```

```
INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below           (IARU)        Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                      a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                          b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                                 a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------
```



```
--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                             a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                               Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


--------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                          No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)    No default   ! NLINES =  0
!

     Units used for line source
     emissions below                (ILNU)      Default: 1  !  ILNU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
```

```
          5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
          6 =     Odour Unit * m**3/min
          7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)        (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                            Default: 7   ! MXNSEG =  7
!

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which               Default: 6   ! NLRISE =  6
!
        transitional rise is computed

        Average building length (XL)               No default   ! XL = .0 !
                                                   (in meters)

        Average building height (HBL)              No default   ! HBL = .0 !
                                                   (in meters)

        Average building width (WBL)               No default   ! WBL = .0 !
                                                   (in meters)

        Average line source width (WML)            No default   ! WML = .0 !
                                                   (in meters)

        Average separation between buildings (DXL) No default   ! DXL = .0 !
                                                   (in meters)

        Average buoyancy parameter (FPRIMEL)       No default   ! FPRIMEL = .0
!
                                                   (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

         a
Source     Beg. X      Beg. Y      End. X    End. Y     Release    Base
Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation
Rates
            (km)        (km)        (km)       (km)       (m)        (m)

------   ----------  ----------  ---------  ----------  -------   ---------
---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
```



```
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                         a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


--------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !
```

```
     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                        a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                               b
         X           Y        Effect.    Base     Initial     Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y     Sigma z     Rates
        (km)        (km)        (m)       (m)        (m)        (m)
     ----------  ----------   ------    ------    --------   --------   --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                 a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                          Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------
```



```
INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC =  12   !

!END!

---------------
Subgroup (17b)
---------------
                                                    a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                        X            Y          Ground        Height   b
Receptor           Coordinate   Coordinate    Elevation    Above Ground
  No.                 (km)         (km)          (m)           (m)
--------           ----------   ----------    ---------    ------------
     1 ! X =     600.932,     5772.884,        96.000,        0.000!   !END!
     2 ! X =     604.206,     5775.082,        83.000,        0.000!   !END!
     3 ! X =     604.311,     5774.536,        84.000,        0.000!   !END!
     4 ! X =     604.608,     5774.217,        78.000,        0.000!   !END!
     5 ! X =     604.974,     5773.257,        85.000,        0.000!   !END!
     6 ! X =     605.074,     5773.003,        79.000,        0.000!   !END!
     7 ! X =     604.834,     5773.225,        80.000,        0.000!   !END!
     8 ! X =      607.95,      5774.77,        73.000,        0.000!   !END!
     9 ! X =      608.65,      5775.43,        70.000,        0.000!   !END!
    10 ! X =      609.93,     5775.515,        68.000,        0.000!   !END!
    11 ! X =      608.24,     5776.313,        85.000,        0.000!   !END!
    12 ! X =     596.725,      5771.04,        71.000,        0.000!   !END!


-------------
    a
     Data for each receptor are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     Receptor height above ground is optional.  If no value is entered,
     the receptor is placed on the ground.
```

```
AGL Tarrone Power Station
Scenario 2 - 3 GE 9FA engines
Continuous (steady state) operation
---------------- Run title (3 lines) ------------------------------------------

                   CALPUFF MODEL CONTROL FILE
                   --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT =             *
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    * RSTARTB=             *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST =C:\URS-DATA\AGLTAR~1\Calpuff\AGL2BSS.LST  !
CONC.DAT      output   ! CONDAT =AGL2BSS.CON     !
DFLX.DAT      output   * DFDAT  =             *
WFLX.DAT      output   * WFDAT  =             *

VISB.DAT      output   * VISDAT =             *
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =             *
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =             *
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
RISE.DAT      output   * RISDAT=             *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------
```



```
     Number of CALMET.DAT files for run (NMETDAT)
                                     Default: 1       ! NMETDAT =   6   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                     Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                     Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                     Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_JF.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_MA.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_MJ.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_JA.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_SO.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_ND.MET     !
!END!


--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR  =  2007  !
                       Month  (IBMO)  --    No default   ! IBMO  =  1  !
                       Day    (IBDY)  --    No default   ! IBDY  =  1  !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR  =  0  !
                       Minute (IBMIN) --    No default   ! IBMIN =  0  !
                       Second (IBSEC) --    No default   ! IBSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2008  !
                       Month  (IEMO)  --    No default   ! IEMO  =  1  !
                       Day    (IEDY)  --    No default   ! IEDY  =  1  !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR  =  0  !
                       Minute (IEMIN) --    No default   ! IEMIN =  0  !
                       Second (IESEC) --    No default   ! IESEC =  0  !

     (These are only used if METRUN = 0)

     Base time zone        (XBTZ) -- No default       ! XBTZ= -10.0  !
     The zone is the number of hours that must be
     ADDED to the time to obtain UTC (or GMT)
     Examples: PST = 8., MST = 7.
```

```
            CST = 6., EST = 5.

     Length of modeling time-step (seconds)
     Equal to update period in the primary
     meteorological data files, or an
     integer fraction of it (1/2, 1/3 ...)
     Must be no larger than 1 hour
     (NSECDT)                        Default:3600     ! NSECDT =  3600  !
                                     Units: seconds

     Number of chemical species (NSPEC)
                                     Default: 5       ! NSPEC =  10   !

     Number of chemical species
     to be emitted  (NSE)            Default: 3       ! NSE =  10   !

     Flag to stop run after
     SETUP phase (ITEST)             Default: 2       ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)      Default: 0       ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)        Default: 0       ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                     Default: 1       ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                     Default: 1       ! MPRFFM =  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                     Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                     Default: 60.0    ! PGTIME = 60. !


!END!
```



```
-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)              Default: 0     ! MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                              Default: 1     ! MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)            Default: 1     ! MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                     Default: 1     ! MRISE =  1  !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW =   2  !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                   Default: 0     ! MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)       Default: 1     ! MCHEM =  0   !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
```

```
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM =  0   !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modeled ? (MWET)          Default: 1     ! MWET =  0   !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  0   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                     Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
```


AGL2BSS.INP

```
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 800


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion modeled for
point sources?
(MPARTL)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTLBA =  0  !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes
```

```
Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                      Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                        Default: 1     ! MREG =  0   !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
                  PGTIME   60. (min)
                  MGAUSS   1
                  MCTADJ   3
                  MTRANS   1
                  MTIP     1
                  MRISE    1
                  MCHEM    1 or 3 (if modeling SOx, NOx)
                  MWET     1
                  MDRY     1
                  MDISP    2 or 3
                  MPDF     0 if MDISP=3
                           1 if MDISP=2
                  MROUGH   0
```



```
                       MPARTL   1
                       MPARTLBA 0
                       SYTDEP   550. (m)
                       MHFTSZ   0
                       SVMIN    0.5 (m/s)


!END!


-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          NOX !         !END!
! CSPEC =          SO2 !         !END!
! CSPEC =           CO !         !END!
! CSPEC =        PM2.5 !         !END!
! CSPEC =      BENZENE !         !END!
! CSPEC =      TOLUENE !         !END!
! CSPEC =     ETYLBENZ !         !END!
! CSPEC =       XYLENE !         !END!
! CSPEC = FORMALDEHYDE !         !END!
! CSPEC =    TOTAL_PAH !         !END!

                                                         Dry                OUTPUT
GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,
(0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st
CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd
CGRUP,
    in length)                                       3=USER-SPECIFIED)     3=
etc.)

!          NOX  =         1,              1,           0,                 0   !
!          SO2  =         1,              1,           0,                 0   !
!           CO  =         1,              1,           0,                 0   !
!        PM2.5  =         1,              1,           0,                 0   !
!      BENZENE  =         1,              1,           0,                 0   !
!      TOLUENE  =         1,              1,           0,                 0   !
!     ETYLBENZ  =         1,              1,           0,                 0   !
!       XYLENE  =         1,              1,           0,                 0   !
! FORMALDEHYDE  =         1,              1,           0,                 0   !
!    TOTAL_PAH  =         1,              1,           0,                 0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
```

```
   for certain species are combined (added) prior to output.  The
   CGRUP name will be used as the species name in output files.
   Use this feature to model specific particle-size distributions
   by treating each size-range as a separate species.
   Order must be consistent with 3(a) above.


-------------------------------------------------------------------------------

INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  54   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0N  !
     (RLON0)                    No Default      ! RLON0 = 0E  !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 0N  !
     (XLAT2)                    No Default      ! XLAT2 = 0N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and
XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)
```



```
     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84  !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =  81   !
            No. Y grid cells (NY)      No default     ! NY =  79   !
         No. vertical layers (NZ)      No default     ! NZ =  12   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = .5 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE = .0, 20.0, 40.0, 80.0, 100.0, 200.0, 300.0, 400.0, 500.0, 1000.0,
             1500.0, 2000.0, 2400.0 !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM = 583.0 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = 5754.0 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1   !
```

```
             (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1   !
             (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP =  81   !
             (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP =  79   !
             (1 <= JECOMP <= NY)



SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)         Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP =  1   !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  1   !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP =  81   !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP =  79   !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN =  1  !
        (MESHDN is an integer >= 1)

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                                *                          *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)              1                   !  ICON =  1   !
   Dry Fluxes (IDRY)                  1                   !  IDRY =  0   !
   Wet Fluxes (IWET)                  1                   !  IWET =  0   !
   2D Temperature (IT2D)              0                   !  IT2D =  0   !
   2D Density (IRHO)                  0                   !  IRHO =  0   !
   Relative Humidity (IVIS)           1                   !  IVIS =  0   !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         ! LCOMPRS = T !
```



```
*
 0 = Do not create file, 1 = create file


 QA PLOT FILE OUTPUT OPTION:

    Create a standard series of output files (e.g.
    locations of sources, receptors, grids ...)
    suitable for plotting?
    (IQAPLOT)                       Default: 1         !  IQAPLOT =  1   !
      0 = no
      1 = yes

 DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

    Mass flux across specified boundaries
    for selected species reported?
    (IMFLX)                         Default: 0         ! IMFLX =  0  !
      0 = no
      1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
               are specified in Input Group 0)

    Mass balance for each species
    reported?
    (IMBAL)                         Default: 0         ! IMBAL =  0  !
      0 = no
      1 = yes (MASSBAL.DAT filename is
           specified in Input Group 0)


 NUMERICAL RISE OUTPUT OPTION:

    Create a file with plume properties for each rise
    increment, for each model timestep?
    This applies to sources modeled with numerical rise
    and is limited to ONE source in the run.
    (INRISE)                        Default: 0         ! INRISE =  0  !
      0 = no
      1 = yes (RISE.DAT filename is
               specified in Input Group 0)


 LINE PRINTER OUTPUT OPTIONS:

    Print concentrations (ICPRT)    Default: 0         ! ICPRT =  0   !
    Print dry fluxes (IDPRT)        Default: 0         ! IDPRT =  0   !
    Print wet fluxes (IWPRT)        Default: 0         ! IWPRT =  0   !
    (0 = Do not print, 1 = Print)

    Concentration print interval
    (ICFRQ) in timesteps            Default: 1         ! ICFRQ =  1   !
    Dry flux print interval
    (IDFRQ) in timesteps            Default: 1         ! IDFRQ =  1   !
    Wet flux print interval
    (IWFRQ) in timesteps            Default: 1         ! IWFRQ =  1   !

    Units for Line Printer Output
    (IPRTU)                         Default: 1         ! IPRTU =  3   !
                    for            for
               Concentration    Deposition
      1 =         g/m**3          g/m**2/s
      2 =        mg/m**3         mg/m**2/s
      3 =        ug/m**3         ug/m**2/s
      4 =        ng/m**3         ng/m**2/s
      5 =      Odour Units

    Messages tracking progress of run
```

```
       written to the screen ?
       (IMESG)                         Default: 2         ! IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------
WET FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
   -------       ------------------------   ------------------------
------------------------   ---------------
!        NOX =      0,          1,          0,          0,          0,
     0,            0   !
!         CO =      0,          1,          0,          0,          0,
     0,            0   !
!        SO2 =      0,          1,          0,          0,          0,
     0,            0   !
!      PM2.5 =      0,          1,          0,          0,          0,
     0,            0   !
!    BENZENE =      0,          1,          0,          0,          0,
     0,            0   !
!    TOLUENE =      0,          1,          0,          0,          0,
     0,            0   !
!   ETYLBENZ =      0,          1,          0,          0,          0,
     0,            0   !
!     XYLENE =      0,          1,          0,          0,          0,
     0,            0   !
! FORMALDEHYDE =    0,          1,          0,          0,          0,
     0,            0   !
!    TOTAL_PAH =    0,          1,          0,          0,          0,
     0,            0   !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                 Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                 Default: 1     ! IPFDEB =  1  !

       Number of puffs to track
       (NPFDEB)                                 Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                    Default: 1     ! NN1 =  1   !

       Met. period to end output
       (NN2)                                    Default: 10    ! NN2 =  10  !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
```



```
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                     1 **
     HILL information


HILL          XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2
SCALE 1    SCALE 2    AMAX1     AMAX2
 NO.          (km)      (km)     (deg.)   (m)     (m)      (m)       (m)
(m)        (m)       (m)       (m)
----          ----      ----     ------  -----  ------    ------    ------
-------    -------    -----     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
```

```
         SCALE 2 = Horizontal length scale along the minor axis
         AMAX    = Maximum allowed axis length for the major axis
         BMAX    = Maximum allowed axis length for the major axis

         XRCT, YRCT = Coordinates of the complex terrain receptors
         ZRCT    = Height of the ground (MSL) at the complex terrain
                   Receptor
         XHH     = Hill number associated with each complex terrain receptor
                   (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)                                           (s/cm)
             (dimensionless)
      -------     -----------      ----------      ----------
--------------------     -----------------------


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                   DEVIATION
                        (microns)                  (microns)
      -------      -------------------        ------------------

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
```



```
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                           Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.      Frozen Precip.
       ---------      --------------      --------------

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)    Default: 1           ! MOZ =  0   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                   Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                  Default: 12*10.
     !  BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                  Default: 0.2         ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                  Default: 2.0         ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                  Default: 2.0         ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)   Default: 1           ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
```

```
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                  Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------
```



```
     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP =
5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0
!

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                    Default: 0.1    ! CONK2 = .1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                      Default: 0.5    ! TBD = .5 !
        TBD < 0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                             Default: 10     ! IURB1 =  10  !
                                                         19     ! IURB2 =  19  !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                              Default: 20     ! ILANDUIN =  20
 !

        Roughness length (m) for modeling domain
        (Z0IN)                                  Default: 0.25   ! Z0IN = .25 !

        Leaf area index for modeling domain
        (XLAIIN)                                Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                Default: -999.  ! XLATIN =
-999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                Default: -999.  ! XLONIN =
-999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                Default: 10.    ! ANEMHT = 10.0
!

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
```

```
        (ISIGMAV)                               Default: 1      ! ISIGMAV =  1
!
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                              Default: 0      ! IMIXCTDM =  0
!
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                   Default: 1.0    ! XMXLEN = 1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                  Default: 1.0    ! XSAMLEN = 1.0
!

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                    Default: 99     ! MXNEW =  99
!

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                    Default: 99     ! MXSAM =  99
!

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                   Default: 2      ! NCOUNT =  2
!

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                    Default: 1.0    ! SYMIN = 1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                    Default: 1.0    ! SZMIN = 1.0  !

     Maximum sigma z (m) allowed to avoid
     numerical problem in calculating virtual
     time or distance.  Cap should be large
     enough to have no influence on normal events.
     Enter a negative cap to disable.
     (SZCAP_M)                                  Default: 5.0e06 ! SZCAP_M =
5.0E06 !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                    ----------  LAND  ----------       ---------  WATER
----------
        Stab Class :  A    B    C    D    E    F         A    B    C    D    E
 F
                     ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---
---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37,
.37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03,
.016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370,
0.370, 0.370, 0.370, 0.370!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120,
```



```
0.080, 0.060, 0.030, 0.016!

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                  Default: 0.0,0.0  ! CDIV = .0,
.0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                  Default: 4      ! NLUTIBL =  4
!

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                   Default: 0.5    ! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                   Default: 3000.  ! XMAXZI =
2400.0 !

     Minimum mixing height (m)
     (XMINZI)                                   Default: 50.    ! XMINZI = 50.0
!

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                      Default   :
                                     ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                          Wind Speed Class :  1     2     3     4     5
                                             ---   ---   ---   ---   ---
                                       ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                       Default   : ISC RURAL values
                                     ISC RURAL : .07, .07, .10, .15, .35, .55
                                     ISC URBAN : .15, .15, .20, .25, .30, .30

                           Stability Class :  A     B     C     D     E
F
                                             ---   ---   ---   ---   ---
---
                                        ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35,
0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                       Default: 0.020, 0.035
                                        ! PTG0 = 0.020,   0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                  Stability Class :  A     B     C     D     E
F
                                  Default  PPC : .50,  .50,  .50,  .50,  .35,
.35
                                             ---   ---   ---   ---   ---
```

```
---
                                    !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35,
0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                           Default: 10.        ! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                        Default:   3        ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                  Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                       Default: 100.       ! ZISPLIT = 100.0
!

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                       Default: 0.25       ! ROLDMAX = 0.25
!


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                       Default:   5        ! NSPLITH =  5  !

       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                      Default:  1.0       ! SYSPLITH = 1.0
!

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                      Default:  2.        ! SHSPLITH = 2.0
!

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                      Default:  1.0E-07   ! CNSPLITH =
1.0E-07 !

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
```



```
       (EPSSLUG)                       Default:   1.0e-04  ! EPSSLUG =
1.0E-04 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                       Default:   1.0e-06  ! EPSAREA =
1.0E-06 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                        Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                       Default:   500.     ! HTMINBC = 500.0
!

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                       Default:   10.      ! RSAMPBC = 10.0
!

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                        Default:   1        ! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =  3  !

     Units used for point source
     emissions below                (IPTU)  Default: 1  !  IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  !  NSPT1 =  0  !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  0  !

     (If NPT2 > 0, these point
```

```
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                           a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                               b
         c
  Source       X          Y        Stack    Base     Stack    Exit  Exit    Bldg.
Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
 Rates
              (km)       (km)       (m)      (m)       (m)  (m/s) (deg. K)

  ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------
   1 ! SRCNAM = GTS1 !
   1 ! X =  602.977, 5773.892,    45.0,  80.0,       6.7,  45.0,  882.6,
1.0,3.06E01, 1.86E00, 9.14E00,
      2.14E00, 4.07E-03, 4.41E-02, 1.09E-02, 2.17E-02, 2.41E-01, 7.47E-04 !
   1 ! ZPLTFM  =       .0 !
   1 ! FMFAC  =      1.0 !   !END!
   2 ! SRCNAM = GTS2 !
   2 ! X =  602.978, 5773.836,    45.0,  80.0,       6.7,  45.0,  882.6,
1.0,3.06E01, 1.86E00, 9.14E00,
      2.14E00, 4.07E-03, 4.41E-02, 1.09E-02, 2.17E-02, 2.41E-01, 7.47E-04 !
   2 ! ZPLTFM  =       .0 !
   2 ! FMFAC  =      1.0 !   !END!
   3 ! SRCNAM = GTS3 !
   3 ! X =  602.978, 5773.779,    45.0,  80.0,       6.7,  45.0,  882.6,
1.0,3.06E01, 1.86E00, 9.14E00,
      2.14E00, 4.07E-03, 4.41E-02, 1.09E-02, 2.17E-02, 2.41E-01, 7.47E-04 !
   3 ! ZPLTFM  =       .0 !
   3 ! FMFAC  =      1.0 !   !END!

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
             (Default: 0.0)

    b
```



```
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                    a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------

 1    ! SRCNAM  =   GTS1 !
 1    ! HEIGHT  =  10.0,   27.0,   27.0,   27.0,   7.0,   7.0,
                   .0,   .0,   .0,   27.0,   27.0,   27.0,
                   27.0,   27.0,   27.0,   10.0,   10.0,   10.0,
                   10.0,   7.0,   7.0,   7.0,   7.0,   7.0,
                   .0,   .0,   .0,   27.0,   27.0,   27.0,
                   27.0,   27.0,   27.0,   10.0,   10.0,   10.0!
 1    ! WIDTH   =  14.88,   9.75,   11.25,   12.5,   16.0,   14.5,
                   .0,   .0,   .0,   13.0,   13.5,   13.5,
                   13.0,   12.25,   11.25,   16.25,   14.88,   13.0,
                   14.91,   16.25,   16.75,   16.5,   15.75,   14.5,
                   .0,   .0,   .0,   12.5,   13.0,   13.5,
                   13.0,   12.25,   11.25,   16.25,   14.88,   13.0!
 1    ! LENGTH =   14.0,   13.5,   13.0,   13.0,   16.5,   16.75,
                   .0,   .0,   .0,   8.0,   9.75,   11.25,
                   12.5,   13.25,   13.5,   15.5,   14.5,   12.0,
                   14.0,   13.0,   15.0,   16.0,   16.5,   16.75,
                   .0,   .0,   .0,   8.0,   9.75,   11.25,
                   12.25,   13.0,   13.5,   16.0,   14.5,   12.0!
 1    ! XBADJ   =  6.0,   -52.0,   -51.5,   -50.0,   4.0,   2.25,
                   .0,   .0,   .0,   -25.31,   -27.88,   -29.5,
                   -30.5,   -30.25,   -29.0,   -25.0,   -23.5,   -21.0,
                   -20.0,   -21.5,   -22.0,   -22.0,   -20.5,   -19.25,
                   .0,   .0,   .0,   17.31,   18.0,   18.25,
                   18.0,   17.25,   16.0,   9.0,   9.0,   9.0!
 1    ! YBADJ   =  11.97,   3.88,   -4.13,   -11.75,   8.5,   10.75,
                   .0,   .0,   .0,   11.5,   7.75,   3.25,
                   -.5,   -4.88,   -8.88,   -3.63,   -6.81,   -9.5,
                   -11.95,   -1.25,   -3.88,   -6.25,   -8.63,   -10.75,
                   .0,   .0,   .0,   -11.25,   -7.5,   -3.75,
                   1.0,   4.88,   8.88,   3.88,   6.69,   9.5!
!END!
 2    ! SRCNAM  =   GTS2 !
 2    ! HEIGHT  =  10.0,   27.0,   27.0,   27.0,   10.0,   10.0,
                   .0,   .0,   .0,   27.0,   27.0,   27.0,
                   27.0,   27.0,   27.0,   10.0,   10.0,   10.0,
                   10.0,   10.0,   10.0,   10.0,   10.0,   10.0,
                   .0,   .0,   .0,   27.0,   27.0,   27.0,
                   27.0,   27.0,   27.0,   10.0,   10.0,   10.0!
 2    ! WIDTH   =  14.88,   9.75,   11.25,   12.5,   15.75,   14.5,
                   .0,   .0,   .0,   12.5,   13.5,   13.5,
                   13.0,   12.25,   11.25,   16.25,   14.88,   13.0,
                   15.38,   16.25,   16.75,   16.5,   16.0,   14.5,
                   .0,   .0,   .0,   13.0,   13.5,   13.5,
                   13.5,   12.25,   11.25,   16.25,   14.88,   13.0!
```

```
 2    ! LENGTH =   14.5,   13.5,   13.0,   13.0,   16.5,   16.75,
                   .0,   .0,   .0,   7.97,   9.75,   11.25,
                   12.5,   13.0,   13.5,   15.5,   14.0,   12.0,
                   11.5,   13.0,   15.0,   16.0,   16.5,   16.75,
                   .0,   .0,   .0,   8.0,   9.75,   11.25,
                   12.25,   13.0,   13.5,   16.0,   14.0,   12.0!
 2    ! XBADJ  =   -49.5,   -52.0,   -52.0,   -51.0,   3.25,   1.5,
                   .0,   .0,   .0,   -26.28,   -28.88,   -30.5,
                   -31.25,   -30.75,   -29.5,   -25.5,   -23.5,   -21.0,
                   -20.5,   -21.0,   -21.5,   -21.0,   -19.75,   -18.25,
                   .0,   .0,   .0,   18.31,   19.0,   19.25,
                   18.75,   17.75,   16.5,   9.5,   9.5,   9.0!
 2    ! YBADJ  =   3.22,   4.75,   -3.38,   -11.0,   9.13,   11.25,
                   .0,   .0,   .0,   11.25,   7.25,   2.75,
                   -1.5,   -5.63,   -9.63,   -4.88,   -7.69,   -10.5,
                   .44,   -2.25,   -4.63,   -7.0,   -9.25,   -11.25,
                   .0,   .0,   .0,   -11.0,   -7.25,   -3.25,
                   1.25,   5.63,   9.88,   4.88,   7.69,   10.5!
!END!
 3    ! SRCNAM  =   GTS3 !
 3    ! HEIGHT  =  7.0,   7.0,   7.0,   7.0,   7.0,   .0,
                   .0,   .0,   .0,   27.0,   27.0,   27.0,
                   27.0,   27.0,   27.0,   10.0,   10.0,   10.0,
                   7.0,   7.0,   7.0,   7.0,   7.0,   .0,
                   .0,   .0,   .0,   27.0,   27.0,   27.0,
                   27.0,   27.0,   27.0,   10.0,   10.0,   10.0!
 3    ! WIDTH  =   15.34,   16.25,   16.5,   16.5,   16.0,   .0,
                   .0,   .0,   .0,   13.0,   13.0,   13.5,
                   13.0,   12.25,   11.25,   16.5,   14.88,   13.0,
                   15.34,   16.25,   16.75,   16.5,   15.75,   .0,
                   .0,   .0,   .0,   13.0,   13.5,   13.5,
                   13.0,   12.25,   11.25,   16.25,   14.88,   13.0!
 3    ! LENGTH =   11.5,   13.5,   15.0,   16.0,   16.5,   .0,
                   .0,   .0,   .0,   8.0,   9.75,   11.25,
                   12.5,   13.0,   13.5,   16.0,   14.0,   12.0,
                   11.0,   13.0,   15.0,   16.0,   16.5,   .0,
                   .0,   .0,   .0,   8.0,   9.75,   11.25,
                   12.25,   13.0,   13.5,   15.5,   14.0,   12.0!
 3    ! XBADJ  =   10.0,   9.0,   7.5,   5.5,   4.0,   .0,
                   .0,   .0,   .0,   -26.47,   -29.13,   -31.0,
                   -31.75,   -31.5,   -30.5,   -26.5,   -24.5,   -22.0,
                   -21.5,   -22.0,   -22.5,   -22.0,   -20.5,   .0,
                   .0,   .0,   .0,   18.5,   19.38,   19.75,
                   19.5,   18.75,   17.0,   11.0,   10.5,   10.0!
 3    ! YBADJ  =   -.27,   2.5,   5.0,   7.5,   10.0,   .0,
                   .0,   .0,   .0,   12.0,   8.0,   3.75,
                   -1.0,   -5.13,   -9.13,   -4.5,   -7.56,   -10.5,
                   .27,   -2.5,   -5.13,   -7.5,   -9.88,   .0,
                   .0,   .0,   .0,   -12.5,   -8.25,   -3.75,
                   .5,   4.88,   9.38,   4.38,   7.56,   10.5!
!END!

--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                                   a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------
```



```
     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below            (IARU)       Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =        lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)       (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
```

```
                                         a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                             b
Source          Effect.    Base      Initial    Emission
 No.            Height   Elevation   Sigma z     Rates
                  (m)       (m)        (m)
-------         ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                              a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                                   a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
```



```
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


--------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                              No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)        No default   ! NLINES =  0
!

     Units used for line source
     emissions below                (ILNU)          Default: 1  !  ILNU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)        (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                             Default: 7   ! MXNSEG =  7
!

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                Default: 6   ! NLRISE =  6
!
        transitional rise is computed

        Average building length (XL)                No default   ! XL = .0 !
                                                    (in meters)

        Average building height (HBL)               No default   ! HBL = .0 !
                                                    (in meters)

        Average building width (WBL)                No default   ! WBL = .0 !
                                                    (in meters)

        Average line source width (WML)             No default   ! WML = .0 !
                                                    (in meters)

        Average separation between buildings (DXL)  No default   ! DXL = .0 !
                                                    (in meters)

        Average buoyancy parameter (FPRIMEL)        No default   ! FPRIMEL = .0
!
                                                    (in m**4/s**3)
```

```
!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

         a
Source     Beg. X      Beg. Y      End. X     End. Y     Release    Base
Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation
Rates
            (km)        (km)        (km)       (km)       (m)        (m)

------   ----------  ----------  ---------  ----------  -------   ---------
---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                 a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                             Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.

-------------------------------------------------------------------------------
```



```
INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                      a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                             b
         X           Y        Effect.    Base     Initial    Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)        (km)        (m)       (m)       (m)        (m)
     ----------  ----------   ------    ------    --------   --------   --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                            a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
```

```
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                              Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC =  12   !

!END!

---------------
Subgroup (17b)
---------------
                                                     a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                     X            Y          Ground       Height   b
Receptor         Coordinate   Coordinate    Elevation   Above Ground
  No.               (km)         (km)          (m)          (m)
--------         ----------   ----------    ---------   ------------
     1 ! X =      600.932,    5772.884,       96.000,        0.000!   !END!
     2 ! X =      604.206,    5775.082,       83.000,        0.000!   !END!
     3 ! X =      604.311,    5774.536,       84.000,        0.000!   !END!
     4 ! X =      604.608,    5774.217,       78.000,        0.000!   !END!
     5 ! X =      604.974,    5773.257,       85.000,        0.000!   !END!
     6 ! X =      605.074,    5773.003,       79.000,        0.000!   !END!
     7 ! X =      604.834,    5773.225,       80.000,        0.000!   !END!
     8 ! X =       607.95,     5774.77,       73.000,        0.000!   !END!
     9 ! X =       608.65,     5775.43,       70.000,        0.000!   !END!
    10 ! X =       609.93,    5775.515,       68.000,        0.000!   !END!
    11 ! X =       608.24,    5776.313,       85.000,        0.000!   !END!
    12 ! X =      596.725,     5771.04,       71.000,        0.000!   !END!


-------------
```



```
 a
  Data for each receptor are treated as a separate input subgroup
  and therefore must end with an input group terminator.

 b
  Receptor height above ground is optional.  If no value is entered,
  the receptor is placed on the ground.
```

```
AGL Tarrone Power Station
Scenario 1 - 4-13E2 Alstoms
Startup Scenario
---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    ! METDAT =C:\URS-DATA\AGLTAR~1\CALPUFF\IG_SO.MET   !
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    * RSTARTB=             *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST =C:\URS-DATA\AGLTAR~1\CALPUFF\AGL1BSU.LST  !
CONC.DAT      output   ! CONDAT =C:\URS-DATA\AGLTAR~1\CALPUFF\AGL1BSU.CON     !
DFLX.DAT      output   * DFDAT  =             *
WFLX.DAT      output   * WFDAT  =             *

VISB.DAT      output   * VISDAT =             *
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    ! PTDAT  =C:\URS-DATA\AGLTAR~1\CALPUFF\S1PTEM~1.DAT  !
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =             *
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
RISE.DAT      output   * RISDAT=             *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------
```



```
     Number of CALMET.DAT files for run (NMETDAT)
                                 Default: 1       ! NMETDAT =   1   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                 Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                 Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                 Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
 none         input    * METDAT=     *   *END*


-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR  =  2007  !
                       Month  (IBMO)  --    No default   ! IBMO  =  10  !
                       Day    (IBDY)  --    No default   ! IBDY  =  19  !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR  =  0  !
                       Minute (IBMIN) --    No default   ! IBMIN =  0  !
                       Second (IBSEC) --    No default   ! IBSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2007  !
                       Month  (IEMO)  --    No default   ! IEMO  =  10  !
                       Day    (IEDY)  --    No default   ! IEDY  =  23  !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR  =  0  !
                       Minute (IEMIN) --    No default   ! IEMIN =  0  !
                       Second (IESEC) --    No default   ! IESEC =  0  !

     (These are only used if METRUN = 0)

     Base time zone        (XBTZ) -- No default       ! XBTZ= -10.0  !
     The zone is the number of hours that must be
     ADDED to the time to obtain UTC (or GMT)
     Examples: PST = 8., MST = 7.
               CST = 6., EST = 5.

     Length of modeling time-step (seconds)
     Equal to update period in the primary
     meteorological data files, or an
     integer fraction of it (1/2, 1/3 ...)
     Must be no larger than 1 hour
     (NSECDT)                    Default:3600     ! NSECDT =  120  !
                                 Units: seconds

     Number of chemical species (NSPEC)
```

```
                               Default: 5       ! NSPEC =  1   !

     Number of chemical species
     to be emitted  (NSE)          Default: 3       ! NSE =  0   !

     Flag to stop run after
     SETUP phase (ITEST)           Default: 2       ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)    Default: 0       ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)      Default: 0       ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                   Default: 1       ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                   Default: 1       ! MPRFFM =  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                   Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                   Default: 60.0    ! PGTIME = 60. !


!END!

-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                 Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian
```



```
     Terrain adjustment method
     (MCTADJ)                            Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                        Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)            Default: 0     ! MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                            Default: 1     ! MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)          Default: 1     ! MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                   Default: 1     ! MRISE =  1  !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Method used to simulate building
     downwash? (MBDW)                    Default: 1     ! MBDW =   1  !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                 Default: 0     ! MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)    Default: 0     ! MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)     Default: 1     ! MCHEM =  0   !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
        4 = secondary organic aerosol formation
            computed (MESOPUFF II scheme for OH)

     Aqueous phase transformation flag (MAQCHEM)
     (Used only if MCHEM = 1, or 3)      Default: 0     ! MAQCHEM =  0   !
        0 = aqueous phase transformation
            not modeled
        1 = transformation rates adjusted
            for aqueous phase reactions

     Wet removal modeled ? (MWET)        Default: 1     ! MWET =  0   !
```

```
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  0   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                     Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
```



```
[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 800


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion modeled for
point sources?
(MPARTL)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTLBA =  0  !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
```

```
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                       Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                       Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                         Default: 1     ! MREG =  0   !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
                  PGTIME   60. (min)
                  MGAUSS   1
                  MCTADJ   3
                  MTRANS   1
                  MTIP     1
                  MRISE    1
                  MCHEM    1 or 3 (if modeling SOx, NOx)
                  MWET     1
                  MDRY     1
                  MDISP    2 or 3
                  MPDF     0 if MDISP=3
                           1 if MDISP=2
                  MROUGH   0
                  MPARTL   1
                  MPARTLBA 0
                  SYTDEP   550. (m)
                  MHFTSZ   0
                  SVMIN    0.5 (m/s)


!END!

-------------------------------------------------------------------------------
```



```
INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          NOX !         !END!

                                                        Dry               OUTPUT
GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,
(0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st
CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd
CGRUP,
    in length)                                       3=USER-SPECIFIED)     3=
etc.)

!          NOX  =         1,               0,            0,                0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



-------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
```

```
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  54   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0N  !
     (RLON0)                    No Default      ! RLON0 = 0E  !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 0N  !
     (XLAT2)                    No Default      ! XLAT2 = 0N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and
XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
```



```
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84  !

METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =  81   !
            No. Y grid cells (NY)      No default     ! NY =  79   !
         No. vertical layers (NZ)      No default     ! NZ =  12   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = .5 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE = .0, 20.0, 40.0, 80.0, 100.0, 200.0, 300.0, 400.0, 500.0, 1000.0,
             1500.0, 2000.0, 2400.0 !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM = 583.0 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = 5754.0 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1   !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1   !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP =  81   !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP =  79   !
                  (1 <= JECOMP <= NY)



SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)         Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP =  1   !
         (IBCOMP <= IBSAMP <= IECOMP)
```

```
        Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  1   !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP =  81   !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP =  79   !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN =  1  !
        (MESHDN is an integer >= 1)

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                             *                          *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)              1                   !  ICON =  1   !
   Dry Fluxes (IDRY)                  1                   !  IDRY =  0   !
   Wet Fluxes (IWET)                  1                   !  IWET =  0   !
   2D Temperature (IT2D)              0                   !  IT2D =  0   !
   2D Density (IRHO)                  0                   !  IRHO =  0   !
   Relative Humidity (IVIS)           1                   !  IVIS =  0   !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         ! LCOMPRS = T !

   *
    0 = Do not create file, 1 = create file


    QA PLOT FILE OUTPUT OPTION:

       Create a standard series of output files (e.g.
       locations of sources, receptors, grids ...)
       suitable for plotting?
       (IQAPLOT)                       Default: 1         !  IQAPLOT =  1   !
         0 = no
         1 = yes

    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported?
       (IMFLX)                         Default: 0         ! IMFLX =  0  !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported?
       (IMBAL)                         Default: 0         ! IMBAL =  0  !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)
```



```
    NUMERICAL RISE OUTPUT OPTION:

       Create a file with plume properties for each rise
       increment, for each model timestep?
       This applies to sources modeled with numerical rise
       and is limited to ONE source in the run.
       (INRISE)                        Default: 0         ! INRISE =  0  !
         0 = no
         1 = yes (RISE.DAT filename is
                  specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:

       Print concentrations (ICPRT)    Default: 0         ! ICPRT =  0   !
       Print dry fluxes (IDPRT)        Default: 0         ! IDPRT =  0   !
       Print wet fluxes (IWPRT)        Default: 0         ! IWPRT =  0   !
       (0 = Do not print, 1 = Print)

       Concentration print interval
       (ICFRQ) in timesteps            Default: 1         ! ICFRQ =  1   !
       Dry flux print interval
       (IDFRQ) in timesteps            Default: 1         ! IDFRQ =  1   !
       Wet flux print interval
       (IWFRQ) in timesteps            Default: 1         ! IWFRQ =  1   !

       Units for Line Printer Output
       (IPRTU)                         Default: 1         ! IPRTU =  3   !
                        for              for
                  Concentration    Deposition
           1 =       g/m**3          g/m**2/s
           2 =      mg/m**3         mg/m**2/s
           3 =      ug/m**3         ug/m**2/s
           4 =      ng/m**3         ng/m**2/s
           5 =     Odour Units

       Messages tracking progress of run
       written to the screen ?
       (IMESG)                         Default: 2         ! IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------
WET FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
   -------       ------------------------   ------------------------
------------------------   ---------------
!          NOX =     0,           1,           0,           0,           0,
     0,           0  !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                 Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                 Default: 1     ! IPFDEB =  1  !
```

```
       Number of puffs to track
       (NPFDEB)                                 Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                    Default: 1     ! NN1 =  1   !

       Met. period to end output
       (NN2)                                    Default: 10    ! NN2 =  10  !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                      1 **
     HILL information


HILL           XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2
SCALE 1    SCALE 2    AMAX1     AMAX2
 NO.          (km)      (km)      (deg.)   (m)     (m)       (m)       (m)
(m)         (m)        (m)       (m)
----          ----      ----      ------ -----  ------    ------    ------
-------    -------    -----     -----

---------------
Subgroup (6c)
```



```
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX    = Maximum allowed axis length for the major axis
          BMAX    = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT    = Height of the ground (MSL) at the complex terrain
                    Receptor
          XHH     = Hill number associated with each complex terrain receptor
                    (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------

INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)                                                (s/cm)
           (dimensionless)
      -------     -----------      ----------      ----------
--------------------     -----------------------


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
```

```
       NAME             DIAMETER                    DEVIATION
                        (microns)                   (microns)
      -------      -------------------        ------------------

!END!

--------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                           Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

--------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------

!END!

--------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =  0   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                   Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
```



```
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                  Default: 12*10.
     !  BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                  Default: 0.2         ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                  Default: 2.0         ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                  Default: 2.0         ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)   Default: 1           ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                 Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
```

```
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP =
5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0
!

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                    Default: 0.1    ! CONK2 = .1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                      Default: 0.5    ! TBD = .5 !
        TBD < 0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                             Default: 10     ! IURB1 =  10  !
                                                         19     ! IURB2 =  19  !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                              Default: 20     ! ILANDUIN =  20
 !

        Roughness length (m) for modeling domain
        (Z0IN)                                  Default: 0.25   ! Z0IN = .25 !

        Leaf area index for modeling domain
```



```
        (XLAIIN)                                Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                Default: -999.  ! XLATIN =
-999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                Default: -999.  ! XLONIN =
-999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                Default: 10.    ! ANEMHT = 10.0
!

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
        (ISIGMAV)                               Default: 1      ! ISIGMAV =  1
!
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                              Default: 0      ! IMIXCTDM =  0
!
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                   Default: 1.0    ! XMXLEN = 1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                  Default: 1.0    ! XSAMLEN = 1.0
!

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                    Default: 99     ! MXNEW =  99
!

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                    Default: 99     ! MXSAM =  99
!

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                   Default: 2      ! NCOUNT =  2
!

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                    Default: 1.0    ! SYMIN = 1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                    Default: 1.0    ! SZMIN = 1.0  !

     Maximum sigma z (m) allowed to avoid
     numerical problem in calculating virtual
     time or distance.  Cap should be large
     enough to have no influence on normal events.
     Enter a negative cap to disable.
```

```
     (SZCAP_M)                                  Default: 5.0e06 ! SZCAP_M =
5.0E06 !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                     ----------  LAND  ----------        ---------  WATER
----------
        Stab Class :  A    B    C    D    E    F          A    B    C    D    E
 F
                     ---  ---  ---  ---  ---  ---        ---  ---  ---  ---  ---
---
     Default SVMIN : .50, .50, .50, .50, .50, .50,       .37, .37, .37, .37, .37,
.37
     Default SWMIN : .20, .12, .08, .06, .03, .016,      .20, .12, .08, .06, .03,
.016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370,
0.370, 0.370, 0.370!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120,
0.080, 0.060, 0.030, 0.016!

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                  Default: 0.0,0.0  ! CDIV = .0,
.0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                  Default: 4      ! NLUTIBL =  4
!

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                   Default: 0.5    ! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                   Default: 3000.  ! XMAXZI =
2400.0 !

     Minimum mixing height (m)
     (XMINZI)                                   Default: 50.    ! XMINZI = 50.0
!

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                      Default   :
                                     ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                              Wind Speed Class :  1     2     3     4     5
                                                 ---   ---   ---   ---   ---
                                      ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                       Default   : ISC RURAL values
                                     ISC RURAL : .07, .07, .10, .15, .35, .55
                                     ISC URBAN : .15, .15, .20, .25, .30, .30
```



```
                           Stability Class :  A     B     C     D     E
F
                                             ---   ---   ---   ---   ---
---
                                      ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35,
0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                           Default: 0.020, 0.035
                                      ! PTG0 = 0.020,   0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                  Stability Class :  A     B     C     D     E
F
                                  Default  PPC : .50,  .50,  .50,  .50,  .35,
.35
                                             ---   ---   ---   ---   ---
---
                                      !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35,
0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                             Default: 10.       ! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                          Default:   3       ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                    Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                         Default: 100.      ! ZISPLIT = 100.0
!

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                         Default: 0.25      ! ROLDMAX = 0.25
!


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                         Default:   5       ! NSPLITH =  5  !
```

```
       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                         Default:  1.0       ! SYSPLITH = 1.0
!

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                         Default:  2.        ! SHSPLITH = 2.0
!

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                         Default:  1.0E-07   ! CNSPLITH =
1.0E-07 !

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
       (EPSSLUG)                          Default:   1.0e-04  ! EPSSLUG =
1.0E-04 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                          Default:   1.0e-06  ! EPSAREA =
1.0E-06 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                           Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                          Default:   500.     ! HTMINBC = 500.0
!

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                          Default:   10.      ! RSAMPBC = 10.0
!

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                           Default:   1        ! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!

--------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =  0  !
```



```
     Units used for point source
     emissions below              (IPTU)  Default: 1  !  IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)       (NSPT1) Default: 0  !  NSPT1 =  0  !

     Number of point sources with
     variable emission parameters
     provided in external file     (NPT2)  No default  !  NPT2 =  4  !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                             a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                               b
         c
  Source       X          Y       Stack    Base     Stack    Exit  Exit    Bldg.
Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
 Rates
              (km)       (km)      (m)      (m)       (m)  (m/s) (deg. K)

  ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
```

```
           (Default: 0.0)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                    a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------


--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                          a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                               Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
```



```
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


--------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below           (IARU)       Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                           a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                                  b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
```

```
         -------------------------------------------------------
Source                                                        a
 No.     Ordered list of X followed by list of Y, grouped by source
------   -----------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                                 a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                            No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)       No default   ! NLINES =  0
!

     Units used for line source
```



```
     emissions below                (ILNU)          Default: 1  !  ILNU =   1  !
           1 =         g/s
           2 =        kg/hr
           3 =        lb/hr
           4 =      tons/yr
           5 =      Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =      Odour Unit * m**3/min
           7 =      metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)        (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                             Default: 7   ! MXNSEG =  7
!

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                Default: 6   ! NLRISE =  6
!
        transitional rise is computed

        Average building length (XL)                No default   ! XL = .0 !
                                                    (in meters)

        Average building height (HBL)               No default   ! HBL = .0 !
                                                    (in meters)

        Average building width (WBL)                No default   ! WBL = .0 !
                                                    (in meters)

        Average line source width (WML)             No default   ! WML = .0 !
                                                    (in meters)

        Average separation between buildings (DXL)  No default   ! DXL = .0 !
                                                    (in meters)

        Average buoyancy parameter (FPRIMEL)        No default   ! FPRIMEL = .0
!
                                                    (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

           a
Source     Beg. X      Beg. Y      End. X     End. Y     Release    Base
Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation
Rates
            (km)        (km)        (km)       (km)       (m)       (m)

------   ----------  ----------  ---------  ----------  -------   ---------
---------

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
```

```
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                      a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
```



```
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                           a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                                   b
         X            Y          Effect.    Base     Initial    Initial   Emission
     Coordinate   Coordinate     Height   Elevation  Sigma y    Sigma z     Rates
        (km)         (km)          (m)       (m)       (m)        (m)
     ----------   ----------     ------    ------   --------   --------   --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
```

and therefore must end with an input group terminator.

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information

---

Subgroup (17a)

Number of non-gridded receptors (NREC) No default ! NREC = 12   !

!END!

Subgroup (17b)

NON-GRIDDED (DISCRETE) RECEPTOR DATA[a]

Receptor No.		X Coordinate (km)	Y Coordinate (km)	Ground Elevation (m)	Height Above Ground (m)[b]	
1	! X =	600.932,	5772.884,	96.000,	0.000!	!END!
2	! X =	604.206,	5775.082,	83.000,	0.000!	!END!
3	! X =	604.311,	5774.536,	84.000,	0.000!	!END!
4	! X =	604.608,	5774.217,	78.000,	0.000!	!END!
5	! X =	604.974,	5773.257,	85.000,	0.000!	!END!
6	! X =	605.074,	5773.003,	79.000,	0.000!	!END!
7	! X =	604.834,	5773.225,	80.000,	0.000!	!END!
8	! X =	607.95,	5774.77,	73.000,	0.000!	!END!
9	! X =	608.65,	5775.43,	70.000,	0.000!	!END!
10	! X =	609.93,	5775.515,	68.000,	0.000!	!END!
11	! X =	608.24,	5776.313,	85.000,	0.000!	!END!
12	! X =	596.725,	5771.04,	71.000,	0.000!	!END!

---

[a] Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.

```
AGL Tarrone Power Station
Scenario 2 3 GE9FA
Startup Scenario
---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    ! METDAT =C:\URS-DATA\AGLTAR~1\CALPUFF\IG_SO.MET   !
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    * RSTARTB=             *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST =C:\URS-DATA\AGLTAR~1\CALPUFF\AGL2BSU.LST  !
CONC.DAT      output   ! CONDAT =AGL2BSU.CON     !
DFLX.DAT      output   * DFDAT  =             *
WFLX.DAT      output   * WFDAT  =             *

VISB.DAT      output   * VISDAT =             *
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    ! PTDAT  =C:\URS-DATA\AGLTAR~1\CALPUFF\S2PTEM1.DAT  !
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =             *
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
RISE.DAT      output   * RISDAT=             *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------
```



```
     Number of CALMET.DAT files for run (NMETDAT)
                                Default: 1       ! NMETDAT =   1   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
 none         input    * METDAT=     *   *END*


--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR  =  2007  !
                       Month  (IBMO)  --    No default   ! IBMO  =  9  !
                       Day    (IBDY)  --    No default   ! IBDY  =  23  !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR  =  0  !
                       Minute (IBMIN) --    No default   ! IBMIN =  0  !
                       Second (IBSEC) --    No default   ! IBSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2007  !
                       Month  (IEMO)  --    No default   ! IEMO  =  9  !
                       Day    (IEDY)  --    No default   ! IEDY  =  27  !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR  =  0  !
                       Minute (IEMIN) --    No default   ! IEMIN =  0  !
                       Second (IESEC) --    No default   ! IESEC =  0  !

     (These are only used if METRUN = 0)

     Base time zone        (XBTZ) -- No default       ! XBTZ= -10.0  !
     The zone is the number of hours that must be
     ADDED to the time to obtain UTC (or GMT)
     Examples: PST = 8., MST = 7.
               CST = 6., EST = 5.

     Length of modeling time-step (seconds)
     Equal to update period in the primary
     meteorological data files, or an
     integer fraction of it (1/2, 1/3 ...)
     Must be no larger than 1 hour
     (NSECDT)                   Default:3600     ! NSECDT =  120  !
                                Units: seconds

     Number of chemical species (NSPEC)
```

```
                               Default: 5       ! NSPEC =  1   !

     Number of chemical species
     to be emitted  (NSE)           Default: 3       ! NSE =  0   !

     Flag to stop run after
     SETUP phase (ITEST)            Default: 2       ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)     Default: 0       ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)       Default: 0       ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                    Default: 1       ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                    Default: 1       ! MPRFFM =  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                    Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                    Default: 60.0    ! PGTIME = 60. !


!END!

-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                  Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian
```



```
     Terrain adjustment method
     (MCTADJ)                             Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                         Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)             Default: 0     ! MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                             Default: 1     ! MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)           Default: 1     ! MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                    Default: 1     ! MRISE =  1  !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Method used to simulate building
     downwash? (MBDW)                     Default: 1     ! MBDW =   1  !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                  Default: 0     ! MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)     Default: 0     ! MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)      Default: 1     ! MCHEM =  0   !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
        4 = secondary organic aerosol formation
            computed (MESOPUFF II scheme for OH)

     Aqueous phase transformation flag (MAQCHEM)
     (Used only if MCHEM = 1, or 3)       Default: 0     ! MAQCHEM =  0   !
        0 = aqueous phase transformation
            not modeled
        1 = transformation rates adjusted
            for aqueous phase reactions

     Wet removal modeled ? (MWET)         Default: 1     ! MWET =  0   !
```

```
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  0   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                     Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
```



```
[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 800


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion modeled for
point sources?
(MPARTL)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTLBA =  0  !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
```

```
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                      Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                        Default: 1     ! MREG =  0   !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
                  PGTIME   60. (min)
                  MGAUSS   1
                  MCTADJ   3
                  MTRANS   1
                  MTIP     1
                  MRISE    1
                  MCHEM    1 or 3 (if modeling SOx, NOx)
                  MWET     1
                  MDRY     1
                  MDISP    2 or 3
                  MPDF     0 if MDISP=3
                           1 if MDISP=2
                  MROUGH   0
                  MPARTL   1
                  MPARTLBA 0
                  SYTDEP   550. (m)
                  MHFTSZ   0
                  SVMIN    0.5 (m/s)


!END!

--------------------------------------------------------------------------------
```



```
INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          NOX !         !END!

                                                       Dry                 OUTPUT
GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,
(0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st
CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd
CGRUP,
    in length)                                       3=USER-SPECIFIED)     3=
etc.)

!          NOX  =         1,              0,           0,                 0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



-------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
```

```
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  54   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0N  !
     (RLON0)                    No Default      ! RLON0 = 0E  !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 0N  !
     (XLAT2)                    No Default      ! XLAT2 = 0N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and
XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
```



```
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84  !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =  81   !
            No. Y grid cells (NY)      No default     ! NY =  79   !
         No. vertical layers (NZ)      No default     ! NZ =  12   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = .5 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE = .0, 20.0, 40.0, 80.0, 100.0, 200.0, 300.0, 400.0, 500.0, 1000.0,
              1500.0, 2000.0, 2400.0 !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM = 583.0 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = 5754.0 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1   !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1   !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP =  81   !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP =  79   !
                  (1 <= JECOMP <= NY)



SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)         Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP =  1   !
         (IBCOMP <= IBSAMP <= IECOMP)
```

```
       Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  1   !
        (JBCOMP <= JBSAMP <= JECOMP)


       X index of UR corner (IESAMP)      No default     ! IESAMP =  81   !
        (IBCOMP <= IESAMP <= IECOMP)

       Y index of UR corner (JESAMP)      No default     ! JESAMP =  79   !
        (JBCOMP <= JESAMP <= JECOMP)


      Nesting factor of the sampling
       grid (MESHDN)                      Default: 1     ! MESHDN =  1  !
       (MESHDN is an integer >= 1)

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                                    *                          *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)              1                   !  ICON =  1   !
   Dry Fluxes (IDRY)                  1                   !  IDRY =  0   !
   Wet Fluxes (IWET)                  1                   !  IWET =  0   !
   2D Temperature (IT2D)              0                   !  IT2D =  0   !
   2D Density (IRHO)                  0                   !  IRHO =  0   !
   Relative Humidity (IVIS)           1                   !  IVIS =  0   !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         ! LCOMPRS = T !

   *
    0 = Do not create file, 1 = create file


    QA PLOT FILE OUTPUT OPTION:

       Create a standard series of output files (e.g.
       locations of sources, receptors, grids ...)
       suitable for plotting?
       (IQAPLOT)                       Default: 1         !  IQAPLOT =  1   !
         0 = no
         1 = yes

    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported?
       (IMFLX)                         Default: 0         ! IMFLX =  0  !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported?
       (IMBAL)                         Default: 0         ! IMBAL =  0  !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)
```



```
    NUMERICAL RISE OUTPUT OPTION:

       Create a file with plume properties for each rise
       increment, for each model timestep?
       This applies to sources modeled with numerical rise
       and is limited to ONE source in the run.
       (INRISE)                        Default: 0         ! INRISE =  0  !
         0 = no
         1 = yes (RISE.DAT filename is
                  specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:

       Print concentrations (ICPRT)    Default: 0         ! ICPRT =  0   !
       Print dry fluxes (IDPRT)        Default: 0         ! IDPRT =  0   !
       Print wet fluxes (IWPRT)        Default: 0         ! IWPRT =  0   !
       (0 = Do not print, 1 = Print)

       Concentration print interval
       (ICFRQ) in timesteps            Default: 1         ! ICFRQ =  1   !
       Dry flux print interval
       (IDFRQ) in timesteps            Default: 1         ! IDFRQ =  1   !
       Wet flux print interval
       (IWFRQ) in timesteps            Default: 1         ! IWFRQ =  1   !

       Units for Line Printer Output
       (IPRTU)                         Default: 1         ! IPRTU =  3   !
                       for              for
                  Concentration    Deposition
           1 =        g/m**3        g/m**2/s
           2 =       mg/m**3       mg/m**2/s
           3 =       ug/m**3       ug/m**2/s
           4 =       ng/m**3       ng/m**2/s
           5 =      Odour Units

       Messages tracking progress of run
       written to the screen ?
       (IMESG)                         Default: 2         ! IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------
WET FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
   -------       ------------------------   ------------------------
------------------------   ---------------
!          NOX =     0,           1,           0,           0,           0,
     0,           0  !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                 Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                 Default: 1     ! IPFDEB =  1  !
```

```
       Number of puffs to track
       (NPFDEB)                                 Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                    Default: 1     ! NN1 =  1   !

       Met. period to end output
       (NN2)                                    Default: 10    ! NN2 =  10  !

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                      1 **
     HILL information


HILL          XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2
SCALE 1    SCALE 2    AMAX1     AMAX2
 NO.        (km)      (km)      (deg.)   (m)     (m)       (m)       (m)
(m)        (m)       (m)       (m)
----        ----      ----      ------ -----  ------    ------    ------
-------    -------    -----     -----

---------------
Subgroup (6c)
```



```
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX    = Maximum allowed axis length for the major axis
          BMAX    = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT    = Height of the ground (MSL) at the complex terrain
                    Receptor
          XHH     = Hill number associated with each complex terrain receptor
                    (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)                                              (s/cm)
            (dimensionless)
      -------     -----------      ----------      ----------
--------------------     ----------------------


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
```

```
      NAME              DIAMETER                  DEVIATION
                        (microns)                 (microns)
     -------       -------------------       ------------------

!END!

--------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                        Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                          Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                       Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                         Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                         Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

--------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.      Frozen Precip.
       ---------      --------------      --------------

!END!

--------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =  0   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                 Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
```



```
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                  Default: 12*10.
     !  BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                  Default: 0.2         ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                  Default: 2.0         ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                  Default: 2.0         ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)    Default: 1           ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                 Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
```

```
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP =
5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0
!

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                    Default: 0.1    ! CONK2 = .1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                      Default: 0.5    ! TBD = .5 !
        TBD < 0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                             Default: 10     ! IURB1 =  10  !
                                                         19     ! IURB2 =  19  !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                              Default: 20     ! ILANDUIN =  20
 !

        Roughness length (m) for modeling domain
        (Z0IN)                                  Default: 0.25   ! Z0IN = .25 !

        Leaf area index for modeling domain
```



```
        (XLAIIN)                                Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                Default: -999.  ! XLATIN =
-999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                Default: -999.  ! XLONIN =
-999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                Default: 10.    ! ANEMHT = 10.0
!

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
        (ISIGMAV)                               Default: 1      ! ISIGMAV =  1
!
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                              Default: 0      ! IMIXCTDM =  0
!
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                   Default: 1.0    ! XMXLEN = 1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                  Default: 1.0    ! XSAMLEN = 1.0
!

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                    Default: 99     ! MXNEW =  99
!

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                    Default: 99     ! MXSAM =  99
!

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                   Default: 2      ! NCOUNT =  2
!

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                    Default: 1.0    ! SYMIN = 1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                    Default: 1.0    ! SZMIN = 1.0  !

     Maximum sigma z (m) allowed to avoid
     numerical problem in calculating virtual
     time or distance.  Cap should be large
     enough to have no influence on normal events.
     Enter a negative cap to disable.
```

```
     (SZCAP_M)                                Default: 5.0e06 ! SZCAP_M =
5.0E06 !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                     ----------  LAND  ----------       ---------  WATER
----------
        Stab Class :  A    B    C    D    E    F         A    B    C    D    E
 F
                     ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---
---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37,
.37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03,
.016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370,
0.370, 0.370, 0.370!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120,
0.080, 0.060, 0.030, 0.016!

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                Default: 0.0,0.0  ! CDIV = .0,
.0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                Default: 4      ! NLUTIBL =  4
!

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                 Default: 0.5    ! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                 Default: 3000.  ! XMAXZI =
2400.0 !

     Minimum mixing height (m)
     (XMINZI)                                 Default: 50.    ! XMINZI = 50.0
!

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                    Default   :
                                   ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                            Wind Speed Class :  1     2     3     4     5
                                                ---   ---   ---   ---   ---
                                     ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                     Default   : ISC RURAL values
                                   ISC RURAL : .07, .07, .10, .15, .35, .55
                                   ISC URBAN : .15, .15, .20, .25, .30, .30
```



```
                            Stability Class :  A     B     C     D     E
F
                                               ---   ---   ---   ---   ---
---
                                      ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35,
0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                          Default: 0.020, 0.035
                                          ! PTG0 = 0.020,   0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))               Stability Class :  A     B     C     D     E
F
                                Default  PPC : .50,  .50,  .50,  .50,  .35,
.35
                                               ---   ---   ---   ---   ---
---
                                      !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35,
0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                                 Default: 10.       ! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                              Default:   3       ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                        Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                             Default: 100.      ! ZISPLIT = 100.0
!

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                             Default: 0.25      ! ROLDMAX = 0.25
!


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                             Default:   5       ! NSPLITH =  5  !
```

```
       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                         Default:  1.0       ! SYSPLITH = 1.0
!

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                         Default:  2.        ! SHSPLITH = 2.0
!

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                         Default:  1.0E-07   ! CNSPLITH =
1.0E-07 !

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
       (EPSSLUG)                          Default:   1.0e-04  ! EPSSLUG =
1.0E-04 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                          Default:   1.0e-06  ! EPSAREA =
1.0E-06 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                           Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                          Default:   500.     ! HTMINBC = 500.0
!

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                          Default:   10.      ! RSAMPBC = 10.0
!

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                           Default:   1        ! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!

-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =  0  !
```



```
     Units used for point source
     emissions below               (IPTU)  Default: 1  !  IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)       (NSPT1) Default: 0  !  NSPT1 =  0  !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  3  !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                            a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                                b
        c
  Source       X          Y        Stack    Base     Stack    Exit  Exit    Bldg.
Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
 Rates
              (km)       (km)       (m)      (m)       (m)  (m/s) (deg. K)

  ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
```

```
           (Default: 0.0)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                               a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------


--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                                  a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
```



```
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below           (IARU)       Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                           a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                                b
Source           Effect.    Base     Initial    Emission
 No.             Height   Elevation  Sigma z     Rates
                   (m)       (m)       (m)
-------          ------    ------    --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
```

```
            ---------------------------------------------------------
Source                                                                 a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                       a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                               No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)        No default   ! NLINES =  0
!

     Units used for line source
```



```
     emissions below                (ILNU)         Default: 1  !  ILNU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)        (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                            Default: 7   ! MXNSEG =  7
!

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which               Default: 6   ! NLRISE =  6
!
        transitional rise is computed

        Average building length (XL)               No default   ! XL = .0 !
                                                   (in meters)

        Average building height (HBL)              No default   ! HBL = .0 !
                                                   (in meters)

        Average building width (WBL)               No default   ! WBL = .0 !
                                                   (in meters)

        Average line source width (WML)            No default   ! WML = .0 !
                                                   (in meters)

        Average separation between buildings (DXL)  No default   ! DXL = .0 !
                                                   (in meters)

        Average buoyancy parameter (FPRIMEL)       No default   ! FPRIMEL = .0
!
                                                   (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

              a
Source     Beg. X      Beg. Y      End. X     End. Y     Release    Base
Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate   Height    Elevation
Rates
            (km)        (km)        (km)       (km)        (m)        (m)

------   ----------  ----------  ---------  ----------  -------   ---------
---------

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
```

```
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                      a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
```



```
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                             a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                              b
         X            Y         Effect.    Base      Initial     Initial    Emission
     Coordinate   Coordinate    Height   Elevation   Sigma y     Sigma z     Rates
        (km)         (km)         (m)       (m)        (m)         (m)
     ----------   ----------    ------    ------    --------    --------    --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                     a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
```

```
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC =  12   !

!END!

---------------
Subgroup (17b)
---------------
                                                   a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                   X            Y          Ground       Height   b
Receptor       Coordinate   Coordinate    Elevation   Above Ground
  No.            (km)         (km)          (m)           (m)
--------       ----------   ----------    ---------   ------------
     1 ! X =     600.932,   5772.884,      96.000,       0.000!   !END!
     2 ! X =     604.206,   5775.082,      83.000,       0.000!   !END!
     3 ! X =     604.311,   5774.536,      84.000,       0.000!   !END!
     4 ! X =     604.608,   5774.217,      78.000,       0.000!   !END!
     5 ! X =     604.974,   5773.257,      85.000,       0.000!   !END!
     6 ! X =     605.074,   5773.003,      79.000,       0.000!   !END!
     7 ! X =     604.834,   5773.225,      80.000,       0.000!   !END!
     8 ! X =      607.95,    5774.77,      73.000,       0.000!   !END!
     9 ! X =      608.65,    5775.43,      70.000,       0.000!   !END!
    10 ! X =      609.93,   5775.515,      68.000,       0.000!   !END!
    11 ! X =      608.24,   5776.313,      85.000,       0.000!   !END!
    12 ! X =     596.725,    5771.04,      71.000,       0.000!   !END!


-------------
    a
     Data for each receptor are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     Receptor height above ground is optional.  If no value is entered,
     the receptor is placed on the ground.
```

```
AGL Tarrone Power Station
Shaw River Emissions (1500 MW)
Continuous (steady state) operation
---------------- Run title (3 lines) ------------------------------------------

                   CALPUFF MODEL CONTROL FILE
                   --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT =            *
    or
ISCMET.DAT    input    * ISCDAT =            *
    or
PLMMET.DAT    input    * PLMDAT =            *
    or
PROFILE.DAT   input    * PRFDAT =            *
SURFACE.DAT   input    * SFCDAT =            *
RESTARTB.DAT  input    * RSTARTB=            *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST =C:\URS-DATA\AGLTAR~1\CALPUFF\AGL_SR.LST  !
CONC.DAT      output   ! CONDAT =AGL_SR.CON     !
DFLX.DAT      output   * DFDAT  =            *
WFLX.DAT      output   * WFDAT  =            *

VISB.DAT      output   * VISDAT =            *
TK2D.DAT      output   * T2DDAT =            *
RHO2D.DAT     output   * RHODAT =            *
RESTARTE.DAT  output   * RSTARTE=            *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =            *
VOLEMARB.DAT  input    * VOLDAT =            *
BAEMARB.DAT   input    * ARDAT  =            *
LNEMARB.DAT   input    * LNDAT  =            *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =            *
VD.DAT        input    * VDDAT  =            *
CHEM.DAT      input    * CHEMDAT=            *
H2O2.DAT      input    * H2O2DAT=            *
HILL.DAT      input    * HILDAT=            *
HILLRCT.DAT   input    * RCTDAT=            *
COASTLN.DAT   input    * CSTDAT=            *
FLUXBDY.DAT   input    * BDYDAT=            *
BCON.DAT      input    * BCNDAT=            *
DEBUG.DAT     output   * DEBUG =            *
MASSFLX.DAT   output   * FLXDAT=            *
MASSBAL.DAT   output   * BALDAT=            *
FOG.DAT       output   * FOGDAT=            *
RISE.DAT      output   * RISDAT=            *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------
```



```
     Number of CALMET.DAT files for run (NMETDAT)
                                  Default: 1       ! NMETDAT =   6   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                  Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                  Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                  Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_JF.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_MA.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_MJ.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_JA.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_SO.MET     !
!END!
 none         input    ! METDAT=C:\URS-DATA\AGLTAR~1\CALPUFF\IG_ND.MET     !
!END!


--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   ! IBYR  =  2007  !
                       Month  (IBMO)  --    No default   ! IBMO  =  1  !
                       Day    (IBDY)  --    No default   ! IBDY  =  1  !
     Starting time:    Hour   (IBHR)  --    No default   ! IBHR  =  0  !
                       Minute (IBMIN) --    No default   ! IBMIN =  0  !
                       Second (IBSEC) --    No default   ! IBSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2007  !
                       Month  (IEMO)  --    No default   ! IEMO  =  12  !
                       Day    (IEDY)  --    No default   ! IEDY  =  31  !
     Ending time:      Hour   (IEHR)  --    No default   ! IEHR  =  23  !
                       Minute (IEMIN) --    No default   ! IEMIN =  0  !
                       Second (IESEC) --    No default   ! IESEC =  0  !

     (These are only used if METRUN = 0)

     Base time zone        (XBTZ) -- No default       ! XBTZ= -10.0  !
     The zone is the number of hours that must be
     ADDED to the time to obtain UTC (or GMT)
     Examples: PST = 8., MST = 7.
```

```
          CST = 6., EST = 5.

     Length of modeling time-step (seconds)
     Equal to update period in the primary
     meteorological data files, or an
     integer fraction of it (1/2, 1/3 ...)
     Must be no larger than 1 hour
     (NSECDT)                        Default:3600     ! NSECDT =  3600  !
                                     Units: seconds

     Number of chemical species (NSPEC)
                                     Default: 5       ! NSPEC =  2   !

     Number of chemical species
     to be emitted  (NSE)            Default: 3       ! NSE =  2   !

     Flag to stop run after
     SETUP phase (ITEST)             Default: 2       ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)      Default: 0       ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)        Default: 0       ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                     Default: 1       ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                     Default: 1       ! MPRFFM =  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                     Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                     Default: 60.0    ! PGTIME = 60. !


!END!
```



```
--------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)              Default: 0     ! MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                              Default: 1     ! MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)            Default: 1     ! MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                     Default: 1     ! MRISE =  1  !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW =   1  !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                   Default: 0     ! MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)       Default: 1     ! MCHEM =  0   !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
```

```
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM =  0   !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modeled ? (MWET)          Default: 1     ! MWET =  0   !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  0   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                     Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
```



```
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 800


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion modeled for
point sources?
(MPARTL)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTLBA =  0  !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes
```

```
Sub-Grid TIBL module used for shore line?
                                       Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                       Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                       Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                       Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                         Default: 1     ! MREG =  0   !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
                  PGTIME   60. (min)
                  MGAUSS   1
                  MCTADJ   3
                  MTRANS   1
                  MTIP     1
                  MRISE    1
                  MCHEM    1 or 3 (if modeling SOx, NOx)
                  MWET     1
                  MDRY     1
                  MDISP    2 or 3
                  MPDF     0 if MDISP=3
                           1 if MDISP=2
                  MROUGH   0
```



```
                       MPARTL   1
                       MPARTLBA 0
                       SYTDEP   550. (m)
                       MHFTSZ   0
                       SVMIN    0.5 (m/s)


!END!


-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          NOX !         !END!
! CSPEC =           CO !         !END!

                                                          Dry                OUTPUT
GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,
(0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st
CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd
CGRUP,
    in length)                                       3=USER-SPECIFIED)     3=
etc.)

!          NOX  =         1,               1,           0,                 0   !
!           CO  =         1,               1,           0,                 0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



-------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------
```

```
     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  54   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0N  !
     (RLON0)                    No Default      ! RLON0 = 0E  !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 0N  !
     (XLAT2)                    No Default      ! XLAT2 = 0N  !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and
XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
     consistent with local mapping products.  The list of Datum-Regions with
```



```
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)

------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84  !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =  81   !
            No. Y grid cells (NY)      No default     ! NY =  79   !
        No. vertical layers (NZ)       No default     ! NZ =  12   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = .5 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE = .0, 20.0, 40.0, 80.0, 100.0, 200.0, 300.0, 400.0, 500.0, 1000.0,
              1500.0, 2000.0, 2400.0 !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM = 583.0 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = 5754.0 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1   !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1   !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP =  81   !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP =  79   !
                  (1 <= JECOMP <= NY)



SAMPLING Grid (GRIDDED RECEPTORS):
```

```
     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)        Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP =  1   !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  1   !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP =  81   !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP =  79   !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN =  1  !
        (MESHDN is an integer >= 1)

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                               *                          *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)             1                    !  ICON =  1   !
   Dry Fluxes (IDRY)                 1                    !  IDRY =  0   !
   Wet Fluxes (IWET)                 1                    !  IWET =  0   !
   2D Temperature (IT2D)             0                    !  IT2D =  0   !
   2D Density (IRHO)                 0                    !  IRHO =  0   !
   Relative Humidity (IVIS)          1                    !  IVIS =  0   !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         ! LCOMPRS = T !

   *
    0 = Do not create file, 1 = create file


    QA PLOT FILE OUTPUT OPTION:

       Create a standard series of output files (e.g.
       locations of sources, receptors, grids ...)
       suitable for plotting?
       (IQAPLOT)                       Default: 1         !  IQAPLOT =  1   !
         0 = no
         1 = yes

    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:
```



```
       Mass flux across specified boundaries
       for selected species reported?
       (IMFLX)                         Default: 0         ! IMFLX =  0  !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported?
       (IMBAL)                         Default: 0         ! IMBAL =  0  !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)


    NUMERICAL RISE OUTPUT OPTION:

       Create a file with plume properties for each rise
       increment, for each model timestep?
       This applies to sources modeled with numerical rise
       and is limited to ONE source in the run.
       (INRISE)                        Default: 0         ! INRISE =  0  !
         0 = no
         1 = yes (RISE.DAT filename is
                  specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:

       Print concentrations (ICPRT)    Default: 0         ! ICPRT =  0   !
       Print dry fluxes (IDPRT)        Default: 0         ! IDPRT =  0   !
       Print wet fluxes (IWPRT)        Default: 0         ! IWPRT =  0   !
       (0 = Do not print, 1 = Print)

       Concentration print interval
       (ICFRQ) in timesteps            Default: 1         ! ICFRQ =  1   !
       Dry flux print interval
       (IDFRQ) in timesteps            Default: 1         ! IDFRQ =  1   !
       Wet flux print interval
       (IWFRQ) in timesteps            Default: 1         ! IWFRQ =  1   !

       Units for Line Printer Output
       (IPRTU)                         Default: 1         ! IPRTU =  3   !
                        for            for
                  Concentration    Deposition
           1 =       g/m**3         g/m**2/s
           2 =      mg/m**3        mg/m**2/s
           3 =      ug/m**3        ug/m**2/s
           4 =      ng/m**3        ng/m**2/s
           5 =     Odour Units

       Messages tracking progress of run
       written to the screen ?
       (IMESG)                         Default: 2         ! IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------
WET FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
   -------       ------------------------   ------------------------
------------------------   ---------------
```

```
!         NOX =     0,           1,           0,           0,           0,
    0,          0   !
!          CO =     0,           1,           0,           0,           0,
    0,          0   !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                 Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                 Default: 1     ! IPFDEB =  1  !

       Number of puffs to track
       (NPFDEB)                                 Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                    Default: 1     ! NN1 =  1   !

       Met. period to end output
       (NN2)                                    Default: 10    ! NN2 =  10  !

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
```



```
---------------

                      1 **
     HILL information


HILL           XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2
SCALE 1    SCALE 2    AMAX1     AMAX2
 NO.          (km)      (km)      (deg.)   (m)     (m)      (m)       (m)
(m)        (m)        (m)       (m)
----          ----      ----      ------  -----  ------    ------    ------
-------    -------    -----     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX    = Maximum allowed axis length for the major axis
          BMAX    = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT    = Height of the ground (MSL) at the complex terrain
                    Receptor
          XHH     = Hill number associated with each complex terrain receptor
                    (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)                                            (s/cm)
             (dimensionless)
      -------     -----------      ----------      ----------
--------------------     -----------------------


!END!

-------------------------------------------------------------------------------
```

```
INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                   DEVIATION
                        (microns)                  (microns)
      -------      -------------------        ------------------

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                           Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                             Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                          Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                            Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                            Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------
```



```
     Ozone data input option (MOZ)     Default: 1            ! MOZ =  0   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.
     !  BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                   Default: 0.2          ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0          ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0          ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)    Default: 1            ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                  Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
```

```
   BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
   OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
   VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

Urban - high biogenic (controls present)
   BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
   OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
   VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

Regional Plume
   BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
   OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
   VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

Urban - no controls present
   BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
   OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
   VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

Default: Clean Continental
!  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !
!  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.15 !
!  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


!END!

-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP =
5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0
!

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                    Default: 0.1    ! CONK2 = .1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                      Default: 0.5    ! TBD = .5 !
        TBD < 0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
```



```
     urban dispersion is assumed
     (IURB1, IURB2)                             Default: 10     ! IURB1 =  10  !
                                                         19     ! IURB2 =  19  !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                              Default: 20     ! ILANDUIN =  20
 !

        Roughness length (m) for modeling domain
        (Z0IN)                                  Default: 0.25   ! Z0IN = .25 !

        Leaf area index for modeling domain
        (XLAIIN)                                Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                Default: -999.  ! XLATIN =
-999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                Default: -999.  ! XLONIN =
-999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                Default: 10.    ! ANEMHT = 10.0
!

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
        (ISIGMAV)                               Default: 1      ! ISIGMAV =  1
!
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                              Default: 0      ! IMIXCTDM =  0
!
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                   Default: 1.0    ! XMXLEN = 1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                  Default: 1.0    ! XSAMLEN = 1.0
!

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                    Default: 99     ! MXNEW =  99
!

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                    Default: 99     ! MXSAM =  99
!

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
```

```
     and PROFILE winds)
     (NCOUNT)                                  Default: 2      ! NCOUNT =  2
!

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                   Default: 1.0    ! SYMIN = 1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                   Default: 1.0    ! SZMIN = 1.0  !

     Maximum sigma z (m) allowed to avoid
     numerical problem in calculating virtual
     time or distance.  Cap should be large
     enough to have no influence on normal events.
     Enter a negative cap to disable.
     (SZCAP_M)                                 Default: 5.0e06 ! SZCAP_M =
5.0E06 !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                     ----------  LAND  ----------       ---------  WATER
----------
        Stab Class :  A    B    C    D    E    F         A    B    C    D    E
 F
                     ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---
---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37,
.37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03,
.016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370,
0.370, 0.370, 0.370, 0.370!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120,
0.080, 0.060, 0.030, 0.016!

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                 Default: 0.0,0.0  ! CDIV = .0,
.0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                 Default: 4      ! NLUTIBL =  4
!

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                  Default: 0.5    ! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                  Default: 3000.  ! XMAXZI =
2400.0 !

     Minimum mixing height (m)
     (XMINZI)                                  Default: 50.    ! XMINZI = 50.0
!

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
```



```
     the 6th class has no upper limit
     (WSCAT(5))                        Default   :
                                       ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                            Wind Speed Class :  1     2     3     4     5
                                                ---   ---   ---   ---   ---
                                         ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                         Default   : ISC RURAL values
                                       ISC RURAL : .07, .07, .10, .15, .35, .55
                                       ISC URBAN : .15, .15, .20, .25, .30, .30

                             Stability Class :  A     B     C     D     E
F
                                                ---   ---   ---   ---   ---
---
                                          ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35,
0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                         Default: 0.020, 0.035
                                          ! PTG0 = 0.020,   0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                  Stability Class :  A     B     C     D     E
F
                                   Default  PPC : .50,  .50,  .50,  .50,  .35,
.35
                                                ---   ---   ---   ---   ---
---
                                          !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35,
0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                              Default: 10.       ! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                           Default:   3       ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                     Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                          Default: 100.      ! ZISPLIT = 100.0
!

       Split is allowed only if ratio of last hour's
```

```
        mixing ht to the maximum mixing ht experienced
        by the puff is less than a maximum value (this
        postpones a split until a nocturnal layer develops)
        (ROLDMAX)                           Default: 0.25       ! ROLDMAX = 0.25
!


        HORIZONTAL SPLIT
        ----------------

        Number of puffs that result every time a puff
        is split - nsplith=5 means that 1 puff splits
        into 5
        (NSPLITH)                           Default:   5        ! NSPLITH =  5  !

        Minimum sigma-y (Grid Cells Units) of puff
        before it may be split
        (SYSPLITH)                          Default:  1.0       ! SYSPLITH = 1.0
!

        Minimum puff elongation rate (SYSPLITH/hr) due to
        wind shear, before it may be split
        (SHSPLITH)                          Default:  2.        ! SHSPLITH = 2.0
!

        Minimum concentration (g/m^3) of each
        species in puff before it may be split
        Enter array of NSPEC values; if a single value is
        entered, it will be used for ALL species
        (CNSPLITH)                          Default:  1.0E-07   ! CNSPLITH =
1.0E-07 !

      Integration control variables ------------------------

        Fractional convergence criterion for numerical SLUG
        sampling integration
        (EPSSLUG)                           Default:   1.0e-04  ! EPSSLUG =
1.0E-04 !

        Fractional convergence criterion for numerical AREA
        source integration
        (EPSAREA)                           Default:   1.0e-06  ! EPSAREA =
1.0E-06 !

        Trajectory step-length (m) used for numerical rise
        integration
        (DSRISE)                            Default:   1.0      ! DSRISE = 1.0 !

        Boundary Condition (BC) Puff control variables ------------------------

        Minimum height (m) to which BC puffs are mixed as they are emitted
        (MBCON=2 ONLY).  Actual height is reset to the current mixing height
        at the release point if greater than this minimum.
        (HTMINBC)                           Default:   500.     ! HTMINBC = 500.0
!

        Search radius (km) about a receptor for sampling nearest BC puff.
        BC puffs are typically emitted with a spacing of one grid cell
        length, so the search radius should be greater than DGRIDKM.
        (RSAMPBC)                           Default:   10.      ! RSAMPBC = 10.0
!

        Near-Surface depletion adjustment to concentration profile used when
        sampling BC puffs?
        (MDEPBC)                            Default:   1        ! MDEPBC =  1  !
           0 = Concentration is NOT adjusted for depletion
           1 = Adjust Concentration for depletion
```



```
!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =  3  !

     Units used for point source
     emissions below                (IPTU)  Default: 1  !  IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  !  NSPT1 =  0  !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  0  !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                                a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                               b
         c
  Source       X          Y       Stack    Base     Stack    Exit  Exit    Bldg.
Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
 Rates
             (km)       (km)       (m)      (m)       (m)  (m/s) (deg. K)

  ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------
   1 ! SRCNAM = SR1 !
   1 ! X =  596.581, 5773.984,    50.0,  80.0,       6.4,  19.8, 372.15,
1.0,3.06E01,  7.5E00 !
   1 ! ZPLTFM  =       .0 !
   1 ! FMFAC  =      1.0 !   !END!
   2 ! SRCNAM = SR2 !
   2 ! X =  596.726, 5773.984,    50.0,  80.0,       6.4,  19.8,  372.2,
1.0,3.06E01,  7.5E00 !
   2 ! ZPLTFM  =       .0 !
   2 ! FMFAC  =      1.0 !   !END!
   3 ! SRCNAM = SR3 !
```

```
   3 ! X =  596.871, 5773.984,    50.0,  80.0,       6.4,  19.8, 372.15,
1.0,3.06E01,  7.5E00 !
   3 ! ZPLTFM  =       .0 !
   3 ! FMFAC  =      1.0 !   !END!

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
             (Default: 0.0)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                  a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------

 1    ! SRCNAM  =   SR1 !
 1    ! HEIGHT  =  35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   33.0,   33.0,   33.0,   33.0!
 1    ! WIDTH   =  23.0,   26.0,   29.0,   31.0,   31.0,   32.0,
                   30.0,   28.0,   25.0,   28.0,   30.0,   31.0,
                   31.0,   30.0,   28.0,   25.0,   22.0,   19.0,
                   23.0,   26.0,   29.0,   31.0,   32.0,   32.0,
                   30.0,   28.0,   25.0,   28.0,   30.0,   31.0,
```



```
                   31.0,   30.0,   78.0,   72.0,   64.0,   54.0!
 1    ! LENGTH =   27.0,   28.0,   82.0,   83.0,   28.0,   26.0,
                   23.0,   20.0,   18.0,   22.0,   26.0,   29.0,
                   31.0,   32.0,   32.0,   31.0,   29.0,   26.0,
                   27.0,   28.0,   29.0,   29.0,   28.0,   26.0,
                   23.0,   20.0,   18.0,   22.0,   26.0,   29.0,
                   31.0,   32.0,   32.0,   82.0,   78.0,   64.0!
 1    ! XBADJ  =   -30.0,   -31.0,   -30.0,   -28.0,   -26.0,   -22.0,
                   -18.0,   -14.0,   -10.0,   -9.0,   -8.0,   -7.0,
                   -5.0,   -3.0,   -2.0,   1.0,   2.0,   4.0,
                   3.0,   1.0,   -2.0,   -3.0,   -4.0,   -6.0,
                   -7.0,   -8.0,   -9.0,   -14.0,   -18.0,   -22.0,
                   -26.0,   -28.0,   -187.0,   -192.0,   -190.0,   -183.0!
 1    ! YBADJ  =   -2.0,   -5.0,   -8.0,   -10.0,   -12.0,   -14.0,
                   -15.0,   -17.0,   -17.0,   -17.0,   -16.0,   -14.0,
                   -13.0,   -11.0,   -8.0,   -6.0,   -3.0,   -1.0,
                   2.0,   5.0,   8.0,   10.0,   12.0,   14.0,
                   16.0,   17.0,   17.0,   16.0,   16.0,   14.0,
                   13.0,   11.0,   48.0,   22.0,   -5.0,   -32.0!
!END!
 2    ! SRCNAM  =   SR2 !
 2    ! HEIGHT  =  35.0,   35.0,   33.0,   33.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   33.0,   33.0,   33.0,   33.0!
 2    ! WIDTH   =  22.0,   26.0,   78.0,   81.0,   32.0,   32.0,
                   31.0,   29.0,   26.0,   27.0,   28.0,   29.0,
                   29.0,   28.0,   26.0,   23.0,   20.0,   18.0,
                   22.0,   26.0,   29.0,   31.0,   32.0,   32.0,
                   31.0,   29.0,   26.0,   28.0,   28.0,   29.0,
                   29.0,   28.0,   80.0,   74.0,   65.0,   56.0!
 2    ! LENGTH =   27.0,   28.0,   82.0,   83.0,   28.0,   26.0,
                   23.0,   20.0,   18.0,   22.0,   26.0,   29.0,
                   31.0,   32.0,   32.0,   31.0,   29.0,   26.0,
                   27.0,   28.0,   29.0,   29.0,   28.0,   26.0,
                   23.0,   20.0,   18.0,   22.0,   26.0,   29.0,
                   31.0,   32.0,   82.0,   78.0,   72.0,   64.0!
 2    ! XBADJ  =   -29.0,   -29.0,   -229.0,   -230.0,   -24.0,   -21.0,
                   -17.0,   -13.0,   -10.0,   -9.0,   -8.0,   -7.0,
                   -6.0,   -4.0,   -3.0,   -1.0,   2.0,   2.0,
                   3.0,   1.0,   -1.0,   -2.0,   -4.0,   -5.0,
                   -6.0,   -7.0,   -8.0,   -157.0,   -17.0,   -22.0,
                   -25.0,   -27.0,   -188.0,   -192.0,   -191.0,   -183.0!
 2    ! YBADJ  =   -2.0,   -5.0,   22.0,   -11.0,   -12.0,   -14.0,
                   -15.0,   -16.0,   -16.0,   -16.0,   -15.0,   -14.0,
                   -12.0,   -10.0,   -8.0,   -5.0,   -3.0,   -1.0,
                   2.0,   5.0,   7.0,   10.0,   12.0,   14.0,
                   15.0,   16.0,   16.0,   -9.0,   15.0,   14.0,
                   13.0,   10.0,   47.0,   21.0,   -6.0,   -32.0!
!END!
 3    ! SRCNAM  =   SR3 !
 3    ! HEIGHT  =  35.0,   35.0,   33.0,   33.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   35.0,   35.0,   35.0,   35.0,
                   35.0,   35.0,   33.0,   33.0,   33.0,   33.0!
 3    ! WIDTH   =  22.0,   26.0,   79.0,   83.0,   32.0,   32.0,
                   31.0,   29.0,   26.0,   28.0,   30.0,   31.0,
                   31.0,   30.0,   28.0,   26.0,   22.0,   18.0,
                   22.0,   26.0,   29.0,   31.0,   32.0,   32.0,
                   31.0,   29.0,   26.0,   28.0,   30.0,   31.0,
                   31.0,   30.0,   79.0,   73.0,   65.0,   55.0!
 3    ! LENGTH =   28.0,   30.0,   83.0,   85.0,   30.0,   28.0,
                   25.0,   20.0,   18.0,   22.0,   26.0,   29.0,
                   31.0,   32.0,   32.0,   31.0,   29.0,   26.0,
```

```
                   28.0,   30.0,   31.0,   31.0,   30.0,   28.0,
                   26.0,   22.0,   18.0,   22.0,   26.0,   29.0,
                   31.0,   32.0,   83.0,   79.0,   72.0,   64.0!
 3    ! XBADJ  =   -31.0,   -31.0,   -229.0,   -231.0,   -26.0,   -22.0,
                   -18.0,   -156.0,   -155.0,   -8.0,   -8.0,   -7.0,
                   -5.0,   -4.0,   -2.0,   .0,   1.0,   3.0,
                   2.0,   1.0,   -2.0,   -3.0,   -4.0,   -6.0,
                   -7.0,   -8.0,   -9.0,   -14.0,   -18.0,   -22.0,
                   -26.0,   -28.0,   -188.0,   -192.0,   -190.0,   -183.0!
 3    ! YBADJ  =   -3.0,   -6.0,   -23.0,   -11.0,   -12.0,   -14.0,
                   -15.0,   -10.0,   -16.0,   -16.0,   -16.0,   -14.0,
                   -13.0,   -11.0,   -8.0,   -6.0,   -3.0,   .0,
                   3.0,   6.0,   8.0,   10.0,   12.0,   14.0,
                   15.0,   16.0,   16.0,   16.0,   16.0,   14.0,
                   13.0,   11.0,   48.0,   21.0,   -6.0,   -33.0!
!END!

--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                                         a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------
```



```
---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below            (IARU)       Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                          a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                                  b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                                a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
```

```
---------------
Subgroup (14d)
---------------
                                               a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                                No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)          No default   ! NLINES =  0
!

     Units used for line source
     emissions below                (ILNU)            Default: 1  !  ILNU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
```



```
     combinations with variable
     emissions scaling factors
     provided below in (15c)       (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                             Default: 7   ! MXNSEG =  7
!

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                Default: 6   ! NLRISE =  6
!
        transitional rise is computed

        Average building length (XL)                No default   ! XL = .0 !
                                                    (in meters)

        Average building height (HBL)               No default   ! HBL = .0 !
                                                    (in meters)

        Average building width (WBL)                No default   ! WBL = .0 !
                                                    (in meters)

        Average line source width (WML)             No default   ! WML = .0 !
                                                    (in meters)

        Average separation between buildings (DXL)  No default   ! DXL = .0 !
                                                    (in meters)

        Average buoyancy parameter (FPRIMEL)        No default   ! FPRIMEL = .0
!
                                                    (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

         a
Source     Beg. X      Beg. Y      End. X     End. Y     Release    Base
Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation
Rates
            (km)        (km)        (km)       (km)       (m)       (m)

------   ----------  ----------  ---------  ----------  -------   ---------
---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
```

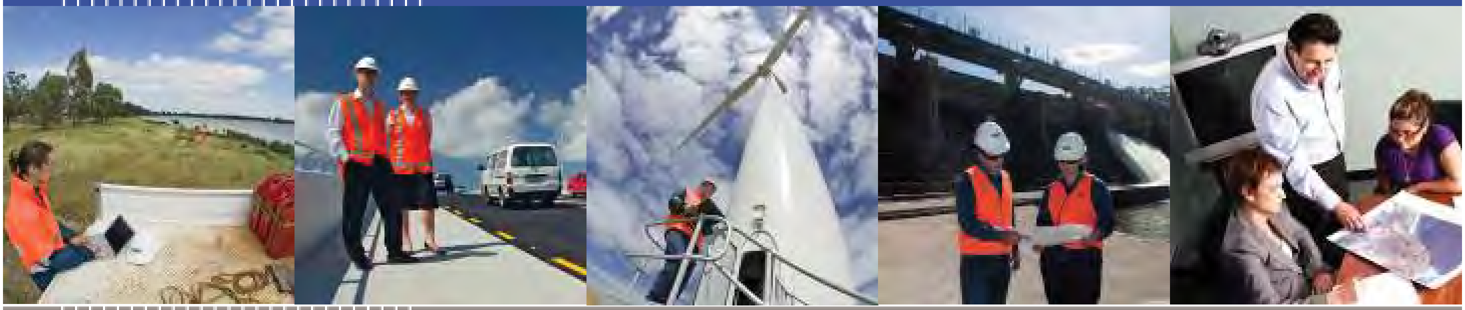
```
                                                 a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!
```



```
---------------
Subgroup (16b)
---------------
                                         a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                              b
         X           Y        Effect.    Base     Initial    Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)        (km)        (m)       (m)       (m)        (m)
     ----------  ----------   ------    ------   --------   --------   --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                 a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (17a)
```

```
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC =  12   !

!END!

---------------
Subgroup (17b)
---------------
                                                   a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                   X            Y          Ground       Height   b
Receptor       Coordinate   Coordinate   Elevation   Above Ground
  No.             (km)         (km)         (m)          (m)
--------       ----------   ----------   ---------   ------------
     1 ! X =     600.932,   5772.884,      96.000,       0.000!   !END!
     2 ! X =     604.206,   5775.082,      83.000,       0.000!   !END!
     3 ! X =     604.311,   5774.536,      84.000,       0.000!   !END!
     4 ! X =     604.608,   5774.217,      78.000,       0.000!   !END!
     5 ! X =     604.974,   5773.257,      85.000,       0.000!   !END!
     6 ! X =     605.074,   5773.003,      79.000,       0.000!   !END!
     7 ! X =     604.834,   5773.225,      80.000,       0.000!   !END!
     8 ! X =      607.95,    5774.77,      73.000,       0.000!   !END!
     9 ! X =      608.65,    5775.43,      70.000,       0.000!   !END!
    10 ! X =      609.93,   5775.515,      68.000,       0.000!   !END!
    11 ! X =      608.24,   5776.313,      85.000,       0.000!   !END!
    12 ! X =     596.725,    5771.04,      71.000,       0.000!   !END!


-------------
    a
     Data for each receptor are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     Receptor height above ground is optional.  If no value is entered,
     the receptor is placed on the ground.
```

Appendix B Noise Impact Assessment



Report

Noise Impact Assessment

Tarrone Power Station

23 AUGUST 2010

Prepared for

AGL Energy Limited

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Executive Summary

URS Australia Pty Ltd (URS) has been commissioned by AGL Energy Limited (AGL) to undertake a noise impact assessment for the proposed gas-fired power station at Tarrone, Victoria. This assessment has been prepared in support of an EPA Works Approval application submitted for the proposed site.

The likely noise issues pertaining to the proposed development include noise associated with the construction and operation of the facility. The proposed site could operate at any time thus an assessment of sleep disturbance for the nearest potentially affected noise sensitive receptors has also been considered in this study.

The nearest potentially affected noise sensitive receptor locations have been identified and the predicted noise impacts of the proposed site on these locations have been assessed with consideration of the following relevant state legislation and guidelines:

- Environment Protection Act 1970 (Victoria);
- State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1, Victoria EPA 1989;
- Interim guidelines for control of noise from industry in country Victoria N3/89, Victoria EPA, 1989
- Noise Control Guidelines, Publication 1254, Victoria EPA, 2008
- Environment Protection (Residential Noise) Regulations 2008: Regulatory Impact Statement (Publication No 1230, June 2008), Victorian EPA;
- Guidelines for Community Noise, World Health Organisation (WHO), 1999; and
- Noise from Industry in Regional Victoria (NIRV) – Recommended maximum noise levels from commerce, industry and trade premises in regional Victoria – Draft for consultation, Publication 1316, Victoria EPA, 2009

The noise limits have been conservatively established by adopting the lowest permissible noise limits to assess the proposed construction and operation with the consideration of above guidelines and the background noise monitoring. Detailed results of noise measurements and the noise criteria applicable to the development are presented in Sections 3 and 4. Daily noise logging plots are also provided in Appendix D.

Noise levels of the proposed construction and operation have been predicted using an acoustic computer model created in SoundPLAN Version 6.5. Details of the area's topography, receptor locations and sound power levels of the noise sources have been incorporated into the noise model. Typical and 'worst-case' scenarios have been taken into consideration throughout the noise modelling. Detailed results of the predictive modelling are provided in Sections 5.3 and 5.6.

On the basis of this assessment, it is concluded that noise impacts of the proposed construction and operation of the power station are not expected to degrade the existing acoustic environment nor create annoyance to the community surrounding the plant.

1 Introduction

URS Australia Pty Ltd (URS) has been commissioned by AGL Energy Limited (AGL) to undertake a noise impact assessment for the proposed gas-fired power station at Tarrone, in regional Victoria. Throughout this report, the proposed power station will simply be referred to as ‘the site’.

This assessment has been prepared in support of an EPA Works Approval application for the proposed site.

Noise impacts associated with the site’s proposed construction and operation have been assessed in accordance with the requirements of the *Environment Protection Act 1970* (Victoria), and relevant guidelines of the Victorian Environment Protection Authority (EPA), primarily the *Interim Guidelines for Control of Noise from Industry in Country Victoria N3/89* (N3/89), but with consideration of the *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No.N-1*, *Noise Control Guidelines TG 302/92* and the Draft Guidelines – *Noise from Industry in Regional Victoria (NIRV)*.

Potential for sleep disturbance has also been assessed as the proposed development is a peaking power station and could operate at any time.

1.1 Scope of Assessment

The scope of this assessment is to:

- Provide a description of the existing acoustic environment and the proposed development;
- Establish appropriate project-specific noise criteria;
- Predict potential noise impacts by means of noise modelling and calculations;
- Assess predicted noise levels against the established noise criteria;
- Provide a statement of potential noise impacts; and
- Report the findings of the assessment.

Site and Project Description

2.1 Site Location

The proposed power station is located on a 75 hectare site approximately 20 kilometres north of Port Fairy, in the Tarrone area of Moyne Shire Council, on the corner of Riordans Road and Landers Lane.

The site and surrounding land use is currently designated as a farming zone. Within the farming zone are scattered farm houses; the closest dwelling is approximately 1.2 kilometres north-east of the site boundary and the closest dwelling to the gas turbines is about 1.5 kilometres.

The site and surrounding areas are relatively flat.

2.2 Noise Sensitive Receptors

The nearest potentially affected noise sensitive receptor locations have been identified from examination of aerial photographs using Google Earth Pro (2009) and a site inspection conducted in December 2008 as follows:

Table 2-1 Noise Sensitive Receptors

Receptor	Address	Approx. Distance from Gas Turbines	Nearest Site Boundary
A	Riordans Road	2250 m	SW
B	386 Tarrone North Road	1750 m	NE
C	426 Tarrone North Road	1550 m	NE
D	473 Tarrone North Road	1700 m	E
E	573 Tarrone North Road	2050 m	SE
F	589 Tarrone North Road	2250 m	SE
G	574 Tarrone North Road	1950 m	SE
H	760 Tarrone North Road	3100 m	SE

Figure 2-1 shows the location of these receptors described above, together with a reference 1 kilometre radius circle from the centre of the site.

2.3 Project Description

AGL proposes development of an open-cycle gas turbine peaking (OCGT) power station in two stages. The ultimate capacity of the power station will depend on the type of turbine that is selected for the final design. Option A may consist of four E class turbines (with nominal capacity of approximately 720 MW) and Option B may consist of three F class turbines (with nominal capacity of approximately 920 MW). The power station facility would also include lay-down area and an electrical substation. Each gas turbine area would consist of a main enclosure housing the turbines, an exhaust stack and transformer.

AGL and Meridian Energy are considering development of the approved Macarthur Wind Farm located approximately 10 kilometres north of the proposed power station site. Power from the wind farm would be connected to the 500 kV electricity grid at a new 500 kV substation at the site proposed for the power station.

2 Site and Project Description

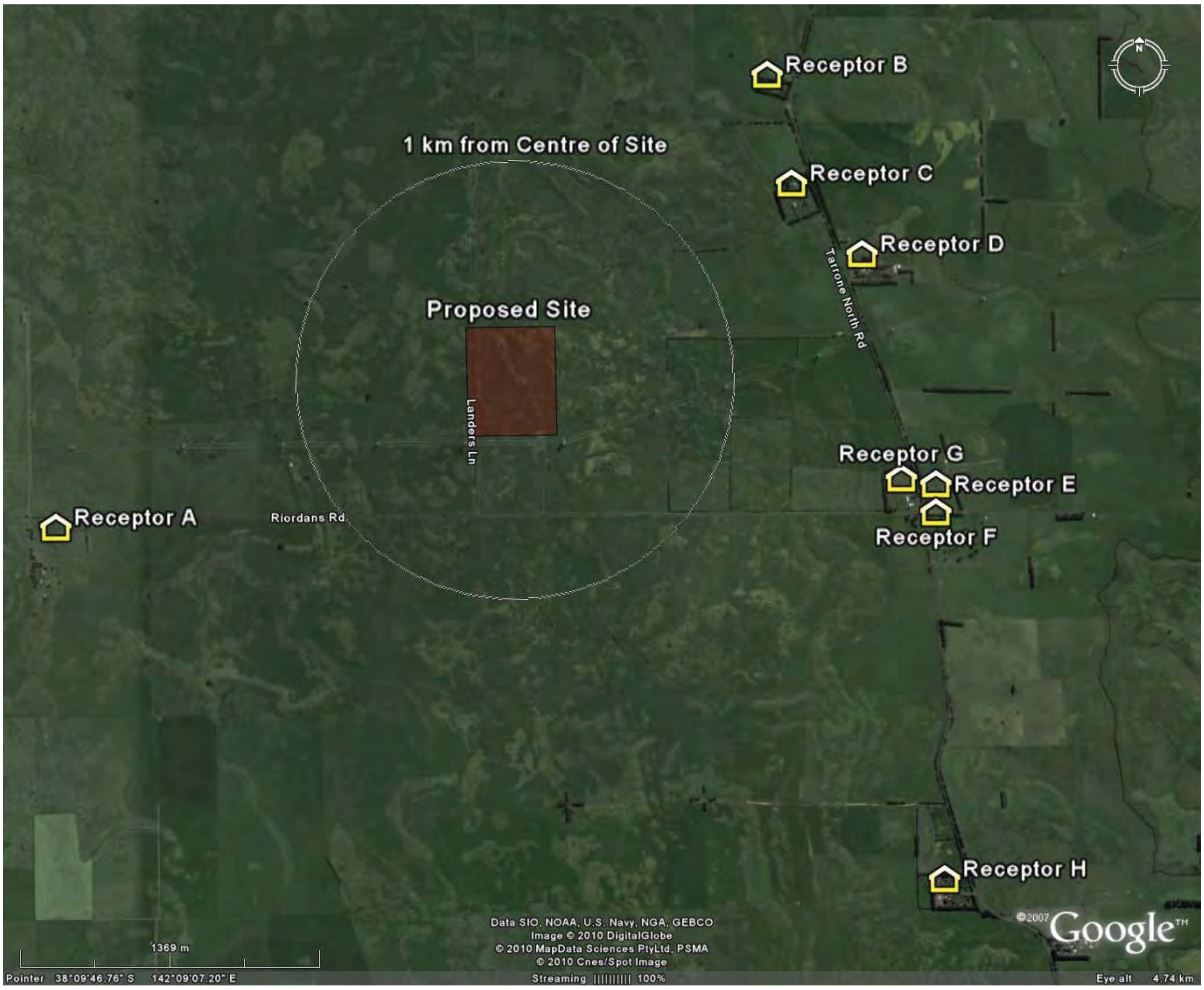
The proposed power station would supply electricity to the grid using the electrical connection on the site. Gas would be supplied to the power station from a new gas lateral (approximately 8-10km in length) connecting to the existing SEA Gas Port Campbell to Adelaide pipeline.

Two pipeline corridors are currently being investigated; an east-west corridor to the SEA Gas Pipeline at Willatook and a north-south corridor to the SEA Gas Pipeline to the north of Heywood-Woolsthorpe Road.

The facility would typically operate during periods of peak electricity demand associated with the morning and evening peaks, particularly at times of extreme weather, however may operate at any time during the day or night and at any time of the year. Therefore, the noise study has considered all weather conditions and all times of day and night.

2 Site and Project Description

Figure 2-1 Aerial Photo Showing Site and Receptor Locations



2 Site and Project Description

Figure 2-2 Preliminary Site Layout

Existing Acoustic Environment

3.1 Noise Measurement Methodology

Noise measurements have been conducted by long-term unattended monitoring and short-term attended monitoring at selected noise sensitive receptors.

All the noise measurements were undertaken in general accordance with AS1055:1997 "*Acoustics – Description and Measurement of Environmental Noise*", consistent with Appendix A of the *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1*.

The equipment detailed in Table 3-1 was used in our survey. These instruments comply with AS IEC 61672.1 – 2004 "*Electroacoustics – Sound level meters – Specifications*" and AS IEC 60942-2004: "*Electroacoustics - Sound Calibrators*" as appropriate, and have a recent calibration certificate traceable to a NATA certified laboratory.

Table 3-1 Equipment used for noise survey

Monitoring	Item	Make	Model	Type
Long-term unattended	Noise logger	Acoustic Research Laboratories (ARL)	EL316	Type 1
	Calibrator	Rion	NC73	Class 1
Short-term attended	Sound level meter	Larson Davis	LXT1	Type 1
	Calibrator	Larson Davis	CAL250	Class 1

The long-term noise monitoring was undertaken using the ARL noise loggers. The noise loggers were positioned with the microphones at 1.2 metres above ground level and were set to statistically process and store the measured noise levels every 15 minutes for the whole monitoring period. The noise loggers were calibrated before logging and the calibration was checked after logging using an acoustic calibrator. No significant discrepancies (greater than 0.3 dB) were noticed in the reference calibration sound signals pre and post measurements.

When analysing measured long-term noise levels, it is a usual practice to make reference to the meteorological data provided by the nearest Bureau of Meteorology (BOM) Automatic Weather Station (AWS) to the site. However, given the distance separation between the nearest met station (Port Fairy AWS ID: 90175) and the noise logging locations, the analysis of the measured data was considered but not reliant on the meteorological data. The trend of background noise during each monitoring period has been examined, and any noise monitoring periods affected by likely extraneous noise were excluded from the final data analysis.

The short-term attended noise monitoring was undertaken using a sound level meter which was positioned for each measurement with the microphone approximately 1.2 metres above the ground level. The sound level meter was calibrated using an acoustic calibrator before measurement sessions and the calibration was checked at the end of measurement sessions. No significant discrepancies (greater than 0.1 dB) were noted in the reference calibration sound signals pre and post measurements.

The short-term noise monitoring was conducted on warm days with slight wind gusts (average speed of less than 3 m/s) and partial cloud cover. The weather conditions during the measurement periods would not have adversely affected the results.

3.2 Noise Measurement Locations

Noise monitoring locations were chosen after examination of satellite imagery of the locality and a site inspection. Consideration was given in selecting the monitoring locations to enable unattended long-term noise monitoring to establish a representation of the natural environment at each receptor location.

The two most representative noise sensitive receptor locations were selected for the long-term noise monitoring, and several short-term attended locations were chosen to supplement the long-term noise monitoring. These locations are considered representative of the most potentially affected noise sensitive receptor locations near the site.

A brief description of each measurement location and the noise sources identified by the monitoring is given below:

- Location D: At 473 Tarrone North Road, located approximately 1,600 metres to the north-east of the proposed location of the gas turbines on site. This location was used for long-term unattended noise monitoring to obtain background noise levels representative of Locations B, C and D.

  The predominant noise sources at this location were local fauna (birds) and occasional road traffic during the daytime period and local fauna (birds and insects) during the evening and the night-time period. No industrial noise was audible at this location.

  Short-term attended noise measurements were also conducted at this location to supplement the long-term noise monitoring.

- Location G: At 574 Tarrone North Road, located approximately 1,800 metres to the south-east of the proposed location of the gas turbines on site. This location was utilised for long-term unattended noise monitoring to obtain background noise levels representative of Locations A, E, F, G and H. Location A has been included in this group as the noise logging at Location G would have been less affected by road traffic noise from Tarrone North Road than at Location D, therefore the noise logging at Location G which would have better represented the background noise at Location A.

  The predominant noise sources at this location were local fauna (birds) and occasional road traffic during the daytime period and local fauna (birds and insects) during the evening and night-time period. No industrial noise was audible at this location.

  Short-term attended noise measurements were also conducted at this location to supplement the long-term noise monitoring.

- Short-term attended noise measurements were conducted at Locations A, B, C, E and F. Background noise levels at these locations have found to be similar to those at Locations D, G and H.

3.3 Noise Measurement Results

The results of the long-term noise monitoring are summarised in Table 3-3, Table 3-4 and Table 3-5. The results of the short-term noise monitoring are summarised in Table 3-6. Any 15-minute period affected by adverse weather conditions or likely extraneous noise were excluded from calculation. Daily noise monitoring plots are provided in Appendix D.

3 Existing Acoustic Environment

For the purpose of this assessment, the following time of day is defined:

Table 3-2 Time of Day

Time of Day	Time
Day	7.00 am – 6.00 pm: Monday to Saturday / 8.00 am – 6.00 pm: Sundays and public holidays
Evening	6.00 pm – 10.00 pm: All days
Night	10.00 pm – 7.00 am: Monday to Saturday / 10.00 pm – 8.00 am: Sundays and public holidays

Table 3-3 Measured Noise Levels - 473 Tarrone North Road (D)

Date	Background Noise Level L_{A90} dB(A)			Ambient Noise Level L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
Tuesday, 3 February 2009		30	26		48	39
Wednesday, 4 February 2009	30	27	24	45	48	39
Thursday, 5 February 2009	31	28	26	46	48	37
Friday, 6 February 2009	27	26	26	46	50	39
Saturday, 7 February 2009	31	30	27	47	47	35
Sunday, 8 February 2009	30	27	23	45	43	38
Monday, 9 February 2009	32	25	23	45	50	41
Tuesday, 10 February 2009	31	-	-	49	-	-
Wednesday, 11 February 2009	-	30	-	-	45	-
Thursday, 12 February 2009	-	-	24	-	-	38
Friday, 13 February 2009	30			44		
Representative Value	**31**	**28**	**25**	**46**	**48**	**38**
Notes: • All measurements in periods showing "-" were affected by extraneous noise.						

Table 3-4 Measured Noise Levels - 574 Tarrone North Road (G)

Date	Background Noise Level L_{A90} dB(A)			Ambient Noise Level L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
Tuesday, 3 February 2009		31	24		45	40
Wednesday, 4 February 2009	34	29	24	45	44	32
Thursday, 5 February 2009	36	28	24	46	44	37
Friday, 6 February 2009	33	29	26	45	43	39
Saturday, 7 February 2009	33	37	25	45	47	35
Sunday, 8 February 2009	30	30	23	47	42	36
Monday, 9 February 2009	32	27	23	47	43	37
Tuesday, 10 February 2009	33	-	-	49	-	-
Wednesday, 11 February 2009	-	37	-	-	46	-
Thursday, 12 February 2009	-	-	24	-	-	38
Friday, 13 February 2009	34			45		

3 Existing Acoustic Environment

Date	Background Noise Level L_{A90} dB(A)			Ambient Noise Level L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
Representative Value	**33**	**29**	**24**	**46**	**45**	**38**
Notes: • All measurements in periods showing "-" were affected by extraneous noise.						

The daily noise logging results generally show consistent noise levels throughout each daily period at both locations. The results at both monitoring locations show similar trend and background noise levels.

An overall representative ambient noise level (AL) is determined by logarithmic averaging of the noise level data from each assessment period for the entire monitoring period, and background noise level (BL) is determined by taking the median value of the data from each assessment period for the entire monitoring period. Table 3-5 presents a summary of overall ambient and background noise levels and at each monitoring location.

Table 3-5 Summary of Measured Noise Levels

Location	Background Noise Level (BL) L_{A90} dB(A)			Ambient Noise Level (AL) L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
D: 473 Tarrone North Road	31	28	25	45	45	38
G: 574 Tarrone North Road	33	29	24	46	44	37

The background noise levels presented above were used to derive the noise limits for the noise impact assessment of the proposed construction and operation of the site which is described in Section 4.2 of this report.

Table 3-6 presents the short-term attended noise measurement results.

Table 3-6 Attended Measurement Results

Location	Date / Time	Background $L_{A90\ (5\text{-}10min)}$ dB(A)	Ambient $L_{Aeq\ (5\text{-}10min)}$ dB(A)	Comments
A Riordans Road	Tuesday, 3 February 2009 / 11:30 pm	26	28	Environment governed by local fauna (insects). No other noise was noted.
	Wednesday, 4 February 2009 / 8:15 am	33	36	Environment governed by local fauna (birds and cattle). No industrial noise was noted.
B 426 Tarrone North Road	Wednesday, 4 February 2009 / 12:25 am	27	29	Environment governed by local fauna (insects). No other noise was noted.
	Wednesday, 4 February 2009 / 8:45 am	39	44	Environment governed by occasional road traffic on Tarrone North Road and local fauna (birds and cattle). No other noise was noted.

3 Existing Acoustic Environment

Location	Date / Time	Background $L_{A90\ (5\text{-}10min)}$ dB(A)	Ambient $L_{Aeq\ (5\text{-}10min)}$ dB(A)	Comments
C 386 Tarrone North Road	Wednesday, 4 February 2009 / 12:35 am	27	28	Environment governed by local fauna (insects). No other noise was noted.
	Wednesday, 4 February 2009 / 8:40 am	41	44	Environment governed by occasional road traffic on Tarrone North Road and local fauna (birds and cattle). No other noise was noted.
D 473 Tarrone North Road	Wednesday, 4 February 2009 / 12:10 am	27	28	Environment governed by local fauna (insects). No other noise was noted.
	Wednesday, 4 February 2009 / 8:45 am	35	37	Environment governed by occasional road traffic on Tarrone North Road and local fauna (birds and cattle). No other noise was noted.
E 573 Tarrone North Road	Wednesday, 4 February 2009 / 8:30 am	42	45	Environment governed by occasional road traffic on Tarrone North Road and local fauna (birds and cattle). No other noise was noted.
F 589 Tarrone North Road	Wednesday, 4 February 2009 / 8:50 am	39	43	Environment governed by occasional road traffic on Tarrone North Road and local fauna (birds and cattle). No other noise was noted.
G 574 Tarrone North Road	Tuesday, 3 February 2009 / 11:45 pm	27	30	Environment governed by local fauna (insects). No other noise was noted.
	Wednesday, 4 February 2009 / 8:25 am	40	43	Environment governed by occasional road traffic on Tarrone North Road and local fauna (birds and cattle). No other noise was noted.

The results from the attended noise monitoring show that the measured night-time background noise levels are consistent with the results from the long-term monitoring. It also shows that the background noise levels measured during early morning period (day) are much higher than the long-term monitoring results (which is the average levels over 11 hour period). This was attributed to the road traffic during the morning period.

It is noted that noise monitoring has not been conducted at Location H. However, considering the natural environment in the vicinity of these receptors, background noise levels obtained from Locations D and G have been adopted to establish noise criteria at these locations. It is our opinion that this approach provides a conservative assessment for these locations.

Project Acoustic Criteria

4.1 Legislation and Guidelines

The potential noise impacts of the site have been assessed with consideration of the following documents:

- Victoria EPA, *Interim Guidelines for Control of Noise from Industry in Country Victoria N3/89* (N3/89);
- Victoria EPA, *State Environment Protection Policy (SEPP) (Control of Noise from Commerce, Industry and Trade) No.N-1*;
- Victoria EPA, *Noise Control Guidelines (Publication 1254, 2008*);
- Victoria EPA, *Environment Protection (Residential Noise) Regulations 2008: Regulatory Impact Statement* (Publication No 1230, June 2008);
- World Health Organisation (WHO), *Guidelines for Community Noise;* and
- Victoria EPA, *Noise from Industry in Regional Victoria (NIRV) – Recommended maximum noise levels from commerce, industry and trade premises in regional Victoria – Draft for consultation* (Publication 1316, December 2009).

State Environment Protection Policy (SEPP) (Control of Noise from Commerce, Industry and Trade) No.N-1 (SEPP No. N-1) only applies to the Melbourne metropolitan area or in provincial cities and rural areas where background noise levels are comparable to Metropolitan. SEPP No. N-1 provides mandatory noise limits which must be achieved. In country areas, N3/89 and the draft NIRV provide guidance on appropriate limits, with recognition of the very low background noise levels that often occur. Unlike SEPP N-1, N3/89 and NIRV are not mandatory and the application of noise limits is for guidance only. The N3/89 and the *Noise Control Guidelines* (Publication 1254) are therefore considered to be the most appropriate documents to assess potential noise impacts from the site. This assessment has also considered the draft NIRV issued for public comment in December 2009.

The relevance of these guidelines is outlined in the following sections.

4.2 Operational Noise Criteria

4.2.1 Victoria EPA Interim Guidelines N3/89

Rural areas often have very low background noise levels. While ideally, noise from new activities should not be significantly higher than the existing background, N3/89 recognises that this is often not practicable to achieve. N3/89 provides the following minimum noise limits.

Table 4-1 N3/89 minimum noise limits

	Day	Evening	Night
Background noise level (L_{A90})	< 30 dB(A)	< 30 dB(A)	< 25 dB(A)
Noise limit (L_{Aeq})	45 dB(A)	37 dB(A)	32 dB(A)
Notes: See Table 3-2 for Time of Day			

Given that the measured background noise levels were close or below to the 'very low' threshold, it is appropriate to apply the minimum noise limits in all locations. SEPP N-1 provides a procedure for adjusting noise levels for special audible characteristics such as tonality and impulsiveness.

4 Project Acoustic Criteria

N3/89 does not specify which acoustic descriptor (e.g. L_{Aeq}, L_{A10}, or L_{Amax}) should be used to describe the noise limits. However, use of the L_{Aeq} is consistent with the requirements set out in the Victoria EPA SEPP No.N-1.

Table 4-2 summarises the selected operational noise criteria applicable to all receptor locations.

Table 4-2 N3/89 Operational Noise Limit

Receptor Locations	Operational Noise Limit $L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night
A, B, C, D, E, F, G and H	45	37	32
Notes: See Table 3-2 for Time of Day			

4.2.2 Victoria EPA Draft Guidelines – NIRV

SEPP N-1 is the statutory policy for industry noise in the Metropolitan Region. It sets allowable noise levels based on the land zoning and the background sound levels in the area.

The EPA last released guidelines for rural industrial noise in 1989 (N3/89), which recommends low noise levels to be met in very quiet rural areas, and describes areas where the methodology of SEPP N-1 should be applied to set recommended levels. However, the guidelines have not provided certainty about the appropriate noise levels in other areas, such as industrial zones in smaller towns, or in the outskirts of Melbourne and major regional centres.

The draft NIRV aims to address gaps in this existing guidance and provide greater certainty and transparency in the setting of appropriate noise levels for industry. The NIRV will supersede the N3/89 when issued in its final form.

Section 3 of the NIRV provides steps to determine recommended maximum noise levels for different land uses.

Taking into consideration:

- Location of the project: rural area – Step 1;
- Generating Zone: Special Use (SUZ) and Receiving Zone: Farming (FZ) – Step 2;
- Adjustments to the zone levels accounting for distance between the noise source and receiver – Step 3;
- Check Step 3 noise levels against the minimum noise levels – Step 4 and 5; and
- Planning noise limits for quiet areas – Step 6b.

The noise limits for each period are 45 dB(A) for day, 37 dB(A) for evening and 32 dB(A) for night.

It also states in Step 6a (i.e. Multiple noise contributors) that the recommended noise limits will become 3 dB less than the above limits if the industrial premises are on an allotment greater than 10 ha in any zone where expansion of the industrial premises is likely to occur, which is not currently anticipated.

Table 4-3 presents the NIRV noise limits according to the steps explained above.

4 Project Acoustic Criteria

Table 4-3 NIRV Operational Noise Limit

Receptor Locations	Operational Noise Limit $L_{Aeq,15min}$ dB(A) No Site Expansion in future			Operational Noise Limit $L_{Aeq,15min}$ dB(A) Site Expansion in future		
	Day	Evening	Night	Day	Evening	Night
A, B, C, D, E, F, G and H	45	37	32	42	34	29
Notes: See Table 3-2 for Time of Day						

4.2.3 Comparison of N3/89 and NIRV Noise Criteria

Table 4-4 presents comparison of noise criteria established in accordance with N3/89 and NIRV respectively.

On the condition that AGL does not propose any expansion to the project site, it can be seen that both N3/89 and NIRV criteria are identical.

Table 4-4 Noise Criteria: N3/89 and NIRV

Guideline	Day	Evening	Night
N3/89 Noise Criteria $L_{Aeq,15min}$ dB(A)	45	37	32
NIRV Noise Criteria $L_{Aeq,15min}$ dB(A) – No site expansion in future	45	37	32
NIRV Noise Criteria $L_{Aeq,15min}$ dB(A) – Site Expansion in future	42	34	29
Notes: AGL does not propose any expansion to the project site.			

4.2.4 Sleep Disturbance

In addition to the criteria in 4.2.1 and 4.2.2, an assessment of sleep disturbance for the potentially affected noise sensitive receptors has also been considered in this study. Where there exists the possibility that instantaneous, short-duration, high-level noise events may occur during night-time hours (10.00 pm – 7.00 am), consideration should be given to the potential for the disturbance of sleep within residences.

Victoria EPA *Environment Protection (Residential Noise) Regulations 2008: Regulatory Impact Statement* makes reference to the World Health Organisation (WHO)'s *Guidelines for Community Noise (Berglund B, Lindvall T and Schwela D H 1999)* for sleep disturbance caused by noise impacts.

The WHO suggests that the maximum noise level (L_{Amax}) inside bedroom should be limited to 45 dB(A). When considering internal noise levels from an external noise source, it is common practice to assume that windows are partially open to allow natural ventilation on warm nights.

The noise reduction through partially opened windows is estimated to be 10 dB(A), as specified in *AS 3671-1989: Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction* [SEPP N-1 provides adjustments for closed windows and façades (15 dB(A)) and doubled glazed windows (25 dB(A)) but not open windows].

To achieve the internal noise levels described above, the noise levels outside bedroom windows, should be limited to 55 dB(A) L_{Amax}.

4.2.5 Low Frequency Noise

Low frequency noise is usually defined as sound between 20Hz and 200Hz (frequencies below 20Hz are considered to represent infrasound). In the absence of specific guidelines to assess low frequency noise for Victoria, URS has considered the following noise policy and guidelines to assess potential low frequency noise impacts:

- NSW Industrial Noise Policy (INP, NSW EPA, 2000)
- A review of Published Research on Low Frequency Noise and its Effects, Report for Department for Environment, Food and Rural Affairs (DEFRA, UK) by Dr Geoff Leventhall, 2003
- Proposed criteria for the assessment of low frequency noise disturbance, prepared for UK DEFRA by Dr. Andy Moorhouse, Dr. David Waddington, Dr. Mags Adams, 2005
- Procedure for the assessment of low frequency noise complaints, prepared for UK DEFRA by Dr. Andy Moorhouse, Dr. David Waddington, Dr. Mags Adams, 2005
- A Noise Limit on Low Frequency Noise Emission due to Power Plants, (Vic, Australia), Dr. N. Broner, 2008
- Proposed Criteria for Low Frequency Noise from Combustion Turbine Power Plants, Noise – Con 2004, Baltimore, Maryland, G. F. Hasseler Jr, 2005
- Proposed Criteria for Low Frequency Industrial Noise in Residential Communities, Journal of Low Frequency Noise, Vibration and Active Control 24, No 2, G. F. Hessler Jr, 2005
- ANSI S12.9 – 2005/ Part 4 Quantities and Procedures for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-term Community Response
- US Oregon Department of Environmental Quality, Noise Control Regulations for Industry and Commerce OAR 340-035-0035
- NSW Leafs Gully Gas Turbine Power Station – Noise & Vibration Assessment, Wilkinson Murray, 2008
- NSW Leafs Gully Gas Turbine Power Station – Director General's Report and Project Approval issued by NSW Department of Planning

The NSW INP recommendations for low frequency noise involve an assessment to be conducted on the difference between C and A weighted levels. The most common frequency weighting in current use is "A-weighting" providing results usually denoted as dB(A), and approximates the response of the human ear at low sound levels. An alternative "C-weighting" curve is often used when evaluating loud or low-frequency sounds. The INP states that if a 15 dB difference exists between the A and C weighted levels, a correction of - 5 dB is to be applied to the noise limit. This approach provides an assessment for potential for low frequency noise.

However, recent international research has shown that the use of this difference approach is not suitable when the noise levels are tend towards the lowerlow frequencies, since the low frequencies may then be below the threshold of hearing levels (A review of *Published Research on Low Frequency Noise and its Effects*, Report for Department for Environment, Food and Rural Affairs (UK) by Dr Geoff Leventhall, 2003). Current research suggests that (dB(C) – dB(A)) difference should not be used as an annoyance predictor, but as a simple indicator of whether further investigation may be necessary (*Low Frequency Noise and Annoyance*, Noise & Health 2004, 6:23, 59-72). DEFRA developed a procedure to assess low frequency noise as follows:

- Take measurements of $L_{eq,}$ L_{10} and L_{90} in third octave bands between 10 Hz and 160 Hz.

4 Project Acoustic Criteria

- If the L_{eq}, taken over a time when the noise is said to be present, exceeds the values in Table 4-5 , it may indicate a source of low frequency that could cause disturbance. The character of the sound should be checked if possible by playing back an audio recording at an amplified level.

Table 4-5 Low Frequency Reference Curve

Hz	10	12	16	20	25	31.5	40	50	63	80	100	125	160
dB	92	87	83	74	64	56	49	43	42	40	38	36	34

- If the noise occurs only during the day then 5 dB relaxation may be applied to all third octave bands.
- If the noise is steady then a 5 dB relaxation may be applied to all third octave bands. A noise is considered steady if either of the conditions a) or b) below is met:
  - a). L_{10} - L_{90} < 5 dB
  - b). the rate of change of sound pressure level (Fast time weighting) is less than 10 dB per second

  where the parameters are evaluated in the third octave band which exceeds the reference curve values (Table 4-5) by the greatest margin.

For protecting residential areas against potential low frequency noise issues caused by combustion turbine open cycle plants, Hessler proposed C-weighted levels supplementary to the A-weighted site criteria as follows:

- For intermittent daytime only or seasonal source operation:
  - 70 dB(C) for normal suburban/urban residential areas, where background level (L_{A90}) is higher than 40 dB(A),
  - 65 dB(C) for quiet suburban or rural residential areas, where background level (L_{A90}) is lower than 40 dB(A), and
- For extensive or 24/7 source operation:
  - 65 dB(C) for normal suburban/urban residential areas, where background level (L_{A90}) is higher than 40 dB(A),
  - 60 dB(C) for very quiet suburban or rural residential areas, where background level (L_{A90}) is lower than 40 dB(A),

ANSI S12.9 – 2005/Part 4 indicates that annoyance is generally minimal when octave band sound levels are less than 67 dB(C) and less than 72 dB(C) to prevent the likelihood of noise-induced rattles.

The US Oregon State Noise Control Regulations for industrial and commercial noise sources suggest the allowable low frequency noise level for the night-time period (10 pm – 7 am) to be 65 dB(C) and for the daytime period (7 am – 10 pm) to be 68 dB(C).

In a review of recent international research, including some of the aforementioned papers, Dr. Broner (*A Noise Limit on Low Frequency Noise Emission due to Power Plants*, 2008) suggested a low frequency noise criterion of L_{eq} 65 dB(C) – 70 dB(C) for residential locations.

The proposed Tarrone power station would operate intermittently, there will be a seasonal component (associated with peak electricity demand) to its operation, and it is proposed to be located in a rural area with background noise levels below 40 dB(A). Therefore, it is considered that L_{eq} 65 dB(C) is the most appropriate criterion to adopt for a low frequency noise assessment for this project. For practical purposes this is taken to be sound from the 25Hz third octave band to the 200Hz third octave band.

We note that this criterion is consistent with that imposed for AGL's most recently approved power station development in Leafs Gully, NSW. The Leafs Gully power station is to be located in a rural area where background noise levels are similar to those of Tarrone. As part of the impact assessment process, relevant overseas research related to assessment of the potential for low frequency noise impact was reviewed. As discussed previously within this section, the research indicated that the use of the approach provided in the NSW Industrial Noise Policy (INP) is not suitable when the predicted resultant noise levels are low. NSW Department of Planning was satisfied with AGL's assessment methodology proposed for the project that a noise level not greater than 65 dB(C) is unlikely cause low frequency noise annoyance impacts at sensitive receptors. Accordingly, the Department concluded that the 5 dB(A) adjustment to the noise criteria is only to be applied if the difference between the C and A-weighted noise levels is greater than or equal to 15 dB when the measured noise levels is greater than 65 dB(C).

4.3 Construction Noise Criteria

The Victoria EPA *Interim Guidelines for Control of Noise from Industry in Country Victoria N3/89* (N3/89) also sets out the daytime construction noise limit, which is to be 10 dB above the lowest permissible daytime noise limit, except where this would result in a limit greater than 68 dB(A).

The construction noise limit applicable to the site is therefore 45 + 10 = **55 dB(A) L_{Aeq}**.

The EPA *Noise Control Guidelines (Publication 1254, 2008) also provide guidelines* for construction noise as follows:

- **Normal working hours**

  The requirements specified in the Guidelines apply during the hours of

  — 7.00 am to 6.00 pm, Monday to Friday;
  — 7.00 am to 1.00 pm, Saturdays.

- **Weekend/Evening working hours**

  Noise levels at any residential premises should not exceed background noise by:

  — 10 dB(A) or more for up to 18 months after project commencement;
  — 5 dB(A) or more after 18 months,

  during the hours of:

  — 6.00 pm to 10.00 pm, Monday to Friday;
  — 1.00 pm – 10.00 pm, Saturdays;
  — 7.00 am – 10.00 pm, Sundays & public holidays.

- **Night period**

  Noise should be inaudible within a habitable room of any residential premises during the hours of:

  — 10.00 pm to 7.00 am, Monday to Sunday.

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As the total construction period is expected to be approximately 24 months, it is considered appropriate to adopt the operational noise limits for evening and night-time period and N3/89 for the daytime period.

Table 4-6 presents the construction noise limits applicable to the development:

Table 4-6 Construction Noise Limit

Time of Day	Noise Limit (L_{Aeq}), dB(A)
Normal working hours[1]	45 + 10 = **55**
Weekend & Evening working hours[2]	37
Night period[3]	32

Notes:
1. 7.00 am – 6.00 pm on Monday to Friday / 7.00 am – 1.00 pm on Saturdays
2. 6.00 pm – 10.00 pm on Monday to Friday / 1.00 pm – 10.00 pm on Saturdays / 7.00 am – 1.00 pm on Sundays and public holidays
3. 10.00 pm – 7.00 am on All days

Assessment of Potential Noise Impacts

5.1 Calculation Method

Noise levels due to the proposed construction and the operation of the site at the identified noise sensitive receptor locations have been predicted using an acoustic computer model created in SoundPLAN Version 6.5. This program is used internationally and recognised by regulators and authorities throughout Australia.

The noise model was constructed to allow the prediction of cumulative noise levels from the site including the contribution of each noise source. The noise model takes into account:

- sound power levels of each source;
- receptor locations;
- screening effects due to topography;
- meteorological effects and attenuation due to distance; and
- ground and atmospheric absorption.

The noise calculations have been carried out using the L_{Aeq} descriptor to assess the operational and construction noise impacts.

The program allows the use of various noise prediction algorithms. To calculate noise emission levels under neutral and adverse meteorological conditions, the CONCAWE algorithm which is designed for industrial sites has been used.

The CONCAWE method was especially designed for the requirements of large industrial facilities such as petroleum and petrochemical complexes, and is now the principal prediction method used in Australia and widely used for calculating noise emissions from all types of industrial facilities. CONCAWE, where prevailing winds and meteorological conditions do not fit normal conditions that are assumed in some other alternate calculation methods, provides complex calculation methods in predicting noise levels under the influence of wind and the stability of the atmosphere as well as ground effects.

CONCAWE, available within SoundPLAN, calculates the sound pressure level at the receptor location taking into consideration the following:

- source levels entered for the 31.5 Hz octave band to 16 kHz octave band frequencies (Original CONCAWE calculation algorithm was only written for 63 Hz and above, however SoundPLAN makes an approximation for the 31.5 Hz octave band using the 63 Hz propagation);
- attenuation due to distance between the source and the receptor;
- attenuation due to air absorption which is evaluated in accordance with ISO9613 (Part 1), ISO3891 or ANSI 126;
- ground attenuation considering hard or soft surfaces;
- correction due to sound refractions by wind and temperature gradients which is based on the Pasquil meteorological atmosphere categories (Pasquil Stability Class);
- correction due to wind speed and direction; and
- screening based on the Nordic General Prediction method.

Additional noise modelling has been carried out using ISO9613 (Part 2) calculation method available within SoundPLAN for comparison with the results generated by CONCAWE method. ISO9613, available within SoundPLAN, calculates the sound pressure level at the receptor location taking into consideration the following:

- source levels entered for the 31.5 Hz octave band to 16 kHz octave band frequencies;
- attenuation due to distance between the source and the receptor;
- attenuation due to air absorption which is evaluated in accordance with ISO9613 (Part 1), ISO1913 (Part 1) or ANSI 126;
- ground absorption;
- correction due to sound refractions by wind and temperature gradients which is based on moderate temperature inversion and downwind meteorological conditions; and
- screening.

The effects of meteorological conditions are explained in more detail in Section 5.2 below.

5.2 Meteorological Conditions

Adverse meteorological conditions have the potential to increase noise levels at a receptor. Such phenomena generally occur during temperature inversions or where there is a wind gradient with wind direction from the source to the receptor. It is known that these meteorological effects typically increase noise levels by 5 to 10 dB, and even greater than 10 dB in extreme conditions.

Temperature inversions generally occur during the night-time and early morning periods, thus the most significant meteorological effect during the daytime period is wind.

The prevailing meteorological conditions for the site were assessed using yearly meteorological data collected from a BOM weather station located in Warrnambool in 2007 and incorporated into an air dispersion program, TAPM (V4). It is noted that the meteorological data used to analyse the long-term noise logging was from a BOM weather station located in Port Fairy. Yearly meteorological data was not available from the Port Fair weather station, therefore the yearly data used for the analysis in this section was obtained from the next closest weather station located in Warrnambool.

The wind rose data used in the assessment are presented in Appendix B.

The meteorological analysis gave the results in Table 5-1:

Table 5-1 Prevailing Meteorological Conditions

Time of Day	Pasquill Stability Class	Wind Speed (m/s)	Wind Direction
Day (7.00 am – 6.00 pm)	D	6	Southerly & Northerly
Evening & Night (6.00 pm – 7.00 am)	D	4	Northerly & North-westerly

5.3 Operational Noise

5.3.1 Sound Power Levels

Table 5-2 presents the sound power levels (L_w) of equipment that have been identified as the primary on-site noise sources. Sound power levels of these sources have been provided by turbine manufacturers in octave frequency bands between 31.5 Hz and 8 kHz. These levels represent the noisiest type of engine which could be selected for each of the two different turbine configuration options (GE 9FA) and thus represent a reasonable worst case scenario. This assumption is consistent for the associated transformer and substation configurations i.e. the F Class configuration

5 Assessment of Potential Noise Impacts

of three 330 MVA transformers and one 600 MVA transformer is a reasonable worst case scenario relative to the alternate E Class configuration of four 200 MVA transformers and one 600 MVA transformer configuration.

The sound power levels presented in Table 5-2 have been input into the noise model.

Sound power level data for the exhaust stack has been estimated. The estimate is comparable to the sound power levels of similar engine stacks from previous studies.

Table 5-2 Sound Power Levels – Operational Equipment

Operational Noise Source		Estimated Overall Sound Power Level[1]	
		dB(Lin)	dB(A)
Inlet System (silencer included)	Inlet Ducting (filter house included)	107	95
	Inlet Filter Face	117	107
GT Power Train Package	Accessory Unit	111	103
	Inlet Plenum	104	103
	Turbine Compartment (acoustic enclosure)	113	107
	Exhaust Diffuser (acoustic enclosure)	119	106
	Load Compartment	114	105
	Liquid Fuel & Atomising Air (LF/AA) Module	111	103
Vent Fans	Turbine Compartment Vent Fans	112	104
	Exhaust Compartment Vent Fans	113	102
Transformers	330 MVA Transformers (3 of))	113	104
Exhaust Stack[1]	Stack Body	-	105
	Stack Opening	-	108
Substation (500 kV)	Reactor (4 of)	-	106[2]
	Transformer (1 x 600 MVA)	111	103

Notes:
1. Sound power level of the exhaust stack has been estimated based on the maximum cumulative sound power level the site can generate in order to meet the noise limits. To ensure the compliance with the noise limit, the sound power level of exhaust stack opening and body combined should not exceed 110 dB(A).
2. Estimated based on AS/NZS 60076.10:2009 – Power Transformers: Determination of sound levels.
3. All manufacturer sound power levels were supplied to URS by AGL.

Table 5-3 shows the cumulative octave band sound power levels of the equipment listed in Table 5-2.

Table 5-3 Overall Sound Power Levels

Overall Level, L_{eq}		Octave Band Centre Frequency, Hz Sound Power Level, dB(Lin) L_{eq}								
dB(Lin)	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
128	118	123	124	120	115	113	110	113	109	105

5.3.2 Noise Modelling Scenarios

Potential noise impacts have been predicted separately for each of the following meteorological conditions. Table 5-4 provides a summary of each meteorological scenario. The neutral and adverse meteorological conditions have been defined based on data presented in Appendix B.

Table 5-4 Meteorological Conditions used in Noise Modelling

Met. Scenario	Meteorological Condition				
	Temperature (°C)	Relative Humidity (%)	Pasquill Stability Class	Wind Speed (m/s)	Wind Direction
1: Daytime Operation – Neutral Met. Conditions (CONCAWE)	20	60	D	0	n/a
2: Evening & Night-time Operation – Neutral Met Conditions (CONCAWE)	10	50	D	0	n/a
3: Daytime Operation – Adverse Met. Conditions (CONCAWE)	20	60	D	6	Southerly wind
4: Evening & Night Operation – Adverse Met. Conditions (CONCAWE)	10	50	D	4	North-westerly wind
5: Daytime Operation (ISO9613)	20	60	Moderate Inversion and downwind conditions		Source-to-receptor
6: Evening & Night Operation (ISO9613)	10	50	Moderate Inversion and downwind conditions		Source-to-receptor

The noise modelling has been conducted based on likely maximum operating conditions for each turbine option. In setting-up the noise model, all pre-defined sources were positioned according to the proposed site layout in the respective noise model (Figure 2-2). The precise positioning of the sources was not found to cause any significant uncertainty.

In addition to the calculation methods presented previously in Sections 5.1 and 5.2, the following assumptions were also made in the noise modelling:

- Noise sources were positioned according to the proposed mechanical layout, shown in Figure 2-2;
- Each noise generating activity operates continuously;
- All the equipment listed in each scenario occur simultaneously;
- Noise mitigation measures for the primary components of the proposed gas turbines are:
  - acoustic enclosure of turbine compartments consists of two layers of 2 mm thick steel outer plate, 75 mm thick rockwool insulation and perforated steel inner plate
  - acoustic enclosure of exhaust diffusers consists of two layers of 4 mm thick steel outer plate, 150 mm thick rockwool insulation and 4 mm thick steel inner plate
  - silencing on the inlet system via an 8 foot long parallel acoustic baffle

The sound power levels shown on Table 5-2 assume the application of the aforementioned mitigation measures. URS considers that the proposed mitigation measures proposed by AGL are best practice for the mitigation of noise from a peaker power station.

5.4 Predicted Operational Noise Levels

The results noise modelling results using neutral and adverse meteorological conditions are presented in Table 5-5 and Table 5-6, using the CONCAWE and ISO9613 methods respectively.

Table 5-5 Predicted Operational Noise Levels – CONCAWE Calculation Method

Receptor Location	Predicted Noise Levels (L_{Aeq}) dB(A)		Criterion (L_{Aeq}) dB(A)		Exceedance
	Neutral Met Conditions (Scenario 1 & 2)	Adverse Met Conditions (Scenario 3 & 4)	Day (Scenario 1 & 3)	Evening & Night (Scenario 2 & 4)	
A	24	19 (3) / 21 (4)	45	37 / 32	No
B	28	33 (3) / 28 (4)	45	37 / 32	No
C	29	34 (3) / 32 (4)	45	37 / 32	No
D	26	30 (3) / 31 (4)	45	37 / 32	No
E	24	21 (3) / 29 (4)	45	37 / 32	No
F	< 20	< 20	45	37 / 32	No
G	25	21 (3) / 30 (4)	45	37 / 32	No
H	< 20	15 (3) / 24 (4)	45	37 / 32	No

Notes:
Results in bold represent the exceedance of the respective noise limit.
Scenario 1: Daytime operation under neutral meteorological conditions.
Scenario 2: Evening & Night-time operation under neutral meteorological conditions.
Scenario 3: Daytime operation under adverse meteorological conditions.
Scenario 4: Evening & Night-time operation under adverse meteorological conditions.

Table 5-6 Predicted Operational Noise Levels - ISO9613 Calculation Method

Receptor Location	Predicted Noise Levels (L_{Aeq}) dB(A)		Criterion (L_{Aeq}) dB(A)		Exceedance
	ISO Conditions (Day - Scenario 5)	ISO Conditions (Evening/Night - Scenario 6)	Day	Evening & Night	
A	28	28	45	37 / 32	No
B	29	30	45	37 / 32	No
C	31	31	45	37 / 32	No
D	28	28	45	37 / 32	No
E	28	28	45	37 / 32	No
F	< 20	< 20	45	37 / 32	No
G	28	28	45	37 / 32	No
H	24	24	45	37 / 32	No

The results presented in Table 5-5 and Table 5-6 presents A-weighted noise levels predicted using SoundPLAN for 31.5 Hz to 8 kHz octave band frequencies. Noise levels of frequencies below 31.5 Hz are not considered attributing their levels to the A-weighted noise levels.

Table 5-5 and Table 5-6 also show that the predicted noise levels generated by the proposed operation would be within the established noise criteria at all receptor locations under all conditions.

Comparing the results using the CONCAWE calculation method (Table 5-5) with the ISO results (Table 5-6), they predict similar noise levels (variation 1 to 3 dB) at all receptor locations. The minor variations are primarily due to wind direction setting used in each calculation method. Whilst the CONCAWE method considers the area's prevailing wind conditions, the ISO method assumes source-to-receptor wind direction.

Given that the power station is a peaking plant and the meteorological conditions that could adversely affect the noise levels are expected to occur less than 15 per cent of time (Appendix B), the operational noise levels would generally be below the levels predicted for Scenarios 3 and 4. It is also noted that there is some vegetation between some receptors and the site which may provide slight noise reduction that has not been included in the noise predictions modelling.

It should be noted that N3/89 and the draft NIRV are not mandatory and the application of noise limits is for guidance only. In very low background noise and adverse meteorological conditions, the site operation may just be audible at Locations C and D at night time, but as previously identified the predicted noise levels would be below the measured ambient noise levels and would not exceed the criteria.

Therefore, further noise mitigation measures beyond those already proposed by AGL (Section 5.3.2) are not considered necessary.

A predicted noise contour map for the adverse night-time meteorological conditions is presented in Appendix C. It should be noted that these noise contours are indicative only due to interpolation within the calculation grid. The results of the point-to-point calculations presented in Table 5-5 are more accurate than the noise contours.

Sleep Disturbance

Noise from the proposed operation is constant in nature and therefore, during the night-time period the levels are expected to be significantly below 55 dB(A) L_{Amax} at all receptor locations. Therefore, the operation is not predicted to give rise to sleep disturbance.

5.5 Low Frequency Noise

To assess potential low frequency noise impacts, C-weighted noise levels of octave band frequency between 31.5 Hz and 8 kHz have been predicted by noise modelling using SoundPLAN.

The predictive noise modelling by SoundPLAN estimated the noise levels (C-weighed) at the receptors and a comparison with the criteria identified in Section 4.2.5 is presented in Table 5-7.

It is noted that sound power levels of frequencies below 31.5 Hz were not available and are beyond the range of the modelling software. URS therefore also estimated the contribution of sound at lower frequencies to the C-weighted noise levels at each receptor location, based on indicative turbine spectra.

Whilst attenuation of noise levels in 31.5 Hz to 8 kHz octave band frequencies considered in calculations using CONCAWE and ISO methods are dependent upon some factors such as air absorption, ground absorption or screening as explained in Section 5.1; attenuation of noise levels in frequencies below 31.5 Hz would primarily be due to geometrical spreading, i.e. attenuation mostly due to distance, with little adjsutment due to air/ground absorption or screening.

Table 5-7 presents C-weighted noise levels predicted using SoundPLAN for 31.5 Hz to 8 kHz octave band frequencies as well as the estimated levels considering lower frequencies (down to 20 Hz) based on indicative turbine spectra.

Table 5-7 Predicted Operational Noise Levels (C-weighted)

Receptor Location	Predicted Noise Levels (L_{eq}) dB(C)		Criterion (L_{eq}) dB(C)	Exceedance
	31.5 Hz – 8 kHz CONCAWE / ISO9613	20 Hz – 8 kHz ISO9613[1]		
A	37 / 50	60	65	No
B	45 / 45	62		
C	47 / 48	63		
D	45 / 48	62		
E	44 / 47	61		
F	28 / 36	60		
G	44 / 47	61		
H	38 / 45	57		
Note:	1. Noise attenuation below 31 Hz would primarily be due to geometrical noise propagation.			

The analysis presented in Table 5-7 compared to the criteria indicates that low frequency noise would not be at a level to cause annoyance to the closest residential receivers. Accordingly, no adjustment to the A-weighted operational noise criteria is required.

5.6 Construction Noise

Based on similar size projects, the total construction period is expected to be approximately 24 months with a peak period of up to 6 months.

The main construction activities would involve the following stages:

- Stage 1: Removing the layer of vegetation and levelling;
- Stage 2: Bulk earthworks including site grading and excavation work;
- Stage 3: Establishing concrete foundations for plant and buildings; and
- Stage 4: Construction of buildings and installation of equipment and machinery.

In addition to the proposed Tarrone power station construction, there will be separate gas pipeline construction works. The pipeline construction component is subject to separate regulatory approvals processes and is not addressed in this report.

5.6.1 Construction Equipment and Associated Noise Levels

Typical construction equipment expected on this site and noise levels are summarised in Table 5-8. The sound power levels of these items have been taken from Appendix D of Australian Standard AS 2436-1981: "*Guide to noise control on construction, maintenance and demolition sites*" and library data.

The sound power levels presented in the table are indicative and should be used only as a guide.

Table 5-8 Sound Power Levels – Construction Equipment

Scenario	Proposed Activities	Equipment / Plant Item	Sound Power Level L_{Aeq} dB(A)
1	Site preparation & Earthworks	Excavator	108 – 112
		Bulldozer	102 – 114
		Grader	114 – 118
		Roller	103 – 112
		Loader	103 – 111
		Dump truck	102 – 107
2	Concrete Foundation Works	Concrete truck	103 – 113
		Concrete mixer	107 – 111
		Compactor	113 – 115
		Crane	104 – 108
3	Building Construction	Crane	104 – 108
		Delivery trucks	102 – 110
		Pneumatic tools	110 – 115
		Electric tools	100 – 108
		Power generators	100 – 106
		Hammers	101 – 112

5.6.2 Predicted Construction Noise Levels

The noise levels at each receptor location generated by the construction activities have been predicted by noise modelling of the noise sources listed in Table 5-8. Noise generated by construction activities would vary as construction progresses. The noise modelling has been carried out considering adverse meteorological conditions. The results for the predicted noise levels during construction of the power station are presented in Table 5-9.

Table 5-9 Predicted Noise Levels During Power Station Construction

Location	Predicted Noise Level under Adverse Meteorological Conditions L_{Aeq} dB(A)	Day Noise Criterion L_{Aeq} dB(A)	Evening Noise Criterion L_{Aeq} dB(A)	Night Noise Criterion L_{Aeq} dB(A)	Exceedance		
					Day	Evening	Night
A	28 – 35	55	37	32	No	No	No
B	32 – 39	55	37	32	No	Possible	Possible
C	34 – 40	55	37	32	No	Possible	Possible*
D	32 – 39	55	37	32	No	Possible	Possible
E	29 – 36	55	37	32	No	No	Possible
F	< 30	55	37	32	No	No	No
G	30 – 37	55	37	32	No	No	Possible
H	22 – 29	55	37	32	No	No	No

* Although the corresponding predicted noise level (lower end of the range) exceeds the night noise criteria, the construction scenario modelled would be considered a reasonable "worst case" daytime construction scenario. It would be still be feasible to conduct some selected construction activities at night whilst still achieving the noise criteria.

The predicted construction noise levels presented in Table 5-9 show that no exceedance of the noise limit is predicted at any location for the construction of the power station during the day. Specific construction activities undertaken during the evening may lead to an exceedance at receptors B, C and D. Construction activities will be scheduled to be undertaken at an appropriate time of the day for the activity in question. The construction activities generating the most noise will be conducted during the day.

It should be noted that the predicted noise levels presented above result from a conservative noise modelling approach where it has been assumed that all equipment would operate continuously and simultaneously during the assessment period.

Physical construction noise mitigation measures are not considered necessary. However, adoption of noise management strategies implementing good industry practice is recommended to minimise noise emissions from the proposed construction works. Recommendations on construction noise management strategies are provided in Section 6.1. It would be expected that these will be incorporated into a construction phase Environmental Management Plan (EMP).

5.7 Off-Site Traffic Noise

The potential off-site traffic noise impact associated with the proposed operation has been assessed based on the URS Traffic Study undertaken for the development.

5.7.1 Operation

The ongoing operation of the power station will generate significantly less traffic than the construction phase of the project. During the operational phase, staff levels are expected to average approximately five full time persons on site generating approximately ten car trips per day. The increase in traffic from the daily operation of the power station is accounted for in the general growth in traffic for the region. An increase in traffic volumes is expected during turbine maintenance / overhaul periods which would take place every 2 to 3 years.

Compared to the existing traffic volumes, the proposed traffic volumes generated by the development would be insignificant. Therefore a further detailed assessment is not deemed necessary.

5.7.2 Construction

As the specific duration and start/finish times of construction shifts have not been determined, it is assumed that that all movements would take place during the peak periods for the region. This would produce a conservative worst-case scenario in the event that shifts commence 7.00 am - 8:00 am and conclude 4.00 pm - 5.00 pm and that all personnel, material and equipment deliveries would occur in those periods.

It is expected that the number of construction personnel during the peak construction period would reach 250 personnel per day. The vehicle movements associated with construction personnel assumes a vehicle occupancy rate of 1.2 persons per vehicle. All construction personnel are assumed to arrive to the site in the morning peak hour and leave in the afternoon peak hour.

The legislation and guidelines listed in Section 4.1 do not include any criteria to assess off-site traffic noise associated with construction. It is assumed that off-site traffic noise with the proposed construction is minimised as much as is practically possible by limitations on construction hours to 7.00 am – 6.00 pm, and Australian Design Rules which apply to road-registered vehicles.

Noise management strategies to minimise the noise from the off-site road traffic associated with the proposed construction have been provided in Section 6.1 of this report.

5.8 Cumulative Noise Impacts – Shaw River Power Station

The predicted noise emission levels arising from the construction and operation of the proposed Shaw River Power Station (SRPS) and the Compressor Station (CS) presented in the Environmental Effects Statement [EES] Shaw River Power Station Project (March 2010) were reviewed for consideration of potential interactions between the proposals. The noise impact assessment present in the SRPS EES was undertaken by Sonus Pty Ltd (July 2009).

The SRPS site is to be located near Orford, approximately 4.5 kilometres to the west of the nearest receptor (Receptor A) considered in this assessment. The CS site is to be located approximately 8 kilometres to the south-east of the nearest receptor (Receptor F) considered in this assessment.

The noise levels estimated, based on the data present in the EES, due to the assumed concurrent operation of the SRPS and CS at the nominated receptors are as follows:

- Noise level at Receptor A is estimated to be less than 20 dB(A), and
- Noise level at Receptor F is estimated to be less than 15 dB(A).

The construction noise levels estimated due to SPRS and CS at the nominated receptors are as follows:

- Noise level at Receptor A is estimated to be less than 30 dB(A), and
- Noise level at Receptor F is estimated to be less than 25 dB(A).

Based on these estimated noise levels, it is concluded that the potential for cumulative noise impact at receptors A and F arising from construction or operation (at full load) of the AGL Tarrone Power Station (presented in Table 5-5, Table 5-6 and Table 5-9) at the same time as construction and/or operation of the proposed SRPS and CS would be negligible and not expected to increase the noise levels at these locations relative to the noise levels predicted to arise from operation of Tarrone Power Station alone.

5.9 Summary of Potential Noise Impact

The following provides a summary of the outcomes of the assessment of potential noise impacts:

- Operation:
  - Noise levels generated by the proposed operation are predicted to be within the established noise limits at all receptor locations under all meteorological conditions.
- Sleep Disturbance:
  - Predicted noise levels are within the sleep disturbance noise limit.
- Low frequency noise:
  - The proposed operation assessed using criteria derived from recent local research suggest that low frequency noise would not be at a level to cause annoyance to the closest residential receivers.
- Construction Noise:
  - No exceedances of the noise limit are predicted during daytime construction of the proposed power station, although there may be some restrictions to certain construction activities in the evening and night periods.
- Off-Site Traffic Noise;
  - Operation: The predicted increase in road traffic volume due to the proposed operation is negligible.
  - Construction: Detailed assessment will be undertaken once specific duration and construction shifts have been determined.

Noise Mitigation Measures

6.1 Construction Noise

Physical construction noise mitigation measures are not considered necessary. While the proposed construction activities have limited potential for impact on the local ambient noise environment, the following noise management strategies can be applied, which would further reduce the potential for noise issues during the proposed construction period:

- Carrying out all construction works with consideration of appropriate noise levels for the respective time of the day;
- Scheduling construction to minimise multiple use of the noisiest equipment or plant items near noise sensitive receptors, where practicable;
- Strategic positioning of plant items to reduce the noise emission to noise sensitive receptors, where possible;
- Carrying out maintenance work away from noise sensitive receptors, where practicable;
- Ensuring engine covers are closed, maintenance of silencers and mechanical condition. Maintenance for major items of construction equipment that are significant contributors to construction noise levels;
- Awareness training for staff and contractors in environmental noise issues including;
  - Minimising the use of horn signals and maintaining to a low volume. Alternative methods of communication should be considered;
  - Avoiding any unnecessary noise when carrying out manual operations and when operating plant; and
  - Switching off any equipment not in use for extended periods during construction work;
- Restricting heavy vehicles' entry to site and departure from site to the nominated construction hours;
- Where noise level exceedances cannot be avoided, consideration should be given to applying time restrictions and/or providing quiet periods for nearby residents;
- Community consultation with local residents and building owners to assist in the alleviation of community concerns. Previous experience on similar projects has demonstrated that affected noise sensitive receptors may be willing to endure higher construction noise levels for a shorter duration if they have been provided with sufficient warning in the place of intermittent but extended periods of construction noise at lower levels; and
- Maintaining a suitable complaints register. Should noise complaints be received, undertake noise monitoring at the locations concerned. Reasonable and feasible measures would need to be implemented to reduce noise impacts.

With the implementation of the aforementioned mitigation measures, construction noise at all receptor locations would be expected to practically comply with the noise limit.

6.2 Operational Noise

The exhaust stack will be designed to achieve overall compliance with the EPA requirements.

Additional mitigation measures have been investigated for the gas turbines to further reduce noise emitted from the site. To ensure compliance with the derived noise limits, noise mitigation measures for the primary components of the proposed gas turbines will include:

- acoustic enclosure of turbine compartments consists of two layers of 2 mm thick steel outer plate, 75 mm thick rockwool insulation and perforated steel inner plate;
- acoustic enclosure of exhaust diffusers consists of two layers of 4 mm thick steel outer plate, 150 mm thick rockwool insulation and 4 mm thick steel inner plate; and
- silencing on the inlet system is an 8 foot long parallel acoustic baffle.

Conclusion

URS has completed a noise impact assessment for the proposed gas-fired power station at Tarrone, Victoria. This assessment has been prepared in support of the Works Approval Application for the proposed operation.

The assessment of potential noise impacts of the proposed construction and operation of the facility, on surrounding noise sensitive receptor locations, has been carried out in accordance with relevant Victoria EPA noise guidelines. Throughout the assessment, typical and 'worst-case' factors have been taken into consideration.

The assessment found that the adopted noise limits can be achieved with no further noise mitigation measures beyond those already proposed by AGL (including mitigation measures for the proposed stack).

No exceedances of the noise limits are predicted for activities relating to the daytime construction of the power station, although some activities may need to be restricted in the evening and night periods.

The predicted noise levels should be verified during commissioning, and in the unlikely event of any significant discrepancies from this assessment, there is scope to provide additional attenuation through measures such as acoustic enclosures and silencers with higher noise reduction rating.

On the basis of this assessment, it is therefore concluded that noise impacts of the proposed construction and operation of the power station are not expected to degrade the existing acoustic environment, nor cause annoyance to the community surrounding the plant.

References

Environment Protection Act 1970 (Victoria);

State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No.N-1, Victoria EPA 1989;

Interim guidelines for control of noise from industry in country Victoria N3/89, Victoria EPA, 1989

Noise Control Guidelines, Publication 1254, Victoria EPA, 2008

Environment Protection (Residential Noise) Regulations 2008: Regulatory Impact Statement (Publication No 1230, June 2008), Victorian EPA; and

Guidelines for Community Noise, World Health Organisation (WHO), 1999

Noise from Industry in Regional Victoria (NIRV) – Recommended maximum noise levels from commerce, industry and trade premises in regional Victoria – Draft for consultation, Publication 1316, Victoria EPA, 2009

A Noise Limit on Low Frequency Noise Emission due to Power Plants, Dr. N. Broner, 2008

Proposed Criteria for the Assessment of Low Frequency Noise Disturbance, 2005, Prepared for DEFRA by Dr. Andy Moorhouse, Dr. David Waddington, Dr. Mags Adams

Procedure for the Assessment of Low Frequency Noise Complaints, 2005, Prepared for DEFRA by Dr. Andy Moorhouse, Dr. David Waddington, Dr. Mags Adams.

Proposed Criteria for Low Frequency Noise from Combustion Turbine Power Plants, Noise – Con 2004, Baltimore, Maryland, G. F. Hasseler Jr, 2005

Proposed Criteria for Low Frequency Industrial Noise in Residential Communities, Journal of Low Frequency Noise, Vibration and Active Control 24, No 2, G. F. Hessler Jr, 2005

ANSI S12.9 – 2005/ Part 4 Quantities and Procedures for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-term Community Response

US Oregon Department of Environmental Quality, Noise Control Regulations for Industry and Commerce OAR 340-035-0035

NSW Leafs Gully Gas Turbine Power Station – Noise & Vibration Assessment, Wilkinson Murray, 2008.

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of AGL Energy Limited (AGL) and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 12 September 2008.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between March 2009 and August 2010 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Glossary of Acoustic Terminology

Appendix A

A wide range of acoustic parameters and technical terms are used in this report. To assist in understanding the technical contents, a brief description of the acoustic terms is provided in this section.

Typical Noise Levels: Compared to the static air pressure (10^5 Pa), the audible sound pressure variations are very small ranging from about 20 µPa (20×10^{-6} Pa), which is called “threshold of hearing” to 100 Pa. A sound pressure of approximately 100 Pa is so loud that it causes pain and is therefore called “threshold of pain”.

dB (Decibel): A unit of sound level measurement. The human ear responds to sound logarithmically rather than linearly, so it is convenient to deal in logarithmic units in expressing sound levels. To avoid a scale which is too compressed, a factor of 10 is introduced, giving rise to the decibel. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.

Perception of Sound: The number of sound pressure variation per second is called the frequency of sound, and is measured in Hertz (Hz). The normal hearing for a healthy young person ranges from approximately 20 Hz to 20 kHz. In terms of sound pressure levels, audible sound ranges from the threshold of hearing at 0 dB to the threshold of pain at 130 dB and over. A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to small but noticeable change in loudness. An increase of about 8 – 10 dB is required before the sound subjectively appears to be significantly louder.

Sound Pressure (SPL): Sound pressure is the measure of the level or loudness of sound. Like sound power level, it is measured in logarithmic units. The symbol used for sound pressure level is SPL, and it is generally specified in dB. 0 dB is taken as the threshold of human hearing.

Table A-1 Sound Pressure Levels of Some Common Sources

Sound Pressure Level (dB)	Sound Source	Typical Subjective Description
140	Propeller aircraft; artillery fire, gunner’s position	Intolerable
120	Riveter; rock concert, close to speakers; ship’s engine room	
110	Grinding; sawing	
100	Punch press and wood planers, at operator’s position; pneumatic hammer or drilling (at 2 m)	Very noisy
80	Kerbside of busy highway; shouting; Loud radio or TV	Noisy
70	Kerbside of busy traffic	
60	Department store, restaurant, conversational speech	
50	General office	Moderate
40	Private office; Quiet residential area	Quiet
30	Unoccupied theatre; quiet bedroom at night	
20	Unoccupied recording studio; Leaves rustling	Very quiet
10	Hearing threshold, good ears at frequency of maximum sensitivity	
0	Hearing threshold, excellent ears at frequency maximum response	

Appendix A

Sound Power (SWL): Sound power is the energy radiated from a sound source. This power is essentially independent of the surroundings, while the sound pressure depends on the surroundings (e.g. reflecting surfaces) and distance to the receptor. If the sound power is known, the sound pressure at a point can be calculated. Sound power is also measured in logarithmic units, 0 dB sound power level corresponding to 1 pW (10^{-12} W). The symbol used for sound power level is SWL or Lw, and it is specified in dB.

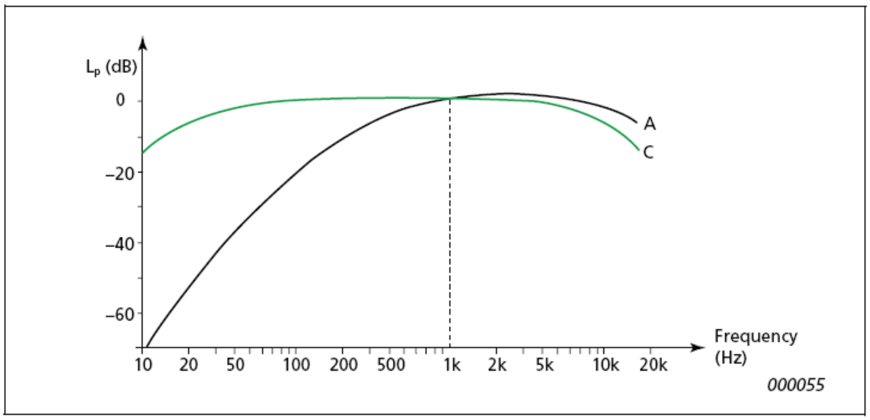
Frequency: Frequency is synonymous to pitch and is measured in units of Hz.

Frequency Spectrum: In environmental noise investigations, it is often found that the single-number indices, such as L_{Aeq}, do not fully represent the characteristics of the noise. If the source generates noise with distinct frequency components, then it is useful to measure the frequency content in octave or one-third octave frequency bands. For calculating noise levels, octave spectra are often used to account for the frequency characteristics of propagation.

"A" Frequency Weighting: The method of frequency weighting the electrical signal with a noise measuring instrument to simulate the way the human ear responds to a range of acoustic frequencies. It is based on the 40 dB equal loudness contour. The symbols for the noise parameters often include the letter "A" (e.g. L_{Aeq}) to indicate that frequency weighting has been included in the measurement. See the graph below.

"C" Frequency Weighting: The response of the human ear varies with the sound level. At higher levels, 100 dB and above, the ear's response is flatter, as shown in the C-Weighted Response below.

Although the A-Weighted response is used for most applications, C-Weighting is also available on many sound level meters. C-Weighting is usually used for Peak measurements and also in some industrial and entertainment noise measurement, where the transmission of low frequency noise can be a problem. C-weighted measurements are expressed as dBC or dB(C).



Adverse Weather: Weather effects (wind and temperature inversions) that enhance noise. The prescribed conditions are for wind occurring more than 30 % of the time in any assessment period in any season and/or for temperature inversions occurring more than 30 % of the nights in winter.

Assessment Period: The period in a day over which assessments are made: day (7.00 am – 6.00 pm, Monday to Saturday; or 8.00 am – 6.00 pm on Sundays and public holidays), evening (6.00 pm – 10.00 pm, all days) or night (10.00 pm – 7.00 am, Monday to Saturday; or 10.00 pm – 8.00 am on Sundays and public holidays).

Appendix A

Ambient Noise: The all-encompassing sound at a site comprising all sources such as industry, traffic, domestic, and natural noises. This is represented as the L_{Aeq} noise level in environmental noise assessment. (See also L_{Aeq})

Background Noise: Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is measured statistically as the A-weighted noise level exceed for ninety per cent of a sample period. This is represented as the L_{A90} noise level (See also L_{A90}).

Free Field: An environment in which a sound wave may propagate in all directions without obstructions or reflections. Free field noise measurements are carried out outdoors at least 3.5 m from any acoustic reflecting structures other than the ground.

Extraneous Noise: Noise resulting from activities that are not typical of the area. Untypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.

Impulsive Noise: Noise having a high peak of short duration or a sequence of such peaks. Noise from impacts or explosions, e.g., from a pile driver, punch press or gunshot, is called impulsive noise. It is brief and abrupt, and its startling effect causes greater annoyance than would be expected from a simple measurement of the sound pressure level.

Intermittent Noise: Noise with a level that abruptly drops to the level of or below the background noise several times during the period of observation. The time during which the level remains at a constant value different from that of the ambient being of the order of 1 s or more.

Meteorological Conditions/Effects: Wind and temperature inversion conditions.

Noise Barrier: Solid walls or partitions, solid fences, earth mounds, earth berms, buildings. Etc used to reduce noise without eliminating it.

Temperature Inversion: An atmospheric condition in which temperature increases with height above the ground.

Tonality: Noise containing a prominent frequency and characterised by a definite pitch.

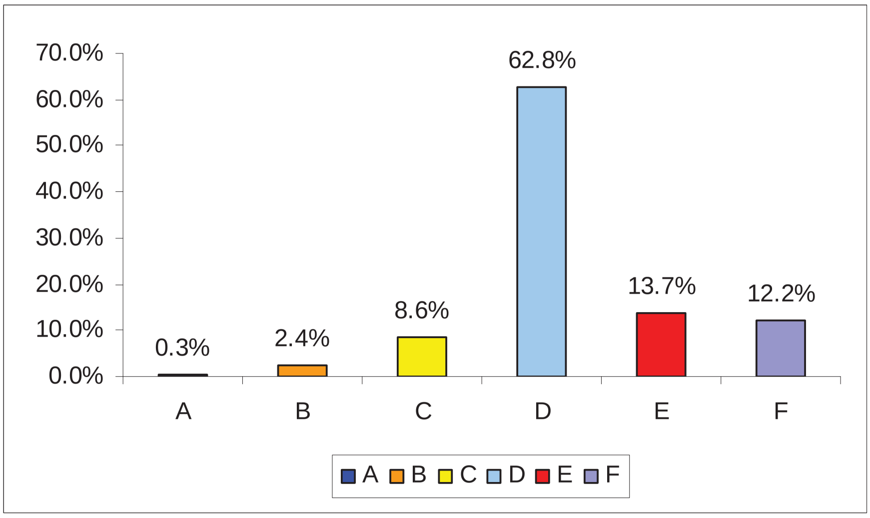
L_{Aeq}: A-weighted equivalent continuous noise level. This parameter is widely used and is the constant level of noise that would have the same energy content as the varying noise signal being measured. The letter “A” denotes that the A-weighting has been included and “eq” indicates that an equivalent level has been calculated. This is referred to as the ambient noise level. (See Ambient Noise)

L_{A90}: The A-weighted sound pressure level which is exceeded for 90 % of the measurement period. It is determined by calculating the 90^{th} percentile (lowest 10 %) noise level of the period. This is referred to as the background noise level. (See Background Noise)

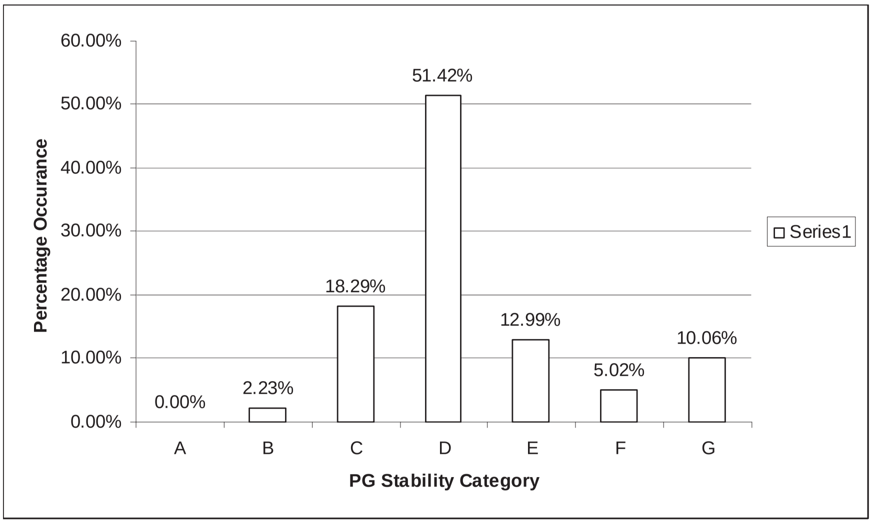
Appendix B Analysis of Meteorological Data

Appendix B

CALMET Stability Categories

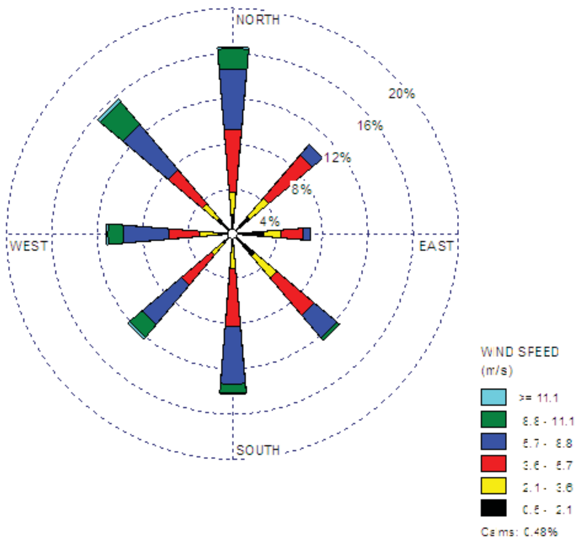


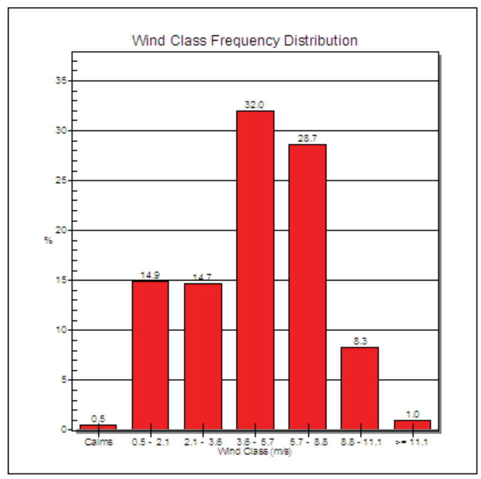
Calculated Stability Categories from Met Data using Cloud Cover



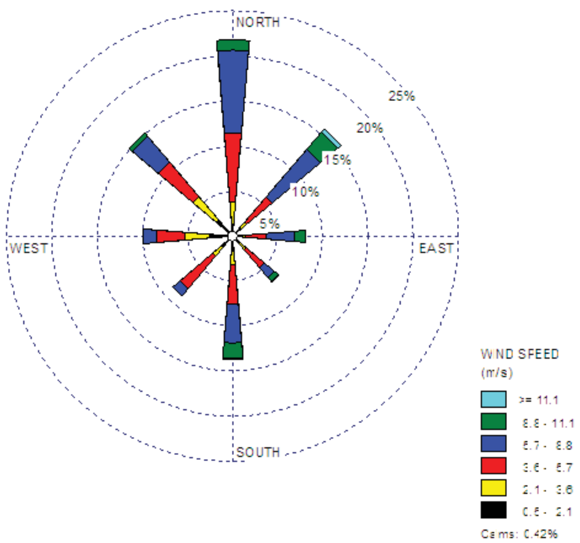
Appendix B

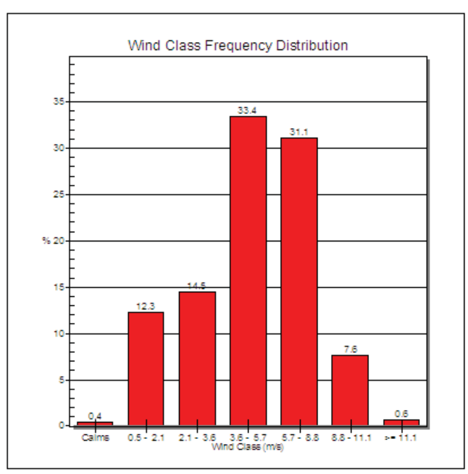
All Seasons





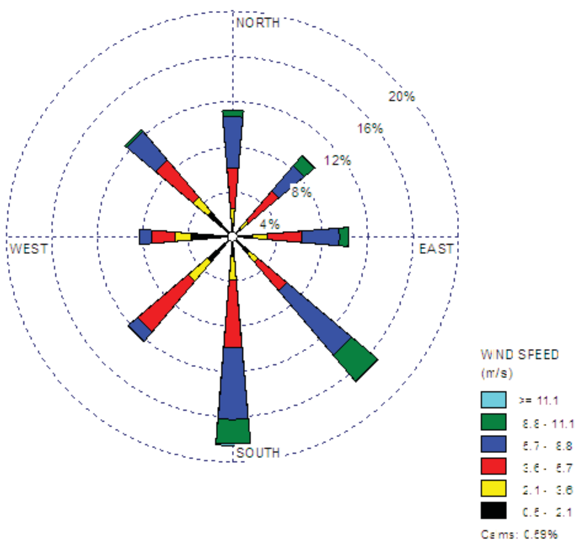
Summer (December – February)

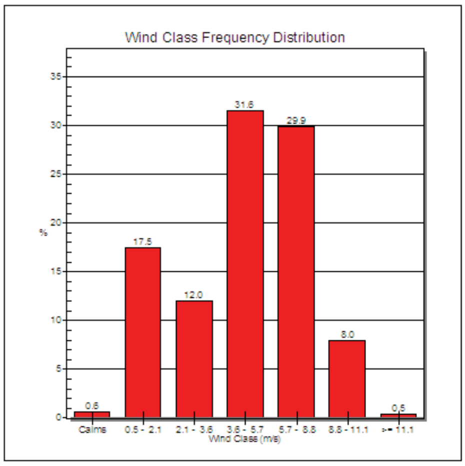




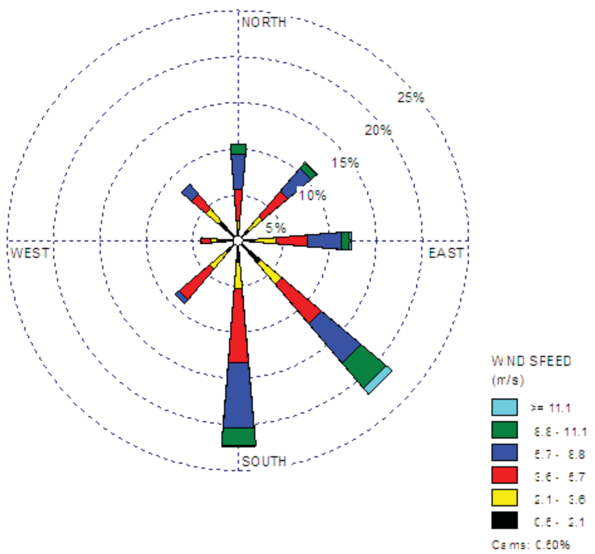
Appendix B

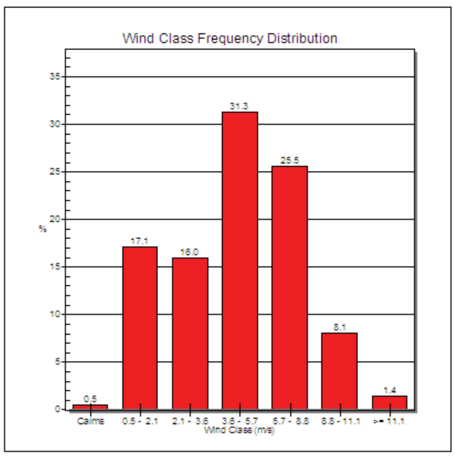
Autumn (March – May)





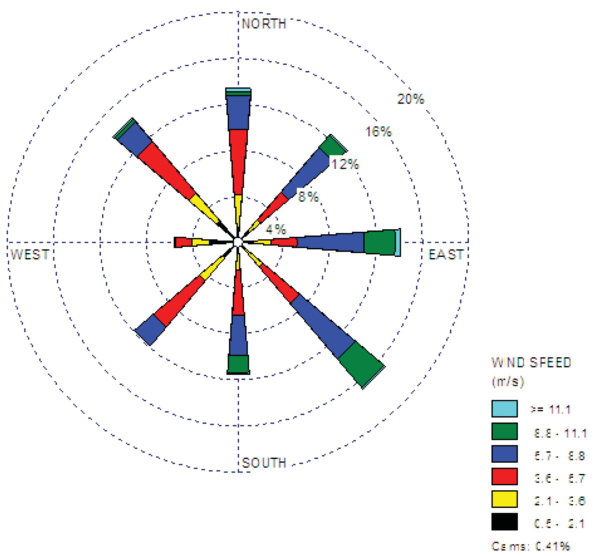
Winter (June – August)

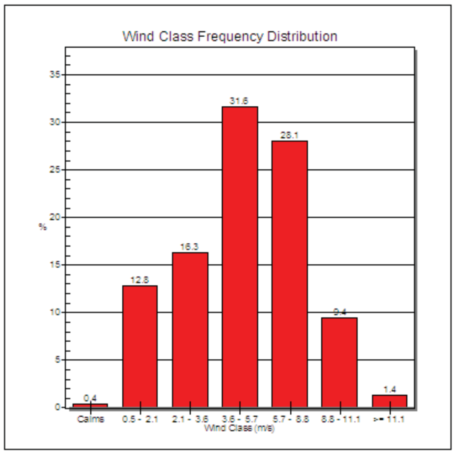




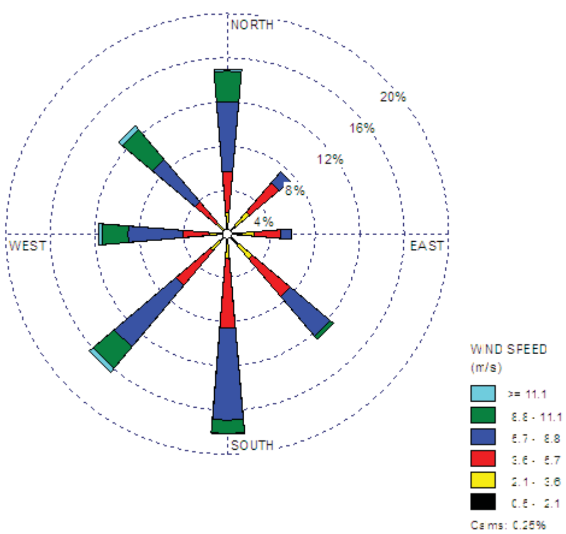
Appendix B

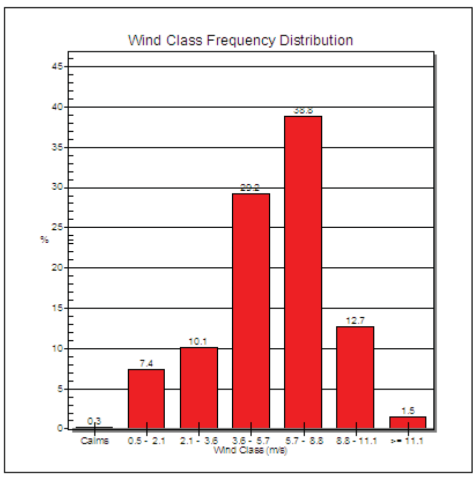
Spring (September – November)





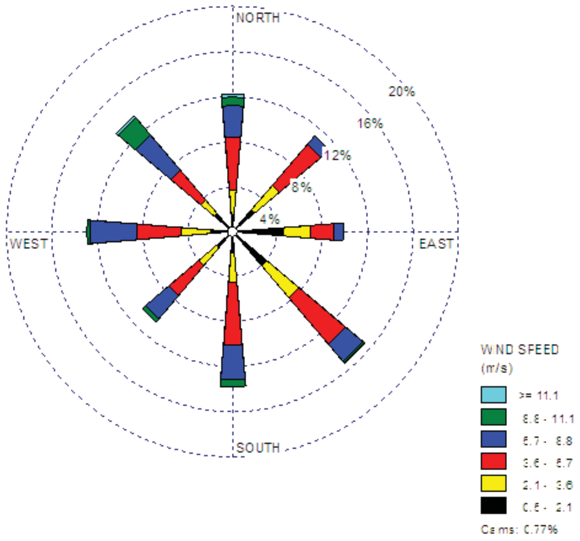
Daytime (7.00 am – 6.00 pm)

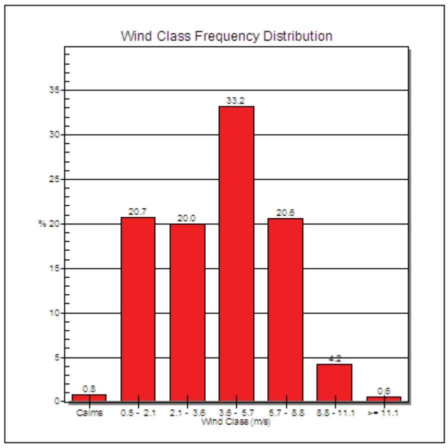




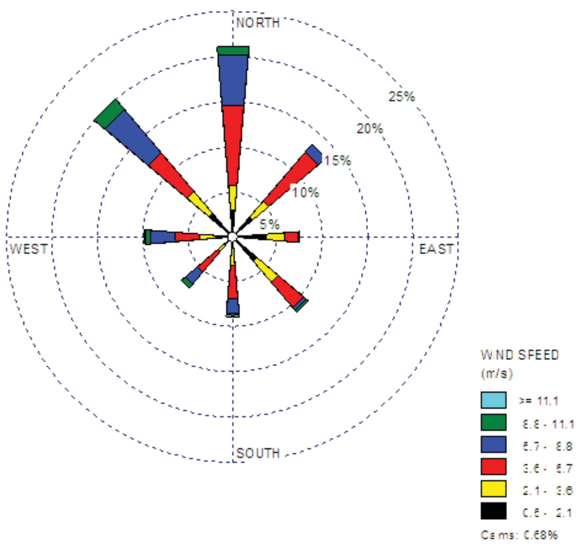
Appendix B

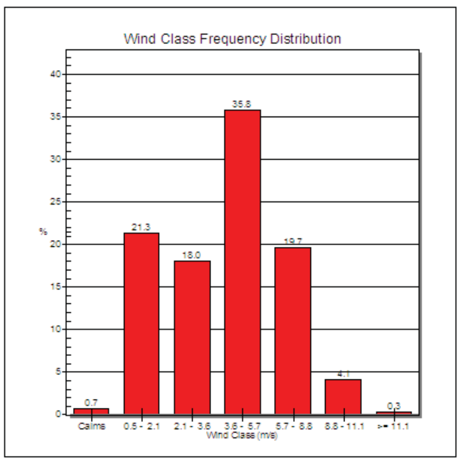
Evening (6.00 pm – 10.00 pm)





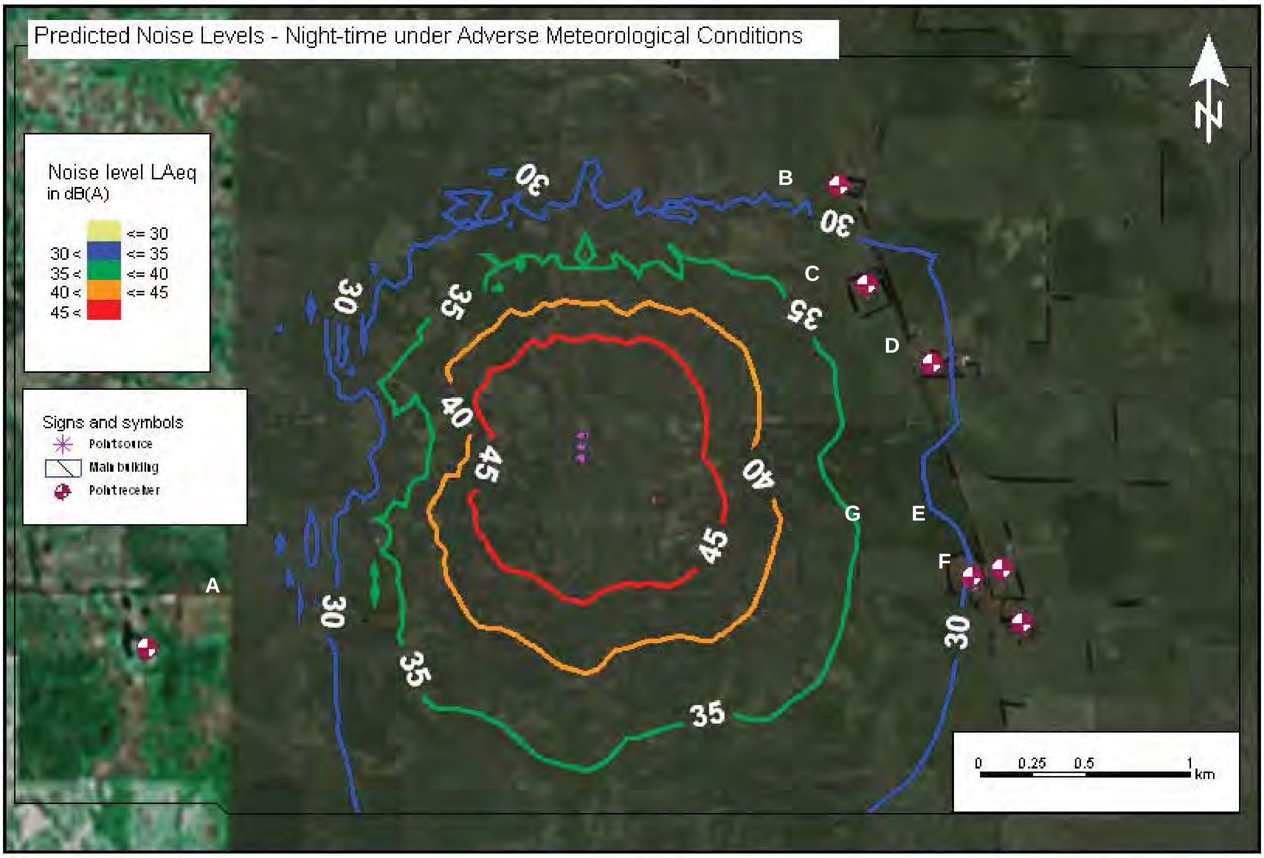
Night-time (10.00 pm – 7.00 am)





Appendix C Noise Contours

Appendix C


Predicted Noise Levels - Night-time under Adverse Meteorological Conditions
Noise level LAeq in dB(A)
<= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 <
Signs and symbols
Point source
Main building
Point receiver
A
B
C
D
E
F
G
30
35
40
45
0 0.25 0.5 1 km
N

D

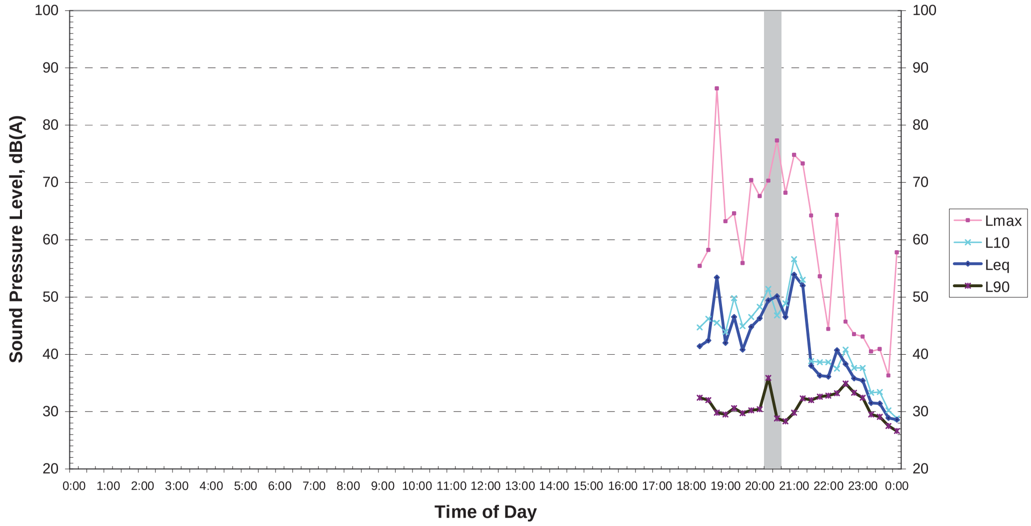
Appendix D Daily Noise Monitoring Plots

Appendix D

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Tuesday 3 February 2009



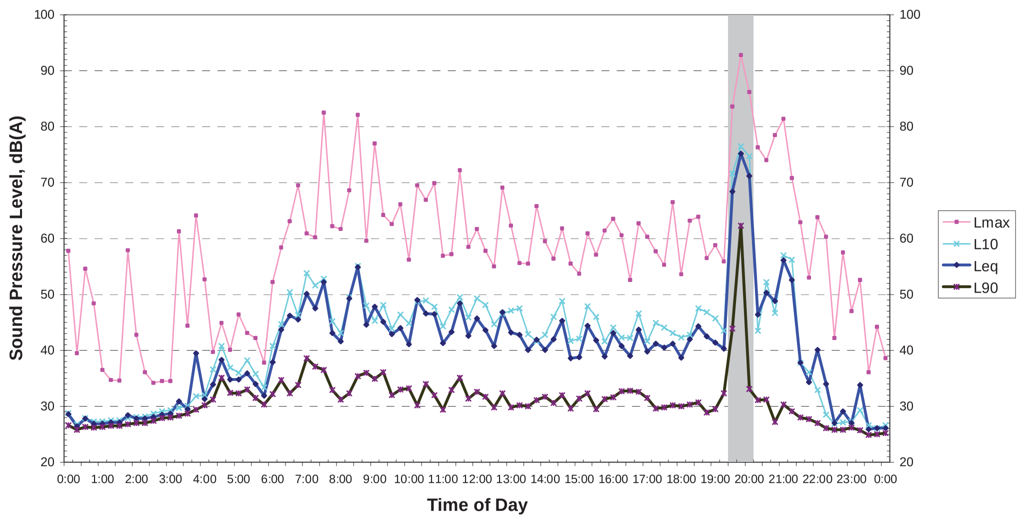
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Wednesday 4 February 2009



Note:

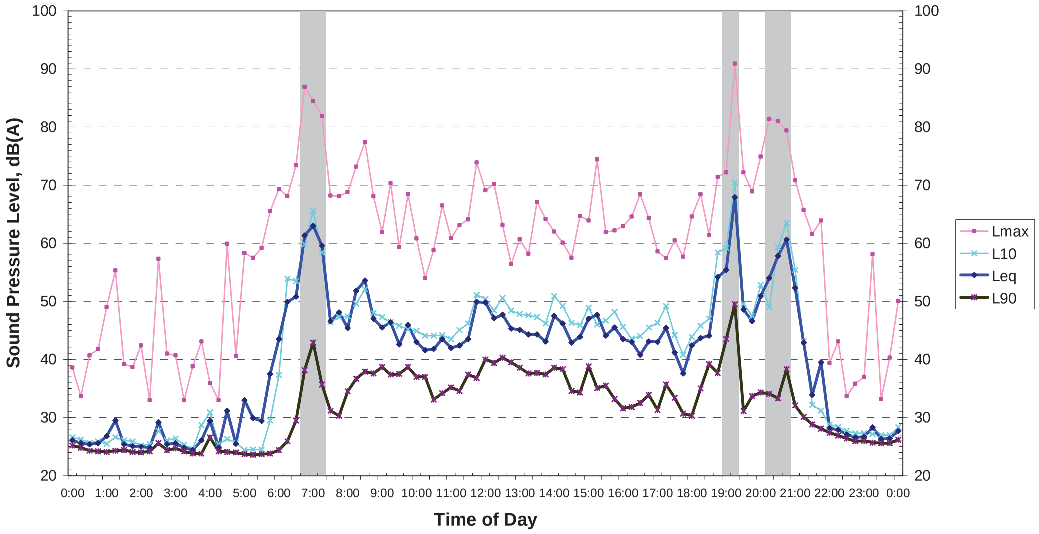
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Thursday 5 February 2009



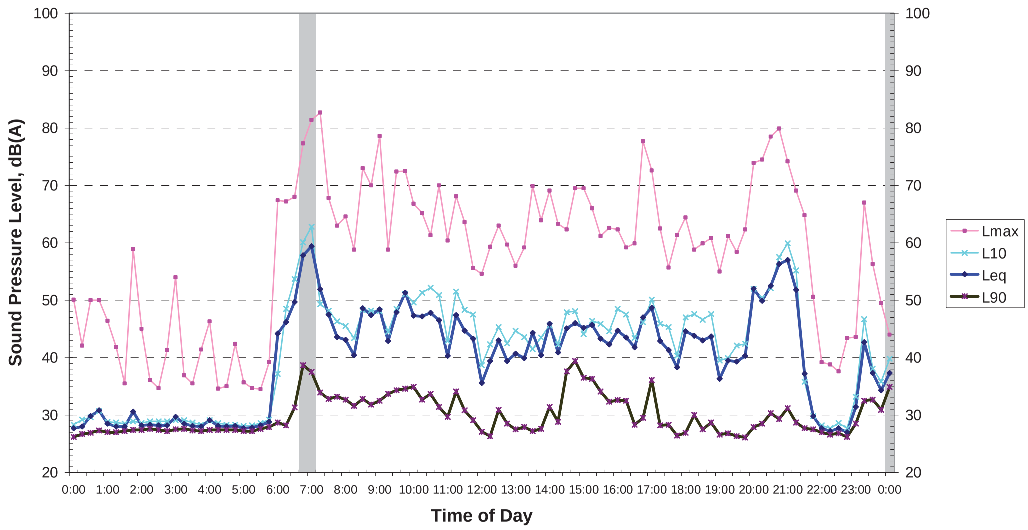
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Friday 6 February 2009



Note:

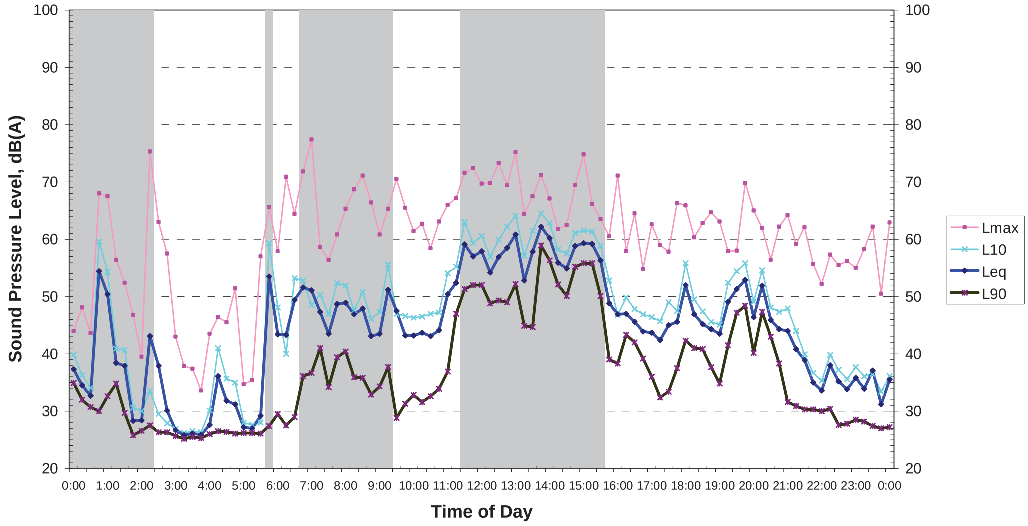
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Saturday 7 February 2009



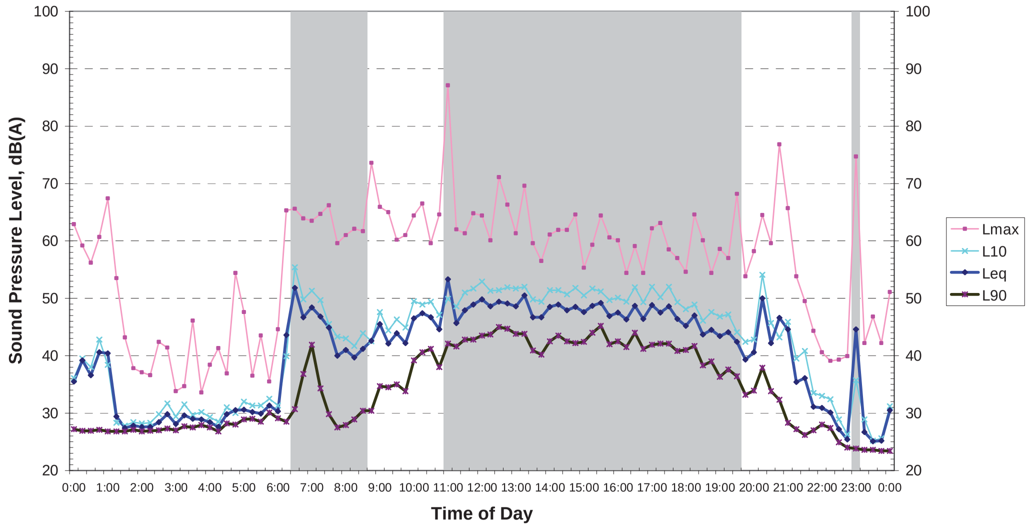
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Sunday 8 February 2009



Note:

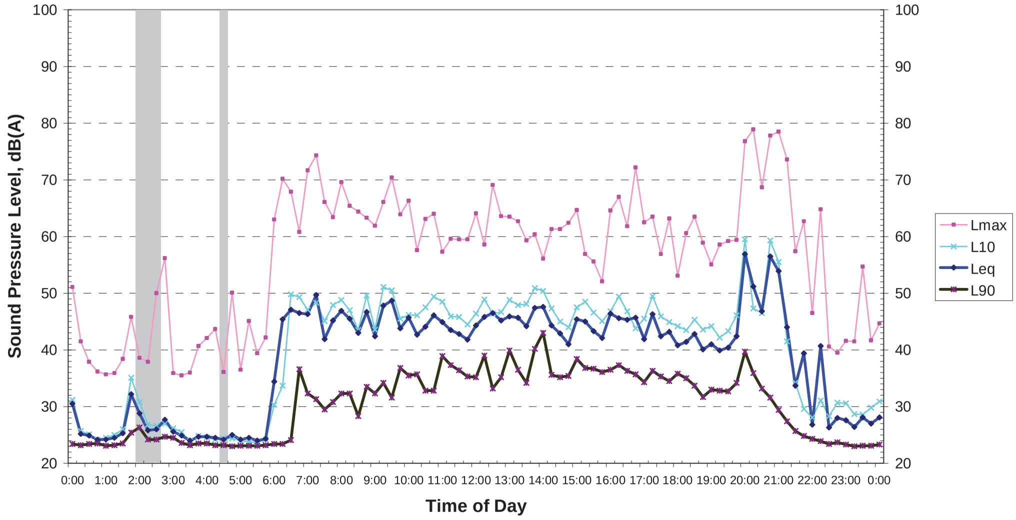
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Monday 9 February 2009



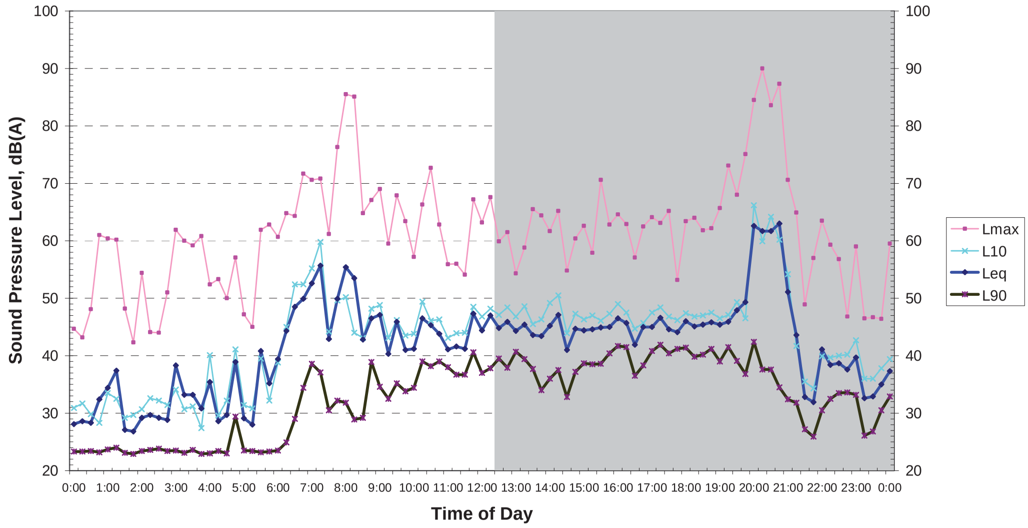
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

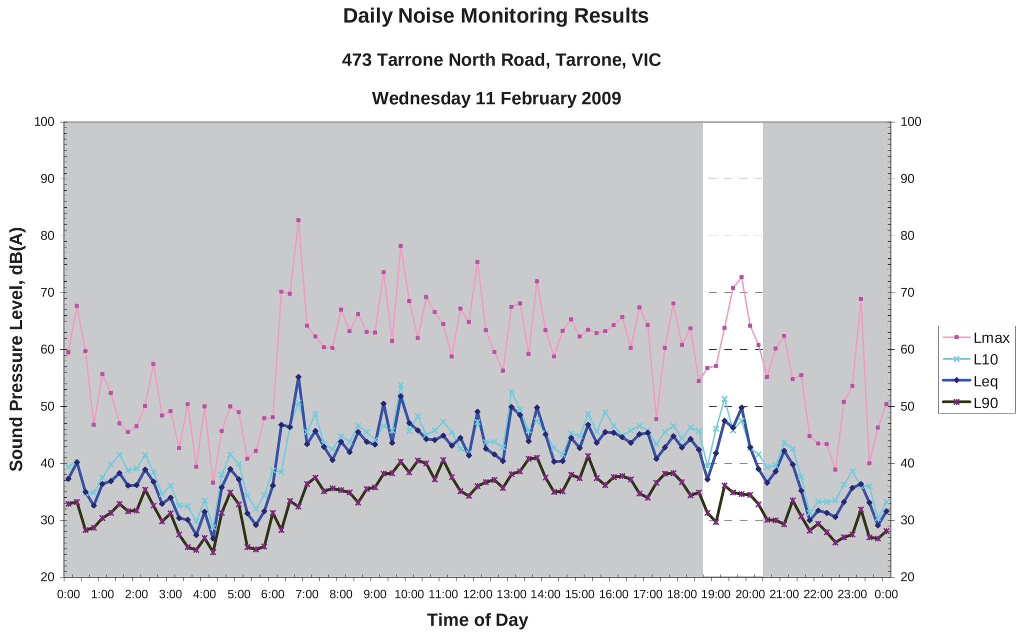
Tuesday 10 February 2009



Note:

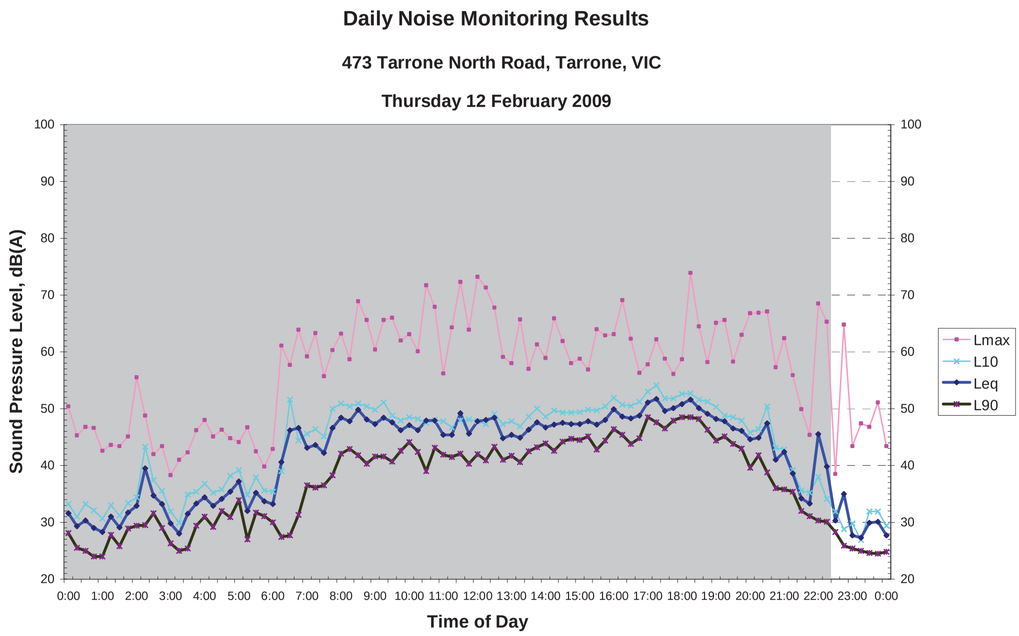
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D



Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.



Note:

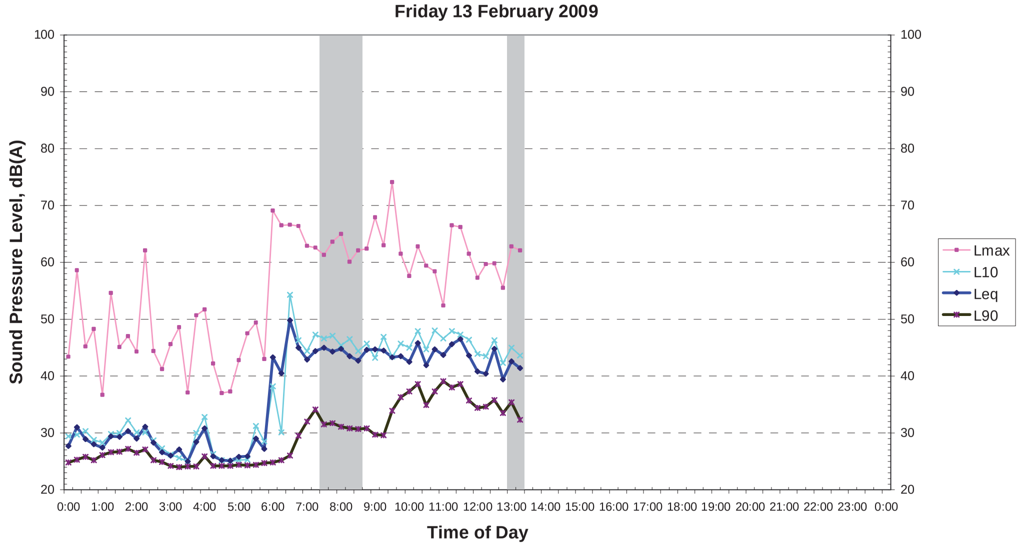
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

473 Tarrone North Road, Tarrone, VIC

Friday 13 February 2009



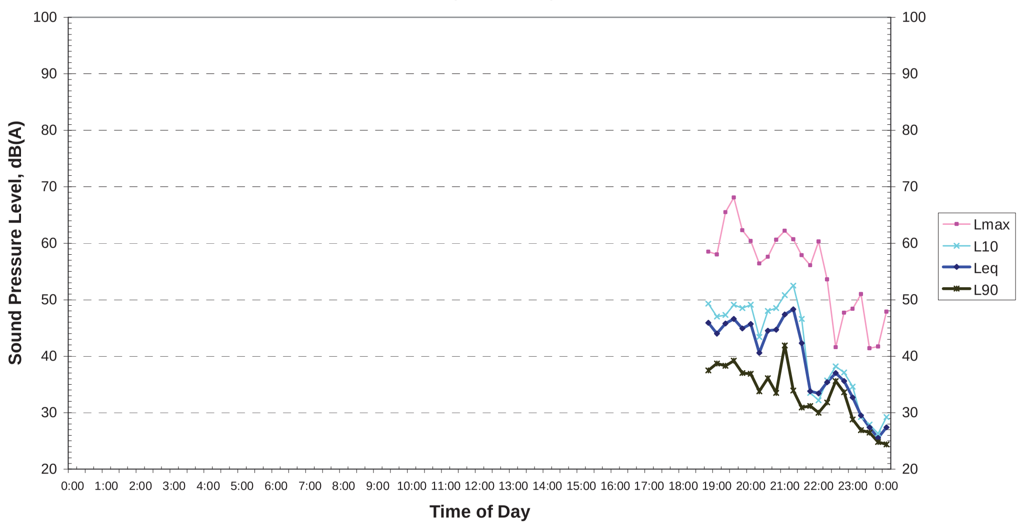
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Tuesday 3 February 2009



Note:

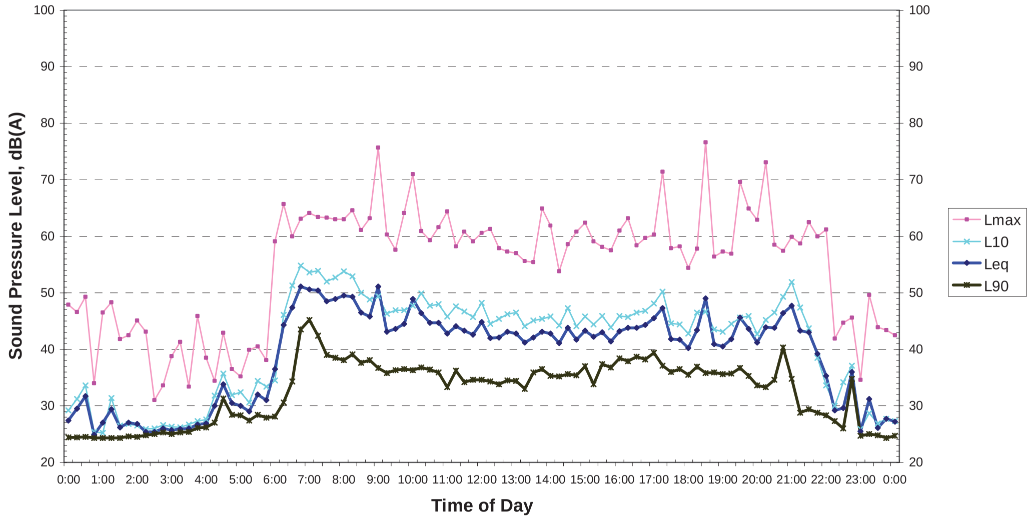
Shaded periods indicate periods affected by adverse weather conditions or extraneous
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Wednesday 4 February 2009



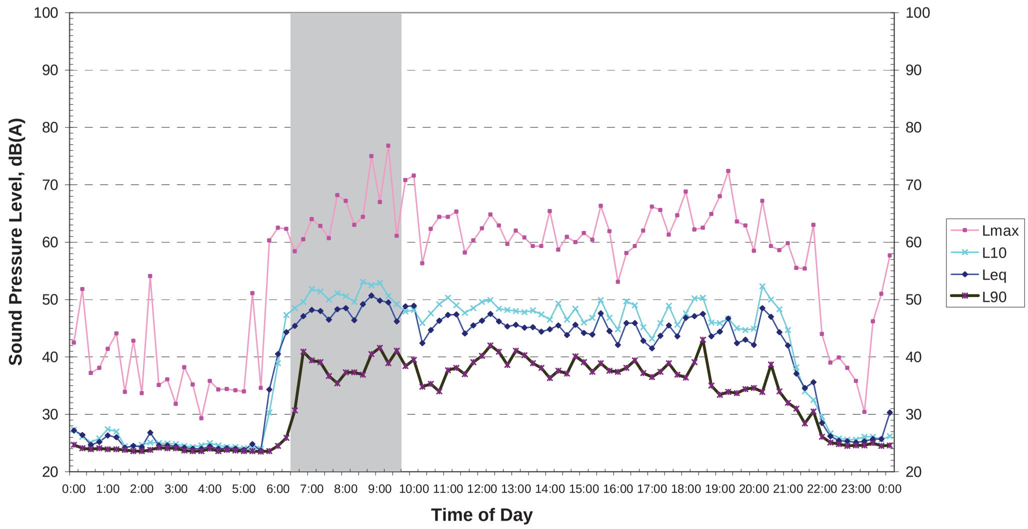
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Thursday 5 February 2009



Note:

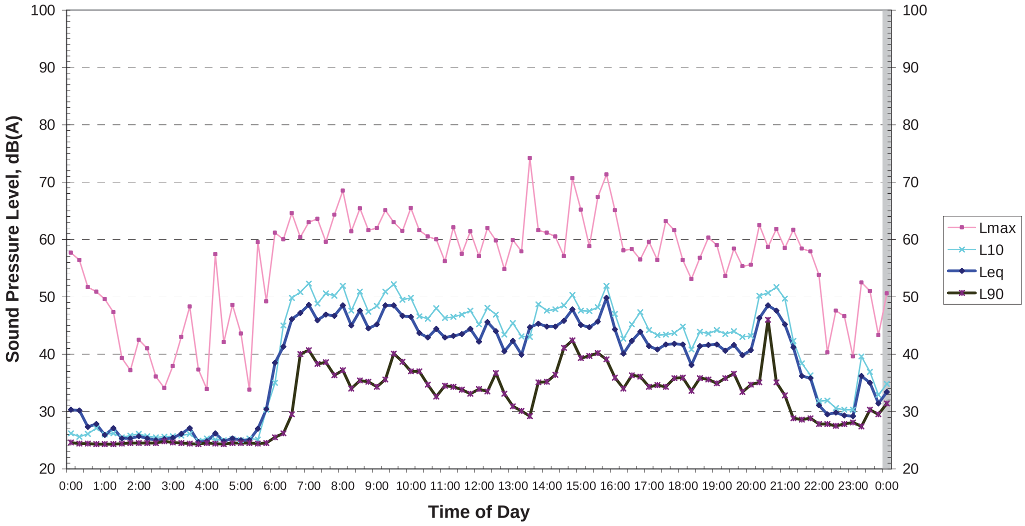
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Friday 6 February 2009



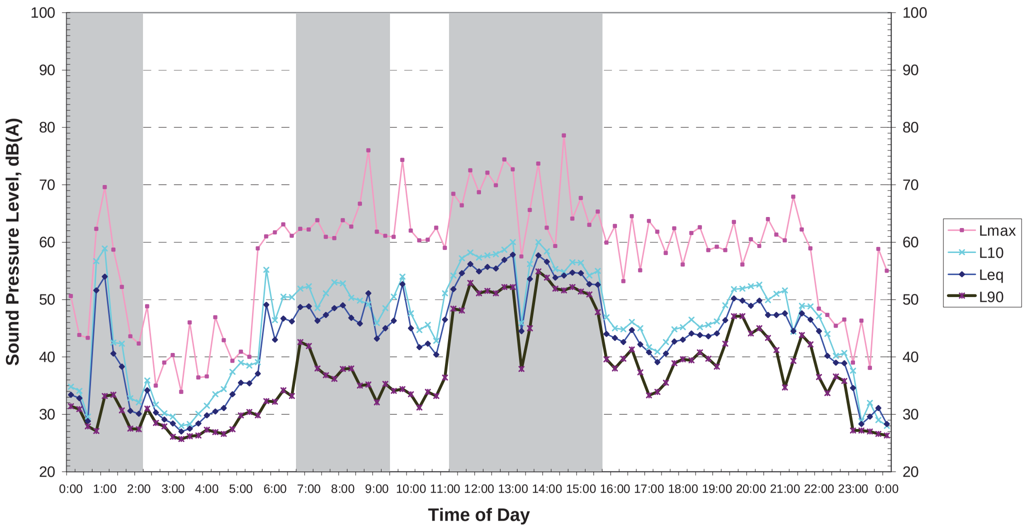
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

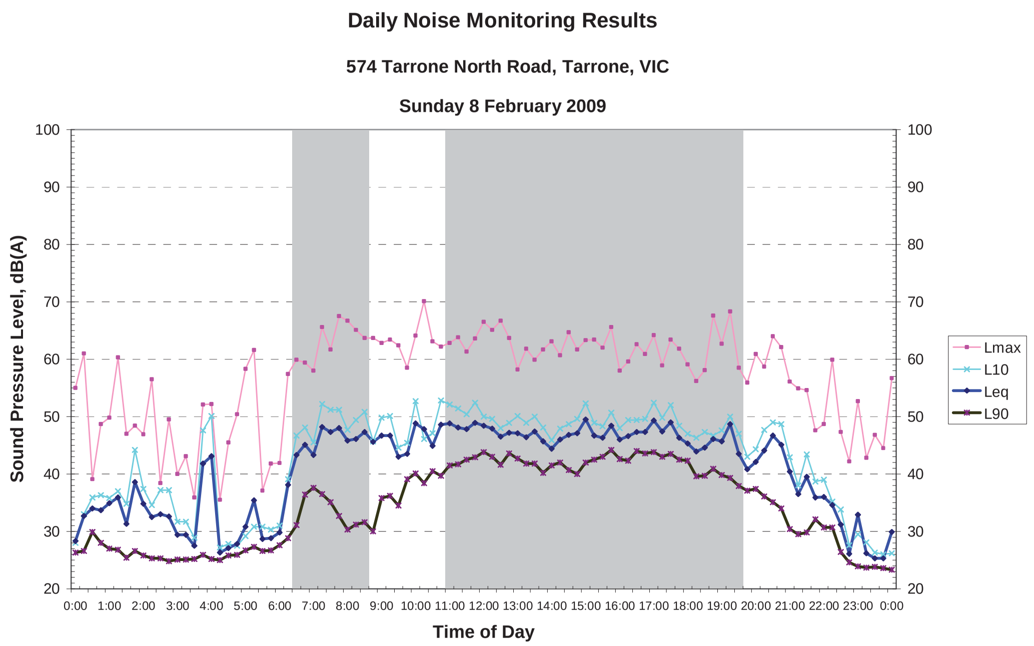
Saturday 7 February 2009



Note:

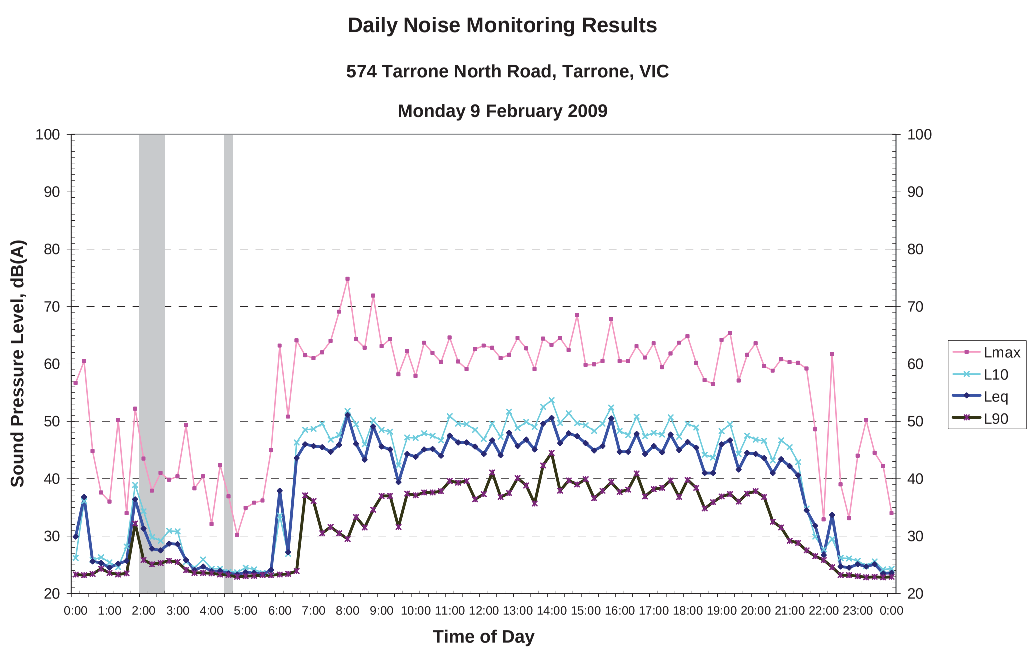
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D



Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.



Note:

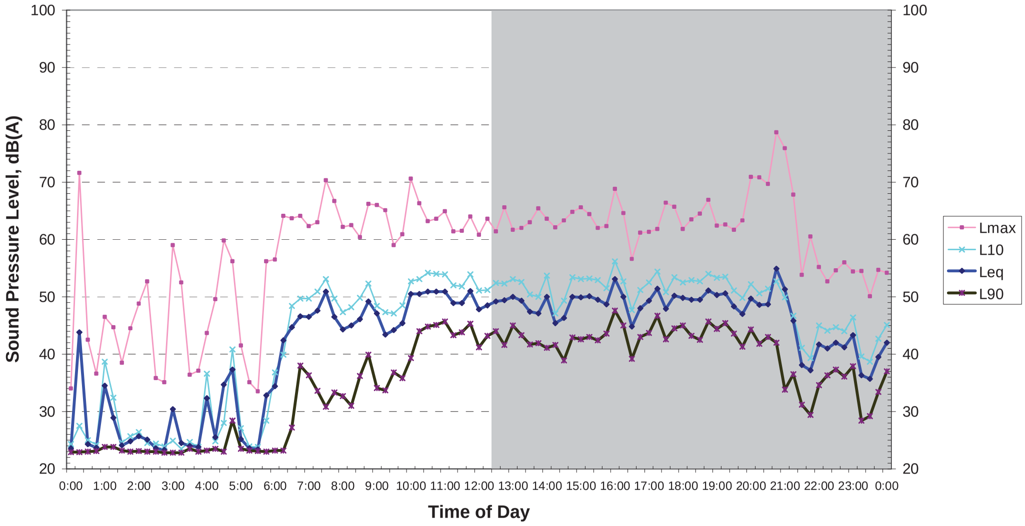
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Tuesday 10 February 2009



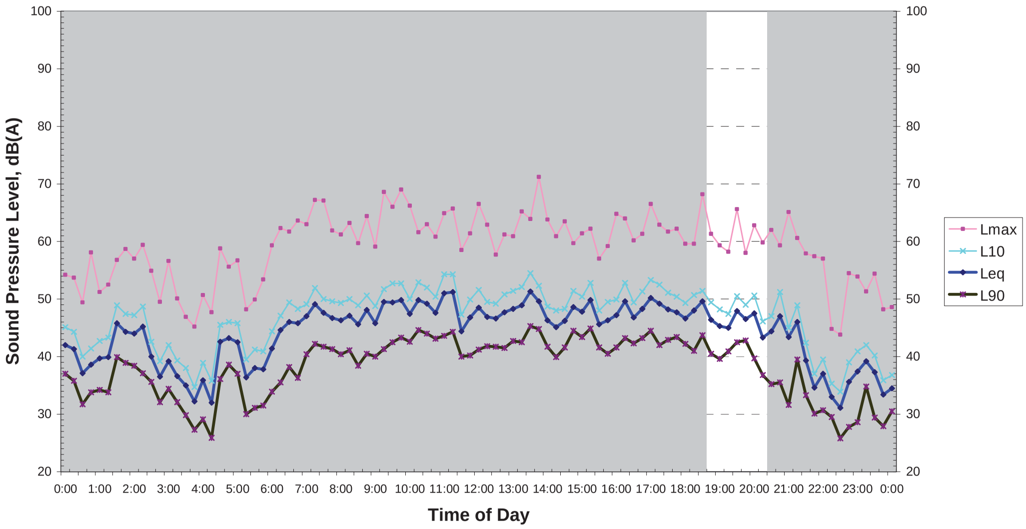
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Wednesday 11 February 2009



Note:

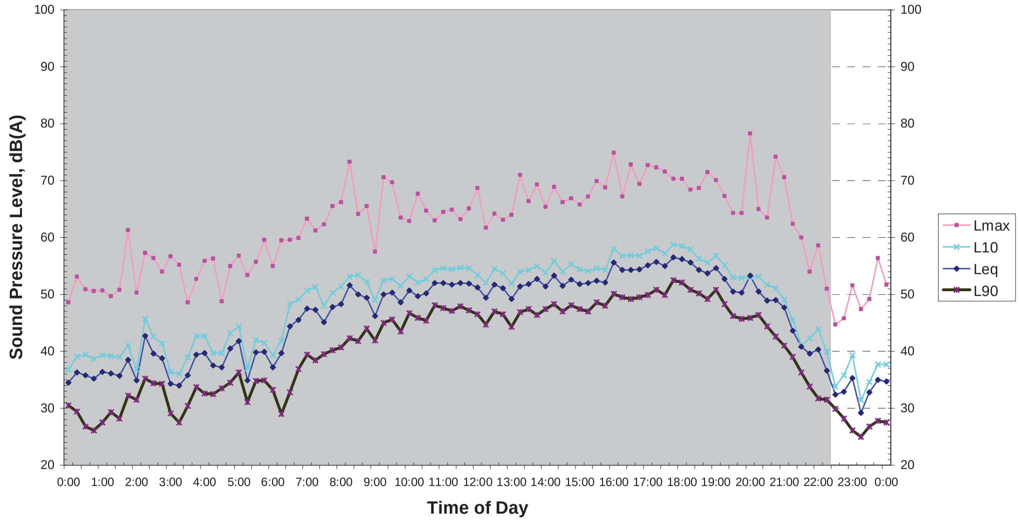
Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Appendix D

Daily Noise Monitoring Results

574 Tarrone North Road, Tarrone, VIC

Thursday 12 February 2009



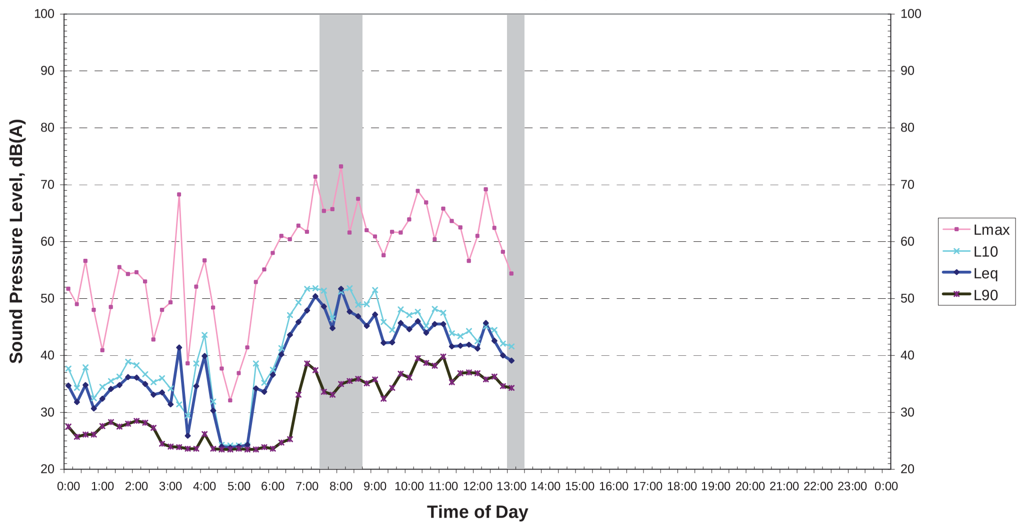
Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.

Daily Noise Monitoring Results

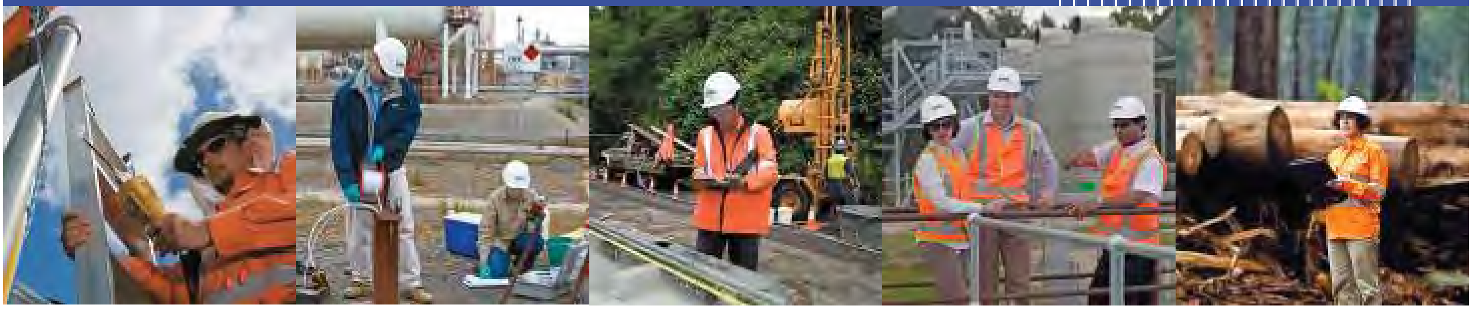
574 Tarrone North Road, Tarrone, VIC

Friday 13 February 2009



Note:

Shaded periods indicate periods affected by adverse weather conditions or extraneous noise.
Measured data during these periods were excluded from calculation of noise levels averaged for the period.



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