ANNEXURE C

ATMOSPHERIC IMPACT REPORT
In support of

Eskom's application for postponement of the Minimum Emission Standards compliance timeframes for the Acacia Power Station

uMoya-NILU Consulting (Pty) Ltd
P O Box 20622
Durban North, 4016
South Africa

Eskom
P O Box 1091
Johannesburg, 2001
South Africa

uMOYA-NILU

M Zunckel
A Raghunandan

February 2014

When used in a reference this document should be cited as follows:

uMoya-NILU (2014): Atmospheric Impact Report in support of Eskom's application for postponement from the Minimum Emission Standards compliance timeframes for Acacia Power Station, Report No. uMN055-2014, February 2014.

EXECUTIVE SUMMARY

Eskom's liquid fuel-fired Acacia power station in Cape Town in the Western Cape Province is a peaking plant with a generation capacity of 171 MW. Power generation is a Listed Activity in terms of Section 21 of the NEMAQA and as a result Acacia is required to comply with the prescribed MES for existing plants by 2015 and for new plants by 2020. SO_2 and PM emissions from Acacia already comply with the MES for both existing and new plants, but NO_x emissions will not comply with the new plant MES. Eskom has therefore applied for postponement of the new plant NO_x MES for Acacia and proposed an alternative emissions limit. The purpose of this AIR has been to assess the likely implications of that postponement and the requested alternative emissions limit for human health and the environment.

An analysis of measured ambient NO_2 concentrations indicates full compliance with the NAAQS for both the hourly and the annual averaging periods. Predicted ambient NO_2 concentrations (using a dispersion model) were also seen to be compliant with the NO_2 NAAQS for current NO_x emissions and the requested NO_x emission limit. Given that Acacia operated for less than 53 hours in 2012, and is expected to operate for similar timeframes in the future, the risk of non-compliance with the NAAQS is very low indeed, and the associated risk to human health and the environment, negligible.

LIST OF ACRONYMS

µm	1 µm = 10^{-6} m
AEL	Atmospheric Emission License
AIR	Atmospheric Impact Report
APPA	Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965)
AQMP	Air Quality Management Plan
BID	Background Information Document
DEA	Department of Environmental Affairs
DoE	Department of Energy
ESP	Electrostatic precipitator
FFP	Fabric Filter Plant
FGD	Flue gas desulphurisation
IRP	Integrated Resource Plan
LNB	Low NO_x Burner
LPG	Liquid Petroleum Gas
NAAQS	National Ambient Air Quality Standards
NEMAQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen (NO_X = NO + NO_2)
OFA	Overfire Air
PM	Particulate Matter
PM_{10}	Particulate Matter with a diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with a diameter of less than 2.5 µm
SO_2	Sulphur Dioxide
TSP	Total Suspended Particulates
WHO	World Health Organisation

TABLE OF CONTENTS

TABLES

FIGURES

1. Enterprise Details

1.1 Enterprise Details

Entity details for Eskom's Acacia Power Station are listed in Table 1.

Table 1: Enterprise details

Enterprise Name:	Eskom Holdings SOC (Ltd)
Trading as:	Eskom Peaking Generation - Acacia Power Station
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	State owned company
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture):	2002/015527/06
Registered Address:	Rosenpark 15 Pasita Street Bellville
Postal Address:	PO Box 3487 Tygervalley 7536
Telephone Number (General):	021 941 5800
Fax Number (General):	021 914 3131
Company Website:	www.eskom.co.za
Industry Type/Nature of Trade:	Liquid-fired power stations that generate electricity. Listed activity (Sub-category 1.2) in terms of the NEMAQA (Section 21), i.e. combustion installations using liquid fuels primarily for steam raising or electricity generation (DEA, 2013).
Land Use Zoning as per Town Planning Scheme:	Residential
Land Use Rights if outside Town Planning Scheme:	-
Responsible Person:	Abedah Wilson
Emission Control Officer:	Abedah Wilson
Telephone Number:	+27 21 914 3111
Cell Phone Number:	+27 83 769 4447
Fax Number:	-
E-mail Address:	WilsonA@eskom.co.za
After Hours Contact Details:	+27 83 769 4447

1.2 Location and Extent of the Plant

Acacia Power Station is located in the City of Cape Town in the Western Cape Province. Site information is provided in Table 2 and the relative location to key landmarks is shown in Figure 1.

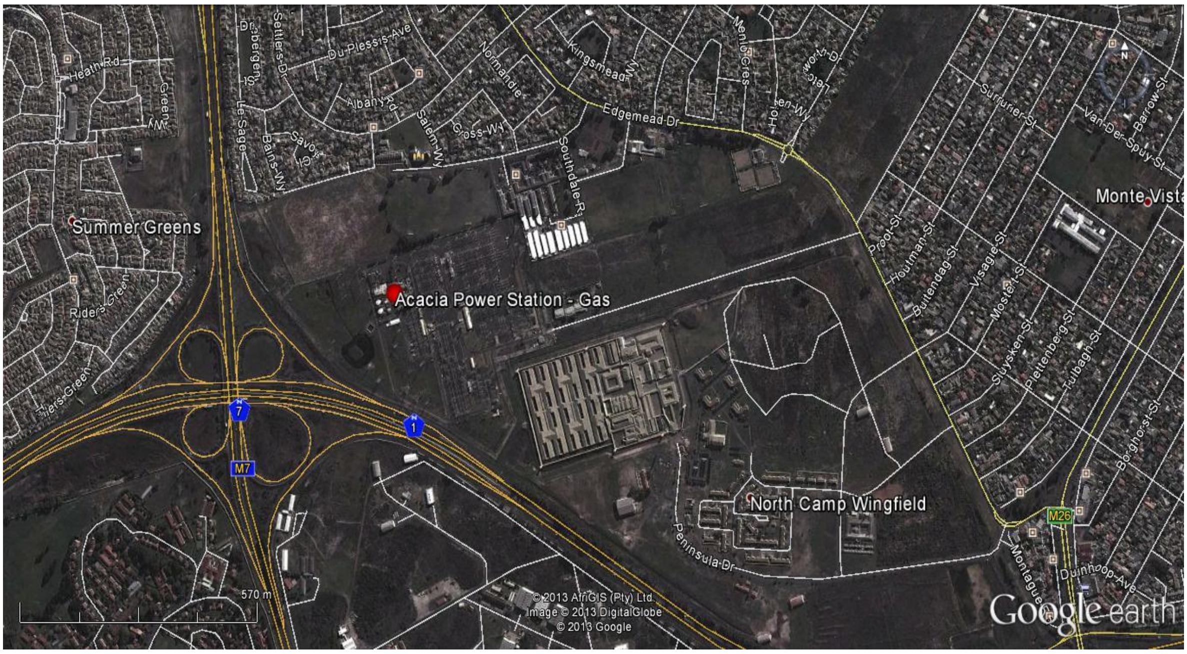
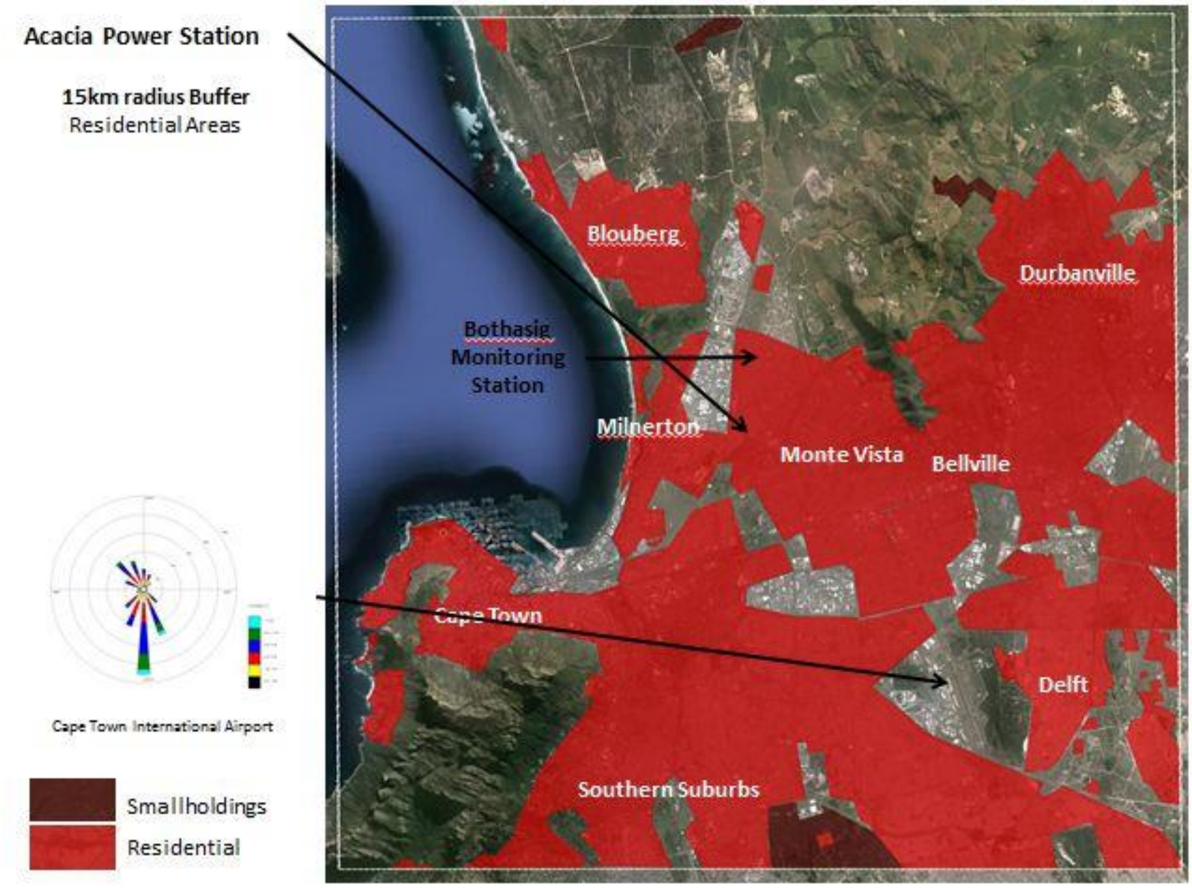


Figure 1: Relative location of the Acacia Power Station (Google Earth, 2013)

Table 2: Site information

Physical Address of the Plant (Licensed Premises)	Erf, 4003, Montague Rd, Goodwood, Cape Town
Description of Site (Where No Street Address):	Erf, 4003, Montague Rd, Goodwood, Cape Town
Coordinates (latitude, longitude) of Approximate Centre of Operations (Decimal Degrees):	Latitude: 33.88° S Longitude: 18.53° E
Coordinates (UTM) of Approximate Centre of Operations:	272 076 mE 6 248 045 mS
Extent (km²):	0.013
Elevation Above Mean Sea Level (m)	24
Province:	Western Cape Province
District/Metropolitan Municipality:	City of Cape Town
Local Municipality:	Goodwood
Designated Priority Area (if applicable):	N/A



Area	Distance (km)	Direction
Summergreen	0.5	W
Monte Vista	1.1	E
Edgemead	0.3	N
Acacia Park	0.6	SW
N7	0.2	S
N2	0.4	W

Figure 2: Land-use and sensitive receptors within a 30x30 km block surrounding the Acacia Power Station, shown by the white square

1.3 Atmospheric Emission License and Other Authorisations

An APPA Registration Certificate (No. 2004) was issued to Acacia Power Station by the Chief Air Pollution Control Officer (CAPCO) on 17 April 1996, in terms of Section 10 of the APPA, in respect of Scheduled Process No. 29 (Power Generation). The Registration Certificate is valid until 1 April 2014 and has not been converted to an AEL yet. The Registration Certificate specifies the use of low sulphur diesel. The current governmental authorisations, permits and licenses related to air quality management is provided in Table 3.

Table 3: Current government authorisations related to air quality

APPA Registration Certificate Number:	Date of Registration Certificate:	Scheduled Process Number:	Scheduled Process Description:
2004	17/04/1996	No. 29	Power Generation

1.3.1 Minimum Emission Standards

All of Eskom's coal- and liquid fuel-fired power stations are required to meet the Minimum Emission Standards (MES) promulgated in terms of Section 21(3)(a) of the NEMAQA under GNR 893 on 22 November 2013 ("GNR 893"). GNR 893 does provide for transitional arrangements in respect of the requirement for existing plants to meet the MES and provides that less stringent limits must be achieved by existing plants by 1 April 2015, and the more stringent 'new plant' limits must be achieved by existing plants by 1 April 2020. The MES are listed in Table 4.

Table 4: Minimum Emission Standards for combustion installations (Category 1) using liquid fuel for electricity generation (Sub-category 1.2) with a design capacity equal or greater to 50 MW heat input per unit

Substance	Plant status	MES mg/Nm^3 under normal conditions of 15% O_2, 273 K and 101.3 kPa
Particulate Matter	New	50
	Existing	75
Sulphur dioxide	New	500
	Existing	3 500
Oxides of nitrogen	New	250
	Existing	1 100

1.3.2 National Ambient Air Quality Standards (NAAQS)

The effects of air pollutants on human health occur in a number of ways with short-term, or acute effects, and chronic, or long-term, effects. Different groups of people are affected differently, depending on their level of sensitivity, with the elderly and young children being more susceptible. Factors that link the concentration of an air pollutant to an observed health effect are the concentration and the duration of the exposure to that particular air pollutant.

Criteria pollutants occur ubiquitously in urban and industrial environments. Their effects on human health and the environment are well documented (e.g. WHO, 1999; 2003; 2005). South Africa has accordingly established National Ambient Air Quality Standards (NAAQS) for the criteria pollutants, i.e. sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), respirable Particulate Matter (PM_{10}), ozone (O_3), lead (Pb) and benzene (C_6H_6) (DEA, 2009) and $PM_{2.5}$ (DEA, 2012a). The NAAQS for SO_2, NO_2, PM_{10} and $PM_{2.5}$ are listed in Table 5.

The NAAQS consists of a 'limit' value and a permitted frequency of exceedance. The limit value is the fixed concentration level aimed at reducing the harmful effects of a pollutant. The permitted frequency of exceedance represents the acceptable number of exceedances of the limit value expressed as the 99th percentile. Compliance with the ambient standard implies that the frequency of exceedance of the limit value does not exceed the permitted tolerance. Being a health-based standard, ambient concentrations below the standard imply that air quality poses an acceptable risk to human health, while exposure to ambient concentrations above the standard implies that there is an unacceptable risk to human health.

Table 5: National Ambient Air Quality Standards for SO_2, NO_2 and PM_{10} (DEA, 2009) and $PM_{2.5}$ (DEA, 2012a). Because the applications apply to regulations that commence in 2015, the 2015 and 2016 standards are deemed to apply.

Pollutants	Averaging period	Limit value ($\mu g/m^3$)	Number of permissible exceedances per annum
SO_2	1 hour	350	88
	24 hour	125	4
	1 year	50	0
NO_2	1 hour	200	88
	1 year	40	0
PM_{10}	24-hour	120 (75[1])	4
	Calendar year	50 (40[1])	0
$PM_{2.5}$	24-hour	65 (40[2]) (25[3])	4
	Calendar year	25 (20[2]) (15[3])	0

1: Implementation date 1 January 2015

2: Implementation date 1 January 2016

3: Implementation date 1 January 2030

2. Nature of the Process

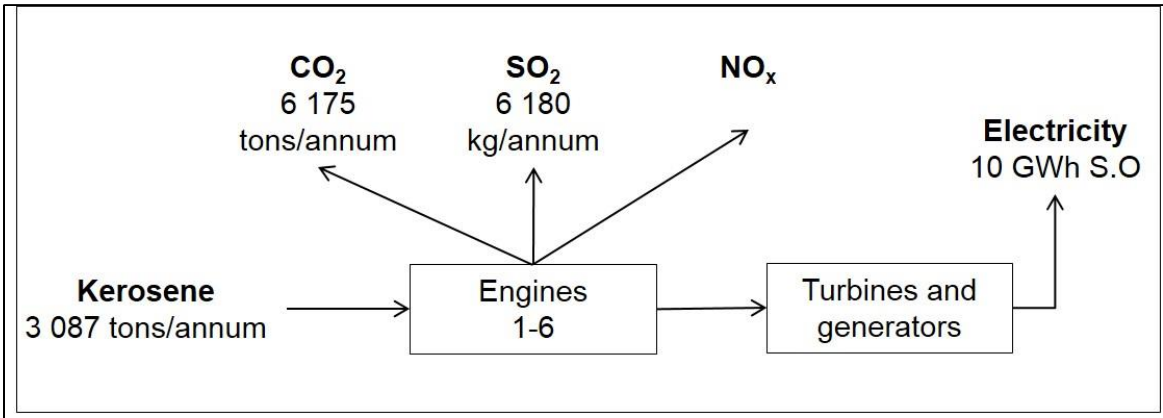
2.1 Listed Activity or Activities

Table 6: Activities listed in GNR 893 which are ‘triggered’ by the Acacia Power Station.

Category of Listed Activities	Sub-category of the Listed Activity	Description and Application of the Listed Activity
1: Combustion Installations	1.2: Liquid Fuel Combustion Installations	Liquid fuels combustion installations used primarily for steam raising or electricity generation. All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.
2: Petroleum Industry, the production of gaseous and liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass	2.4: Storage and Handling of Petroleum Products	All permanent immobile liquid storage facilities at a single site with a combined storage capacity of greater than 1000 cubic meters.

2.2 Process Description

Eskom Holdings SOC (Ltd) is a South African utility that generates, transmits and distributes electricity. The bulk of that electricity is generated in large coal-fired power stations that are situated close to the sources of coal, with most of the stations occurring on the Mpumalanga Highveld. In addition to the large coal-fired power plants that provide so-called ‘baseload’, the utility also has a series of ‘peaking stations’ that can be started and stopped quickly to respond to peak electricity demand. One such peaking station is the Acacia Power Station (hereafter referred to as ‘Acacia’) which is a liquid fuel-fired power station located in Cape Town in the Western Cape Province (Figure 1). Acacia has a generation capacity of 171 MW, which derives from three gas turbines, each of which is driven by two engines.



Figures based on 2012/2013 financial year

Figure 3: A basic atmospheric emissions mass balance for Acacia Power Station showing the key inputs and outputs. Note that all quantities are expressed in tonnes per annum unless otherwise stated.

2.2.1 Atmospheric emissions resulting from power generation

The main product of combustion from a liquid-fuel fired power station such as Acacia, is CO_2 which is produced from the oxidation of carbon in the fuel. However, incomplete combustion results in the formation of CO, albeit in much smaller quantities than CO_2. SO_2 is produced from the combustion of sulphur bound in fuel but the sulphur content of the fuel (kerosene or diesel or jet-A1) used at Acacia is relatively low. NO_X is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the fuel. The quantity of NO_X produced is directly proportional to the temperature of the flame. SO_2 and NO_X are released to the atmosphere via the power station stacks. The non-combustible portion of the fuel remains as solid waste and is released as PM but again in very small quantities. A summary of the different unit process is provided in Table 7. The relative location of these is shown in Figure 4 and the process flow is illustrated in Figure 3.

2.3 Unit Processes

Table 7: Unit processes at Acacia Power Station

Unit Process	Function of Unit Process	Batch or Continuous Process
Unit 1	Power generation process	Batch
Unit 2	Power generation process	Batch
Unit 3	Power generation process	Batch
Fuel storage	Fuel storage tanks	Continuous

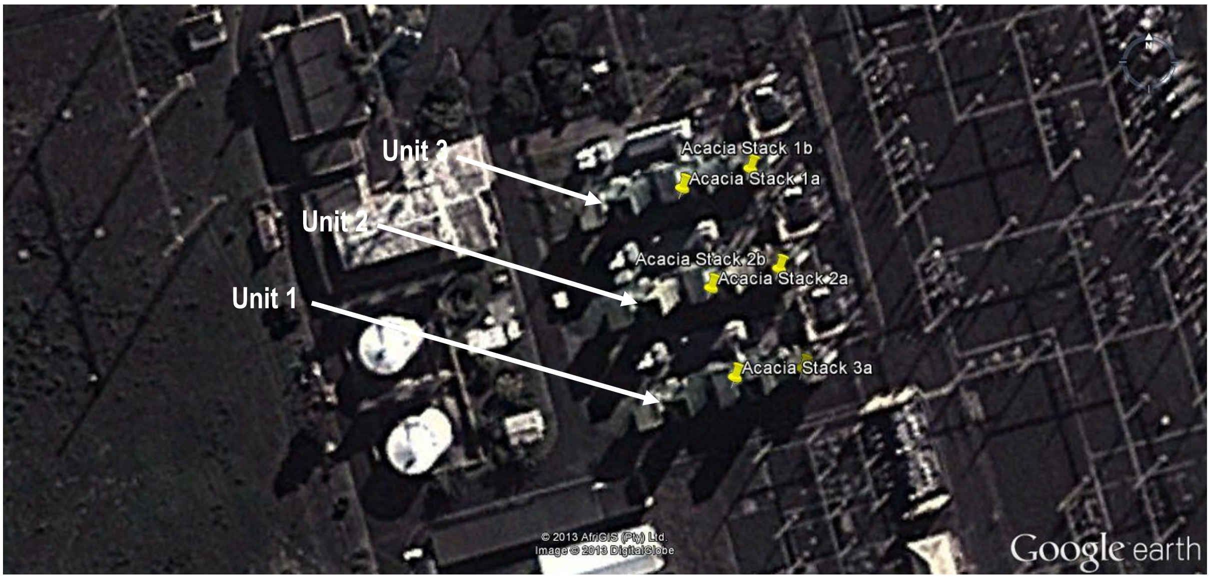


Figure 4: Relative location of the different process units at Acacia Power Station

3. Technical Information

3.1 Raw Materials Used

The permitted raw materials consumption rate, the permitted production rates and the energy sources at Acacia Power Station are listed in Tables 8 to 9 according to the Registration Certificate.

Table 8: Raw material used at Acacia Power Station

Raw material	Maximum permitted consumption rate (Volume)	Units (quantity / period)
Low sulphur diesel / kerosene / jet-A1	Not specified	Not specified

Table 9: Production rates at Acacia Power Station

Product/by-product	Maximum Production capacity permitted (Volume)	Units (quantity / period)
Electricity	171	MW

3.2 Appliances and Abatement Equipment Control Technology

No abatement equipment control technology has been installed at Acacia Power Station.

4. Atmospheric Emissions

4.1 Point source parameters

The physical data for the stacks at Acacia Power Station are listed in Table 10.

Table 10: Point sources at Acacia Power Station

Source Description	Latitude of centre (UTM)	Longitude of centre (UTM)	Height of Release Above Ground (m)	Height above nearby building (m)	Diameter at Stack Tip / Vent Exit (m) *	Actual Gas Exit Temp (^0C)	Normal Gas volumetric flow per stack (Nm^3/s)	Actual Gas Exit Velocity (m/s)	Type of emission (continuous/ batch)
Stack 1a	6248.055 S	272.091 E	14	8	3.9	540	105.2	26.1	Batch
Stack 1b	6248.059 S	272.104 E	14	8	3.9	540	105.2	26.1	Batch
Stack 2a	6248.036 S	272.097 E	14	8	3.9	540	105.2	26.1	Batch
Stack 2b	6248.040 S	272.110 E	14	8	3.9	540	105.2	26.1	Batch
Stack 3a	6248.019 S	272.102 E	14	8	3.9	540	105.2	26.1	Batch
Stack 3b	6248.021 S	272.115 E	14	8	3.9	540	105.2	26.1	Batch

** Effective stack diameter. Individual flue dimensions are 3mx4m*

4.2 Point source maximum emission rates (normal operating conditions)

No emission limits are stipulated in the current APPA Certificate.

4.3 Point source maximum emission rates (start-up, shut-down, upset and maintenance conditions)

The Acacia Power Station starts up very quickly. There is thus no prolonged period with elevated emission levels, as is the case for coal-fired power stations.

4.4 Fugitive emissions (area and or line sources)

Fugitive emissions at Acacia Power Station result from fuel storage and handling. Fugitive emissions are not assessed in this AIR.

4.5 Emergency Incidents

A record is maintained of all emergency incidents occurring at Eskom Power Stations reported in terms of Section 30 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)(NEMA). There have been no emergency incidents at Acacia Power Station

5. Impact of Enterprise on the Receiving Environment

5.1 Analysis of emissions

5.1.1 Overview

The application for postponement means that Acacia's emissions will remain unchanged from what they are currently. In addition the requested interim emissions have been expressed as a ceiling limit to ensure that Eskom can comply with the same under all normal operating circumstances given the variability of emissions from day to day. As such, assessing the impact of Acacia on the receiving environment requires that:

- The existing state of the environment must be assessed in terms of prevailing climate and air quality, including those areas where there are no direct measurements of air quality;
- The air quality that could prevail if the ceiling limits are approved must also be assessed; and,
- The air quality state must then be assessed in terms of the risks to human health and the environment.

This assessment is then based on a detailed analysis of the prevailing climate together with an analysis of air quality monitoring data. Thereafter dispersion modelling has been used to predict ambient air pollution concentrations in the areas where there are no physical measurements and the worst case scenario under the requested emission limits. This analysis is presented in the following section.

5.1.2 Prevailing climatic conditions

Temperature and rainfall

The City of Cape Town experiences warm summers that are relatively dry and mild, wet winters. Summer temperatures range between maximums of 26 ºC and minimums of 16 ºC. The average winter maximum and minimum temperatures are 17 ºC and 7 ºC respectively. The monthly average temperatures are shown in Figure
Figure 55. Rain occurs throughout the year, but the bulk of the rainfall occurs from May to August.

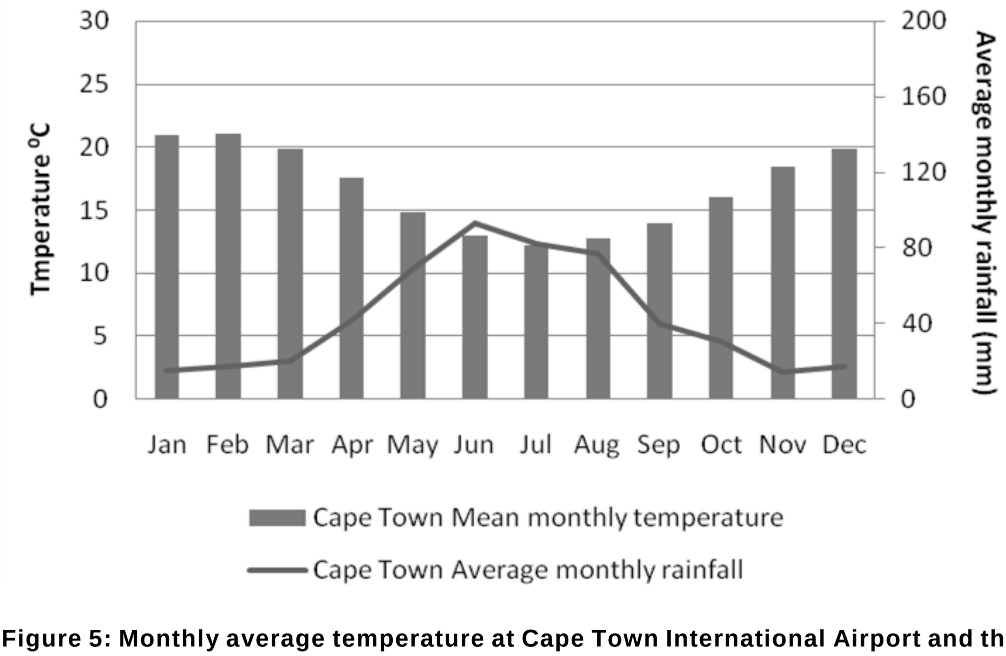


Figure 5: Monthly average temperature at Cape Town International Airport and the mean monthly rainfall (SAWS, 1990)

5.1.3 Wind

Generally, four synoptic weather systems control Cape Town's meteorology. In summer, the ridging Atlantic Ocean Anticyclone results in a high frequency of strong south-easterly winds and partly cloudy skies. Frontal weather systems in winter result in north-westerly winds in advance of the front with low temperatures and cloudy conditions, followed by south-westerly winds with the passage of the front, cold temperatures, cloudy skies and rainfall. In late winter and spring, the frontal systems are weaker and pressure gradients are generally slack. Clear skies result is the development of light berg winds and strong surface temperature inversions at night. In summer, the Atlantic Ocean Anticyclone is situated over the southern parts of the subcontinent resulting in light winds, clear skies and an elevated temperature inversion.

Windroses from Cape Town International Airport and Cape Point show different wind patterns (Figure 6). Southerly to south-south-easterly winds are the most frequent, and strong winds occur in this sector. The winter north-westerlies are more frequent in winter when they can also be strong. At the exposed Cape Point monitoring station, strong winds occur from all sectors. The prevailing winds are from the east to the southeast with the north westerlies in winter. The windrose illustrates the frequency of hourly wind from the 16 cardinal wind directions, with wind indicated from the direction it blows, i.e. easterly winds blow from the east. It also illustrates the frequency of average hourly wind speed in six wind speed classes.

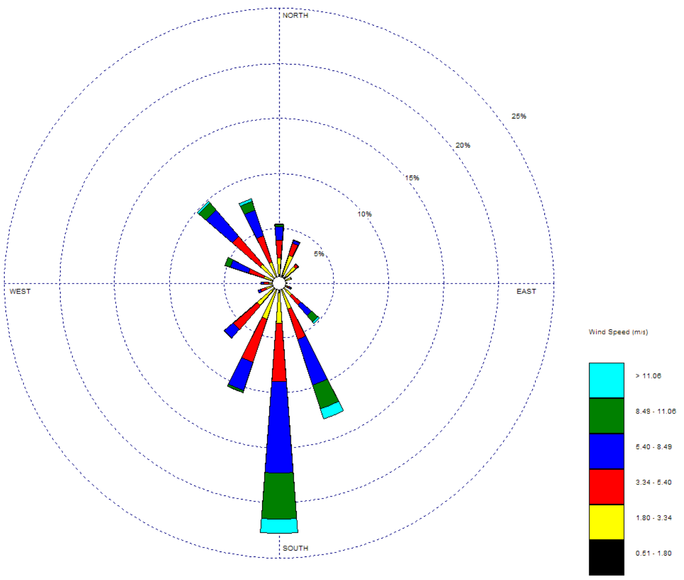


Figure 6: Annual windrose for Cape Town International Airport

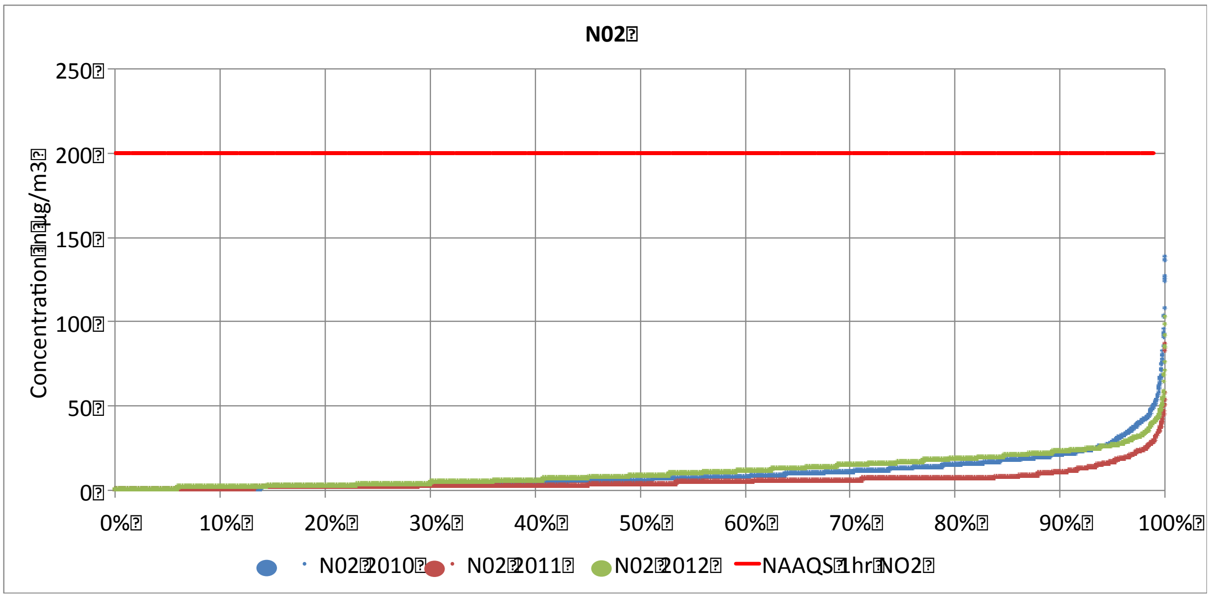
5.2 Current status of ambient air quality

5.2.1 Ambient air quality monitoring

There are multiple sources of atmospheric emissions in Cape Town including industrial emissions which derive most notably from the Caltex oil refinery in Milnerton, and motor vehicle emissions. Cape Town has a specific air quality problem, which is known as 'brown haze' which occurs during stable atmospheric conditions. Various studies have highlighted that the brown haze derives principally from emissions from diesel vehicles. For the purpose of this assessment, ambient air quality monitoring data was sourced from the Bothasig and Goodwood monitoring stations operated by the City of Cape Town. As the application pertains only to NO_x, it is only that pollutant that is further assessed in this AIR.

Nitrogen dioxide

Frequency distributions of ambient hourly average concentrations of NO_2 from the Bothasig and Goodwood monitoring stations are shown in Figure 7. It can be seen from the graphs that the limit value is not exceeded at any time at Bothasig and on two occasions only at Goodwood implying that there is full compliance with the NO_2 NAAQS at both stations. It can also be seen from the data that NO_2 concentrations are maintained at well below 50 µg/m^3 for more than 95% of the year (some 25% of the limit value) at Bothasig but there is a generally higher loading at Goodwood. This higher loading is evident in the annual average NO_2 concentrations of 17,6, 11,7 and 16,1 for 2010-2012 at Goodwood, and 9,8, 5,7 and 11,2 (for 2010-2012) at Bothasig all of which are below 45% of, and thus compliant with the NAAQS of 40 µg/m^3.



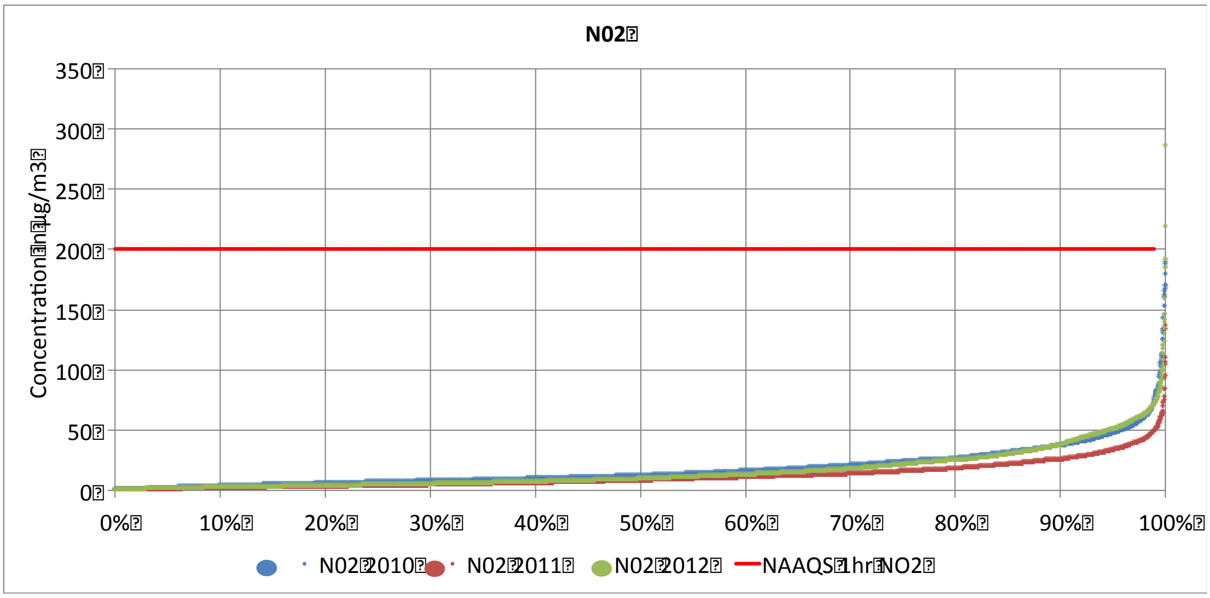


Figure 7: Frequency distribution of hourly average ambient NO_2 concentrations (µg/m^3) measured at the Bothasig (top) and Goodwood (bottom) monitoring stations from 2010-2012. The NAAQS limit value of 200 µg/m^3 is shown by the red horizontal line.

5.3 Dispersion Modelling

The approach to the dispersion modelling in this assessment is based on the requirements of the DEA guideline for dispersion modelling (DEA, 2012c) and is described in detail in the Plan of Study report (uMoya-NILU, 2013), made available during the public consultation process. An overview of the dispersion modelling approach for Acacia Power Station is provided here.

5.3.1 Models used

A number of models with different features are available for air dispersion studies. The selection of the most appropriate model for an air quality assessment needs to consider the complexity of the problem and factors such as the nature of the development and its sources, the physical and chemical characteristics of the emitted pollutants and the location of the sources. This assessment is considered to be a level 2 assessment, according to the definition on the dispersion modelling guideline (DEA, 2012c). The CALPUFF suite of models (http://www.src.com/calpuff/calpuff1.htm) was therefore used. The U.S. EPA Guideline of Air Quality Models also provides for the use of CALPUFF on a case-by-case basis for air quality estimates involving complex meteorological flow conditions, where steady-state straight-line transport assumptions are inappropriate.

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. CALPUFF can be applied on scales of tens to hundreds of kilometres. It includes algorithms for sub-grid scale effects (such as terrain impingement), as well as, longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

The Air Pollution Model (TAPM) (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002) is used to model surface and upper air metrological data for the study domain. TAPM uses global gridded synoptic-scale meteorological data with observed surface data to simulate surface and upper air meteorology at given locations in the domain, taking the underlying topography and land cover into account. The global gridded data sets that are used are developed from surface and upper air data that are submitted routinely by all meteorological observing stations to the Global Telecommunication System of the World Meteorological Organisation. TAPM has been used successfully in Australia where it was developed (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002), and in South Africa (Raghunandan et al., 2007). It is considered to be an ideal tool for modelling applications where meteorological data does not adequately meet requirements for dispersion modelling. TAPM modelled output data is therefore used to augment the site-specific surface meteorological data for upper air data for input to CALPUFF.

5.3.2 Model parameterisation

TAPM

In Cape Town, TAPM is set-up in a nested configuration of three domains centred on Acacia Power Station. The outer domain is 420 km by 420 km with a 21 km grid resolution, the middle domain is 240 km by 240 km with a 12 km grid resolution and the inner domain is 60 km by 60 km with a 3 km grid resolution (Figure 7). One year (2012) of hourly observed meteorological data from the SAWS stations at Cape Town and Molteno Reservoir are input to TAPM to ‘nudge’ the modelled meteorology towards the observations. The nesting configuration ensures that topographical effects on meteorology are captured and that meteorology is well resolved and characterised across the boundaries of the inner domain.

Twenty-seven vertical levels are modelled in each nest from 10 m to 5 000 m, with a finer resolution in the lowest 1 000 m. The vertical levels are 10, 25, 50, 75, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 3000, 3500, 4000, 4500 and 5000 m.

The 3-dimensional TAPM meteorological output on the inner grid include hourly wind speed and direction, temperature, relative humidity, total solar radiation, net radiation, sensible heat flux, evaporative heat flux, convective velocity scale, precipitation, mixing height, friction velocity and Obukhov length. The spatially and temporally resolved TAPM surface and upper air meteorological data is used as input to the CALPUFF meteorological pre-processor, CALMET.

CALPUFF

The CALMET grid (light blue square in Figure 8), which is 900 km^2 is 30 km (west-east) by 30 km (north-south). It is a subdomain of the TAPM inner grid and is centred on Acacia Power Station. It consists of a uniformly spaced receptor grid with 500 m spacing, giving 3 600 grid cells (60 X 60 grid cells). The CALPUFF modelling domain is the same as the CALMET modelling domain and is based on a similar grid structure.

The topographical and land use for the respective modelling domains is obtained from the dataset accompanying the CSIRO's The Air Pollution Model (TAPM) modelling package. This dataset includes global terrain elevation and land use classification data on a longitude/latitude grid at 30-second grid spacing from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Centre Distributed Active Archive Centre (EDC DAAC).

Figure 8: TAPM and CALPUFF modelling domains for Acacia, showing the relative locations of the meteorological stations

The parameterisation of key variables that are applied in CALMET and CALPUFF are indicated in Table 11 and Table 12.

Table 11: Parameterisation of key variables for CALMET

Parameter	Model value
12 vertical cell face heights (m)	0, 20, 40, 80, 160, 320, 640, 1000, 1500, 2000, 2500, 3000, 4000
Coriolis parameter (per second)	0.0001
Empirical constants for mixing height equation	Neutral, mechanical: 1.41 Convective: 0.15 Stable: 2400 Overwater, mechanical: 0.12
Minimum potential temperature lapse rate (K/m)	0.001
Depth of layer above convective mixing height through which lapse rate is computed (m)	200
Wind field model	Diagnostic wind module
Surface wind extrapolation	Similarity theory
Restrictions on extrapolation of surface data	No extrapolation as modelled upper air data field is applied
Radius of influence of terrain features (km)	5
Radius of influence of surface stations (km)	Not used as continuous surface data field is applied
Conversion of NO_x to NO_2	75%

Table 12: Parameterisation of key variables for CALPUFF

Parameter	Model value
Chemical transformation	Default NO_2 conversion factor of 0.75 is applied (DEA, 2012c).
Wind speed profile	Rural
Calm conditions	Wind speed < 0.5 m/s
Plume rise	Transitional plume rise, stack tip downwash, and partial plume penetration is modelled
Dispersion	CALPUFF used in PUFF mode
Dispersion option	Dispersion coefficients use turbulence computed from micrometeorology
Terrain adjustment method	Partial plume path adjustment

5.3.3 Model accuracy

Air quality models attempt to predict ambient concentrations based on “known” or measured parameters, such as wind speed, temperature profiles, solar radiation and emissions. There are however, variations in the parameters that are not measured, the so-called “unknown” parameters as well as unresolved details of atmospheric turbulent flow. Variations in these “unknown” parameters can result in deviations of the predicted concentrations of the same event, even though the “known” parameters are fixed.

There are also “reducible” uncertainties that result from inaccuracies in the model, errors in input values and errors in the measured concentrations. These might include poor quality or unrepresentative meteorological, geophysical and source emission data, errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. “Reducible” uncertainties can be controlled or minimised. This is achieved by making use of the most appropriate input data, preparing the input files correctly, checking and rechecking for errors, correcting for odd model behaviour, ensuring that the errors in the measured data are minimised and applying appropriate model physics.

Models recommended in the DEA dispersion modelling guideline (DEA, 2012b) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). It is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

For Acacia Power Station the reducible uncertainty in CALMET and CALPUFF is minimised by:

- Using representative quality controlled observed hourly meteorological data to nudge the meteorological processor to the actual values;
- Using 3-years of spatially and temporally continuous surface and upper air meteorological data field for the modelling domain;
- Appropriate parameterisation of both models (Tables 11 and 12);
- Using representative emission data;
- Applying representative background concentrations to include the contribution of other sources;
- Using a competent modelling team with considerable experience using CALPUFF; and,
- For the most part NO_2 concentrations were over predicted by the model (in some cases the predictions were considerably higher than the measured values) which seems attributable to the rate assumed for the modelling at which NO_x would be converted to NO_2.

5.4 Modelled ambient concentrations

Emissions for two operational scenarios are calculated for Acacia Power Station:

Scenario 1: Actual emissions for 2012, taking into account the load factor (number of operating hours) of the power station.

Scenario 2: Requested emission limits: Emissions that Eskom believe are achievable at Acacia. It is assumed that emissions are continually at the requested limit, to show the worst case scenario.

Emission concentrations and rates for NO_2, SO_2 and PM_{10} for these scenarios are listed in Table 13.

Table 13: Current actual emissions and Eskom's requested emission limits for Acacia Power Station

Pollutant	Source	Scenario 1: Current actual emissions	Scenario 2: Proposed emission limits
		Rate (g/s)	Concentration (mg/Nm³)
NO_X	Stacks 1-6	33.71	750
SO_2	Stacks 1-6	22.36	500
PM_{10}	Stacks 1-6	0.46	50

Note for Scenario 1 the units operate in batch mode as demand requires. Actual emissions for 2012 were calculated from the total operational time of 52.5 hours and total fuel consumption of 2 218 kl for the year. Average operational time in 2012 was 4.4 hours per month. For Scenario 2 all units are assumed to operate continuously.

Acacia Power Station complies with Minimum Emission Standards for existing and new plants (Table 4) for SO_2 and PM_{10}. These pollutants are not assessed in this AIR, i.e. only NO_x emissions are assessed.

5.4.1 Modelled operational scenarios

The predicted maximum hourly ambient NO_2 concentrations from the dispersion modelling for Actual Emissions (Scenario 1) and the 99th percentile predicted ambient NO_2 concentrations for the Requested Emission Limits (Scenario 2) at Acacia are presented as isopleths over the modelling domain. The DEA (2012) recommend the 99th percentile concentrations for short-term assessment with the NAAQS since the highest predicted ground-level concentrations can be considered outliers due to complex variability of meteorological processes. The assessment is based on a comparison between the predicted 99th percentile values and the corresponding NAAQS.

The predicted annual average concentration and predicted maximum 1-hour concentration at the points of maximum ground-level impact for Scenario 1 and the predicted annual average concentration and the 99th percentile concentration at the points of maximum ground-level impact for the Requested Emission Limits (Scenario 2) are presented in Table 14.

Table 14: Predicted annual average and predicted maximum 1-hour concentration at the points of maximum ground-level impact for Actual Emissions (Scenario 1) and the predicted annual average and the 99th percentile hourly concentration at the points of maximum ground-level impact for the Requested Emission Limits (Scenario 2).

	NO_2 (µg/m^3)		
	Scenario 1: Current Actual Emissions (based on maximum concentrations)	Scenario 2: Requested Emission Limits (based on 99th percentile concentrations)	NAAQS Limit Values (µg/m^3)
1-hour	129	111	200
Annual	0.04	11	40

5.5 Scenario 1: Current actual emissions

5.5.1 Nitrogen dioxide

For current emissions at Acacia the predicted annual average NO_2 concentration (which is 0.04 µg/m^3 at the point of highest impact in the domain) is significantly less than the NO_2 NAAQS of 40 µg/m^3 (Figure 9, Table 14). At the point of maximum ground-level impact, the predicted maximum 1-hour NO_2 concentration is 129 µg/m^3, which is well below the NAAQS of 200 µg/m^3 (Figure 10, Table 14).

Figure 9: Annual average NO_2 concentrations resulting from current actual emissions for Acacia (Scenario 1)

Figure 10: Maximum concentration of the predicted hourly NO_2 concentrations resulting from current actual emissions for Acacia (Scenario 1)

5.6 Requested NO_x emission limit: Annual and 99th percentile concentrations

In this scenario, it was assumed that emissions were continuous at the emission limit, although in fact Acacia Power Station only operates for a few days a year, at most. For these requested emission limits at Acacia the predicted annual average NO_2 concentration (which is 11 µg/m^3 at the point of highest impact in the domain) is significantly less than the NO_2 NAAQS of 40 µg/m^3 (Figure 11 and Table 14). At the point of maximum ground-level impact, the predicted 99th percentile 1-hour concentration for NO_2 is 111 µg/m^3, which is well below the NAAQS limit value of 200 µg/m^3 (Figure 12 and Table 14).

Figure 11: Annual average NO_2 concentrations resulting from Eskom's requested emission limits for Acacia Power Station (Scenario 2)

Figure 12: 99th percentile concentration of the predicted hourly NO_2 concentrations resulting from Eskom's requested emissions for Acacia Power Station

5.7 Analysis of Emissions' Impact on Human Health

5.7.1 Potential health effects

As previously described, although atmospheric emissions from Acacia include SO_2 and PM, the application for postponement of the MES at Acacia, is only for NO_X. As such only NO_2 is considered here in terms of its potential impact on human health and the environment.

Nitrogen dioxide (NO_2)

Exposure to NO_2 is typically inhalation and the seriousness of the effects depend more on the concentration than on the length of exposure. The site of deposition for NO_2 is the distal lung where NO_2 reacts with moisture in the fluids of the respiratory tract to form nitrous and nitric acids. About 80 to 90% of inhaled nitrogen dioxide is absorbed through the lungs (CCINFO, 1998). Nitrogen dioxide (present in the blood as the nitrite ion) oxidises unsaturated membrane lipids and proteins, which then results in the loss of control of cell permeability. Nitrogen dioxide caused decrements in lung function, particularly increased airway resistance. People with chronic respiratory problems and people who work or exercise outside will be more at risk to NO_2 exposure (EAE, 2006).

5.7.2 Analysis

The potential impacts on human health have been assessed in this report by comparing the measured and predicted ambient air quality with the published NAAQS. It can be seen from the measured ambient air quality measurements that NO_2 concentrations comply with the NAAQS for the various averaging periods. Ambient air quality concentrations predicted using a dispersion model are seen to comply with the NAAQS for NO_2 for both current and the requested emissions. Drawing conclusions about the potential human health effects of these concentrations is not straight forward but the following can be stated with a reasonable degree of confidence:

Nitrogen oxides

Both measured and predicted ambient NO_2 concentrations for current and requested emissions from Acacia, are seen to be fully compliant with the NAAQS, and ambient monitoring shows that there is currently compliance with ambient NO_2 NAAQS in the vicinity of Acacia. While it cannot be argued that there is no health risk, the health risk posed by NO_x emissions must be considered permissible. It is also interesting to note that the load factor on Acacia (number of hours operated) is simply too low to result in non-compliance even were there to be predicted non-compliances. The NAAQS allows some 88 hourly exceedances of the limit value year per annum, but Acacia has never yet operated for 88 hours in a year (some 75 hours in 2012/13) neither is it likely to do so. The risk to human health posed by emissions from Acacia are thus considered negligible and, as importantly, compliance with the MES will make not make a material difference to that risk.

5.8 Analysis of Emissions' Impact on the Environment

In terms of impact on the environment, NO_2 does pose the risk of a variety of potential non-health impacts. Of these impacts dry and wet acid deposition is considered to be the most significant but there are also concerns around potential impacts on vegetation and fauna. The most challenging part of assessing such impacts is the absence of defined damage thresholds (i.e. defined concentrations at which damage is known to occur) especially in a regulatory sense. As a result the assumption that is made here is that if there is compliance with the NAAQS that the damage risk will be considered permissible. The NO_x emissions from Acacia and the predicted ambient concentrations of NO_2 are so low that the risk of non-health related impacts on the environment is negligible.

6. Complaints

Acacia Power Stations does maintain a Complaints register. Any complaints that are received by the power station are recorded in this register. Complaints are presented in Table 15.

Table 15: Complaints register for Acacia Power Station

Date	Nature of the complaint	Source of the complaint	Response measures taken
20-Mar-13	Complainant has noticed substantial increase in activity from the power station and has seen a huge increase in emissions. After speaking with residents he realized they are suffering respiratory health issues, his girlfriend has a persistent wet cough.	Savoy Close, Edgemead	The complaint has been forwarded to APS by the City of Cape Town's Air Quality Department and the complainant wishes to remain anonymous at this stage. A response has been sent through to the Air Quality Centre of Excellence
18-Sep-13	The City of Cape Town officials came to Acacia Power Station to discuss a complaint they received enquiring about the station decommissioning and also complaining about noise and air pollution. On discussion it emerged that the resident had experienced the	E-mail from the COCI's meeting	The City of cape Town officials were asked to get the specifics of the complaint in order for Acacia Power Station to respond accordingly. The plant had not operated that much in August 2013 which is the time under review. The station is still awaiting specific dates and times

	noise/ air pollution about three weeks ago.		regarding the complaint (ie. when the discomfort was experienced)
27-Nov-13	Complaint about the smells and fumes from the burners at Acacia Power Station. The main concern is health related and also related to the values of the affected properties in the area.	Stuart Ridley (Edgemead resident)	Eskom sent out a letter communicating reasons as to why the power stations activities do not pose a risk to the communities
13-Nov-13	Houses in Edgemead had to be evacuated due to the fumes experienced. Three years ago it was communicated in public participation that Acacia Power Station would be decommissioned, but it is still running. Complainant plans to oppose the Exemption/ Postponement application from the Minimum Emission Standards	Mr Vos	A media holding statement was prepared to address the concerns

7. Current or planned air quality management interventions

Not applicable.

8. Compliance and Enforcement History

No compliance and enforcement actions have been undertaken against Eskom's Acacia Power Station within the last five years.

9. Additional Information

No additional information is necessary.

10. Summary and Conclusion

Eskom's liquid fuel-fired Acacia power station in Cape Town in the Western Cape Province is a peaking plant with a generation capacity of 171 MW. Power generation is a Listed Activity in terms of Section 21 of the NEMAQA and as a result Acacia is required to comply with the prescribed MES for existing plants by 2015 and for new plants by 2020. SO_2 and PM emissions from Acacia already comply with the MES for both existing and new plants, but NO_x emissions will not comply with the new plant MES. Eskom has therefore applied for postponement of the new plant NO_x MES for Acacia and proposed an alternative emissions limit. The purpose of this AIR has been to assess the likely implications of that postponement and the requested alternative emissions limit for human health and the environment.

An analysis of measured ambient NO_2 concentrations indicates full compliance with the NAAQS for both the hourly and the annual averaging periods. Predicted ambient NO_2 concentrations (using a dispersion model) were also seen to be compliant with the NO_2 NAAQS for current NO_x emissions and the requested NO_x emission limit. Given that Acacia operated for less than 53 hours in 2012, and is expected to operate for similar timeframes in the future, the risk of non-compliance with the NAAQS is very low indeed, and the associated risk to human health and the environment, negligible.

11. References

CCINFO, (1998 and 2000): The Canadian Centre for Occupational Health and Safety database. http://ccinfoweb.ccohs.ca visited on 21 July 2003.

DEA, (2008): Proposed Regulations regarding the form of the Atmospheric Impact Report, as contemplated in Section 30 of the National Environmental Management: Air Quality Act, (Act No. 39 of 2004), Notice 619 of 2008, Government Gazette, 6 June 2008, No. 31107.

DEA, (2009): National Ambient Air Quality Standards, Government Gazette, 32861, Vol. 1210, 24 December 2009.

DEA, (2012a): National Ambient Air Quality Standard for Particulate Matter of Aerodynamic Diameter less than 2.5 micometers, Notice 486, 29 June 2012, Government Gazette, 35463.

DEA, (2012b): Guideline to Air Dispersion Modelling for Air Quality Management in South Africa, draft regulation.

DEA, (2013): Listed activities and associated minimum emission standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette Notice No. 893 of 22 November 2013.

DEA&DP (2010): Air Quality Management Plan for the Western Cape Province, Base Line Assessment, July 2009.

EAE, (2006): Encyclopaedia of the Atmospheric Environment, 2006, Nitrogen [Online], http://www.ace.mmu.ac.uk/eae/Air_Quality/Older/Nitrogen_Dioxide.html

Hurley, P. (2000): Verification of TAPM meteorological predictions in the Melbourne region for a winter and summer month. Australian Meteorological Magazine, 49, 97-107.

Hurley, P.J., Blockley, A. and Rayner, K. (2001): Verification of a prognostic meteorological and air pollution model for year-long predictions in the Kwinana industrial region of Western Australia. Atmospheric Environment, 35(10), 1871-1880.

Hurley, P.J., Physick, W.L. and Ashok, K.L. (2002): The Air Pollution Model (TAPM) Version 2, Part 21: summary of some verification studies, CSIRO Atmospheric Research Technical Paper No. 57, 46p.

Raghunandan, A., Scott, G., Zunckel, M. and Carter, W. (2007): TAPM verification in South Africa: modelling surface meteorology at Alexander Bay and Richards Bay. South African Journal of Science, in prep.

Schulze, B. R. (1980): Climate of South Africa. Part 8. General Survey, WB 28, Weather Bureau, Department of Transport, Pretoria, 330 pp.

uMoya-NILU (2013a): Plan of Study Report, in support of Eskom's application for exemption from the minimum emission standards and/or extension of the minimum emission standards compliance timeframes.

Wicking-Baird, M., De Villiers, G., and Dutkiewicz, R. K., (1997): Cape Town Brown Haze Study, Energy Research Institute.

WHO, (1999): Guidelines for Air Quality, World Health Organisation, http://www.who.int/peh/air/Airqualitygd.htm

WHO, (2000): Air Quality Guidelines for Europe, 2nd Edition, World Health Organisation, ISBN 92 890 1358 3.

WHO (2003): Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide. Report on a WHO Working Group Bonn, Germany 13-15 January 2003, WHO Geneva.

12. Formal Declarations