ANKERLIG POWER STATION CONVERSION OF THE

OPEN CYCLE GAS TURBINE UNITS

TO COMBINED CYCLE GAS TURBINE UNITS

AIR QUALITY IMPACT ASSESSMENT

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1. INTRODUCTION

Savannah Environmental (Pty) Ltd has appointed DDA in order to provide input regarding air pollution and noise to the Environmental Impact Assessment (EIA) phase for the conversion of the Ankerlig Power Station Open Cycle Gas Turbine (OCGT) units to Combined Cycle Gas Turbine (CCGT) units.

The air pollution associated with construction activities and the operation of Combined Cycle Gas Turbine units, which may impact on the surrounding areas to the power station and the Atlantis communities, is assessed in this report.

1.1 Study Area and Background

The Ankerlig Power Station is situated on the western side of the Atlantis Industrial Zone (see Figure 1-1). This area is located 7 km inland from the Cape West Coast, and is approximately 40 km north of Cape Town. The existing Ankerlig Power Station is approximately 10 km northeast of the Koeberg Nuclear Power Station.

Potentially sensitive receptors within the study area include:

- The residential township of Atlantis;
- The residential township of Mamre;
- The residential area of Malmesbury;
- The informal settlement of Witzand;
- The residential areas of Dynefontein and Melkbosstrand.
- Farms on Klein Dassenberg.

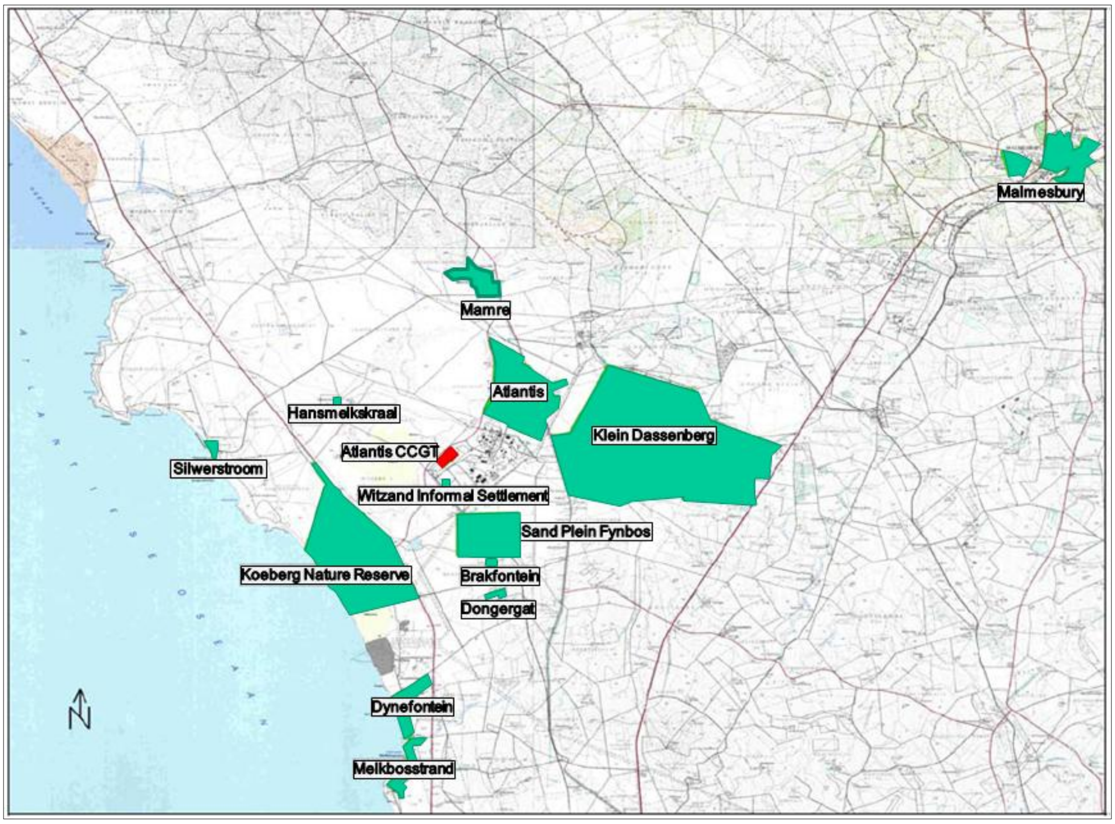

Figure 1-1 Locality Map

The Ankerlig Power Station provides peaking capacity to ESKOM's power grid. The power station utilises Open Cycle Gas Turbine (OCGT) technology for the generation of electricity. Currently, there are four operational units (first phase) and five under construction (second phase). Two air quality specialist studies covered the first and second phases of the OCGT project. The first study was conducted by CSIR (CSIR, 2005) and the second by Airshed Planning Professionals (AIRSHED, 2007). These studies will be referred to throughout the report.

The present study provides updating of the emissions and dispersion modelling estimations based on the original assumptions utilised in the previous studies, as well as in-stack measurement currently performed at the existing units.

1.2 Terms of Reference

The main goal of the study is to estimate the air quality impacts which may result due to the upgrade project. The secondary goal is to assess compliance with guidelines in the surrounding community. The study will cover the following:

- Identification of sensitive receptors that could be impacted upon by activities relating to operation of the proposed development.
- Dispersion simulation of various emission scenarios utilising diesel as well as natural gas as fuel.
- Estimation of the resulting ground level concentration for SO_2, NO_2, PM_{10} and VOCs due to the upgrading project.
- Assessment of the impacts based on comparisons of the results against relevant standards and guidelines.
- Assessment of the cumulative impacts due to the potential Acacia and Port Rex units' relocation.
- Recommendations regarding air pollution mitigation procedures and measures, if proven to be necessary.

2 METHODOLOGY

2.1 Dispersion Modelling

The dispersion calculations were performed using the US-EPA approved Industrial Source Complex 3 (ISC3) Short-Term Model for the prediction of the ground level 1-hourly, daily and annual concentrations of SO_2, NO_2, PM_{10} and VOCs.

Different emission scenarios were generated for the operational phase for the diesel and natural gas options as potential fuel.

Three full years (2004, 2005 and 2006) of hourly meteorological data from Koeberg's weather station were utilised for the assessment. The local meteorological conditions were parameterised for input into the model, and the worst-case scenario maximum concentrations were generated for each identified emission scenario.

These results were compared against South African and international air quality guidelines, such as from the World Health Organisation (WHO).

The operational emissions inventory was based partially on emission factors for similar operations utilised in previous studies, as well as actual in-stack measurements at the existing units.

Figure 2-1 below shows the location of the Ankerlig Power Station's existing Open Cycle Gas Turbine (OCGT) units and the Acacia relocation position.

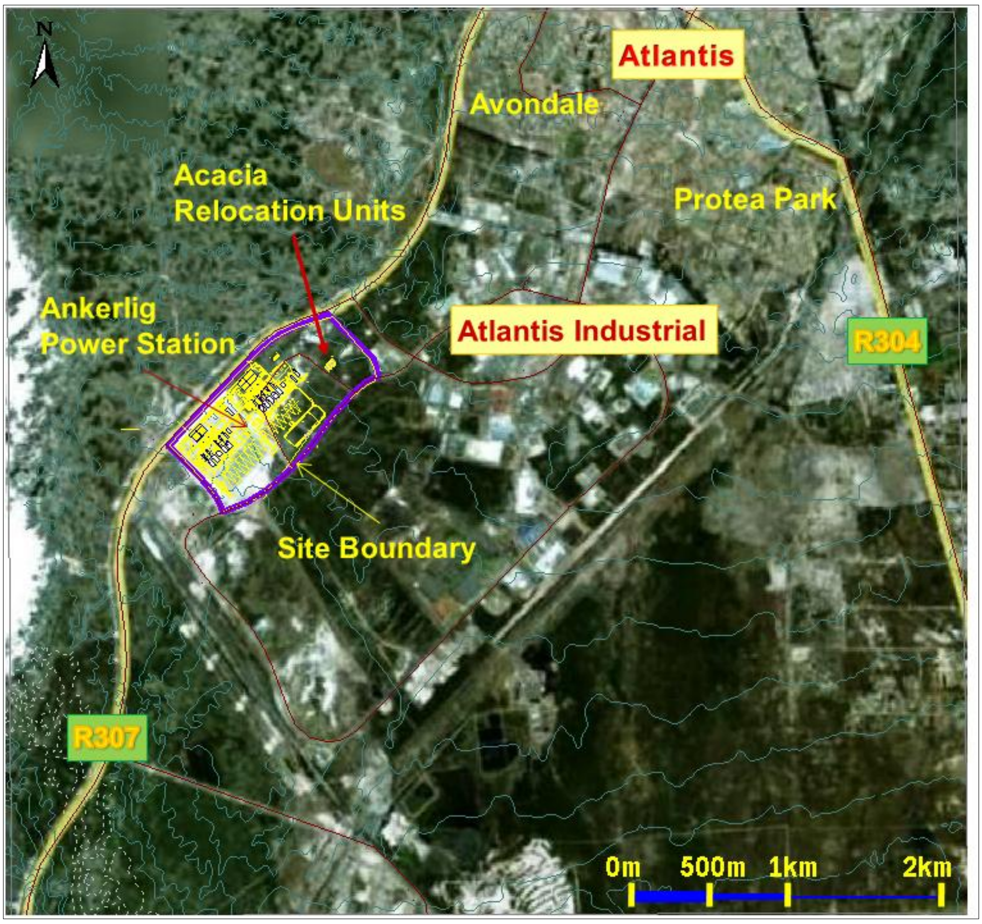

Figure 2-1. Site Layout

The dispersion calculations were performed on a grid extending 15 km in every direction from the Ankerlig Power Station. The resulting concentrations of each pollutant at the grid nodes were then utilised for the calculation of the ground level concentration contours around the site.

In addition to the contour plots, discrete receptors were positioned at the communities and sensitive receptors in the surrounding areas. These receptors, together with their distance from the Ankerlig Power Station, are presented in the following Table 2-1. The locations of these areas can be seen in Figure 1-1.

Table 2-1: Identified Sensitive Receptors

Receptor	Coordinates		Distance
	X	Y	(m)
Avondale	47578	16221	3.2
Beacon Hill	45797	15020	5.3
Brakfontein	48331	23412	5.4
Donkergat	48218	24996	6.9
Dynefontein	51385	29577	11.4
Hansmelkskraal	54337	15674	5.1
Klein Dassenberg	44368	17869	5.6
Klein Midlands	56945	10072	10.8
Koeberg Nature Reserve	53415	22658	5.6
Malmesbury	26695	4372	27.1
Mamre	48772	9818	8.6
Melkbosstrand	51372	33556	15.3
Protea Park	46589	16883	3.7
Robinvale	45857	15765	4.8
Sand Plein Fynbos	48632	22134	4.0
Saxonsea	47539	13962	5.0
Sherwood	46389	14376	5.3
Silwerstrooms	59201	17930	9.2
Wesfleur	48485	16081	2.7
Witzand	50044	19870	1.6

2.2 Dispersion Simulation Scenarios

For comparison purposes the future emission quantities were estimated for the following 4 scenarios, which included the cumulative impact of the Acacia Power Station relocation:

- **Scenario 1:** Combined cycle gas turbine units (9 units) with diesel as fuel.

- **Scenario 2:** Combined cycle gas turbine units (9 units) + Acacia units with diesel as fuel.
- **Scenario 3:** Combined cycle gas turbine units (9 units) with natural gas as fuel.
- **Scenario 4:** Combined cycle gas turbine units (9 units) with natural gas as fuel + Acacia units.

The main assumptions for the dispersion simulation scenarios were:

- Continuous operation of the Ankerlig units.
- Continuous operation of the Acacia and Port Rex units.

It should be noted that the above-mentioned assumptions are worst-case scenarios, since the operation of the Ankerlig units may only realistically reach 50% of their annual hourly availability. In addition, the Acacia units will be utilised for potential peaking demands and for the Koeberg Power Station start-up requirements. Therefore, the continuous operation assumption for these units also represents a worst-case scenario.

2.3 Emissions Inventory

In order to estimate the resulting concentrations of the pollutants emitted, the identification of emission sources and the quantification of each source's contribution is necessary. In the present study, the stack emission data was obtained from ESKOM, in terms of in-stack measurements and from the EPA AP-42 emission factor manual for diesel and natural gas fuel.

Table 2-2 shows the emission quantities in grams per second for each stack and fuel scenario. It should be noted that the previous air quality studies utilised NO_2 emissions based on worst-case maximum emission assumptions. In the present study, since actual in-stack measurements for NO_2 and CO were available for a whole year of operation, they were utilised instead. These emissions of NO_2 and CO represent the actual emission quantities from the Ankerlig units and are much lower than the ones assumed in the previous studies, i.e. 66.9 g/s of NO_2 and 36.5 g/s for CO. The actual emissions can be seen in Table 2-2.

The source characteristics utilised in the modelling are presented in Table 2-3 further below.

Table 2-2: OCGT Stack Emissions for a Single Unit

Pollutant	OCGT Units (Diesel)	CCGT Units (Diesel)	CCGT Units (Nat. Gas)	Acacia Units (Diesel)
	Emissions (g/s) per unit			
SO_2	11.11[a]	11.11[a]	0.13[d]	4.99[a]
NO_2	38.95[b]	38.95[b]	18.25[d]	15.96[e]
PM_{10}	10.37[c]	10.37[c]	1.65[d]	1.33[e]
CO	2.31[b]	2.31[b]	18.25[d]	3.33[e]
CO_2	37037.04[c]	37037.04[c]	26075.90[d]	16641.67[e]
VOC	0.50[c]	0.50[c]	1.20[d]	0.23[e]

[a] Based on the sulphur content of the fuel, 0.05%.
[b] Based on in-stack measurements (Nico Gewers, Eskom, 2008, Pers. Com.).
[c] Based on AP-42 emission factors for large units with low NOx burners using diesel (EPA, 2006).
[d] Based on AP-42 emission factors for large units with low NOx burners using natural gas (EPA, 2006).
[e] Based on AP-42 emission factors large units using diesel (EPA, 2006).

Table 2-3: Stack Characteristics of Gas Turbine Units

Stack Characteristics	Existing OCGT	Future CCGTs	Acacia and Port Rex Units[a]
Height (m)	30	60	14
Diameter (m)	6.1	6.1	3.7
Gas exit velocity (m/s)	23.2[b]	11.7[c]	20.0
Gas exit temperature (k)	833	422	813

[a] Emissions estimation study for Acacia Power Station (ECOSERVE, 2007).
[b] Based on in-stack measurements (Nico Gewers, Eskom, 2008, Pers. Com.).
[c] Based on volume calculations due to reduced exit temperature.

The cumulative effect of the vehicular traffic along the Dassenberg Drive (R307), Niel Hare and Charl Uys Roads were also taken into consideration.

The movements on the roadways were used for the calculation of the vehicle exhaust emissions. The variables utilised were distance travelled, vehicle speed and total number of vehicles. The speed-variable vehicular emission factors were obtained from the COPERT III program (EEA, Computer Program to Calculate Emissions from Road Transport, 1999).

The vehicle counts and emission rates estimated along the above-mentioned roads are presented in the table below. The traffic volumes were obtained from the review and update of the traffic impact study (ARUP, 2008), as well as the previous air quality study (Airshed, 2007).

The traffic generated by the power station's fuel requirements was based on a worst-case scenario of 252 fuel tankers per week (7 days), which equates to about 36 fuel tankers per day.

Table 2-4: Total Vehicle Counts Along the Various Routes Surrounding the Ankerlig Site

Road Sections	Heavy Duty Vehicles (HDV) (Diesel)		Passenger Vehicles (LDV) (Petrol)	
Dassenberg	987.59		6287.40	
Neil Hare 1	187.95		530.36	
Neil Hare 2	100.56		722.82	
Charl Uys	415.60		3463.60	
Total	**1691.70**		**11004.18**	
Road Sections	**am Peak**		**pm Peak**	
	HDV	**LDV**	**HDV**	**LDV**
Dassenberg	42	686	80	912
Neil Hare 1	28	123	41	153
Neil Hare 2	9	171	6	64
Charl Uys	19	357	50	502
Total	**98**	**1337**	**177**	**1631**

Table 2-5: Estimated Emissions Release Along Road Sections

Pollutants	Annual Emission Rates (t/a)			
	Dassenberg	**Neil Hare 1**	**Neil Hare 2**	**Charl Uys**
Carbon Monoxide	35.99	3.10	4.13	19.75
Sulphur Dioxide	0.63	0.12	0.06	0.27
Oxides of Nitrogen	9.59	1.07	1.07	4.97
Volatile Organic Compounds	3.14	0.29	0.36	1.68
Particulate Matter	0.15	0.03	0.02	0.06

Small amounts of volatile organic compounds are also expected to be emitted from the diesel and propane storage tanks on site. These emission estimations were based on the "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources" (AP-42), Section 7.1, Organic

Liquid Storage Tanks (US-EPA, 2006) and the use of the US-EPA emissions inventory model TANKS 4.0.9d (US-EPA, 2006).

Table 2-6 summarises the source characteristics and emission rates estimated for these sources. As can be seen, the emitted VOC quantities are very small and are not expected to have any significant contribution to the ground level concentrations. They were, however, utilised in the dispersion modelling.

Table 2-6: Storage Tank Source Characteristics and Emission Rates.

Storage	Shell Height (m)	Diameter (m)	Working Volume (l)	Total VOC's (kg/a) per Tank	Number of Tanks
Diesel	21	6.1	21,600	91.6	4
Propane Gas	8.7	5.3	3,900	0.231	3

2.4 Meteorological Parameters

Turbulent, high-velocity winds such as pre-cold front north-westerly winds help to both dilute air pollutants at their source and disperse them as they travel downwind, whereas gentle breezes under stable atmospheric conditions do little to dilute or disperse air pollution.

Cold, gentle winds flow down slope on calm nights under clear skies, also flowing into hollows and into and down valleys. Such winds travel at less than 1 metre per second. Walls, steep embankments and tree plantations can impede this air and mix it with the air above it, so helping to reduce the impact on air quality.

The minimum requirements for dispersion modelling are knowledge of the wind speed, wind direction, atmospheric turbulence parameters, the ambient temperature, as well as the mixing height. The atmospheric boundary during the day is normally unstable, as a result of the sun's heating effect on the earth's surface. The thickness of the mixing height depends strongly on solar radiation, amongst other parameters. This mixing layer gradually increases in height from sunrise, to reach a maximum at about five to six hours after sunrise. Cloudy conditions, surface and upper air temperatures also affect the final mixing height and its growth. During these conditions, dispersion plumes can be trapped in this layer and result in high ground-level concentrations. This dispersion process is known as Fumigation and is more pronounced during the winter months due to strong night-time inversions, weak wind conditions and slower developing mixing layers.

Dispersion models also require the atmospheric condition to be categorised as one of six stability classes, which are:

Table 2-7. Meteorological Conditions Represented by the Stability Categories.

Stability Category	Meteorological Conditions	Occurrence
A	Very Unstable	Hot daytime conditions, clear skies, calm wind
B	Unstable	Daytime conditions, clear skies
C	Slightly Unstable	Daytime conditions, moderate winds, slightly overcast
D	Neutral	Day and night, high winds or cloudy conditions
E	Stable	Night-time, moderate winds, slightly overcast conditions
F	Very Stable	Night-time, low winds, clear skies, cold conditions

Hourly meteorological data was obtained from Koeberg's weather station for the beginning of 2004 to the end of 2006. The cloud cover for the same time period was obtained from the Cape Town International Airport's weather station.

In order to determine the worst-case scenarios for the most probable weather combinations and their related dispersion characteristics for the modelling simulation, the 2004, 2005 and 2006 data was combined and analysed in one data pool.

Figure 2-2 depicts the wind roses of all hours, daytime and night-time of the combined 2004 to 2006 weather data. The all-hours wind rose clearly illustrates that the most predominant wind in the area is from the southerly direction, with an occurrence of approximately 27% of the time. The second most predominant direction is the north-north-westerly. The daytime and night-time wind patterns were slightly different. During the night, the northerly direction was the most frequent reaching 16%, while during daytime the most predominant was the southerly direction reaching 17%.

From the wind speed frequency distributions in Figure 2-3, it is evident that the night-time wind speeds demonstrate lower ranges than the daytime. During night-time the wind speeds are primarily below 3 m/s, with only 6.2% being above 5 m/s. During daytime, most of the wind speeds were between 3 m/s and 5 m/s, and more than 26% of the hourly values were above 5 m/s.

It is important to note that calm or light wind conditions with speeds below 1m/s accounted for only 1.7% of the total hours. These calm wind conditions were more predominant during the night-time, reaching approximately 2.9% (refer to Figure 2-3).

The summer and winter wind patterns are shown in Figure 2-4. Summer winds are generally higher than the winter ones and blow mainly from the south and south-south-westerly directions (24% and 17%). In winter the northerly winds dominate, where the north wind has a frequency of 15%. The frequency of the south and south-south-westerly winds is below 5%.

As can be seen from Figure 2-5 during the winter-time, calm wind conditions have the highest frequency (2%), which translates to poor dispersion of pollutants. This, in conjunction with the low height and strong temperature inversions, could be a cause for high ground level concentrations close to emission locations. In general, winter-time winds are between 1m/s and 3m/s, with their frequency reaching 58% of the time. During summer, the winds are predominantly between 3m/s and 7m/s.

The atmospheric stability category for each hour of the three years was calculated, using the wind speed and solar radiation method. Figure 2-6 shows the stability frequencies for the years 2004 to 2006. The atmospheric condition with the highest frequency was Neutral (D), which occurred 41% of the time. A Stable atmosphere (F) was the second most frequent atmospheric condition.

The atmospheric stability was also examined in terms of winter and summer patterns. It is evident that during winter the atmospheric conditions Neutral (D) and Very Stable (F) dominated, each occurring 35% of the time. During summer the Neutral condition had the highest occurrence of 52%, primarily due to the high winds.

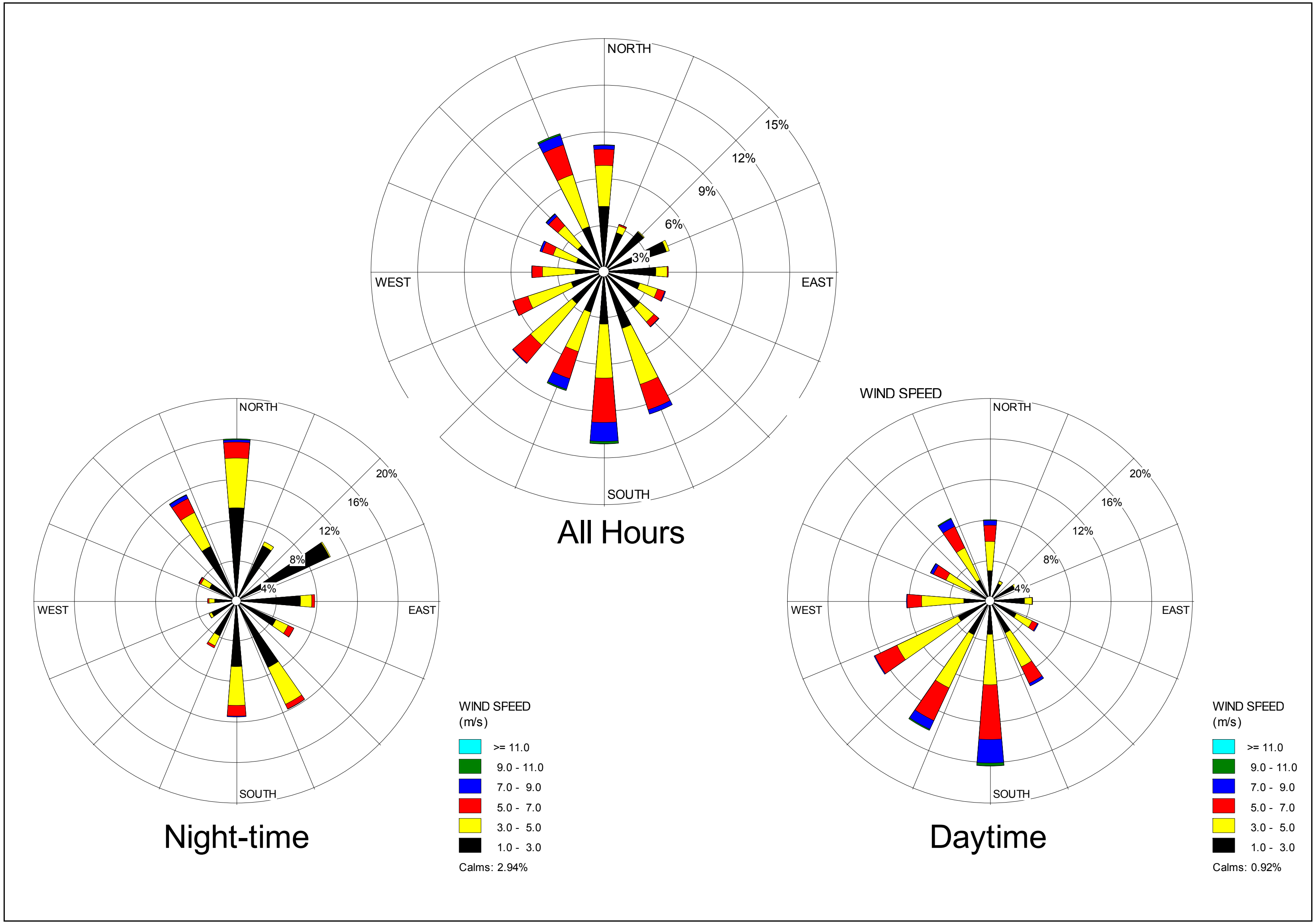

Figure 2-2. Wind Roses for Combined Years 2004 to 2006: All-hours, Daytime and Night-time

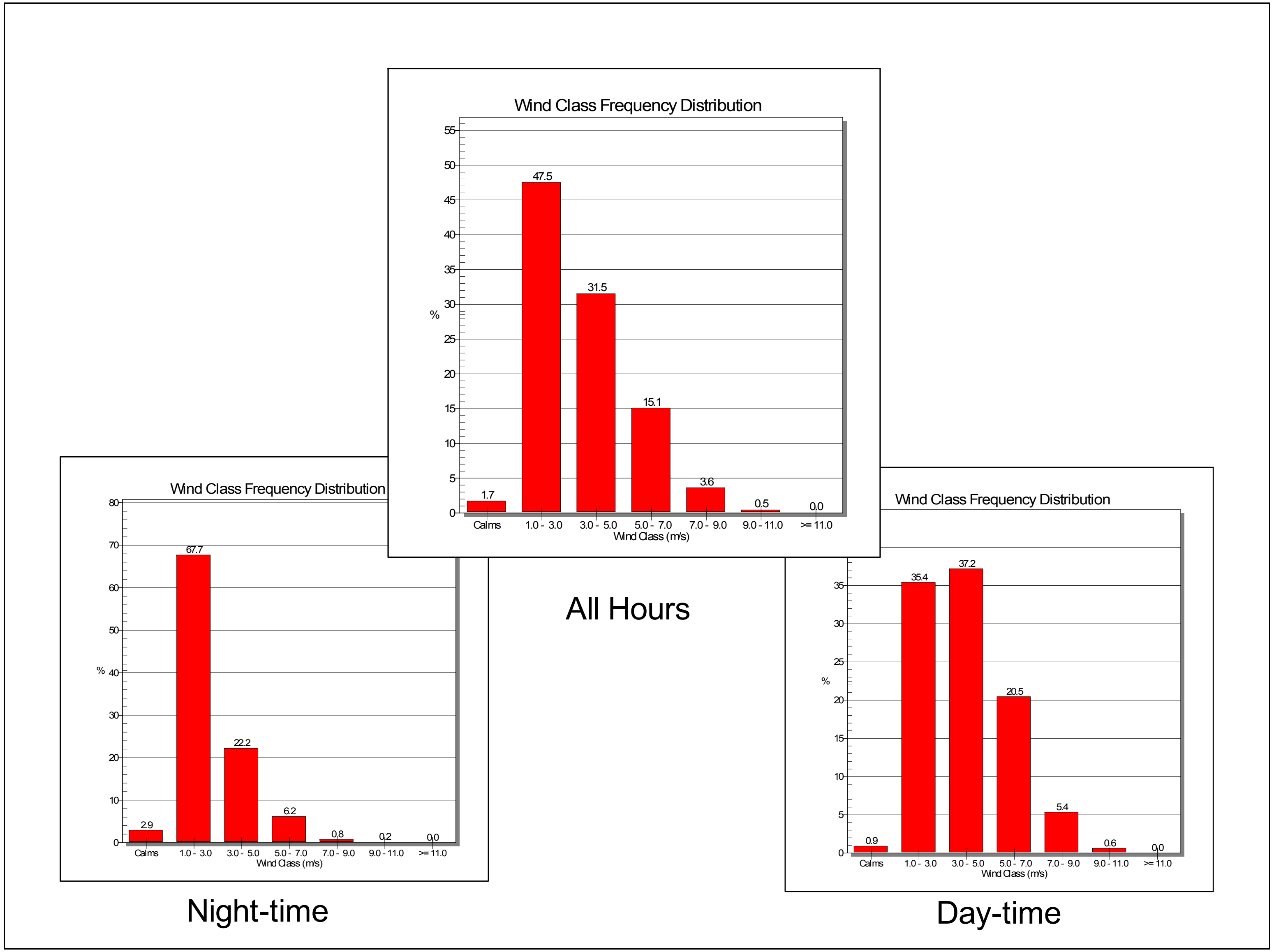

Figure 2-3. Wind Speed Frequency Distribution for Combined Years 2004 to 2006: All-hours, Daytime and Night-time

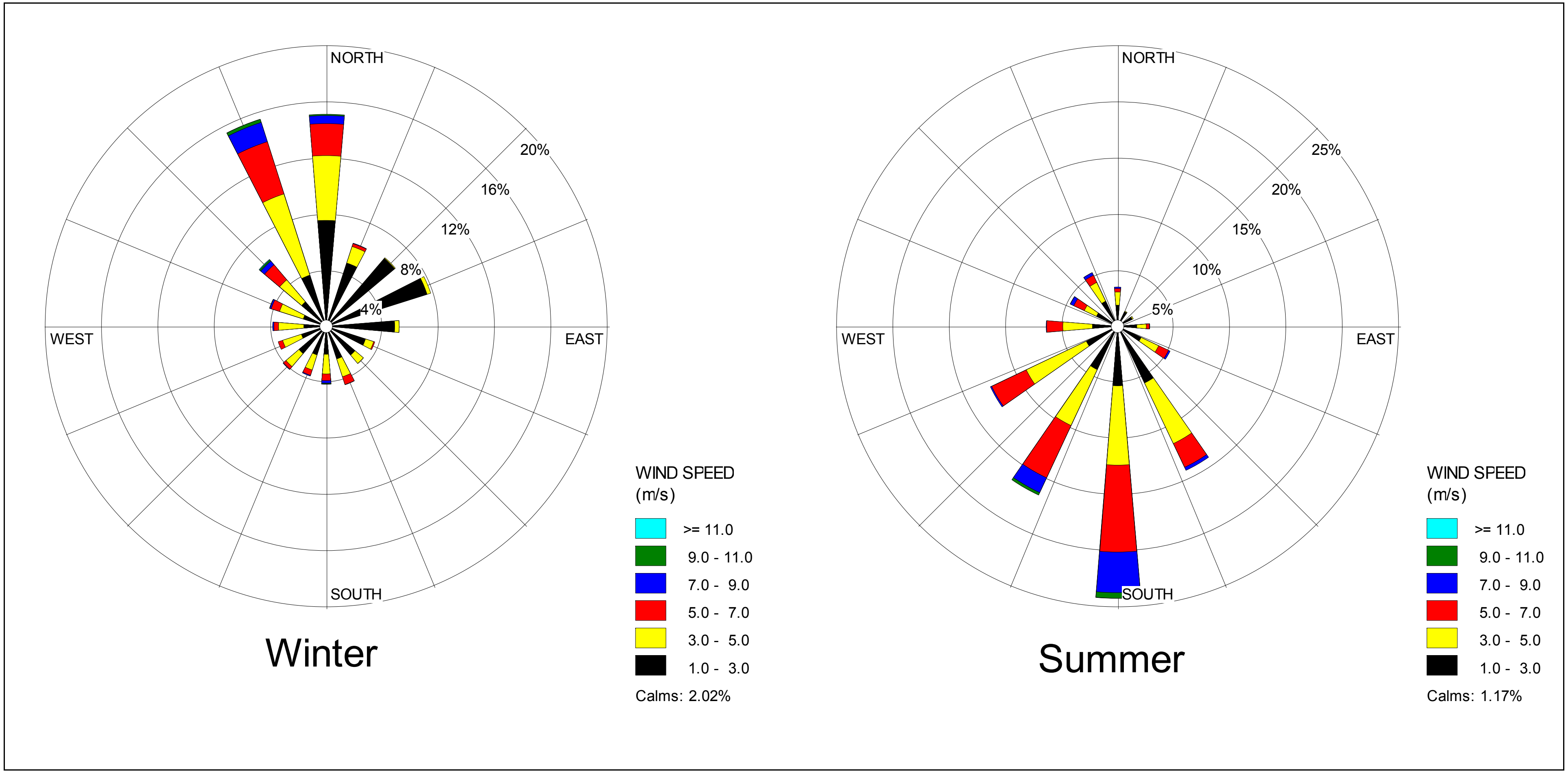

Figure 2-4. Wind Roses for Combined Years 2004 to 2006: Winter and Summer

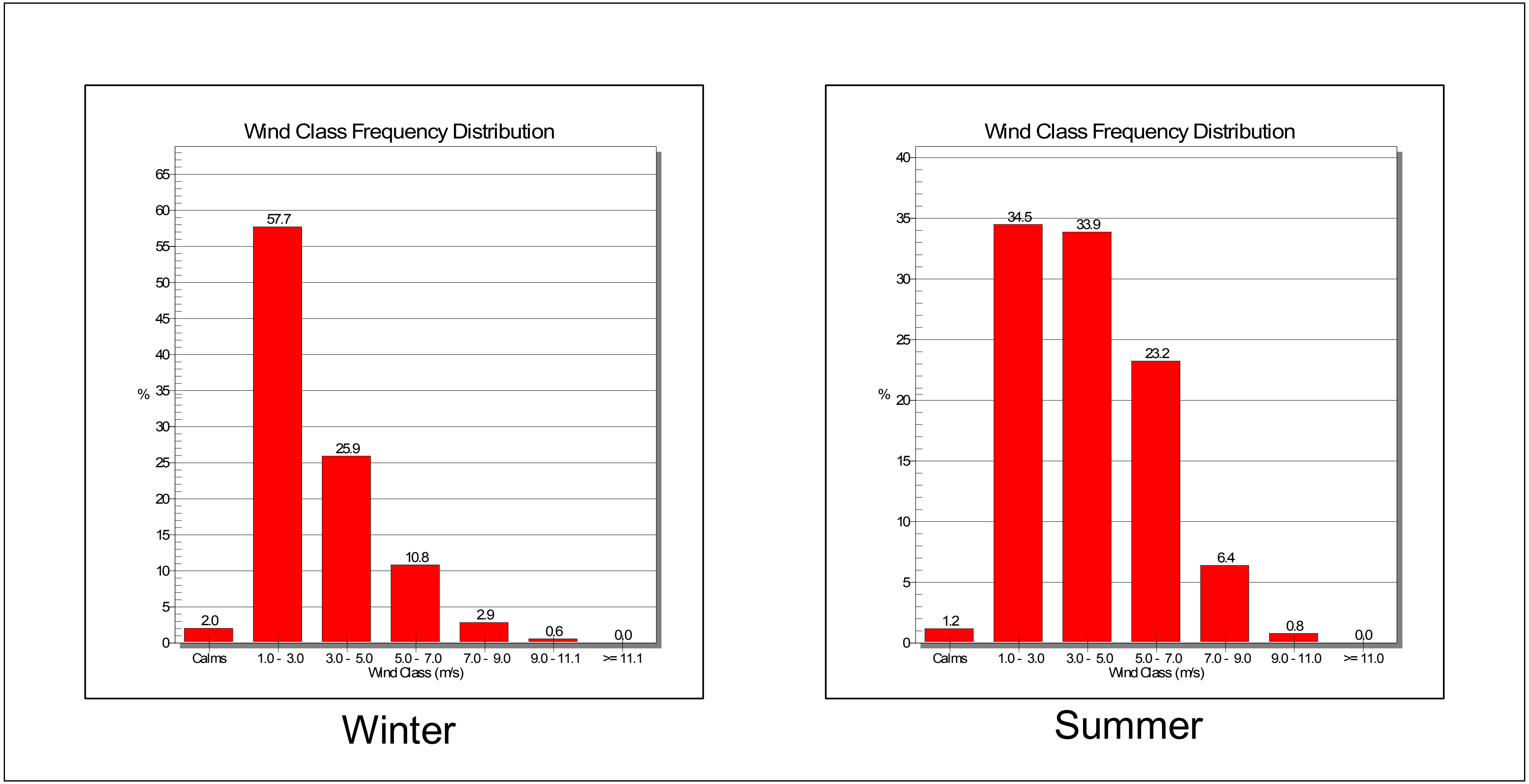

Figure 2-5. Wind Speed Frequency Distribution for Combined Years 2004 to 2006: Winter and Summer

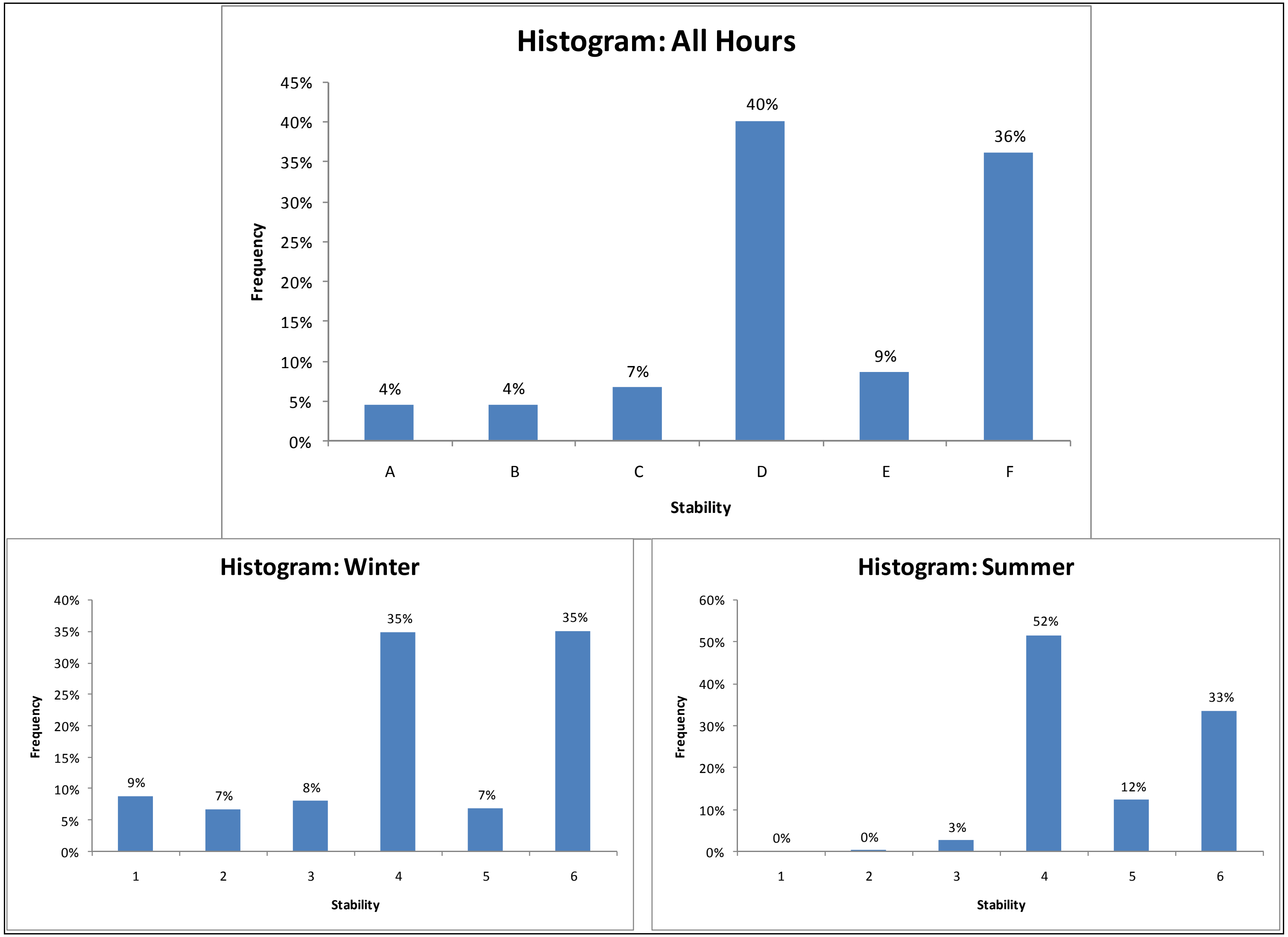

Figure 2-6. Atmospheric Stability Frequency Distribution for Combined Years 2004 to 2006: All-hours, Winter and Summer

2.5 Ambient Air Quality Standards and Guidelines

The ambient air quality in South Africa is regulated in accordance with the National Environmental Management: Air Quality Act, 2004. This Act specifies the ambient air quality standards for PM_{10}, sulphur dioxide, nitrogen oxides, etc. These standards together with the World Health Organisation (WHO), the European Commission (EC), the United Kingdom (UK) and WORLD BANK guidelines are presented in the following tables.

Table 2-8. Ambient Sulphur Dioxide Concentration Guidelines and Standards

Country/Organisation	Annual Average	Max. Daily Average	Max. Hourly Average
	(µg/m^3)	(µg/m^3)	(µg/m^3)
DEAT Guidelines	50	125	
SANS Standard (1)	50	125	
WHO	50 (2) 10-30 (3)	125 (2)	350 (7)
EC	20 (4)	125 (5)	350 (8)
UK	20 (4)	125 (5)	350 (8)
World Bank	50 (6)	125 (6)	

(1) SANS (2004). South African National Standards: Ambient air quality – Limits for common pollutants. SANS 1929:2005.
(2) Air quality guidelines for the protection of human health (WHO, 2000).
(3) Critical level for ecotoxic effects. The range accounts for different sensitivities of vegetation types.
(4) Limit value to protect ecosystems, Air Quality Framework Directive 96/62/EC.
(5) Limit to protect health. Not to be exceeded more than 3 times per calendar year.
(6) Ambient air concentration permissible at property boundary.
(7) WHO 1994. Derived from the 10-min limit.
(8) To be complied with by 1 January 2005. Not to be exceeded more than 24 times per calendar year.
Note1: The SANS 10-min guideline is: 500 µg/m^3.
Note2: The UK 15-min guideline is: 266 µg/m^3. Not to be exceeded more than 35 times a year.

Table 2-9. Ambient Nitrogen Dioxide Concentration Guidelines and Standards

Country/Organisation	Annual Average (µg/m³)	Max. Daily Average (µg/m³)	Max. Hourly Average (µg/m³)
DEAT Guidelines	96	191	382
SANS Standard (1)	40	-	200
WHO	40	150	200
EC	40 (2)	-	200 (3)
UK	40 (4)	-	200 (5)
US EPA	100	-	-

(1) SANS (2004). South African National Standards: Ambient air quality – Limits for common pollutants. SANS 1929:2005.
(2) Annual limit value for the protection of human health. To be complied with by 1 January 2010.
(3) 98th percentile of averaging periods. To be complied with by 1 January 2010.
(4) Annual mean.
(5) Not to be exceeded more than 18 times a year

Table 2-10. Ambient PM_{10} Concentration Guidelines and Standards

Country/Organisation	Annual Average (µg/m³)	Max. Daily Average (µg/m³)	Max. Hourly Average (µg/m³)
DEAT Guidelines	60	180	-
SANS Standard (1)	40	75	-
WHO (2)	n/a	n/a	-
EC	30 (3)	50 (4)	-
UK	40	50 (6)	-
US EPA	50 (5)	150	-

(1) SANS (2004). South African National Standards: Ambient air quality – Limits for common pollutants. SANS 1929:2005.
(2) WHO abandoned PM_{10} threshold levels. Instead, exposure-effect information is supported.
(3) To be complied with by 2005 and not to be exceeded more than 25 times per year.
(4) To be complied with by 2005.
(5) Not to be exceeded more than once for a three-year annual average.
(6) Not to be exceeded more than 35 times a year

Table 2-11. Ambient CO Concentration Guidelines and Standards

Country/Organisation	Max. 8-hour Average ($\mu g/m^3$)	Max. 1-hour Average ($\mu g/m^3$)
DEAT Guidelines	10,000	40,000
SANS Standard	-	30,000
WHO	10,000	30,000
UK	11,600 [(1)]	-
US EPA	10,000	40,000
[(1)] Running 8-hour mean.		

No standards or guidelines exist for exposure to volatile organic compounds (VOCs) in non-industrial settings. However, a number of indoor exposure limits have been recommended. Two possible approaches for deriving indoor air quality guidelines for VOCs (excluding formaldehyde and carcinogenic VOCs) have been proposed (Molhave 1990; Seifert, 1990). These approaches are outlined in Table 2-12.

The approach used by Molhave (1990) summarised field investigations and controlled experiments on the relation between low levels of indoor air pollution with volatile organic compounds (VOC) and human health and comfort. Molhave suggested four exposure ranges of increasing concern. The concentrations were measured by gas chromatograph (GC) techniques and a flame ionisation detector calibrated against toluene. The ranges were: a comfort range (< 0.2mg/m^3), a multifactorial exposure range (0.2-3 mg/m^3), a discomfort range (3-25 mglm^3) and a toxic range (> 25 mg/m^3).

In the approach suggested by Seifert (1990), empirical data from a field study in German homes was utilised to estimate an upper concentration of TVOC which is not normally exceeded. Based on this empirical data, Seifert proposed that 300 µg/m^3 of TVOC (the average value of the study) should not be exceeded. If this TVOC concentration was apportioned to different chemical classes, then the following concentrations resulted: 100 µg/m3 for alkanes, 50 µg/m3 for aromatics, 30 µg/m3 for terpenes, 30 µg/m3 for halocarbons, 20 µg/m3 for esters, 20 µg/m3 for carbonyls (excluding formaldehyde) and 50 µg/m3 for "other". Furthermore, Seifert proposed that no individual compound should exceed 50% of the average value of its class or exceed 10% of the measured TVOC value. The values were not based on toxicological considerations, but on a judgement about which levels are reasonably achievable.

For the present study, the tentative guideline for VOC's in non-industrial indoor environments of 200 µg/m^3 is adopted as the no-effect level. This value will be used as a screening level. If the VOC concentrations exceed this value then a more detailed, compound-based approach is to be recommended.

Table 2-12. Health Risks and Effects of Total VOCs:

Source	Effect Description	Range or Typical Hourly Value (mg/m^3)
Indoor air pollution ranges taken from Molhave, 1990: 'Volatile organic compounds, indoor air quality and health'	None	< 0.20
	Irritation and discomfort if other exposures also interact	0.20 - 3.0
	Discomfort, headache, if other exposures interact	3.0 - 25
	Toxic effects	> 25
Indoor air pollution taken from Seifert ,1990	discomfort from total VOC	> 0.3
	discomfort from total alkanes	> 0.1

2.6 Air Quality Impact Assessment of Significance – Method

The significance of potential environmental impacts identified will be determined using the following approach, taking into consideration the following aspects:

a) Probability of occurrence

b) Duration of occurrence

a) Magnitude of impact

b) Scale/extent of impact

In order to assess each of these factors for each impact, ranking scales were employed as follows:

Table 2-13. Air Quality Impact Ranking Scales

Probability:	**Duration:**
5 – Definite	5 - Permanent
4 - Highly probable	4 - Long-term (> 15 years)
3 – Probable	3 - Medium-term (5-15 years)
2 - Improbable	2 - Short-term (2-5 years)
1 - Very improbable	1 - Immediate (0 -1 years)
Extent:	**Magnitude:**
5 - International	10 - Very high
4 - National	8 – High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
	0 - None

Once the above factors had been ranked for each impact, the overall risk (environmental significance) of each impact will be assessed using the following formula:

S = (*scale* + *duration* + *magnitude*) x *probability*

The maximum value is 100 significance points (S). Environmental impacts will be rated as either of **High**, **Moderate** or **Low** significance on the following basis:

Table 2-14: Environmental Significance Rating

Environmental Significance	**Significance Points**
High	SP > 60
Moderate	$30 \leq SP \leq 60$
Low	SP < 30

The impact assessment will also include:

- The **nature**, a description of what causes the effect, what will be affected and how it will be affected.

- The **status**, which is described as either positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

3 EXISTING AIR QUALITY

3.1 Current Air Pollution Emission Sources

Currently there is an emissions inventory for the Atlantis area, maintained by the Air Quality Management section of the City of Cape Town. This inventory, however, is not comprehensive and is restricted primarily to industries burning fuel. Based on this emissions inventory, topographical maps and a site visit, the following sources of air pollution have been identified:

- Existing Atlantis OCGT Plant (four operational units and five under construction).
- Other industrial operations in the area.
- Vehicle entrainment and exhaust gas emissions.
- Agricultural activity.
- Domestic fuel burning.

At present, there are four operational units at the Ankerlig Power Station and five under construction, for which authorisation has been granted by DEAT. The original assumptions utilised in the previous studies, regarding emissions from each unit, are presented in the following Table 3-1. It should be noted, however, that the emission levels of NO_2 and CO are monitored in each stack and are much lower than the ones presented in Table 3-1 (refer to Table 2-2)

Table 3-1. Previously Assumed Stack Emissions for a Single Unit for the Existing Atlantis OCGT plant.

Pollutant	Emissions (g/s)
SO_2	7.72
PM_{10}	20.27
NO_x	66.87
CO	36.53
CO_2	12.67

Other sources in the Atlantis industrial area include industries for packaging, chemicals, textiles, furniture, motor, engineering, foods, appliance, brick and tyre manufacturing. Emissions released from these industries are primarily related to combustion processes and include sulphur dioxide, carbon monoxide, carbon dioxide, oxides of nitrogen, particulate matter, volatile organic compounds and heavy metals. The primary pollutant emissions from the Atlantis industrial area are shown in Table 3-2 (Airshed, 2007). It should be noted that the cumulative effect of these emissions were not taken into consideration, since there was no adequate information regarding source characteristics.

Table 3-2. Emissions from the Atlantis Industrial Area

Pollutant	Emissions (kg/month)	Emissions (tons/annum)
SO_2	14,937	179.24
PM_{10}	21,969	263.63
NO_x	10,177	122.12
Source: Airshed, 2007.		

The agricultural activities in the area could be associated primarily with particulate emissions. These emissions are, however, not continuous as they are associated with seasonal operations such as tilling, harvesting and field preparation.

The vehicles travelling on the paved and unpaved road network are also associated with particulate matter emissions. The quantity of dust emissions from paved and unpaved roads varies linearly with the volume of traffic.

Vehicles also emit various gaseous emissions from their tailpipes. A traffic study undertaken for the current and the previous EIA at the Atlantis site provided the amount of vehicles currently making use of the road networks surrounding the proposed development. In addition, tanker trucks delivering fuel for the future Atlantis CCGT plant are an additional source of exhaust emissions in the area. This information will be used as input to the dispersion simulations for the evaluation of the impacts of the proposed future operations at the site.

3.2 Air Quality Monitoring at Atlantis

Based on the requirement stipulated by the "Record of Decision" of the Environmental Impact Assessment for the Open Cycle Gas Turbine Power Station (OCGT), an Air Quality Monitoring (AQM) Station was recently established in Atlantis. The position of the station is approximately 5km north-east of the OCGT site and can be seen in Figure 3-1 below.

Figure 3-1. Air Quality Monitoring Station Location

The purpose of the station is to monitor the levels of nitrogen oxides (mainly nitrogen dioxide) downwind from the Open Cycle Gas Turbine Power Station (OCGT).

The monitoring commenced in February 2007, but the only available data was for December 2007. The table below summarises the results for that month. The maximum hourly value of 37 μg/m^3 for nitrogen dioxide during the month of December was recorded between 22h00 and 23h00 on the 19th of December 2007 and was well below the national and international standard of 200 μg/m^3.

Table 3-3. Atlantis Air Quality Monitoring Results

Pollutant	December 2007 Hourly Max (μg/m^3)	International Standard for Hourly Max (μg/m^3)	December 2007 Monthly Mean (μg/m^3)
Nitric Oxide (NO)	22		1
Nitrogen Dioxide (NO_2)	37	200	8
Nitrogen Oxides (NO_x)	53		10

The monthly mean values were also low, especially when compared to other sites in the city (see Table 3-4).

Table 3-4. Measured Nitrogen Oxides in Atlantis and at Other Monitoring Sites (μg/m^3)

Pollutant	Site Location and Type					
	Atlantis		Cape Town City		Bothasig	
	Residential		Business		Residential	
	Hourly Max	Monthly Mean	Hourly Max	Monthly Mean	Hourly Max	Monthly Mean
NO	22	1	391	55	37	4
NO_2	37	8	90	22	36	8
NO_x	53	10	460	81	64	12

4 DISPERSION SIMULATION RESULTS

Based on the methodology outlined in Section 2, the meteorological input and the emissions input, the ground-level concentration contours for each pollutant were generated for each emission scenario. These scenarios were:

- **Scenario 1:** Combined cycle gas turbine units (9 units) with diesel as fuel.
- **Scenario 2:** Combined cycle gas turbine units (9 units) + Acacia units with diesel as fuel.
- **Scenario 3:** Combined cycle gas turbine units (9 units) with natural gas as fuel.
- **Scenario 4:** Combined cycle gas turbine units (9 units) with natural gas as fuel + Acacia units.

In addition, several receptors were positioned at the sensitive receptors within the study area and the maximum hourly, daily and annual concentrations were also estimated for each scenario and pollutant examined.

The sections below present the results for each scenario and pollutant for the averaging period where guidelines and standards are available for comparison.

The concentration contours for all pollutants and averaging periods that have a guideline can be found in Appendix A.

4.1 Scenario 1: Combined Cycle Gas Turbine Units (9 Units) With Diesel as Fuel.

The concentrations at the sensitive receptors around the site can be seen in Table 4-1 for Scenario 1, i.e. the nine combined cycle gas turbines (CCGTs) utilising diesel as fuel.

It should be noted that the results represent the worst-case scenario, since it was assumed that all nine units are operational throughout the day and night.

It is evident that the only pollutant that generated an exceedance of its guideline was NO_2. The maximum hourly value reached 322 µg/m^3.

The NO_2 1-hour guideline of 200 µg/m^3 was not exceeded at any of the sensitive receptors, except for at Witzand, where it reached 244 µg/m^3. At

Witzand, however, there were only three exceedances in the three years of data modelled, which is well within the permitted limit of 18 times a year.

All of the other pollutants and averaging periods, including the daily and annual NO_2, were found to be well within their guidelines. The highest of the other pollutants was SO_2, with the 15-minute and hourly maximum reaching 31% and 26% of their guidelines respectively.

The concentration contours for this scenario can be found in Figure A1-1 to Figure A1-10 in Appendix A.

Table 4-1. Predicted Concentrations for the CCGT Units with Fuel Diesel

Location	X	Y	SO_2 15Min Aver	SO_2 1hr Aver	SO_2 24hr Aver	SO_2 Annual	NO_2 1hr Aver	NO_2 24hr Aver	NO_2 Annual	PM_{10} 24hr Aver	PM_{10} Annual	CO 1hr Aver	VOC 1hr Aver
Avondale	-47578	-16221	54.9	46.2	5.9	0.3	161.8	20.6	0.9	5.5	0.2	9.6	2.1
Beacon Hill	-45797	-15020	42.1	35.4	5.0	0.3	124.1	17.4	0.9	4.6	0.3	7.4	1.6
Brakfontein	-48331	-23412	45.4	38.1	7.6	0.3	133.6	26.5	0.9	7.1	0.2	7.9	1.7
Donkergat	-48218	-24996	41.9	35.2	7.7	0.3	123.5	27.1	1.0	7.2	0.3	7.3	1.6
Dynefontein	-51385	-29577	29.7	24.9	6.1	0.2	87.4	21.2	0.7	5.7	0.2	5.2	1.1
Hansmelkskraal	-54337	-15674	39.1	32.8	4.2	0.2	115.1	14.8	0.6	3.9	0.2	6.8	1.5
Klein Dassenberg	-44368	-17869	44.2	37.2	4.6	0.2	130.3	16.0	0.7	4.3	0.2	7.7	1.7
Klein Midlands	-56945	-10072	36.9	31.0	5.5	0.2	108.7	19.1	0.6	5.1	0.2	6.4	1.4
Koeberg Nat. Res.	-53415	-22658	42.5	35.7	2.4	0.1	125.1	8.3	0.2	2.2	0.1	7.4	1.6
Malmesbury	-26695	-4372	42.8	36.0	3.6	0.2	126.1	12.6	0.7	3.4	0.2	7.5	1.6
Mamre	-48772	-9818	29.3	24.7	8.3	0.4	86.5	29.3	1.4	7.8	0.4	5.1	1.1
Melkbosstrand	-51372	-33556	34.1	28.6	6.4	0.2	100.4	22.5	0.7	6.0	0.2	6.0	1.3
Protea Park	-46589	-16883	50.0	42.0	5.8	0.3	147.2	20.4	1.0	5.4	0.3	8.7	1.9
Robinvale	-45857	-15765	41.4	34.8	5.4	0.3	122.0	18.9	1.0	5.0	0.3	7.2	1.6
Sand Plein Fynbos	-48632	-22134	47.0	39.5	5.5	0.2	138.4	19.2	0.8	5.1	0.2	8.2	1.8
Saxonsea	-47539	-13962	49.4	41.5	4.6	0.2	145.6	16.0	0.8	4.3	0.2	8.6	1.9
Sherwood	-46389	-14376	46.5	39.1	3.5	0.3	137.0	12.2	0.9	3.3	0.2	8.1	1.8
Silwerstrooms	-59201	-17930	33.5	28.1	2.5	0.1	98.6	8.7	0.4	2.3	0.1	5.8	1.3
Wesfleur	-48485	-16081	63.5	53.4	4.4	0.2	187.1	15.6	0.7	4.1	0.2	11.1	2.4
Witzand	-50044	-19870	82.9	69.6	6.6	0.2	244.1	23.1	0.6	6.1	0.2	14.5	3.2
GRID MAXIMUM			109.2	91.7	17.1	0.5	321.6	60.1	1.7	16.0	0.5	19.1	4.2
Guideline			266	350	125	50	200	150	40	75	40	30000	200
Percentage of GL			31.2%	26.2%	13.7%	1.0%	160.8%	40.1%	4.2%	21.3%	1.1%	0.1%	2.1%

4.2 Scenario 2: Combined Cycle Gas Turbine Units (9 Units) + Acacia Units with Diesel as Fuel.

Table 4-2 shows the results for the nine CCGT units utilising diesel as fuel, together with the Acacia and Port Rex units relocated to the northern section of the Ankerlig site.

The estimated 1-hour NO_2 maximum increased to 358 $\mu g/m^3$. The exceedance of the 200 $\mu g/m^3$ guideline was at Witzand and Wesfleur. These exceedances, however, also occurred no more than 5 times at each location in the three years examined. The daily NO_2 maximum reached 46% of its guideline and the annual 5.4%. The remaining pollutants fell well within their respective guidelines.

The concentration contours for Scenario 2 can be seen in Figure A2-1 to Figure A2-10 in Appendix A.

Table 4-2. Predicted Concentrations for the CCGT Units with Fuel Diesel Plus Acacia and Port Rex Units

Location	X	Y	SO_2 15Min Aver	SO_2 1hr Aver	SO_2 24hr Aver	SO_2 Annual	NO_2 1hr Aver	NO_2 24hr Aver	NO_2 Annual	PM_{10} 24hr Aver	PM_{10} Annual	CO 1hr Aver	VOC 1hr Aver
Avondale	-47578	-16221	64.3	54.1	6.8	0.3	187.1	23.7	1.1	5.7	0.3	14.9	2.5
Beacon Hill	-45797	-15020	51.6	43.3	5.8	0.3	149.5	20.2	1.2	4.9	0.3	12.6	2.0
Brakfontein	-48331	-23412	55.6	46.7	9.1	0.3	161.1	31.4	1.2	7.5	0.3	13.7	2.1
Donkergat	-48218	-24996	52.8	44.4	9.6	0.4	152.7	33.0	1.3	7.7	0.3	13.4	2.0
Dynefontein	-51385	-29577	42.1	35.4	7.5	0.3	120.9	25.7	0.9	6.0	0.2	12.2	1.6
Hansmelkskraal	-54337	-15674	48.4	40.7	5.8	0.2	140.1	19.7	0.7	4.4	0.2	12.0	1.8
Klein Dassenberg	-44368	-17869	54.2	45.6	5.6	0.3	157.1	19.3	0.9	4.5	0.2	13.3	2.1
Klein Midlands	-56945	-10072	49.2	41.3	7.6	0.2	141.6	26.0	0.7	5.7	0.2	13.3	1.9
Koeberg Nat. Res.	-53415	-22658	51.1	43.0	3.0	0.1	148.3	10.3	0.3	2.4	0.1	12.3	1.9
Malmesbury	-26695	-4372	55.3	46.4	4.4	0.3	159.6	15.2	0.9	3.6	0.2	14.4	2.1
Mamre	-48772	-9818	40.8	34.3	10.3	0.5	117.3	35.7	1.9	8.3	0.4	11.6	1.6
Melkbosstrand	-51372	-33556	47.0	39.5	7.9	0.3	135.1	27.3	0.9	6.4	0.2	13.2	1.8
Protea Park	-46589	-16883	60.0	50.4	7.0	0.3	174.2	24.2	1.1	5.7	0.3	14.3	2.3
Robinvale	-45857	-15765	50.5	42.5	6.3	0.3	146.5	21.8	1.2	5.3	0.3	12.4	1.9
Sand Plein Fynbos	-48632	-22134	56.2	47.2	6.9	0.3	163.2	23.6	1.1	5.5	0.2	13.4	2.1
Saxonsea	-47539	-13962	58.6	49.2	5.3	0.3	170.2	18.5	1.0	4.5	0.2	13.8	2.2
Sherwood	-46389	-14376	56.0	47.1	4.3	0.3	162.5	14.8	1.1	3.5	0.3	13.4	2.1
Silwerstrooms	-59201	-17930	45.3	38.1	3.6	0.2	130.4	12.2	0.5	2.6	0.1	12.5	1.7
Wesfleur	-48485	-16081	74.8	62.9	5.3	0.3	217.4	18.5	0.9	4.4	0.2	17.4	2.8
Witzand	-50044	-19870	95.4	80.2	7.9	0.2	277.8	27.4	0.8	6.5	0.2	21.5	3.6
GRID MAXIMUM			122.8	103.2	20.0	0.6	358.2	69.0	2.2	16.6	0.5	29.3	4.7
Guideline			266	350	125	50	200	150	40	75	40	30000	200
Percentage of GL			35.1%	29.5%	16.0%	1.3%	179.1%	46.0%	5.4%	22.1%	1.2%	0.1%	2.3%

4.3 Scenario 3: Combined Cycle Gas Turbine Units (9 Units) with Natural Gas as Fuel.

The utilisation of natural gas by the nine CCGTs will have as an effect the significant reduction of the ground level concentrations for NO_2 and SO_2. As can be seen in Table 4-3, the 1-hour maximum NO_2 concentration reached 151 µg/m^3. The maximum NO_2 concentrations at all sensitive receptors were within the guidelines for all averaging periods.

The sulphur dioxide maximum reached below 1% of the guidelines for all averaging periods.

The concentration contours for Scenario 3 can be seen in Figure A3-1 to Figure A3-10 in Appendix A.

Table 4-3. Predicted Concentrations for the CCGT Units with Fuel Natural Gas

Location	X	Y	SO_2 15Min Aver	SO_2 1hr Aver	SO_2 24hr Aver	SO_2 Annual	NO_2 1hr Aver	NO_2 24hr Aver	NO_2 Annual	PM_{10} 24hr Aver	PM_{10} Annual	CO 1hr Aver	VOC 1hr Aver
Avondale	-47578	-16221	0.64	0.54	0.07	0.00	75.84	9.68	0.44	0.88	0.04	75.84	4.97
Beacon Hill	-45797	-15020	0.49	0.42	0.06	0.00	58.18	8.13	0.44	0.74	0.04	58.18	3.81
Brakfontein	-48331	-23412	0.53	0.45	0.09	0.00	62.62	12.41	0.43	1.12	0.04	62.62	4.10
Donkergat	-48218	-24996	0.49	0.41	0.09	0.00	57.88	12.68	0.46	1.15	0.04	57.88	3.79
Dynefontein	-51385	-29577	0.35	0.29	0.07	0.00	40.95	9.95	0.32	0.90	0.03	40.95	2.68
Hansmelkskraal	-54337	-15674	0.46	0.39	0.05	0.00	53.94	6.95	0.27	0.63	0.02	53.94	3.53
Klein Dassenberg	-44368	-17869	0.52	0.44	0.05	0.00	61.05	7.49	0.34	0.68	0.03	61.05	4.00
Klein Midlands	-56945	-10072	0.43	0.36	0.06	0.00	50.95	8.96	0.27	0.81	0.02	50.95	3.34
Koeberg Nat. Res.	-53415	-22658	0.50	0.42	0.03	0.00	58.63	3.90	0.11	0.35	0.01	58.63	3.84
Malmesbury	-26695	-4372	0.50	0.42	0.04	0.00	59.11	5.91	0.34	0.53	0.03	59.11	3.87
Mamre	-48772	-9818	0.34	0.29	0.10	0.00	40.52	13.71	0.67	1.24	0.06	40.52	2.65
Melkbosstrand	-51372	-33556	0.40	0.34	0.08	0.00	47.05	10.55	0.32	0.95	0.03	47.05	3.08
Protea Park	-46589	-16883	0.59	0.49	0.07	0.00	69.00	9.55	0.45	0.86	0.04	69.00	4.52
Robinvale	-45857	-15765	0.49	0.41	0.06	0.00	57.15	8.88	0.46	0.80	0.04	57.15	3.74
Sand Plein Fynbos	-48632	-22134	0.55	0.46	0.06	0.00	64.84	9.01	0.37	0.82	0.03	64.84	4.25
Saxonsea	-47539	-13962	0.58	0.49	0.05	0.00	68.22	7.51	0.39	0.68	0.04	68.22	4.47
Sherwood	-46389	-14376	0.55	0.46	0.04	0.00	64.20	5.74	0.41	0.52	0.04	64.20	4.20
Silwerstrooms	-59201	-17930	0.39	0.33	0.03	0.00	46.20	4.07	0.19	0.37	0.02	46.20	3.02
Wesfleur	-48485	-16081	0.75	0.63	0.05	0.00	87.67	7.30	0.35	0.66	0.03	87.67	5.74
Witzand	-50044	-19870	0.97	0.82	0.08	0.00	114.41	10.82	0.29	0.98	0.03	114.41	7.49
GRID MAXIMUM			1.28	1.08	0.20	0.01	150.72	28.17	0.79	2.55	0.07	150.72	9.87
Guideline			266	350	125	50	200	150	40	75	40	30000	300
Percentage of GL			0.37%	0.31%	0.16%	0.01%	75.36%	18.78%	1.98%	3.40%	0.18%	0.50%	3.29%

4.4 Scenario 4: Combined Cycle Gas Turbine Units (9 Units) with Natural Gas as Fuel + Acacia Units.

If the nine Ankerlig units utilise natural gas, the relocation of the Acacia and Port Rex units will result in the 1-hour NO_2 maximum almost reaching the 200 µg/m^3 guideline but not exceeding it.

From Table 4-4 it is evident that for Scenario 4 the 1-hour NO_2 guideline will not be exceeded at any of the sensitive receptors. The receptors with the highest 1-hour NO_2 values were Witzand, Wesfleur and Avondale.

The SO_2 maximum concentration for this scenario did not exceed 10% of the guidelines for all averaging periods. The rest of the pollutants were well within their respective guidelines.

The concentration contours for this scenario can be found in Figure A4-1 to Figure A4-10 in Appendix A.

Table 4-4. Predicted Concentrations for the CCGT Units with Fuel Natural Gas Plus Acacia and Port Rex Units

Location	X	Y	SO_2 15Min Aver	SO_2 1hr Aver	SO_2 24hr Aver	SO_2 Annual	NO_2 1hr Aver	NO_2 24hr Aver	NO_2 Annual	PM_{10} 24hr Aver	PM_{10} Annual	CO 1hr Aver	VOC 1hr Aver
Avondale	-47578	-16221	10.04	8.44	1.02	0.07	101.09	12.70	0.64	1.13	0.06	81.10	5.32
Beacon Hill	-45797	-15020	9.93	8.35	0.95	0.07	83.54	10.97	0.66	0.97	0.06	63.46	4.17
Brakfontein	-48331	-23412	10.78	9.06	1.61	0.09	90.14	17.29	0.71	1.53	0.06	68.35	4.49
Donkergat	-48218	-24996	11.37	9.56	1.95	0.09	87.11	18.63	0.75	1.64	0.07	63.97	4.20
Dynefontein	-51385	-29577	12.83	10.78	1.47	0.06	74.48	14.44	0.52	1.27	0.05	47.94	3.16
Hansmelkskraal	-54337	-15674	9.76	8.20	1.58	0.05	78.93	11.85	0.43	1.04	0.04	59.15	3.89
Klein Dassenberg	-44368	-17869	10.51	8.83	1.08	0.06	87.88	10.79	0.51	0.95	0.04	66.64	4.38
Klein Midlands	-56945	-10072	12.69	10.66	2.22	0.06	83.87	15.84	0.44	1.38	0.04	57.81	3.80
Koeberg Nat. Res.	-53415	-22658	9.14	7.68	0.64	0.02	81.86	5.85	0.18	0.52	0.02	63.47	4.17
Malmesbury	-26695	-4372	12.95	10.88	0.86	0.06	92.55	8.52	0.51	0.75	0.04	66.08	4.34
Mamre	-48772	-9818	11.84	9.95	2.10	0.14	71.40	20.12	1.10	1.77	0.10	46.95	3.09
Melkbosstrand	-51372	-33556	13.33	11.20	1.58	0.07	81.78	15.35	0.52	1.35	0.05	54.28	3.57
Protea Park	-46589	-16883	10.60	8.91	1.27	0.06	95.91	13.40	0.64	1.18	0.06	74.61	4.90
Robinvale	-45857	-15765	9.63	8.10	0.96	0.07	81.73	11.74	0.67	1.04	0.06	62.27	4.09
Sand Plein Fynbos	-48632	-22134	9.81	8.24	1.44	0.09	89.70	13.40	0.64	1.18	0.06	70.02	4.60
Saxonsea	-47539	-13962	9.74	8.19	0.82	0.06	92.84	9.97	0.59	0.88	0.05	73.35	4.82
Sherwood	-46389	-14376	10.04	8.43	0.84	0.07	89.69	8.30	0.62	0.73	0.05	69.51	4.57
Silwerstrooms	-59201	-17930	12.24	10.29	1.12	0.04	78.03	7.56	0.32	0.66	0.03	52.83	3.48
Wesfleur	-48485	-16081	12.04	10.12	0.95	0.06	118.02	10.18	0.53	0.90	0.05	93.99	6.17
Witzand	-50044	-19870	13.50	11.34	1.43	0.06	148.06	15.14	0.47	1.34	0.04	121.42	7.97
GRID MAXIMUM			23.95	20.12	5.31	0.15	192.19	40.06	1.26	3.52	0.11	158.34	10.39
Guideline			266	350	125	50	200	150	40	75	40	30000	300
Percentage of GL			6.84%	5.75%	4.25%	0.30%	96.10%	26.71%	3.15%	4.69%	0.28%	0.53%	3.46%

5 IMPACT ASSESSMENT AND RECOMMENDATIONS

5.1 Air Pollution Impact Rating

Based on the impact ranking described in the impact assessment methodology, the resulting rating and significant points for the Ankerlig Power Station are as follows:

Table 5-5. Construction: Air Pollution Impact Assessment Ranking and Environmental Significance

Nature: Increase of air pollution levels and dust deposition around the power station construction area.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Short-term (2)	Short-term (2)
Magnitude	Low-Moderate (5)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	No loss	No loss
Can impacts be mitigated?	Yes	Yes
Mitigation: Essential: Speed reduction to below 20 km/hr within and around the site. Paving of internal roads as soon as possible. Application of water suppression.		
Cumulative impacts: Cumulative impacts due to the existing power station units, industrial sources in the adjacent Atlantis Industrial area and vehicular traffic in the area.		
Residual Impacts: No residual impact after the activity ceases.		

Table 5-6. Operation: Air Pollution Impact Assessment Ranking and Environmental Significance for the Combined Cycle Power Plant Conversion

Nature: Increase of air pollution levels around the power station site.		
	With Diesel Fuel	**With Gas Fuel**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	High impact (9)	Low to Moderate (5)
Probability	Highly probable (4)	Improbable (2)
Significance	**High (60)**	**Low (22)**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	No irreplaceable loss	No irreplaceable loss
Can impacts be mitigated?	Yes	Yes
Mitigation: *Essential:* Increase the stack height to 60m.		
Cumulative impacts: Cumulative impacts due to existing industrial air pollution sources in the adjacent Atlantis Industrial area and vehicular traffic in the area.		
Residual Impacts: No residual impact after the activity ceases.		

Table 5-7. Acacia and Port Rex Relocation Cumulative Air Pollution Impact Assessment Ranking and Environmental Significance

Nature: Increase of the air pollution levels around the power station site.		
	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	High impact (10)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	**High (64)**	**Moderate (36)**

Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	No irreplaceable loss	No irreplaceable loss
Can impacts be mitigated?	Yes	Yes
Mitigation: The relocated units to utilise diesel, similar to the one used by the Ankerlig units.		
Cumulative impacts: Cumulative impacts due to emissions from existing Ankerlig Power Station units, industrial air pollution sources in the adjacent Atlantis Industrial area and vehicular traffic in the area.		
Residual Impacts: No residual impact after the activity ceases.		

5.2 Conclusions

Based on the air quality modelling results, the following can be concluded:

- During the construction of the combined cycle units, the impact is considered to be *Low*.
- For the operational phase, the introduction of the combined cycle units will not change the emission quantities of the air pollutants. It will reduce, however, the temperature of the exit gases.
- During operation, the introduction of the combined cycle units will increase the ground-level concentrations if the stack heights are not increased from the existing 30m.
- Increasing the stack heights to 60m will bring the ground level concentrations to levels similar to those of the open cycle units.
- With the introduction of 60m high stacks, nitrogen dioxide was the only pollutant, exceeding its hourly guideline limit of 200 $\mu g/m^3$. The number of incidents per year, however, was below 10. The annual guideline for this pollutant was not exceeded at any of the sensitive receptors.
- The other pollutants examined, i.e. sulphur dioxide, PM_{10} and VOCs were well within their respective guidelines for all sensitive receptor locations.
- The utilisation of natural gas as fuel for the Ankerlig units will significantly reduce the ground level concentrations of all pollutants, including nitrogen oxides to well below their respective guidelines.

- The overall impact significance for the combined cycle Ankerlig units was found to be *High*.
- The introduction of natural gas will reduce this impact to *Low*.
- The relocation of the Acacia and Port Rex units will have a high impact on the existing air quality of the area. The introduction of mitigation measures in terms of better quality diesel will reduce the impact to *Moderate*.

5.3 Recommendations

During construction the following is recommended:

Emission Source	Recommended Control Methods
Material handling	Wet suppression [a] Wind speed reduction screens [b]
Truck transport	Early paving of permanent access roads [a] Speed limit implementation (app. 20 km/hr) [a] Covering of all trucks transporting materials [a] Cleaning of trucks on exit [a] Traffic over exposed areas be kept to a minimum and temporary roads be chemically stabilised via chlorides, asphalt emulsions or petroleum resins [b]
General construction and stock piles	Wet suppression [a] Minimise drop heights [a]

[a] Essential

[b] Optional

For the operational phase of the combined cycle units, the following is recommended:

- The stacks of the combined cycle units should be at least 60m high.
- Investigate additional mitigation measures for the reduction of nitrogen dioxide emissions.
- Introduce natural gas as fuel as and when it becomes available.
- For the Acacia and Port Rex relocation, utilise the better quality diesel currently used for the Ankerlig units.

5.4 Air Pollution Management Measures

OBJECTIVE: The objective is to maintain the air quality levels around the power station site within guideline levels and minimise the impact on residential areas and communities.

Project Component/s	The components affecting the air pollution impact are the construction activities during the construction phase, and during the operational phase the emissions from the Ankerlig Power Station units. The Acacia generation units are also to be relocated on the northern side of the site.
Potential Impact	Increased air pollution levels in the surrounding areas and affected communities.
Activity/Risk Source	The activities and equipment which could impact on achieving the objective are: • Construction activities, i.e. excavating, loading and unloading of trucks, piling, material transport, general building activities, etc. • Exhaust emissions from the power stations units at a reduced temperature due to the combined cycle units.
Mitigation: Target/Objective	The measures required during the construction period are: • Wet suppression of access roads, stock piles and general construction areas. • Paving of permanent access roads. • Covering of transport trucks and cleaning them at the exit of the site. The measures required for the operational phase of the combined cycle units: • Increase the stack height to 60m. • Introduce natural gas as fuel as and when it becomes available. • Investigate additional mitigation measures to further reduce nitrogen dioxide emissions. For the Acacia and Port Rex relocation units: • Utilise better quality diesel.

Mitigation: Action/Control	Responsibility	Timeframe
Construction Phase		
Wet suppression on and off site	Site engineer/ mine employees	Throughout the construction lifespan
Early paving of permanent access roads	Site engineer	Throughout the construction lifespan

Covering of transport trucks and cleaning them on exit.	Site engineer/ mine employees	Throughout the construction lifespan
Operational Phase		
Use 60m high stacks for the combined cycle units	Design engineers / Construction engineers	Throughout the operational lifespan
Introduce natural gas	ESKOM	Throughout the operational lifespan
Proper maintenance of equipment	Site engineer/ qualified power station employees	Throughout the operational lifespan
In-stack monitoring of emissions	Systems Engineer	Throughout the operational lifespan
Monitoring of nitrogen oxides at local communities	ESKOM / local authorities	Throughout the operational lifespan

Performance Indicator	Compliance with the South African ambient NO_2 air quality standards.

6 REFERENCES

ARUP, 2008. Expansion of Ankerlig Power Station, Atlantis Industrial. Review and Update of Traffic Impact Study. August 2008.

ECOSERVE, 2007. Emissions Estimation at Acacia Power Station. May 2007.

Molhave L., 1990. Volatile Organic Compounds, Indoor Air Quality and Health. Proceedings of the 5^{th} International Conference on Indoor Air Quality and Climate, Toronto, 1990, Vol. 5, pp 15 – 33.

Nico Gewers, 2008. Chief Advisor, Generation Environmental Management, Eskom Generation Division. Personal Communication.

Seifert, B., 1990. Regulating indoor air. In: Walkinshaw, D.S. (ed.), Indoor Air '90, Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Toronto, Canada, July 29 -August 3, vol. 5, pp. 35-49.

U.S. Environmental Protection Agency, 2006. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Eleventh Edition, AP-42. United States Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC, USA.

World Health Organisation, 2000. Air Quality Guidelines, World Health Organisation, April 2000, Geneva.

APPENDIX A

Dispersion Modelling Concentration Contour Plots