Appendix J Stanwell Power Station Noise Monitoring Program

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Stanwell Power Station
Noise Monitoring Program

2121R01V01 April 2001

Prepared For

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Executive Summary

Pacific Air & Environment was retained to determine the nature and extent of operational noise from Stanwell Power Station on the adjacent environment. Over a period of almost two years, four noise surveys and assessments were undertaken with the intention of carrying out a thorough investigation of the noise impacts. The monitoring was to be carried out during each of the four seasons to identify any seasonal influences.

Noise Monitoring Design

Each of the four investigations required that the following noise levels be obtained:

- Close to the power station to obtain an estimation of the noise power emissions from its operation;
- Between the power station and Stanwell to obtain a noise level predominantly influenced by power station noise;
- In Stanwell township to obtain noise levels that may or may not be influenced by the power station;
- Well away from the power station and Stanwell yet be subjected to similar types of noise as Stanwell; and finally
- Well away from all noise sources to obtain the likely ambient noise level.

Finding suitable locations to satisfy all requirements was particularly difficult. However, the selection of the monitoring sites (shown in **Figure 3.1**) generally conforms with these requirements. “Background” monitoring site B1 was located along the Capricorn Highway some 10 km west of Stanwell. This site is considered to be representative of noise in Stanwell during the evening and night when human outdoor activity has abated and the common noise at the two sites is traffic noise. Due to traffic speed differences and setback distance the maximum noise levels at B1 would be higher but the background noise levels are considered to be representative of Stanwell township without the Stanwell Power Station.

The validation site V1, within Stanwell township, is well located close to the residence and is not subjected to noise from the occupation of the house. The long term logging of noise was supplemented with extremely valuable attended monitoring. Attended monitoring includes qualitative statements relating to noises making up the measured noise level.

Validation site V2 was located between the power station and Stanwell. Its location was strongly influenced by noise levels from Stanwell Power station. However, the site was far enough away from the power station for meteorological conditions to influence the measurements.

Meteorology

Stanwell Power Station essentially produces constant noise levels. It is primarily the effect of meteorological conditions that leads to changes of noise levels in Stanwell and the adjacent environment. Meteorological records were obtained from Stanwell Power Station meteorological station. In addition short duration meteorological measurements were obtained at the time of some of the measurements.

The on site meteorological data was comprehensive and covered most aspects well. However, the vertical temperature gradient was based on temperature probes close to the ground and at an elevation of 30m. This was not suitable to assess vertical temperature gradient and the optimum location to obtain the vertical temperature profile is to have measurements obtained at about 10m and 50 m to 60 m.

First Report Spring Monitoring Program

The first report provided details of a noise survey carried out in October 1998. This survey highlighted that noise levels in the areas surrounding Stanwell Power Station are in keeping with the rural nature of the area. The purpose of this report was to determine the nature and extent of operating noise on the adjacent environment. Modelling of noise was not a part of this study. However the report did propose amendments to the monitoring plan so that future reports would adequately address modelling issues.

Noise levels were monitored at a total of eleven locations surrounding Stanwell Power Station. Noise was logged continuously at three sites over a period of seven days. Noise levels were measured at all eleven sites by attended monitoring incorporating a real-time 1/3 octave band spectral analyser. These were obtained during the day, evening and night.

The results indicate that the noise from Stanwell Power Station could be detected some distance from the site particularly in the 160 Hz 1/3 octave frequency band. During the monitoring period easterly winds occurred from time to time and the noise from the power station was detectable at Kalapa to the west of the site.

Second Report Autumn Monitoring Program

The second report provided details of a noise survey carried out in May and early June 1999. The report also included modelling of noise levels from Stanwell Power Station.

At this stage the monitoring procedure for this and all future noise surveys was fixed, ie the use of two validation sites and two background sites. Background noise levels, within Stanwell township, were as low as about 30 dB(A) at night up to a background noise level of 45 dB(A) during the day. For much of the time the wind was generally light.

The tonal noise measured during the first monitoring program was also evident but not to the same extent. Tonal noise can be annoying because it contains a distinct pitch related to an energy peak at particular frequencies.

Noise modelling of Stanwell Power Station for the no wind case indicated that noise levels in Stanwell were likely to be about 30 dB(A) to 35 dB(A). For a 3 m/s southerly wind the noise levels were predicted to be between 35 dB(A) to 40 dB(A).

Third Report Summer Monitoring Program

The third report provided details of a noise survey carried out in January 2000. The report also included modelling of noise levels from Stanwell Power Station.

The noise survey within Stanwell township provided background noise levels of 33 dB(A) to 36 dB(A) at night and 45 dB(A) to 50 dB(A) during the day. The noise from Stanwell Power Station was audible when the background noise level was 40 dB(A) and less. Typically noises are not audible when the noise level is more than 10 dB(A) below the background noise level, ie the noise from Stanwell Power Station is likely to be more than 30 dB(A).

The wind was generally from the east during this monitoring period.

This report refined the modelling carried out and presented in the second report. Similar conclusions were drawn in relation to the overall noise levels

Fourth Report Winter Monitoring Program

The fourth report provided details of a noise survey carried out in August 2000. The report also included extensive modelling of noise levels from Stanwell Power Station. The report also assessed the noise levels surrounding the site.

The noise survey within Stanwell township showed a background noise level of 25 dB(A) to 30 dB(A) at night and 40 dB(A) to 45 dB(A) during the day. This was the quietest period of the year. The noise from Stanwell Power Station was audible during various wind conditions in Stanwell township.

To validate the noise model a number of predictions were carried out at the two validation locations. While wind speed, direction, temperature and humidity were known, the temperature profile range was assessed based on a generic approach.

The validated noise level showed a high level of correspondence between measurements and predictions at V2. At V1 the predicted noise levels were generally lower than the measured noise levels. This was most likely due to other noise sources influencing the measured noise level in Stanwell township.

Finally, the likely variability of noise in Stanwell township was assessed by predicting noise levels for each hour of the day for a full year. The predictions used a Meteorological data file from the EPA. The EPA meteorological data file is based on the long term average meteorology for the area and is in a suitable format. This datafile is typically used in air pollution assessments. This process revealed that the likely range of noise levels for best case and worst case meteorology is 32 dB(A) to 40 dB(A) with the average being between 34 dB(A) and 38 dB(A).

Conclusions

Noise levels up to 35 dB(A) have been measured which are directly attributable to Stanwell Power Station within Stanwell Township. In addition, tonality of the noise is readily distinguishable.

These measurements, combined with the knowledge that the background noise levels at night vary from as low as 25 dB(A) during the winter to 33 dB(A) during the summer, indicate that Stanwell Power Station would most likely exceed nuisance noise level criteria based solely on background noise levels at night during still or downwind conditions. This is more likely to occur during winter rather than summer.

The computer models developed to assess noise from the operations indicate that the noise levels in Stanwell are likely to vary between 30 dB(A) and about 40 dB(A). The upper range noise levels are likely to occur during adverse meteorological conditions, namely downwind or during temperature inversions. During both these conditions it is possible that the background noise levels would also be at the lower limits of the range of backgrounds measured. It is therefore likely, during these occasions, that the noise from Stanwell Power Station is the dominant noise source in Stanwell.

It is considered desirable to provide temperature probes at about 10 m and at 50 m to 60 m in order to obtain the vertical temperature profile. This will enable the vertical temperature profile to be entered accurately into the model and thereby eliminate one of the significant unknowns in the noise model. Indeed the noise level from the Stanwell Power Station could then be better predicted using a meteorological file prepared from Stanwell's on site meteorological data.

It is considered essential to further investigate noise emissions from Stanwell Power Station if it is proposed to provide noise ameliorative measures. This requires careful measurement of each contributing noise source as an input into the computer model. The purpose of the investigation would be to identify the major noise sources and particularly those noise sources emitting 160 Hz noise. From this information an appropriate noise control program can be developed which adequately targets the major noise producers. With the possibility of the new AMC plant to be constructed in the near future it would be wise to resolve any outstanding noise issues at the earliest possible stage.

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1 Introduction

Kamst & Simpson was commissioned by Pacific Air Environment on behalf of the Stanwell Corporation to conduct a series of noise measurements in the vicinity of Stanwell Power Station (SPS). The aim of the study is to determine the nature and extent of noise from station operations on the adjacent environment and community and to use computer modelling to predict noise levels at the Stanwell township.

This report provides the results of the fourth and final in a series of background noise level measurements. It also includes the outcome from modelling of the noise produced by the Stations' operations.

2 Study Area Description

Stanwell Power Station (SPS) is a 1400 MW coal fired power station located near the small township of Stanwell , approximately 30 km to the south west of Rockhampton.

Land use in the vicinity of the station is predominantly rural and includes some rural/residential properties. In line with Stanwell Corporation's proactive environmental policy, the company determined that a detailed assessment of the noise environment should be done to quantify the extent and potential impacts of noise from the station.

To achieve this objective, Pacific Air & Environment commissioned Kamst and Simpson to conduct measurements over a period of seven days at a number of sites surrounding the station. Measurement sites were selected to represent the locations that noise may be experienced from the station.

3 Survey Methodology

The methodology employed in this survey was based on the Environmental Protection (Noise) Policy 1997 and on Australian Standard 1055.1 1997 *Acoustics: Description and Measurement of Environmental Noise; Part 1: General Procedures.*

Figure 3.1 shows the two background monitoring sites (B1 and B2)as well as the two validation sites (V1 and V2). **Figure 3.2** shows the monitoring locations within the Stanwell Power Station compound.

The two background sites (B1 and B2) were selected to provide a measure of the background noise at locations V1 and V2 if the SPS was not there.

Site B1 is located near to the Capricorn Highway. The site B1 is taken to be

representative of the noise levels at V1 without the SPS. Site B2 is located in a rural area well away from the Capricorn Highway. The site B2 is taken to be representative of the noise levels at V2 without the SPS.

Measurements were also taken at a number of locations inside the SPS compound so as to provide information on the noise levels directly attributable to the SPS. These noise levels were used in the noise modelling process.

Site V1 was selected to provide direct measurements of the noise levels in the most sensitive area in the township of Stanwell. These measurements can be used to compare with the monitoring results from the first three studies as well as to validate the computer noise model.

Site V2 was selected as it is in a location which is close enough to SPS to be strongly influenced by SPS noise. It is somewhat closer than the nearest residences to SPS.

At monitoring locations B1, B2, V1 and V2 attended monitoring was carried out at different times of the day and observations of the range of noise sources were recorded throughout each measurement.

Meteorological readings were obtained from SPS meteorological station for the entire monitoring period. This station is located to the west of the Stanwell Power Station. The station recorded wind speed, wind direction and relative humidity at 10 metres and 30 metres. Temperature was measured at ground level and at 30 m.

4 Noise Monitoring Results

Four (4) calibrated ARL environmental noise loggers were used to record noise levels over 15 minute periods for a period of two weeks between 8 August 2000 and 24 August 2000 at locations B1, B2, V1 and V2.

Short duration attended monitoring was carried out using a Rion NA27 sound level meter.

4.1 Ambient Monitoring Results

Monitoring was carried out using an environmental noise logger at monitoring locations B1, B2, V1 and V2 for a period of approximately two weeks between the 9/8/2000 and the 23/8/2000. The summary of results of this monitoring are shown in **Table 4.1**. The table illustrates the noise levels at these four sites during the day, evening and night time periods. Day, evening and night are as defined in the Environment Protection (Noise) Policy 1997. **Appendix B** contains charts of the noise monitoring survey.

The noise levels are expressed in terms of the L_{Aeq}, L_{A10} and the L_{A90}. The L_{A10} and L_{A90} are the 'A' weighted noise levels exceeded 10% and 90% of the time respectively. TheL_{A90} is commonly taken to be the background noise level. The L_{Aeq} is the average noise level for each specified time period.

The noise levels in **Table 4.1** are the arithmetic average of all 15 minute periods during the period in question.

Table 4.1 Ambient Noise Levels dB(A) August 2000

Site	Time								
	Day (0600 - 1800)			Evening (1800 - 2200)			Night (2200 - 0600)		
	L_{Aeq}	L_{A10}	L_{A90}	L_{Aeq}	L_{A10}	L_{A90}	L_{Aeq}	L_{A10}	L_{A90}
B1	51.9	55.2	36.5	55.1	59.2	37.5	52.5	54.4	29.3
B2	39.7	41.0	30.9	35.9	37.0	32.0	32.5	34.0	29.5
V1	49.9	52.9	40.9	46.9	51.0	34.6	45.5	49.2	31.4
V2	43.5	45.7	38.3	43.2	45.8	39.7	42.5	45.4	38.6

A second sound level meter was used to obtain short duration octave band noise level measurements at sites V1 and V2 at various times of the day. The results of this monitoring are shown in **Appendix C**.

The report relies upon the data obtained from the attended monitoring periods to validate the computer noise model of the SPS.

4.2 Source Noise Levels

Noise levels, expressed as L_{A10}, directly attributable to the SPS were measured at locations A to H surrounding the power station. Locations A to T are shown on **Figure 3.2**. These monitored noise levels are shown in **Table 4.2**.Locations A to N are obtained at a distance of approximately 40 metres from the building/ station. Locations O to T are obtained at a distance of approximately 1 metre from the ducting between the precipitator and the stack downstream of the fans.

Table 4.2: Noise Levels Close to Stanwell Power Station in Terms of L_{A10}

Reference	Location	Noise Level in dB(A) in Octave Band Centre Frequency (Hz)								Overall dB(A)
		63	125	250	500	1000	2000	4000	8000	
A	Turbine house (west)	54.9	63.4	63.5	72.7	74.3	72.1	68.3	55.6	77.4
B	Boiler house (west)	54.9	61.0	62.7	73.0	68.6	68.7	60.8	49.5	74.9
C	Boiler house (west)	56.4	61.2	60.1	69.6	66.2	64.5	58.1	49.5	71.8
D	Precipitators	58.7	66.3	63.5	64.7	66.1	61.4	55.5	45.3	70.5
E	Precipitators	62.2	71.7	68.7	68.3	68.5	63.0	56.6	46.0	74.7
F	Precipitators	60.1	68.1	65.2	66.5	66.6	61.9	54.7	45.6	72.0
G	Precipitators	62.8	69.0	67.9	67.0	69.0	67.5	58.8	46.7	74.0
H	Precipitators	60.0	67.8	64.3	62.2	62.1	58.8	53.4	45.1	70.2
I	Boiler house (east)	60.2	66.6	65.9	68.2	67.6	65.7	58.8	50.8	72.8
J	Boiler house (east)	59.9	64.2	63.1	73.9	71.1	69.8	63.5	52.6	76.3
K	Opposite ducting	58.3	65.7	65.4	74.3	76.1	73.4	66.0	57.7	78.9
L	Turbine house (south)	55.1	64.7	71.7	69.8	71.5	72.2	68.3	54.9	76.8
M	Turbine house (south)	54.4	62.1	65.0	67.7	70.0	67.8	63.2	53.2	73.4
N	Turbine house (south)	55.2	67.3	71.4	72.6	70.8	69.2	64.3	55.5	76.6
O	Next to precipitators	72.2	81.3	77.9	75.5	73.7	68.0	62.1	53.0	83.5

Reference	Location	Noise Level in dB(A) in Octave Band Centre Frequency (Hz)								Overall dB(A)
		63	125	250	500	1000	2000	4000	8000	
P	Next to precipitators	70.5	74.8	76.4	75.7	72.8	68.3	63.8	54.3	80.4
Q	Next to precipitators	66.0	75.7	75.0	70.4	65.8	59.4	54.8	47.4	78.2
R	Next to precipitators	69.1	75.9	74.4	70.6	65.8	59.9	55.0	47.0	78.2
S	Next to precipitators	70.9	74.6	75.6	75.6	72.9	69.3	64.6	53.0	80.3
T	Next to precipitators	71.6	80.9	77.5	75.3	71.9	66.9	62.1	54.0	82.7

4.3 Measured Noise Levels at Validation 1

Table 4.3 shows the measured noise levels (L_{A10}) at location validation 1 (V1) in each octave band. The results are expressed in terms of dB(A) and this equates to how the human ear hears noise.

Traffic noise and noise from birds and insects are predominant noise sources at V1 during the day and evening period. During the evening period SPS becomes audible when noise from other sources reduces. Between 12 am and 5 am the SPS is audible in the Stanwell township.

The last measurement obtained at V1 (11/8/2000 at 2:15 am) was predominantly due to SPS. While a higher frequency noise was evident, it did not strongly influence the overall noise level. The dominant frequency at this time was 125 Hz and from our experience this is primarily due to industrial noise sources.

Table 4.3: Measured Noise Levels at Validation 1 in L_{A10}

Time	Noise Level in dB(A) in Octave Band Centre Frequency (Hz)							Overall dB(A)	Comment - Meteorology
	63	125	250	500	1000	2000	4000		
9/8/2000 14:26	36.9	42.2	39.3	33.2	37.2	41.3	37.0	48.2	Traffic, bird noise, 1.4 m/s northerly breeze
9/8/2000 16:54	31.5	38.5	31.6	29.5	40.6	43.4	40.1	49.7	Traffic, bird noise, 1 train pass, dog barking, 1.5 m/s northerly breeze
9/8/2000 20:00	37.7	40.8	32.8	33.4	42.9	43.7	34.3	48.4	Traffic, 1 train pass, insects and crickets, 1 m/s northnorth easterly breeze
10/8/2000 05:06	38.5	42.1	41.6	41.9	46.5	48.0	35.4	52.9	Traffic, 1 train pass, low frequency from SPS (high frequency also audible), rooster crowing, still conditions 0.3 m/s southerly breeze
10/8/2000 08:02	37.3	41.7	39.9	39.0	44.5	46.6	41.4	52.0	Light traffic, 1 train pass, bird noise, low frequency from SPS audible in quiet spells (higher frequency also audible), calm conditions 0.4 m/s westerly breeze
11/8/2000 00:25	24.6	31.6	29.8	23.1	24.4	18.3	16.8	34.7	Low frequency from SPS (higher frequency also audible), insect noise, calm conditions 0.5 m/s southerly breeze
11/8/2000 02:15	24.6	33.7	29.2	23.9	21.9	18.7	16.5	35.1	Low frequency from SPS (higher frequency also audible), calm conditions 0.3 m/s southerly breeze

4.4 Validation 2 Measured Noise Levels

Table 4.4 shows the measured noise levels at location validation 2 (V2) in each octave band.

Noise from SPS dominates at validation 2 (V2)during all measurements. During the day traffic, insects, and a rustle of leaves in the trees is also observed.

This site is suitable to validate the computer noise model.

Table 4.4: Measured Noise Levels at Validation 2

Time	Noise Level in dB(A) in Octave Band Centre Frequency (Hz)							Total dB(A)	Comment - Meteorology
	63	125	250	500	1000	2000	4000		
9/8/2000 14:45	28.5	37.0	31.4	27.6	31.9	36.0	26.2	41.4	Low frequency from SPS audible, traffic, bird noise, rustle of leaves in trees, calm conditions 0.7 m/s westerly breeze
9/8/2000 20:20	25.2	31.4	32.0	37.5	37.7	30.4	32.1	42.7	Low frequency from SPS audible, traffic, insects and crickets, calm conditions 0.8 m/s north easterly breeze
10/8/2000 5:30	33.0	37.1	35.8	44.4	43.3	34.1	24.9	47.3	Low frequency from SPS obvious (also a higher frequency audible from SPS), traffic, conditions very calm 0.3 m/s south westerly breeze
10/8/2000 8:20	29.1	32.4	32.4	36.8	37.8	37.9	29.7	43.6	Low frequency from SPS obvious (also higher frequency from SPS audible), light traffic, bird noise, very calm conditions 0.3 m/s westerly breeze
11/8/2000 2:34	35.3	37.0	38.3	41.0	39.1	33.6	20.8	45.4	Low frequency from SPS obvious (higher frequency from SPS also audible), very calm conditions 0.3 m/s south easterly breeze
11/8/2000 11:30	32.1	35.8	36.1	37.0	34.1	32.4	33.6	42.9	Low frequency from SPS obvious (higher frequency from SPS also audible), insects and birds, rustle of leaves, 1 train pass, calm conditions 0.9 m/s south westerly breeze

5 Noise Modelling

These monitored noise levels (**Section 4, Table4.2**) were then used to calculate a sound power level for each building element. The sound power level (the quantity of acoustic energy emitted by a specified source) is used in the computer noise model to predict noise levels at validation 1 (V1) and validation 2 (V2).

The octave band frequency data allows accurate environmental noise modelling, as noise sources can be characterised according to their frequency spectra. **Table 5.1** contains the spectra of the noise source used in the modelling. Environmentally the low frequency noise levels (<500Hz) to propagate more readily than high frequency noise.

Table 5.1: Sound Power Level Attributable to Stanwell Power Station

Location	Sound Power Level in dB in Octave Band Centre Frequency (Hz)								Total dB
	63	125	250	500	1000	2000	4000	8000	
Turbine house (west)	111.9	110.3	102.9	106.7	105.1	101.7	98.1	87.5	115.8
Boiler house (west)	112.6	108.0	100.8	105.3	98.2	96.2	89.3	81.4	114.8
Downstream of Precipitators	121.6	119.3	109.1	103.6	101.1	95.9	89.4	81.5	123.8
Boiler house (east)	117.0	112.3	103.9	105.0	100.2	97.3	90.9	83.6	118.7
Opposite ducting	115.3	112.6	104.8	108.3	106.9	103.2	95.8	89.6	118.4
Turbine house (south)	115.7	115.4	112.6	107.9	105.4	103.2	98.9	90.2	120.1
Next to precipitators	126.6	122.7	115.8	107.5	100.8	94.7	90.9	82.9	128.4
Roof (south)	124.6	123.1	117.1	117.9	116.1	112.9	107.9	99.4	128.3
Roof (north)	127.4	123.5	114.9	115.0	110.1	106.8	100.2	92.5	129.3

It should be noted that noise from the stack and cooling towers are not included in this analysis. It is unlikely that the stack is a significant noise source due to various directivity effects. Measurements close to the cooling tower did not suggest the noise source to be significant. However noise from the cooling towers was included in several measurements.

The noise levels obtained at validation 2 have been used to validate the

computer noise model at the power station. V2 is approximately 1.5 kilometres from the power station and SPS noise dominates at this site.

The validation of the noise model relies upon the 15 minute octave band measurements at different times of the day and night and their comparison with the predicted noise levels for the appropriate meteorological conditions.

A number of modelling cases were developed including:

- a prediction of the noise levels at location validation 1 (V1) for the meteorological conditions occurring at the time of the measurements;
- a prediction of the noise levels at location validation 2 (V2) for the meteorological conditions occurring at the time of the measurements;
- a prediction of the diurnal variation of noise levels at validation 1 (V1) using the meteorological conditions occurring at the time of the measurements.

The technical aspects of the model are contained in **Appendix A**. A discussion relating to the results is contained below.

5.1 Model of Noise Source

The SPS has a rectangular footprint with the long side orientated east - west. Most noise sources are enclosed in the building which is approximately 20 metres high. The measurement of noise sources was of individual noise sources as well as groups of noise sources combined. Sound power levels shown in **Table 5.1** were used in the model to obtain noise level predictions at locations V1 and V2.The sound power levels assume an elevation of 10 metres for the walls of the building and 20 metres from the roof.

5.2 Validation of Computer Noise Model

Using the sound power levels in **Table 5.1** the noise was predicted at validation location V2 using the attended measurements. Location V2 was used as the noise level at this location is mostly due to SPS noise.

The predicted noise levels shown in **Table 5.2** below for validation 2 show two predicted noise levels based on an estimated upper and lower bound of the temperature gradient. The meteorological station provided a measurement of temperature at ground level and at 30 m. The ground level temperature probe is located in an zone which is non-linear (with respect to vertical temperature profile) and the resulting calculated vertical temperature gradient was not accurate. As a consequence the atmospheric stability and hence temperature gradient was assessed based on the approach recommended by the NSW EPA in their document ‘ NSW Industrial Noise Policy’. This policy recommends vertical temperature gradient be measured at two locations one between 1.5 m and 10 m and the other between 50 m and 60 m.

Table 5.2: Predicted Noise Levels at Validation 2 (V2)

Time	Noise Level in dB(A) in Octave Band Centre Frequency (Hz)						Total dB(A)
	63	125	250	500	1000	2000	
9/8/2000 14:45	29	33.8	29.7	29.5	22.7	8.2	37.1
	29.5	35	31.9	32.8	25.7	12.4	39
9/8/2000 20:20	29.5	34.8	31.8	33.7	27.6	17.1	39.2
	33.9	40.1	38.2	39.2	34.6	24.3	44.9
10/8/2000 5:30	34.3	40.3	38.4	40.2	37	26.7	45.6
	42.4	40.8	43.1	40.6	30.4	1.5	48.2
10/8/2000 8:20	28.8	33.6	29.8	30.2	24.2	12.3	37.3
	29.5	34.8	31.9	33.2	27.3	16.3	39.1
11/8/2000 2:34	34.2	40.3	38.4	40.2	37	26.7	45.6
	42.3	40.7	43.1	40.6	30.4	1.5	48.2
11/8/2000 11:30	29.7	35.3	32.6	34	27.8	15.7	39.7
	30.9	36.3	33.3	32.2	25.4	12.5	39.9

5.3 Comparison of Noise Model with Measurements at Validation 2

Table 5.3 contains the predicted noise level at location validation 2 (V2) and the measured noise level for the meteorological conditions occurring at the time.

The measured noise level includes noise from all noise sources occurring at the measurement location including Stanwell Power Station. The predicted noise level is the noise level from Stanwell Power Station as predicted by the noise model.

Table 5.3 Predicted Noise Levels Compared with Measurements (V2)

Date Time	Temperature (°C)	Humidity (%)	Wind speed m/s	Wind Direction (deg)	Vertical Temperature Gradient Range (C/100 m)	Measured Noise Level dB(A)	Predicted Noise Level dB(A)
9/8/00 14:45	27.9	40	0.7	262	-3.0 to -1.4	41.4	37.1 to 39
9/8/00 20:20	17.5	99	0.8	47	2.0 to 4.5	42.7	39.2 to 44.9
10/8/00 5:30	10	100	0.3	220	2.0 to 4.5	47.3	45.6 to 48.2
10/8/00 8:20	17.7	100	0.3	263	-3.0 to -1.4	43.6	37.3 to 39.1
11/8/00 2:34	11.8	100	0.3	143	2.0 to 4.5	45.4	45.6 to 48.2
11/8/00 11:30	26.9	49	0.9	237	-3.0 to -1.4	42.9	39.7 to 39.9

The predicted noise level range in **Table 5.3** are generally within± 2dB(A) of the measured noise levels.

It is also noted that for those predictions outside the ±2 dB(A) range the measured noise level exceeds the predicted noise levels. This may be due to other noise sources affecting the measurements.

Noise level predictions at the validation locations were shown to be highly sensitive to wind speed and direction and to temperature gradient.

5.4 Predicted Noise Levels at Validation 1

Table 5.4 contains the predicted noise levels at location validation 1 (V1). Two predicted noise levels are shown based on an upper and lower bound of the temperature gradient.

Table 5.4 Predicted Noise Levels at Validation 1 (V1)

Time	Noise Level in dB(A) in Octave Band Centre Frequency (Hz)						Total dB(A)
	63	125	250	500	1000	2000	
9/8/2000 14:26	26.2	31.3	26.9	20.6	10.1	-	33.7
	26.4	31.6	27.4	21.2	10.5	-	34.1
9/8/2000 16:54	26.4	31.6	27.4	21.3	10.9	-	34.1
	26.7	31.8	27.6	21.8	11.2	-	34.4
9/8/2000 20:00	26.7	32.1	28.9	24.0	15.4	-	35
	27.0	32.5	29.2	24.6	15.8	-	35.4
10/8/2000 05:06	29.2	35.2	32.5	32.2	25.8	-	39.0
	30.0	35.9	33.2	33.1	27.0	-	39.8
10/8/2000 08:02	26.8	32.2	28.9	24.7	17.1	-	35.1
	27.3	32.9	29.6	26.0	18.2		35.9
11/8/2000 00:25	27.9	34.1	31.4	30.6	24.1	-	37.8
	28.7	34.8	32.1	31.6	25.0		38.5
11/8/2000 02:15	29.1	35.1	32.4	32.1	25.7	-	38.9
	29.9	35.9	33.1	33.0	26.9		39.7

5.5 Comparison of Noise Model with Measurements at Validation 1

Table 5.5 contains the predicted noise level at location validation 1 (V1) and the measured noise level for the meteorological conditions occurring at the time.

It is noted that the final two predictions are approximately 4 dB(A) higher than the measured result. This may be due to an incorrect assumed temperature gradient or due to screening effects from intervening buildings, structures and vegetation or meteorology.

Table 5.5 Predicted Noise Levels Compared with Measurements (V1)

Time	Temperature (°C)	Humidity (%)	Wind speed m/s	Wind Direction (deg)	Temperature Gradient Range (C/100 m)	Measured L_{A10} Noise Level dB(A)	Predicted Noise Level dB(A)
9/8/00 14:26	27.1	43	1.4	349	-3.0 to -1.4	48.2	33.7 to 34.1
9/8/00 16:54	26.5	43	1.5	1	-1.0 to 0.0	49.7	34.1 to 34.4
9/8/00 20:00	17.9	99	1	15	-1.0 to 0.0	48.4	35 to 35.4
10/8/00 5:06	10	100	0.3	184	2.0 to 4.5	52.9	39 to 39.8
10/8/00 8:02	15.5	100	0.4	287	-3.0 to -1.4	52.0	35.1 to 35.9
11/8/00 0:25	13.1	100	0.5	197	-1.0 to 0.0	34.7	37.8 to 38.5
11/8/00 2:15	11.9	100	0.3	192	2.0 to 4.5	35.1	38.9 to 39.7

During several monitoring periods the predicted noise level was well below the measured noise level. This occurred during daylight hours. This result is to be expected since during the day there are many other sources of noise.

In order to assess the variability of noise levels at validation 1 (V1) due to meteorology, calculation of noise levels was carried out using the Stanwell Ausplume meteorological file. The computer model calculates a noise level every hour of the day, every day of the year using the meteorology in the Stanwell file. The noise level in each hour is then post processed to obtain statistical variability. For instance, **Table 5.6** indicates that for the period between midnight and 1 am, the maximum noise level during the year is expected to be 40 dB(A). Ten percent of nights the noise level between midnight and 1 am is expected to be 39.2 dB(A) etc.

5.6 Predicted Diurnal Noise Levels at Validation 1

The Stanwell meteorological file was analysed and **Table 5.6** shows the variability of noise levels at validation site 1 (V1). The noise levels are in terms of the noise level exceed for the percentage of the time. They are also shown graphically in **Figure 5.1**.

It may be seen that the maximum noise level, due to noise from the Stanwell Power Station, occurring at validation site 1(V1) is about 41 dB(A) and this is likely to occur at night time. The lowest noise levels due to the SPS at V1 is likely to be 32 dB(A). This is a range of only 9 dB(A) for all meteorological conditions.

During the period 2100 to 0600 for 50 % of the time the noise level is likely to be 38 dB(A). This is only 3 dB(A) below the maximum noise level likely from SPS. The night time period has meteorological conditions which favour the propagation of noise.

Table 5.6 Diurnal Statistical Distribution for location Validation 1

Hour	Maximum Noise Level in dB(A) Exceeded % of time				
	Maximum	1%	10%	50%	100%
0100	40	40	39	38	34
0200	40	40	39	38	33
0300	40	40	39	38	33
0400	40	40	39	38	34
0500	41	40	39	38	34
0600	40	40	39	38	34
0700	40	40	39	37	34
0800	40	39	37	35	34
0900	39	39	37	35	33
1000	39	38	37	35	33
1100	39	38	37	35	33
1200	40	38	37	35	33
1300	40	38	37	35	32
1400	39	38	37	35	32
1500	39	38	37	35	32
1600	39	38	37	35	33
1700	40	39	37	34	32
1800	40	39	39	35	33
1900	41	40	39	37	33
2000	41	40	39	37	33
2100	40	40	39	38	33
2200	40	40	39	38	33
2300	40	40	39	38	33
2400	40	40	39	38	33

The windroses for Stanwell are attached in **Appendix D**. The data shows that during the daytime the wind is often from the east through to the north east. All seasons show a similar pattern. These winds would tend to enhance noise levels down wind, to the west and south est of the plant. Since the town of Stanwell is generally to the north these winds would suppress the noise level.

The effect of the variability resulting from the wind direction and speed is included in the diurnal statistical distribution. It is noted that daytime noise levels are quieter than evening noise levels.

5.7 Noise Contours

Noise contours surrounding SPS for several meteorological cases are presented. The cases considered are:

- neutral meteorology (zero wind speed, zero vertical temperature profile), **Figure 5.2**;
- down wind (wind speed 2 m/s from the south west, zero vertical temperature gradient), **Figure 5.3**;
- mild inversion (zero wind speed, 2 C^o/100 m vertical temperature gradient), **Figure 5.4**;
- typical daytime downwind (2 m/s from the south west, -2 C^o/100 m vertical temperature gradient), **Figure 5.5**.

It is the case as elevation increases the air temperature reduces. This is known as the lapse rate or vertical temperature gradient. In a neutral atmosphere the lapse rate is known as the adiabatic lapse rate and all temperature gradients are referred to this rate. With an inversion the vertical temperature gradient is greater than the adiabatic lapse rate while during the day the reverse applies; that is the atmosphere cools more quickly than the adiabatic rate, hence the vertical temperature gradient is more negative.

The contours for the neutral meteorology are considered to be the average case without any meteorological influences. It is the normal modelling condition. The effects of the tree zones and the hill south of Stanwell Township can be seen. These conditions occur typically about dusk and soon after dawn.

The contours for the downwind case show an increase in noise levels in Stanwell and a reduction to the southwest of the SPS compared with the neutral meteorology case. A wind speed of only 2 m/s increases noise levels in Stanwell Township by about 2 dB(A). These conditions occur typically about dusk or dawn.

The contours for the inversion case show an increase in noise levels in all directions from SPS compared with the neutral meteorology case. An mild inversion would lead to an increase of up to 2 dB(A) in Stanwell Township compared with the neutral meteorology case. This would occur during most night periods. During the cooler months stronger inversions may occur. During the warmer months the inversion may not be so pronounced.

The contours for the typical daytime downwind show an increase of about 1 dB(A) in Stanwell Township compared with the neutral meteorology case. However the mild daytime vertical temperature profile causes a reduction in noise levels (of about 1 dB(A)) in Stanwell Township, while the down wind

causes an increase (of about 2 dB(A)). If the wind blows away from Stanwell Township the noise would reduce by about 2 dB(A) (compared with neutral conditions) due to the combined effect of vertical temperature profile and wind. This is expected to be a typical daytime noise level when Stanwell Township is downwind of the SPS. During summer periods or periods when the wind blows in other directions the noise level would be lower.

The major noise produces at SPS appear to be located at the north west end of SPS, namely the coal preparation areas and the ID fans. This project was not designed to identify specific noise sources, rather obtain the noise of the operations as a whole and any directivity associated with the plant. To improve the accuracy of modelling it would be necessary to carry out a noise audit of SPS and measure each noise source.

6 Assessment of Noise Levels

Noise levels in the Stanwell township at validation 1 (V1) are generally higher than those measurements at background 1 (B1). The background noise levels at B1 and V1 are similar, mostly within about 3 dB(A) of each other. The background noise level at V1 show a diurnal fluctuation similar to that to that at B1 and on the basis of the statistical measurements alone the influence of SPS cannot be readily determined. The attended monitoring indicates that noise from the station is audible and at levels equivalent to that predicted, ie between 32 dB(A) and 41 dB(A).

SPS produces noise at a constant level with very little fluctuation in noise level output. The measurements indicate that the difference between the L_{10} and the L_{90} close to the power stations is about 2 dB(A) to 3 dB(A). At large distances, as is the case between SPS and Stanwell Township, there are always fluctuations in the noise level due to atmospheric turbulence and variability in the wind speed, wind direction and temperature. As a consequence the noise in Stanwell would tend to fluctuate by up to the addition of the meteorological influences and the plant emissions variability. This would be about 2 dB(A) to 3 dB(A) where the predicted noise level is close to the upper limit and by more than 5 dB(A) where the predicted noise levels are close to the lower limit.

It is considered likely that the noise levels in Stanwell vary between about 32 dB(A) and 41 dB(A) plus or minus short term fluctuations in noise. The L_{10} noise from SPS during the evening is likely to be about 38 dB(A) (with an accuracy of ± 3 dB(A)) for about 50% of the time during the evening. Since the background noise level without SPS present would be about 29 dB(A) it is likely that noise from SPS would be quite noticeable.

Under the Environmental Protection (Noise) Policy 1997, referred to hereafter as the EPP (noise), SPS would most likely be defined as a beneficial asset.

The EPP(Noise) contains the following in relation to Beneficial Assets,

5.(1) A beneficial asset is an airport, approved industrial estate, navigable waterway, public road or railway.

5.(2) It is recognised that, although the operation or use of a beneficial assets may have significantly adverse effects on environmental values, they are necessary for the community's social and economic well being.

5.(3) However it is intended that, as so far as practicable, any significantly adverse effects from their use or operation be progressively reduced.

Section 10 of the EPP (noise) states:

> The environmental values to be enhanced or protected under this policy are the qualities of the acoustic environment that are conducive to:
>
> (a) The wellbeing of the community or a part of the community, including its social and economic amenity; or
>
> (b) The wellbeing of an individual, including the individual's opportunity to have sleep, relaxation and conversation without unreasonable interference from intrusive environmental noise.

The $L_{Amax\ adj,T}$ is described as the average maximum A-weighted sound pressure level. It is commonly held that for residential dwelling the above would be attained when the $L_{Amax\ adj,T}$ does not exceed the background noise level by more than 5 dB(A) during the hours 7:00 am and 10:00 pm measured outside the most exposed part of a residential place. Between the hours 10:00 pm to 7:00 am, compliance with noise goal will be achieved when the $L_{Amax\ adj,T}$ does not exceed background noise levels by more than 3 dB(A).

It should be noted that the predicted noise levels are "component noise levels", which means that these do not include any other noise sources. The noise limit, however, is in term of the $L_{Amax\ adj,T}$, which is a measured noise level that is it includes the ambient noise level. For the purposes of this assessment the $L_{Amax\ adj,T}$ may be taken to be equal to the L_{A10}.

In terms of component (predicted) noise levels, the noise level goal should not exceed background noise level plus 3 dB(A) between 7:00 am and 10:00 pm.

Table 3.1 Noise Level Goal not to be Exceeded

Time Period	Predicted Noise Level dB(A)
Daytime (7 am to 6 pm)	background + 3 dB(A)
Evening (6 pm to 10 pm)	background + 3 dB(A)
Night Time (10 pm to 7 am)	background + 0 dB(A)

Currently the noise from SPS exceeds the night time noise level goal. The night noise level goal would be about 30 dB(A) and this is close to the lower bound of the range of predicted noise levels.

With the likely construction of the Australian Magnesium Corporation plant in the close vicinity to SPS in the near future, it is possible that this may exacerbate any existing noise complaints.

7 Conclusion

Noise levels have been measured in the Stanwell area to assess the noise from the Stanwell power Station under a variety of meteorological conditions.

The following may be concluded from the study:

- the measurements indicate that the noise levels in Stanwell Township are generally noisier than an equivalent position along the highway;
- measurements have been obtained in Stanwell Township up to 35 dB(A) which is attributable to SPS;
- modelling indicates that the noise level in Stanwell due to SPS is between 30 dB(A) and 40 dB(A). The upper noise level occurs during adverse meteorological conditions namely, downwind conditions or during temperature inversions;
- while high frequency noise is audible it is low frequency noise that is significant both from measurements and modelling;
- It is likely that the noise from SPS would exceed a nuisance noise level goal based on the background noise level;
- to improve the accuracy of the noise model and to identify the major contributing noise sources it would be desirable to carry out a noise audit of plant and equipment to identify the major source of the 160 Hz noise component; currently the noise levels only identify broad sections of the plant rather than individual components i.e. fans/ducts etc;
- it is likely that some noise control would be desirable;
- the vertical temperature gradient is a significant factor influencing noise levels in Stanwell. The gradient could not be determined from the supplied weather station data and a generic temperature gradient (based on temperate latitudes profiles) was used based on calculated stability. Improved vertical temperature gradient data would improve modelling accuracy. This could be improved by providing additional temperature probes at the meteorological station, typically a temperature probes at10 m and between 50 m to 60 m is required;
- it would be desirable to obtain improved meteorological data (incorporating better vertical temperature gradient) and to reassess

the likely variability of noise in Stanwell; and

- With the likely construction of new industry in the close vicinity to SPS in the near future, it is possible that this may exacerbate any existing noise complaints.

Appendix A

Technical Details Relating to Model

A digital terrain noise model of the site and surroundings was set up using the PEN3D2000 environmental noise model. The terrain data was obtained from Orthophoto maps of Stanwell (1:25000). These maps have an accuracy of ±12.5 m in the horizontal plane and ±5m in the vertical plane. These maps were digitised into the model and form the topographic basis for the investigation.

The computer model also requires identification of ground types, tree zones, surface roughness estimates and meteorological data.

The default ground type is rough grass for the map. Certain areas have been nominated as 5 m high tree zones.

The surface roughness assumed for this model is dependent on the type of terrain, quantity and density of vegetation and other factors.

The model contains an algorithm for meteorological effects. Meteorological effects are due to numerous effects which generally cannot be readily calculated. These include such effects as multiple ground reflections, focussing of sky rays or the effect of shadow zones.

The model also computes noise level each hour for a full year using an AUPLUME meteorological file. In this instance the Stanwell meteorological file was used. The AUSPLUME meteorological file contains hourly data in terms of wind speed, wind direction, temperature, Pasquil stability and mixing height. However PEN3D2000 requires a temperature gradient and to a certain extent the Pasquil stability implies a range of temperature gradient. **Table A.1** contains the assumed vertical temperature gradient ranges for the Pasquil stability class.

Table A.1: Assumed Vertical Temperature Gradient for Pasquil Stability Class

Pasquil Stability Class	Range of Vertical Temperature Gradient (C/100m)	
	minimum	maximum
A	-3.0	-1.4
B	-1.4	-1.2
C	-1.2	-1.0
D	-1.0	0.0
E	0.0	2.0
F	2.0	4.5

When the vertical temperature gradient is less than zero it will tend to suppress noise levels while when the temperature gradient is positive it will tend to enhance noise levels at receptor locations .

Appendix B
Noise Monitoring Results and Meteorological Data

Appendix C

Octave Band Noise Monitoring Results at V1 and V2

Monitored Noise Levels at V1 and V2											
			Total	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
V1	9/08/00	14:26	48.2	29.8	37.3	34.2	28.1	31.9	36.5	31.0	20.5
V2	9/08/00	14:47	41.4	23.6	32.1	26.3	22.7	25.6	30.1	21.3	20.1
V1	9/08/00	16:54	49.7	25.1	33.2	26.3	23.9	34.8	38.6	34.9	21.9
V2	9/08/00	17:15	52.0	25.6	29.2	35.4	40.6	42.0	36.3	23.1	20.1
V1	9/08/00	19:59	48.4	29.9	34.4	27.8	28.1	37.5	37.1	25.2	20.1
V2	9/08/00	20:19	42.7	20.4	26.6	26.5	32.6	32.5	25.4	24.8	20.1
V1	10/08/00	05:06	52.9	32.6	36.4	36.6	37.1	41.6	42.6	29.1	20.1
V2	10/08/00	05:27	47.3	27.9	32.2	30.9	38.9	38.1	27.8	20.1	20.1
V1	10/08/00	08:02	52.0	31.6	36.6	35.0	34.3	39.4	41.8	36.0	21.8
V2	10/08/00	08:24	43.6	24.3	27.6	27.3	31.5	33.0	33.0	24.2	20.1
V1	10/08/00	23:15	37.4	16.2	26.1	20.6	22.7	26.7	23.8	14.4	10.1
V2	10/08/00	23:55	39.3	24.7	28.6	25.2	29.6	26.8	18.5	17.9	10.5
V1	11/08/00	02:15	35.1	19.7	28.1	24.3	18.8	17.0	13.4	11.5	10.1
V2	11/08/00	02:34	45.4	30.2	32.0	33.1	36.2	34.1	28.2	13.8	10.1
V1	11/08/00	10:57	44.6	25.2	31.1	27.2	26.5	31.7	34.3	29.5	17.4
V2	11/08/00	11:33	42.9	27.3	30.8	31.2	32.1	29.0	27.6	28.8	22.7

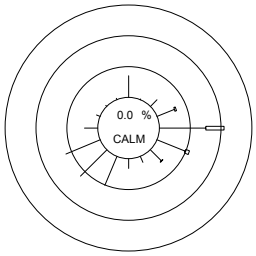
Description of Noise Sources at V1 And V2

V1	9/08/00	14:26	Bird noise , mower in the distance and traffic on Capricorn Highway
V2	9/08/00	14:47	Low rumble from power station, bird noise, slight rustle of long grass and traffic on Capricorn Highway
V1	9/08/00	16:54	Bird noise, traffic on Capricorn Highway, 1 train pass, dog barking (still conditions with no significant wind)
V2	9/08/00	17:15	Bird noise, traffic on Capricorn Highway, 1 train pass, rumble from SPS just audible (no wind ,still conditions)
V1	9/08/00	19:59	Insects and crickets, traffic on the Capricorn Highway and 1 train pass
V2	9/08/00	20:19	Insects and crickets, traffic on Capricorn Highway and low rumble from the SPS is just audible
V1	10/08/00	05:06	Traffic on Capricorn Highway, rooster crowing, SPS is audible (higher frequency from the SPS is audible) 1 train pass, (very still conditions)
V2	10/08/00	05:27	Low hum from the sps (higher frequency from the SPS is also audible), traffic on the Capricorn Highway (very still conditions)
V1	10/08/00	08:02	Very light traffic on the Capricorn Highway, 1 train pass, bird noise, low rumble and higher frequency from SPS is audible in the quite times (ie. no traffic) (very still conditions)
V2	10/08/00	08:24	Bird noise , light traffic on the Capricorn Highway, low rumble and higher frequency from the SPS is audible
V1	10/08/00	23:15	Low hum of the SPS (160 Hz, sounds like the ducting from outside the boiler room), lower rumble of SPS also audible, light traffic on Capricorn highway,, insect noise
V2	10/08/00	23:55	Low hum of the SPS (approx. 160 Hz), lower rumble of the SPS, insect noise
V1	11/08/00	02:15	SPS noise only
V2	11/08/00	02:34	insect noise, low rumble from SPS, also hum of approx 160 Hz
V1	11/08/00	10:57	insect and bird noise, SPS audible, traffic on Capricorn Highway, occasional rustle of leaves in the nearby trees
V2	11/08/00	11:33	SPS noise (higher frequency and low rumble as before, low rumble tends to wax and wane), insects and bird noise, rustle of grass and trees, 1 train pass

Appendix D

Windrose Data

March 1995 to February 1996



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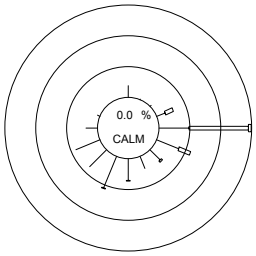

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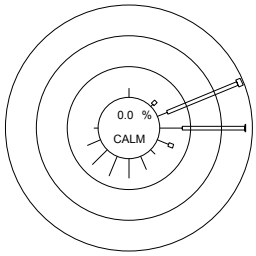

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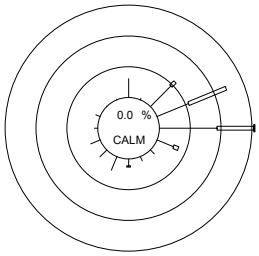

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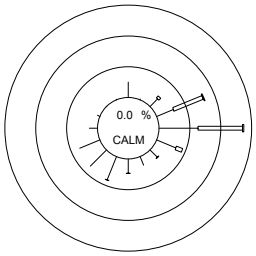

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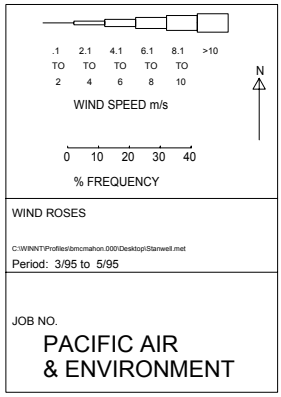
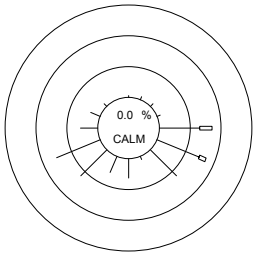
ALL HOURS



Autumn



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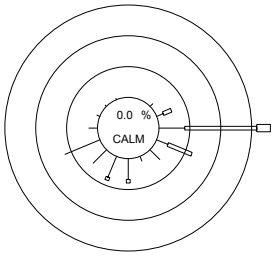

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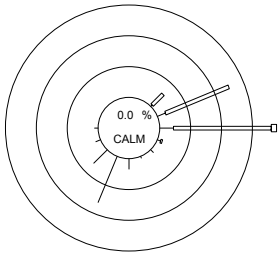

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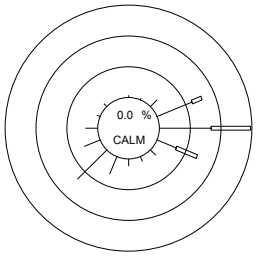
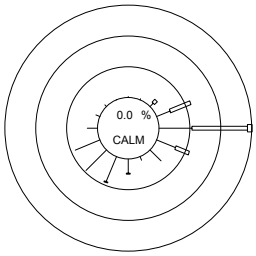


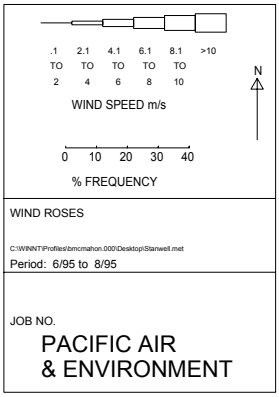
No. of Records :- 180

18:01 - 24:00

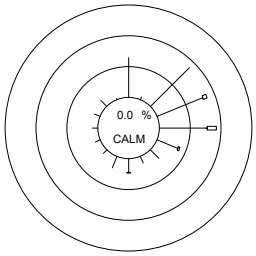


No. of Records :- 717

ALL HOURS

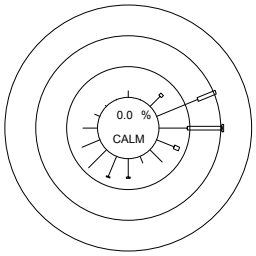


Winter



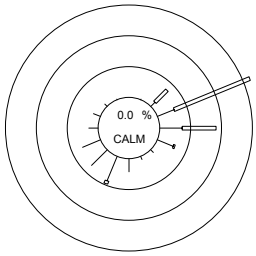
No. of Records :- 526

0:01 - 6:00



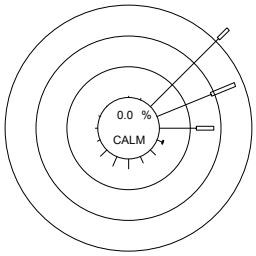
No. of Records :- 528

6:01 - 12:00



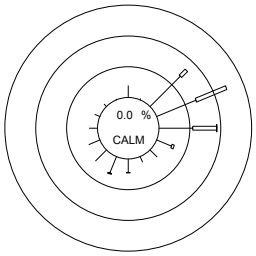
No. of Records :- 528

12:01 - 18:00



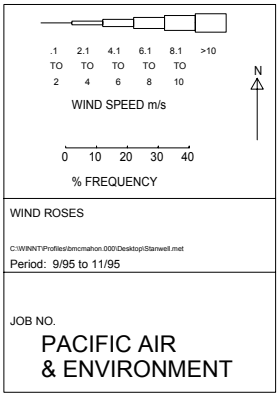
No. of Records :- 528

18:01 - 24:00

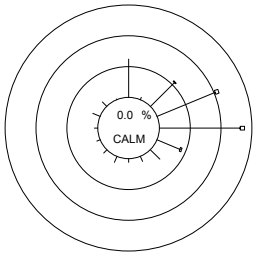


No. of Records :- 2110

ALL HOURS

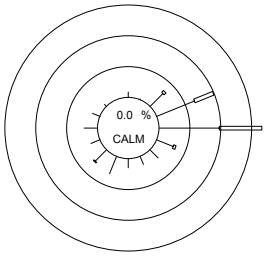


Spring



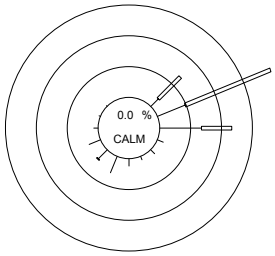
No. of Records :- 348

0:01 - 6:00



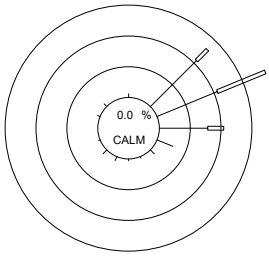
No. of Records :- 349

6:01 - 12:00



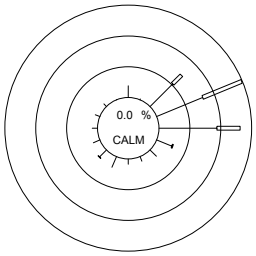
No. of Records :- 348

12:01 - 18:00



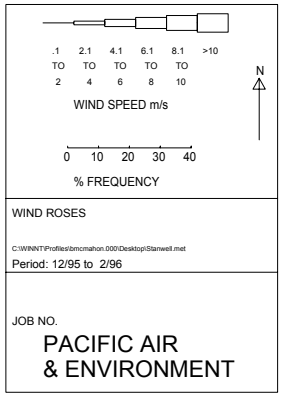
No. of Records :- 346

18:01 - 24:00



No. of Records :- 1391

ALL HOURS



Summer