Appendix B

Additional air quality modelling – revisions to the plume assessment

1 Introduction

Heggies Australia Pty Ltd (Heggies) has been commissioned by GHD Pty Ltd (GHD) on behalf of Delta Electricity (DE) to conduct a Plume Rise Assessment (PRA) as part of the Environmental Impact Statement (EIS) for a proposed gas turbine power facility at Bamarang, NSW.

The Royal Australian Navy Naval Air Station (NAS Nowra) is located approximately 4 km to the southwest of the site of the proposed gas turbine power facility at Bamarang.

The proposed power station will have two exhaust stacks, both of which are anticipated to have a height of 40 m Above Ground Level (AGL). The Defence (Areas Control) Regulations (DACR) controls the height of structures, and the purpose for which they may be used, within a 15 km radius of an aerodrome. Although the 40 m AGL stacks proposed for the Bamarang site are located within this 15 km radius, the structure of the stacks will not infringe on the Obstruction Clearance Surface (OCS) for NAS Nowra.

However, the exhaust plumes of the stacks have the potential to effect aircraft operations in terms of damage caused to airframes and the handling of aircraft during flight. The Civil Aviation Safety Authority (CASA) has identified that there is a need to assess the potential hazards that the vertical velocity from gas efflux present to the aviation activities in the surrounding region.

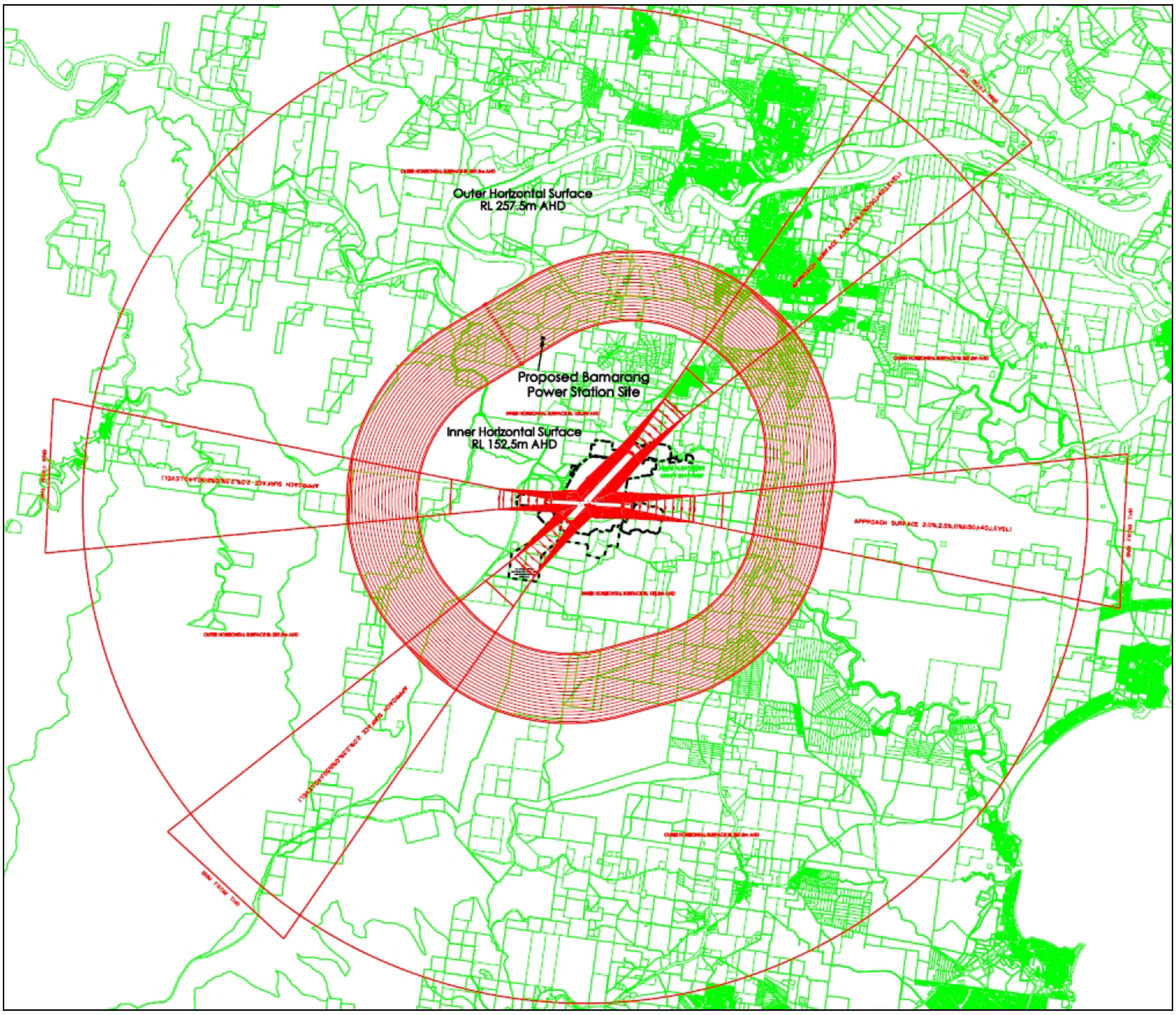
According to CASA's Advisory Circular titled *Guidelines for Conducting Plume Rise Assessments*, June 2004, exhaust plumes with a vertical velocity in excess of 4.3 m/s may cause damage to an aircraft airframe, or upset an aircraft when flying at low levels.

The proposed gas turbine power facility at Bamarang is located within the Conical Surface OCS for NAS Nowra. Through correspondence with the Department of Defence it is understood that the plume velocity from the two stacks should not exceed 4.3 m/s at the height of the Conical Surface OCS. The Conical Surface OCS at the site of the Bamarang stacks has been determined as 167 m AHD.

Topographical data for the site indicates that the Bamarang site lies at an elevation of approximately 107 m AHD. Accordingly, the critical OCS used for this assessment is 60 m AGL directly above the stacks.

Figure 1 shows the location of the NAS Nowra in relation to the gas turbine power facility at Bamarang, including a scaled illustration of the 15 km kilometre radius.

Figure 1 NAS Nowra, Location of proposed Bamarang Site and 15km



2 Assessment Methodology

This assessment has been conducted for both Stage 1 and Stage 2 Operations, to account for the different stack exit parameters associated with each phase of the project.

In accordance with CASA requirements, The Air Pollution Model (TAPM) was used in plume rise mode to analyse plume behaviour from the stacks for meteorological conditions predicted for the site over a modelling period of 5 years (2000-2005).

TAPM software, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), is a prognostic model which may be used to predict three-dimensional meteorological data, with no local data inputs required. The model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations.

The TAPM plume rise estimation uses commonly referenced plume rise algorithms for the determination of vertical plume rise velocity. For multiple sources TAPM allows a buoyancy enhancement factor to be input to account for overlapping plumes from multiple stacks. The buoyancy enhancement factor used is based on the Briggs (1984) equations.

The proposed gas turbine power facility at Bamarang will have two units operating online with corresponding identical stacks situated 40 m apart. The plumes from the stacks may merge for some wind conditions and accordingly the combined plume may rise higher than the plumes would have in isolation.

CASA have determined that TAPM is not suitable for the determination of plume dynamics for plumes that merge significantly.

To conservatively account for the possibility that plume merging may occur between the two stacks resulting in enhanced plume rise, a plume rise enhancement factor has been applied to the TAPM exit velocity input. The plume rise enhancement factors used were calculated and described in **Section 6.6** of the air quality impact assessment for this project, conducted by Heggies for GHD, and equate to 1.89 and 1.76 for Stage 1 and Stage 2 respectively.

An examination of the TAPM plume rise output data indicates that the two plumes would first begin to merge slightly above the Conical Surface OCS immediately above the site (67 m AGL). This corresponds to the height at which the horizontal plume radius is of the order of 20 m. This represents 50% of the stack separation, and thus the point at which the two plumes first touch. Total merging of the plumes is not predicted to occur until the plumes reach at least 100 m AGL.

Heggies conservative approach is to assume that the plume rise enhancement factor is applied to the exit velocity of the stack. As the stack efflux velocities adopted for the air quality impact assessment were 44 m/s and 23 m/s, the application of the two buoyancy enhancement factors to the original exit velocities result in revised exit velocities of 83 m/s and 45 m/s for the two stages respectively. This is deemed to be a highly conservative estimation of the influence of the merged stacks on vertical velocity.

Other stack parameters used were a height of 40 m AGL, a radius of 2.8 m and exit temperatures of 763 K and 398°K for Stage 1 and Stage 2 operations respectively. The stack locations used are latitude -34°54', longitude 150°31', and AMG co-ordinates Easting 273816, Northing 6134906 for Stage 1 and Easting 273812, Northing 6134875 for Stage 2.

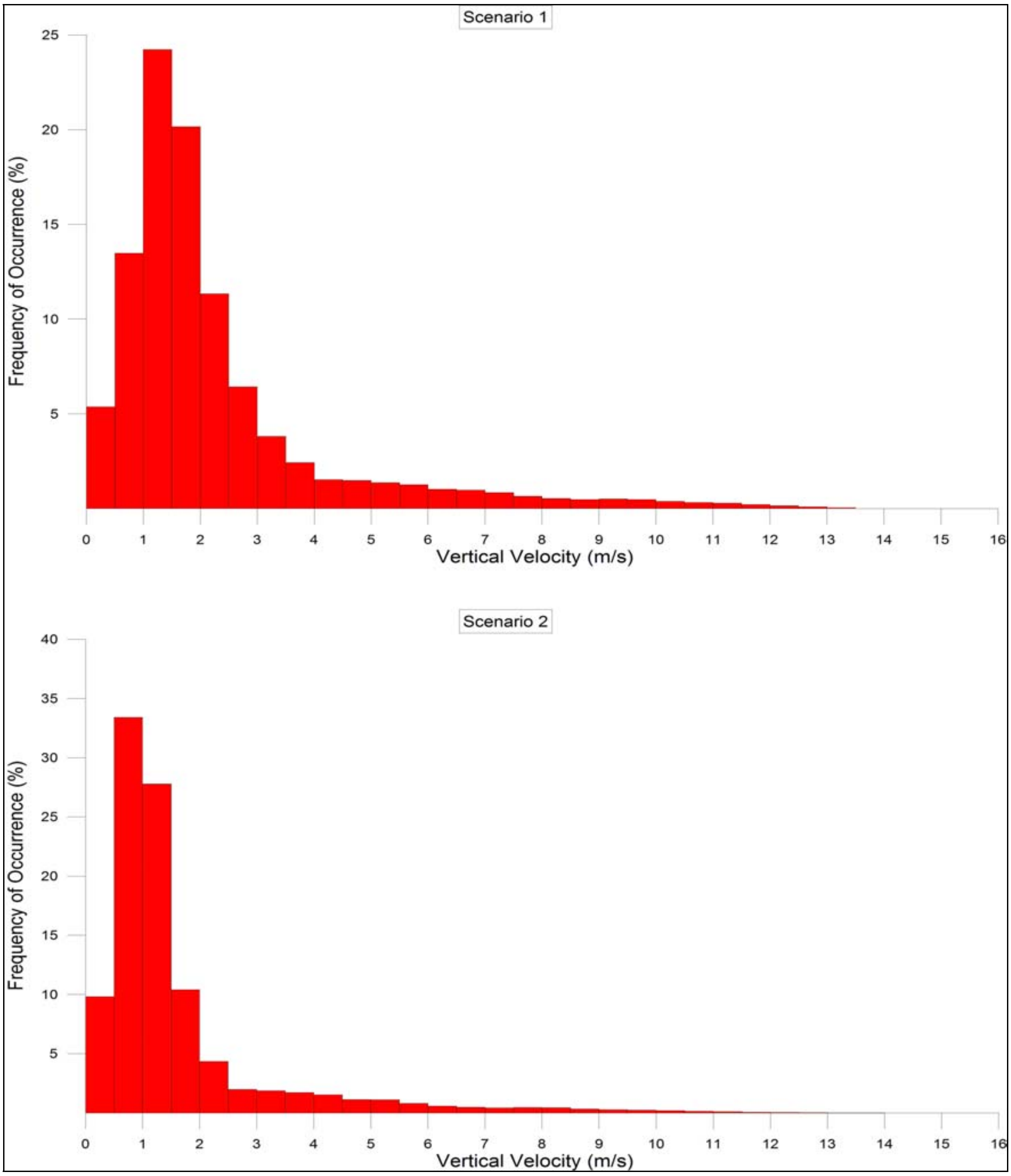
The modelling period was 1 January 2000 to 31 December 2004. TAPM was used in a nested mode, consisting of 25 × 25 × 25 grid points, and 30-km, 10-km, 3-km spaced horizontal grids for meteorology. The number of vertical levels was set to 25 and the grid centre coordinates were extracted over the plume source. No observational meteorology data was assimilated into the model.

3 Results and Discussion

3.1 Frequency Distribution of Vertical Velocity

Figure 2 presents the distribution of all predicted vertical velocities within the plume for the modelled period for Stages 1 and 2, over the vertical plume extent. It can be seen that approximately 65% and 80% of the predicted vertical velocities within the plume are predicted to be less than 2 m/s for Stage 1 and 2 respectively.

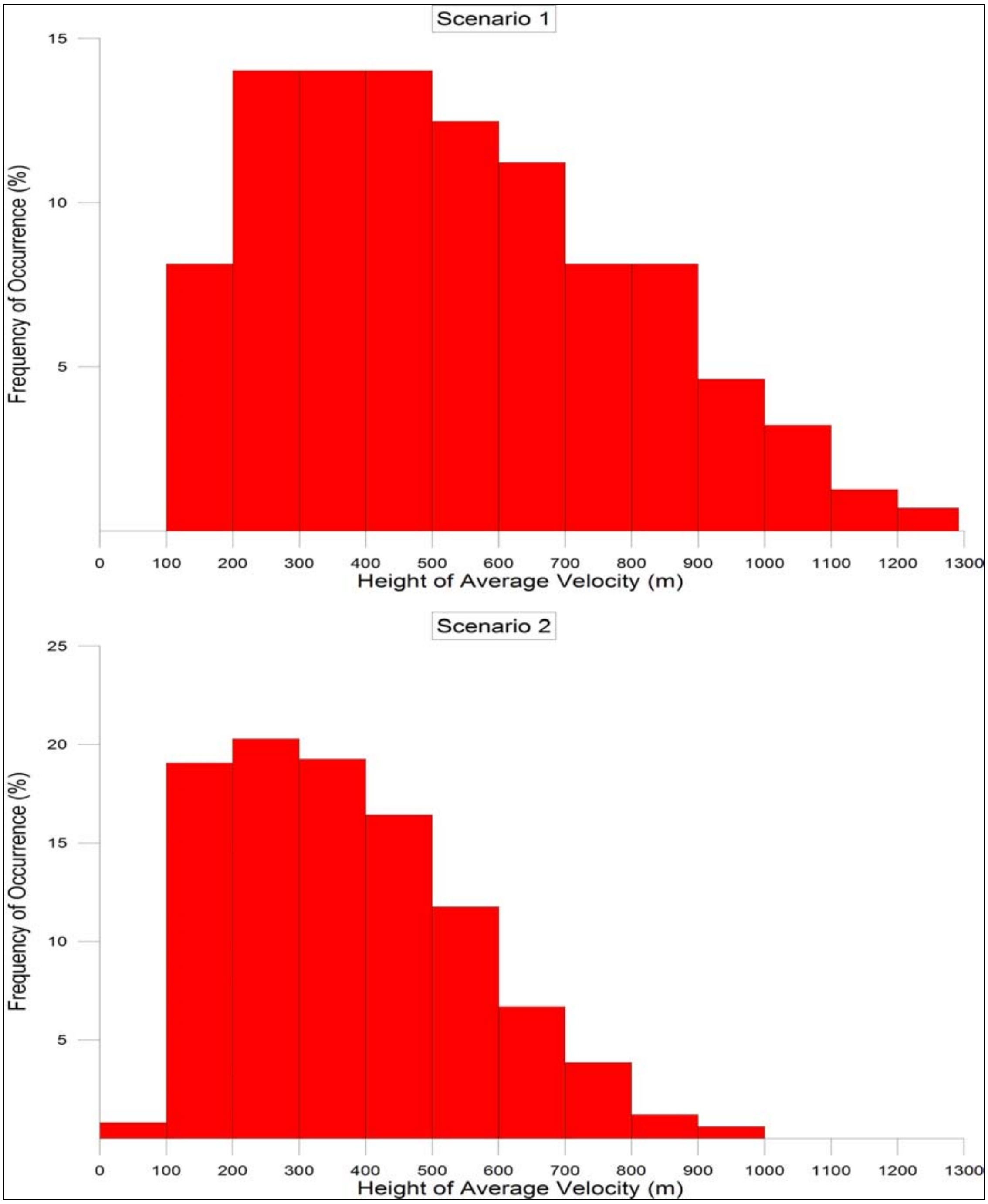
Figure 2 Frequency Distribution of Vertical Velocity within Plume



3.2 Height Distribution of Vertical Velocity

Analysis of the TAPM generated plume rise data provided the average vertical velocity within the plume, which is approximately 2.3 m/s and 1.6 m/s for Stage 1 and 2 respectively. Additionally, the frequency distribution of average vertical velocity with height may also be derived from this output, and is presented in Error! Reference source not found..

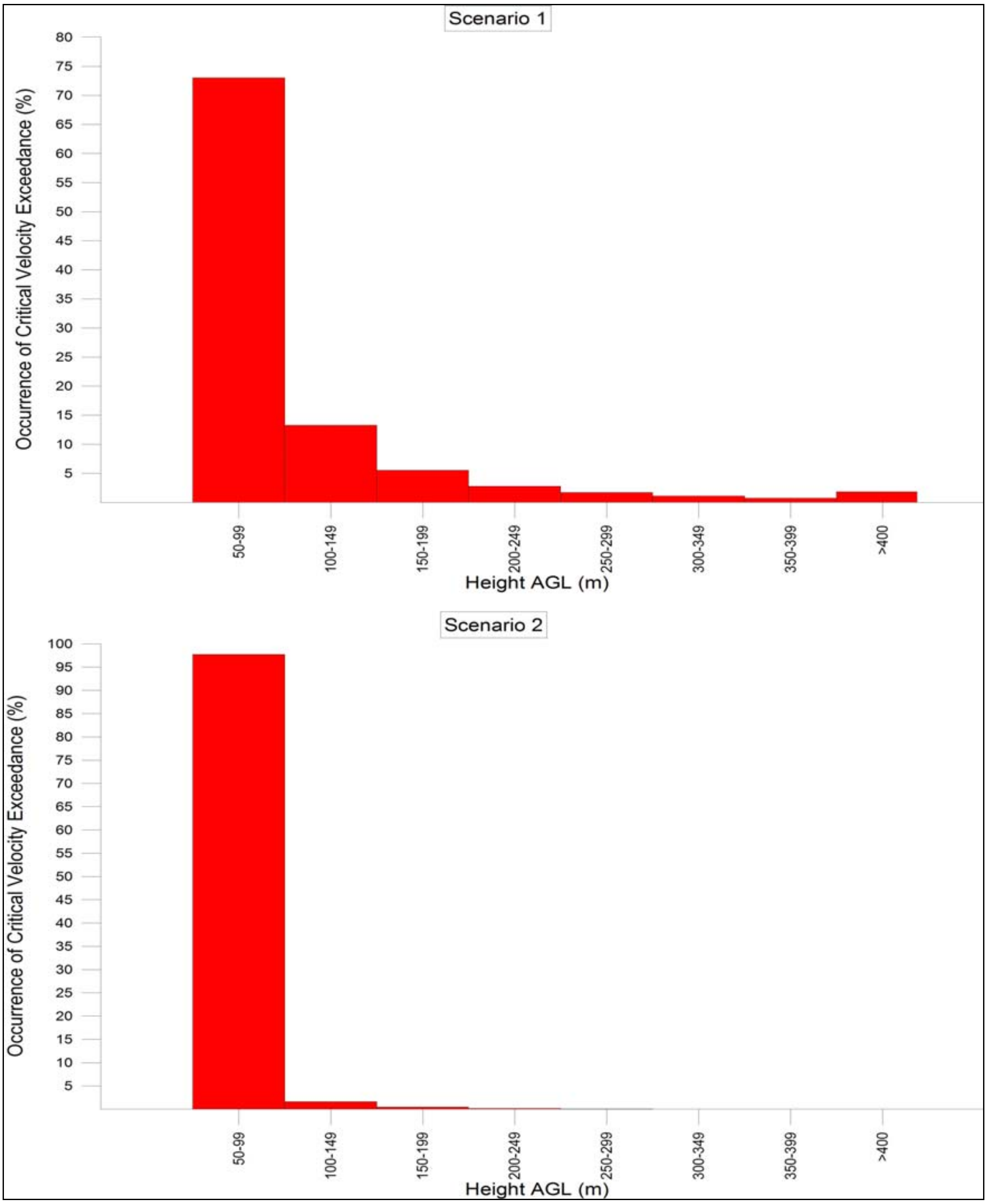
Figure 3 Frequency Distribution of Average Vertical Velocity (1.5 m/s) with Height



It can be seen from Figure 3 that the average vertical velocity for the two modelled Stages occurs below an altitude of 600 m AGL approximately 65% and 90% respectively.

Figure 4 displays the frequency distribution of exceedances of the critical vertical velocity (vertical velocity of ≥ 4.3 m/s) with height. It can be seen from this figure that approximately 73% and 98% of critical vertical velocity exceedances occur below a height of 100 m AGL for Stage 1 and 2 respectively.

Figure 4 Frequency Distribution of Critical Vertical Velocity (≥ 4.3 m/s) with Height



3.3 In-Plume Meteorology

Analysis of the TAPM generated plume rise data allowed for the comparison of vertical velocity with predicted horizontal wind speed and air temperature respectively. This analysis is addressed in the following sections.

3.3.1 Vertical Velocity and Horizontal Wind Speed

Figure 5 and **Figure 6** illustrate the relationship between TAPM predicted plume vertical velocity and horizontal wind speed at altitudes 60m, 100m, 200 and 300m AGL. Each individual vertical velocity from the entire modelling period has been plotted against its corresponding paired-in-time horizontal velocity at each of the four given heights, while the linear relationship for each altitude has also been indicated.

From **Figure 5** and **Figure 6**, it can be seen that a negative correlation exists between vertical velocity and horizontal wind speed, suggesting that plume rise can be expected to be strongest during periods of low horizontal wind speeds. The strength of this negative relationship weakens with altitude.

Figure 5 Vertical Velocity Against Horizontal Wind Speed - Stage 1 – 50 m, 100 m, 200 m and 300 m AGL

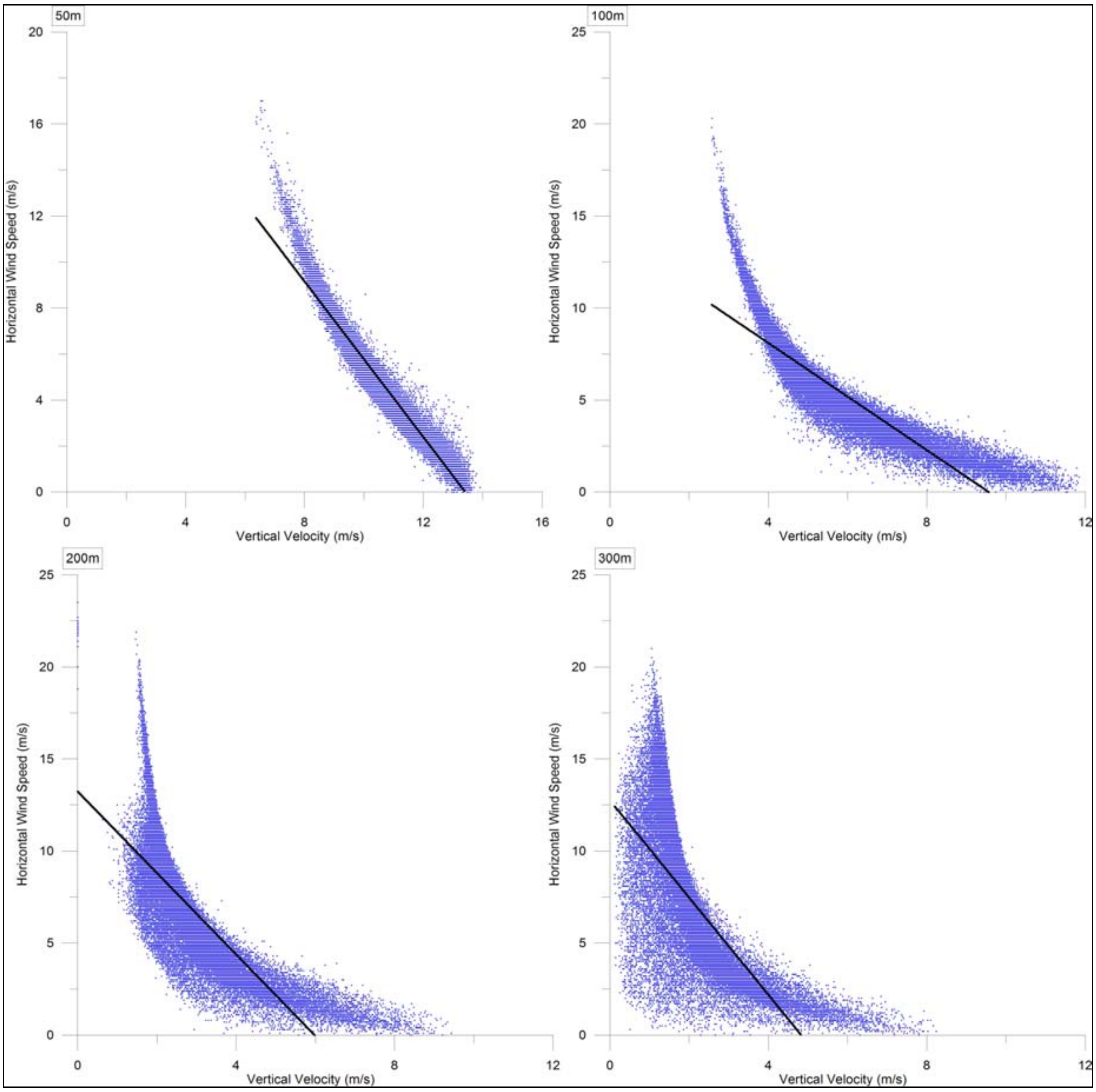
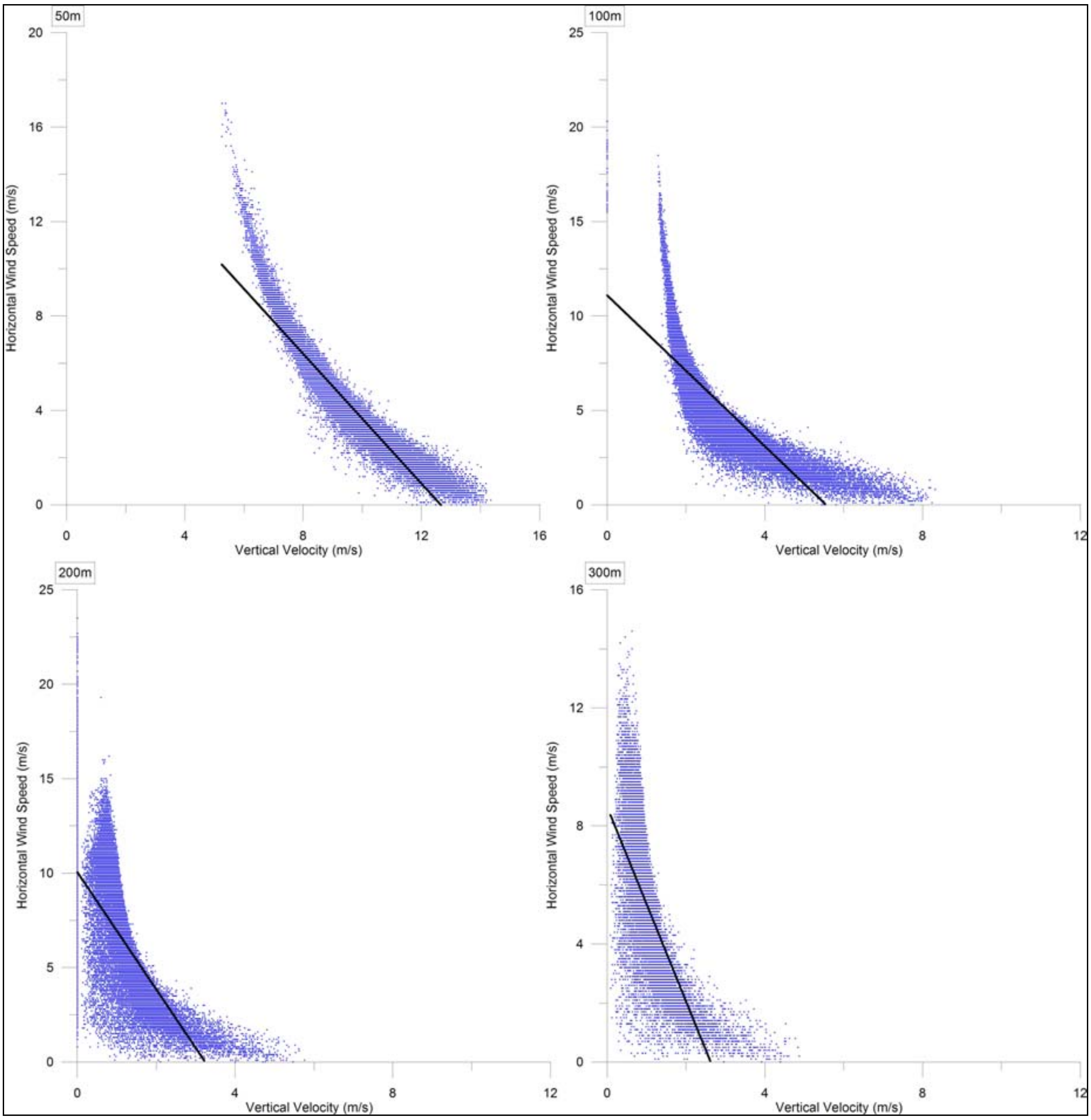


Figure 6 Vertical Velocity Against Horizontal Wind Speed - Stage 2 – 50 m, 100 m, 200 m and 300 m AGL



3.3.2 Vertical Velocity and Temperature

Figure 7 illustrates the relationship between TAPM predicted plume vertical velocity and temperature at altitudes 50m, 100m, 150 and 200m AGL. Each individual vertical velocity from the entire modelling period has been plotted against its corresponding temperature at each of the four given heights, while the linear relationship for each altitude has also been indicated.

The linear relationship fit lines marked on the plots in **Figure 7** indicate that a relatively weak positive correlation exists between vertical velocity and temperature at each altitude, suggesting that plume rise will be strongest during higher ambient temperatures. However, following closer review of the plots, it would appear that a large number of outliers are affecting this relationship, suggesting that there is no significant correlation between plume vertical velocity and the surrounding temperature.

Figure 7 Vertical Velocity Against Air Temperature – Stage 1 - 50 m, 100 m, 150 m and 200 m AGL

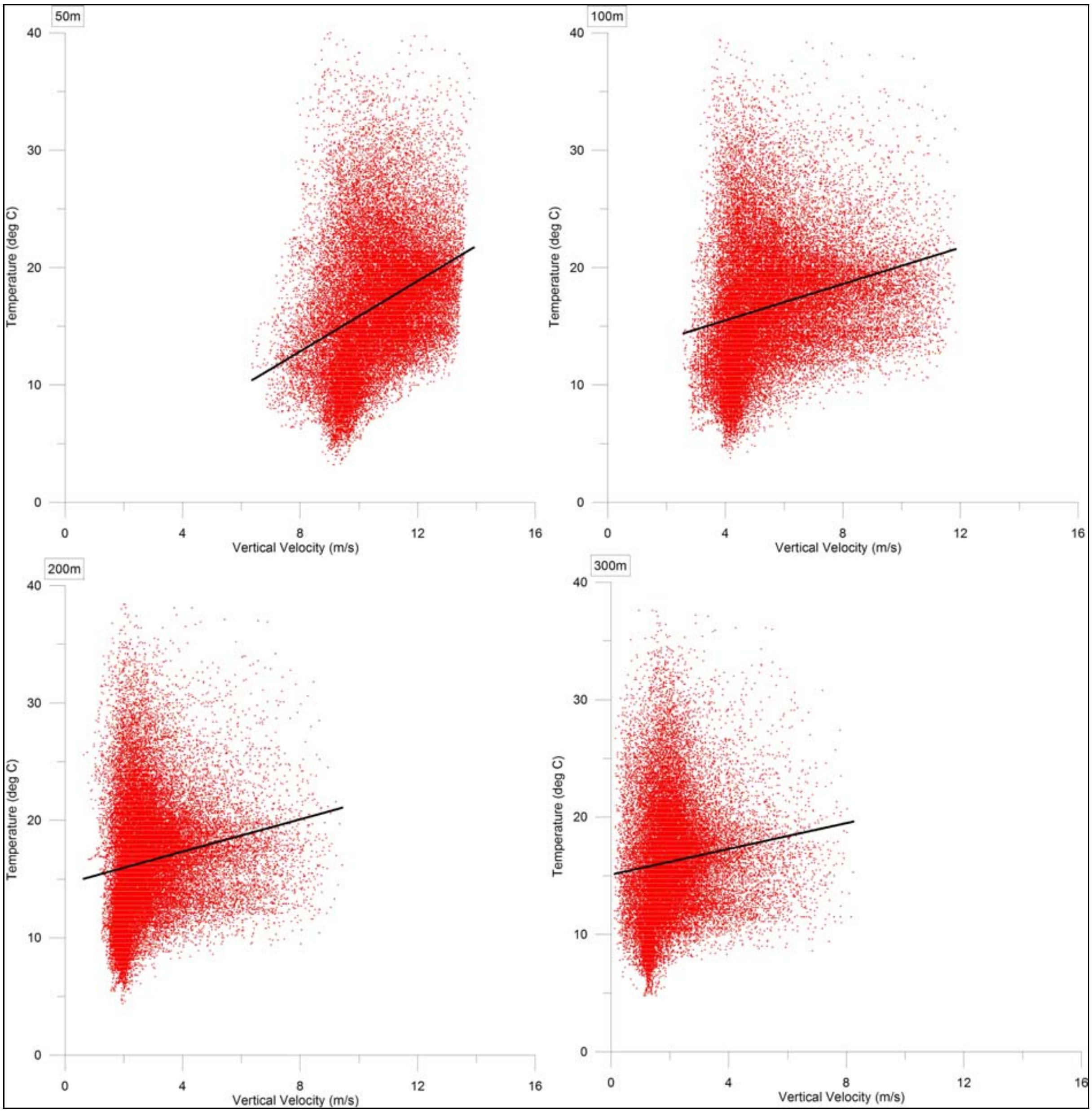
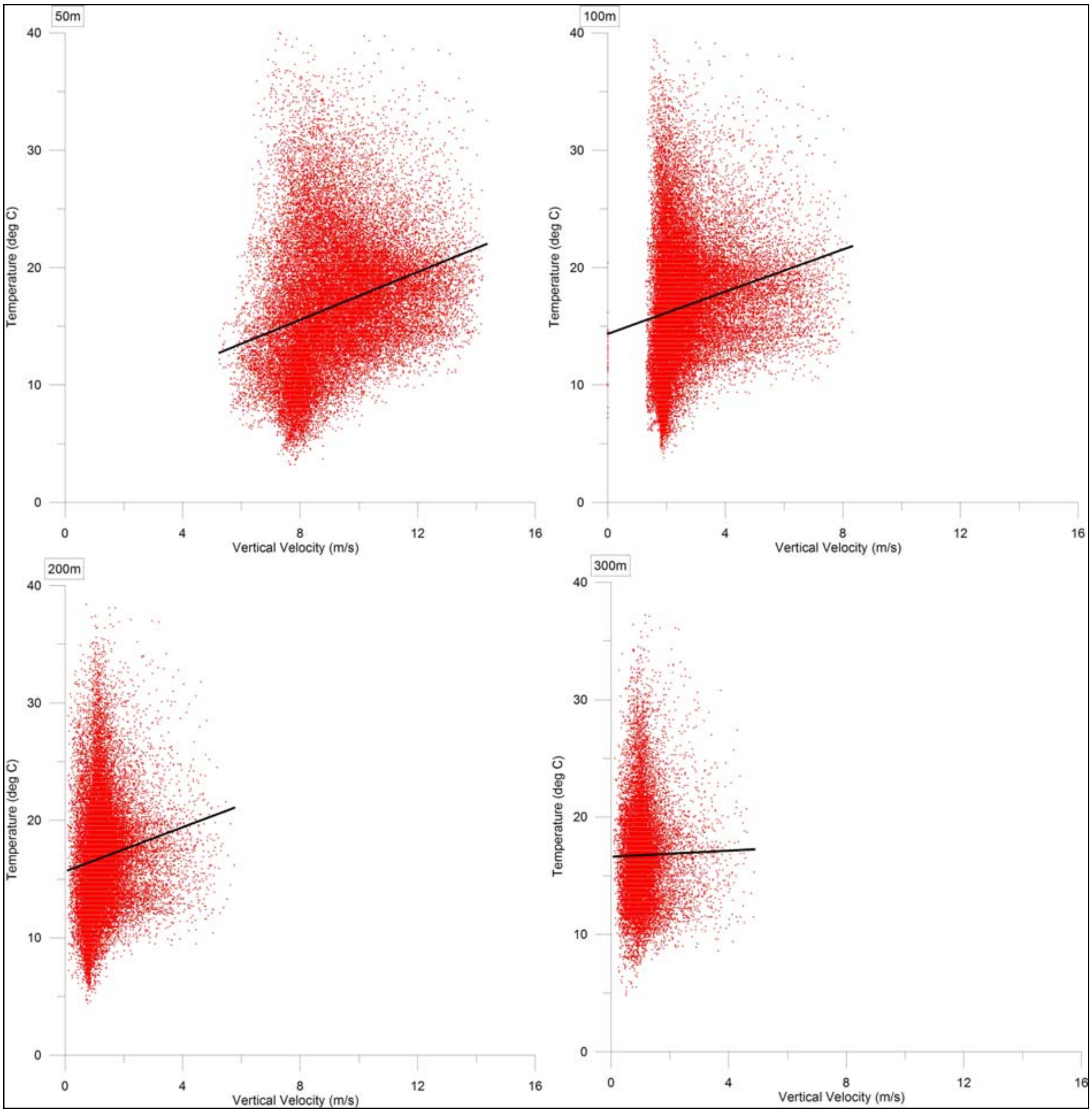


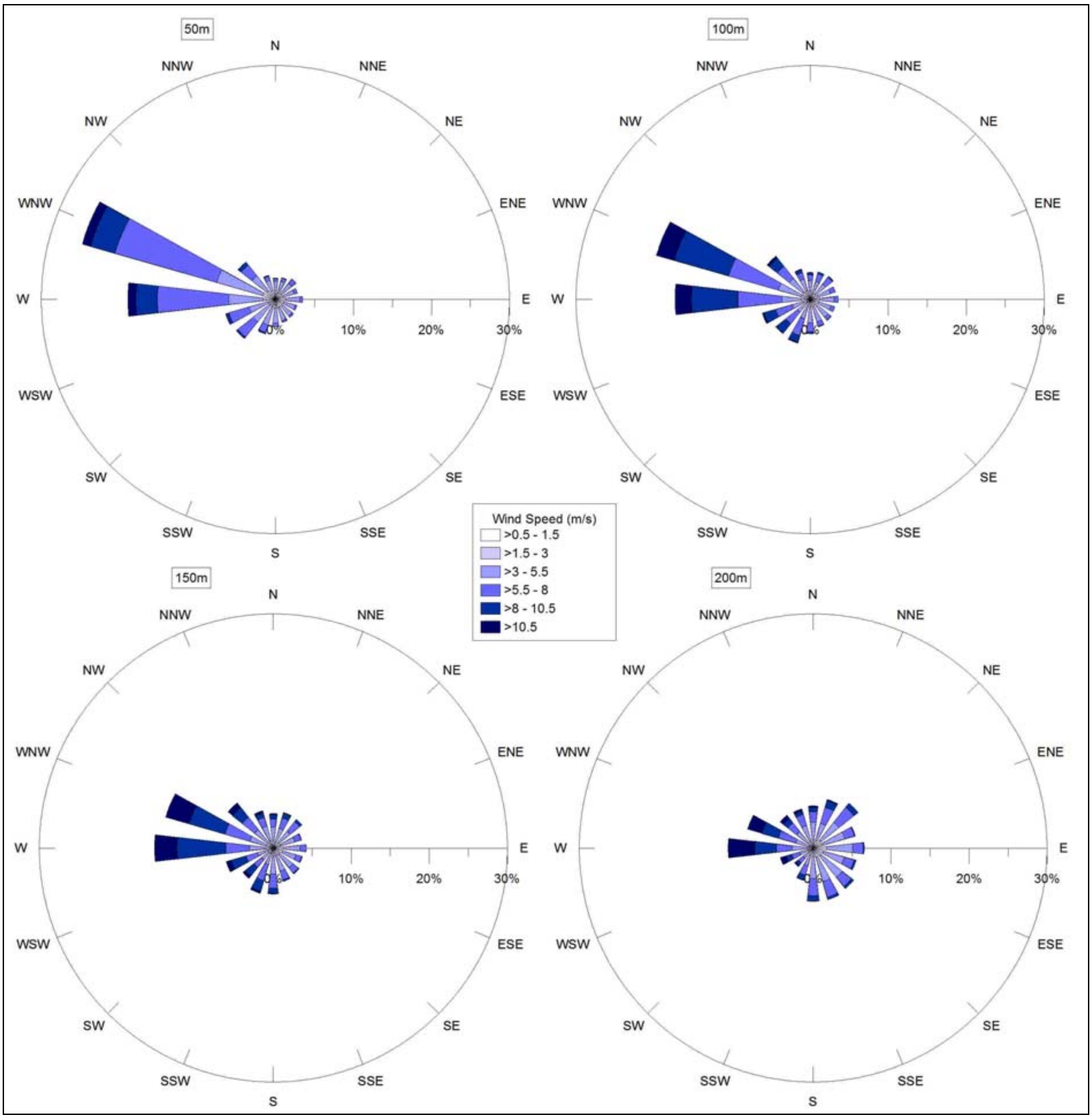
Figure 8 Vertical Velocity Against Air Temperature – Stage 2 - 50 m, 100 m, 150 m and 200 m AGL



3.3.3 Horizontal Wind Speed and Direction

Figure 9 illustrates the horizontal wind roses at altitudes of 50 m, 100 m, 150 m and 200 m AGL from the TAPM generated meteorological data. It can be seen that as altitude increases, horizontal wind speed increases, while the dominant wind direction becomes less defined.

Figure 9 TAPM Generated Wind Roses at 50 m, 100 m, 150 m and 200 m AGL



3.3.4 Upper Level Wind Analysis

As per CASA requirements, analysis of the upper level TAPM generated meteorology was carried out for the Bamarang site at 50 m, 100 m, 200 m, 300 m, 400 m, 500 m, 600 m, 800 m and 1000 m, corresponding to the maximum height over at which the peak vertical velocity reduces to the critical vertical velocity, (approximately 1,040 m for Stage 1).

Figure 10 presents the predicted average horizontal wind speeds (m/s) with height. As per discussions in **Section 3.3.3**, the results show an increase in wind speed (m/s) with height. The average horizontal wind speed at 60 m AGL (the OCS directly above the stacks) is of the order of 3 m/s, over the five year period modelled.

Figure 10 TAPM predicted Upper Level Wind Speeds

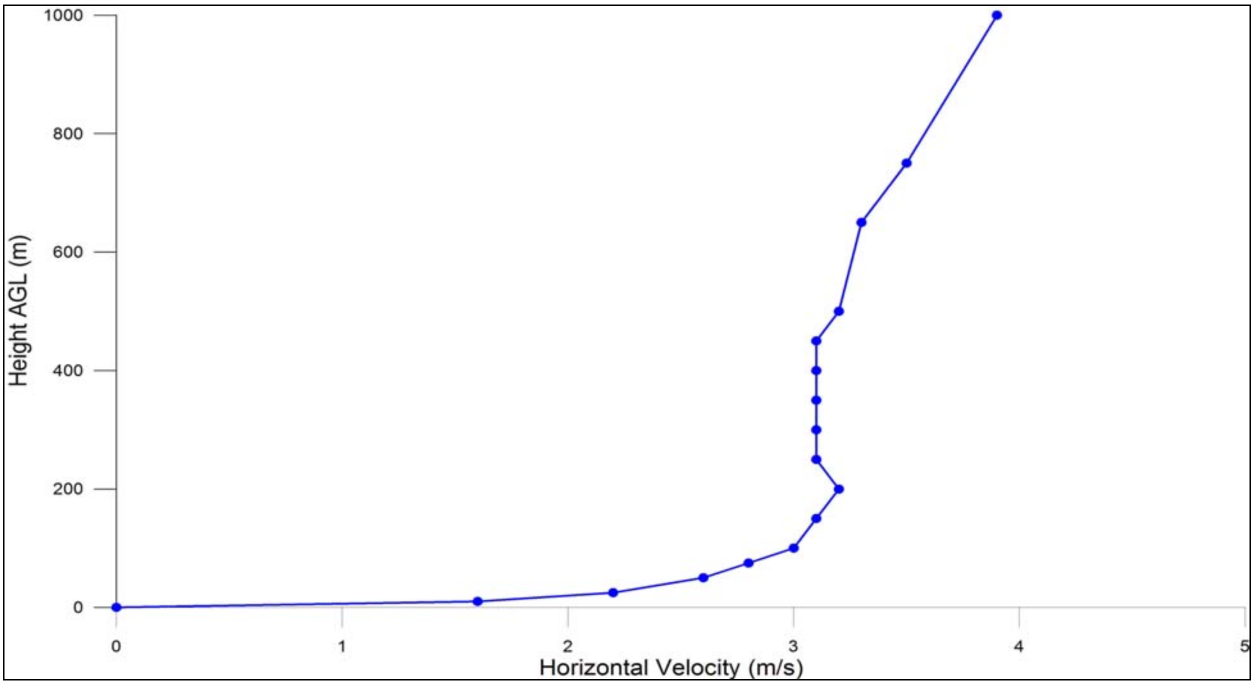


Table 1 shows the percentage occurrences of wind speeds less than 0.5 m/s predicted by the TAPM model for various heights above the Bamarang site. The results indicate that calm conditions are experienced less than 1% of the time at Bamarang at all heights.

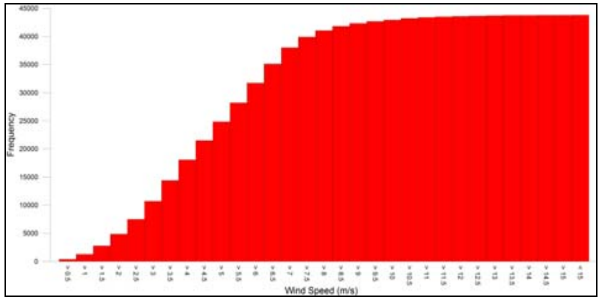
Table 1 Percentage of Low Horizontal Wind Velocities with Height – 2000 - 2004

Height AGL (m)	<0.1 m/s	<0.2 m/s	<0.3 m/s	<0.4 m/s	<0.5 m/s
50	0.0 %	0.1 %	0.2 %	0.4 %	0.6 %
100	0.0 %	0.1 %	0.2 %	0.3 %	0.5 %
200	0.0 %	0.1 %	0.1 %	0.3 %	0.4 %
300	0.0 %	0.1 %	0.1 %	0.3 %	0.4 %
400	0.0 %	0.1 %	0.1 %	0.2 %	0.4 %
500	0.0 %	0.1 %	0.2 %	0.3 %	0.4 %
600	0.0 %	0.1 %	0.1 %	0.3 %	0.4 %
800	0.0 %	0.1 %	0.1 %	0.2 %	0.4 %
1000	0.0 %	0.1 %	0.1 %	0.2 %	0.4 %

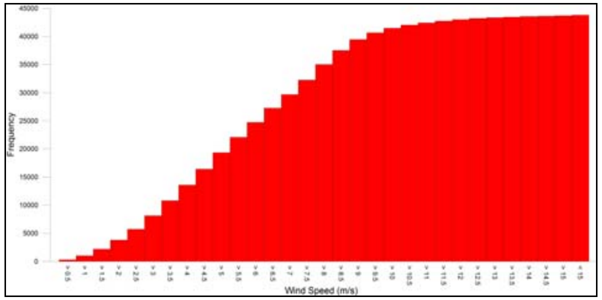
Figure 11 illustrates the cumulative frequency of the horizontal wind speeds predicted by TAPM at the heights of 50 m, 100 m, 200 m, 300 m, 400 m, 500 m, 600 m, 800 m and 1000 m for the modelled period. The frequency bars are grouped in bins of 0.5 m/s, covering a range from occurances of wind speeds less than 0.5 m/s to those greater than 15 m/s. The plots displayed in **Figure 11** show that as height above ground level increases, the frequency of occurrence of low wind speeds decreases.

Figure 11 Cumulative Frequency Plots of TAPM Predicted Horizontal Wind Speed with Height – 2000 - 2004

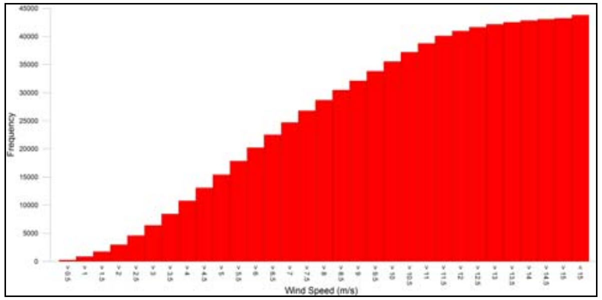
50 m



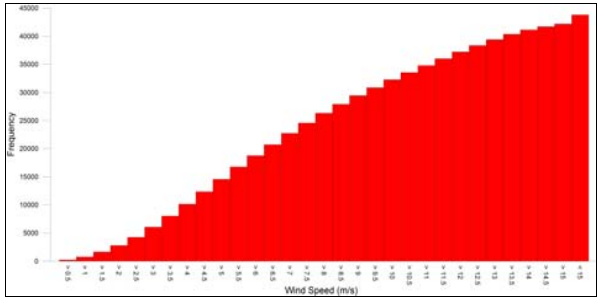
100 m



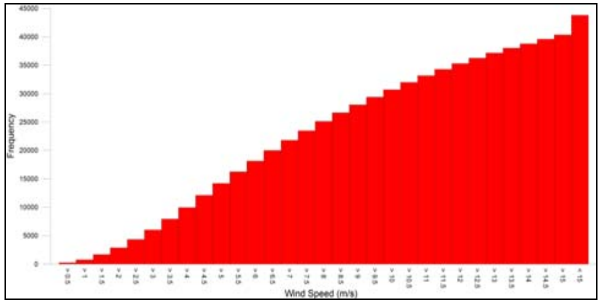
200 m



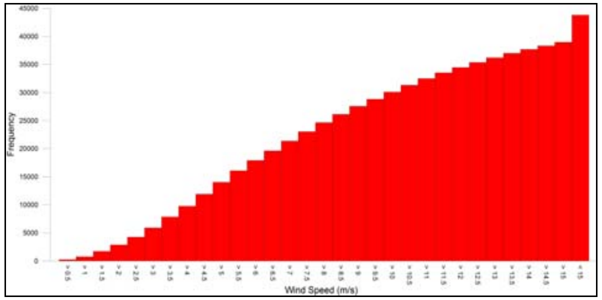
300 m



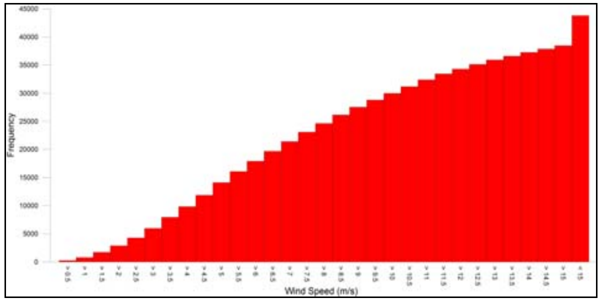
400 m



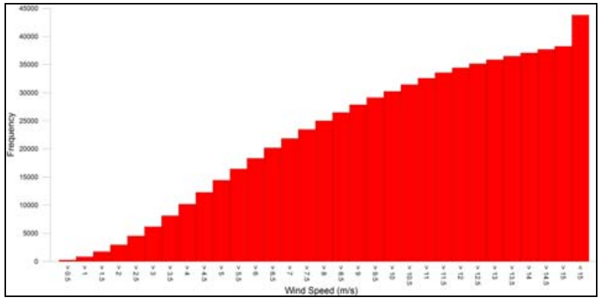
500 m



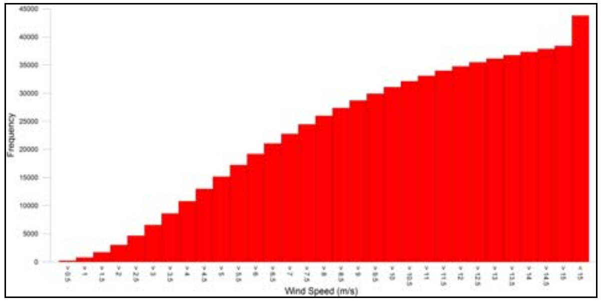
600 m



800 m



1000 m



3.4 Plume Development

To determine the potential for impact of the stack exhaust plume vertical velocities on the OCS, analysis of the extent of predicted horizontal and vertical plume development is necessary. This analysis was conducted as per CASA requirements for both Stage 1 and 2.

3.4.1 Average Plume Development

An assessment of average plume development has been conducted by combining the average vertical velocity, horizontal plume radius, horizontal wind speed, direction and average time steps taken for a range of heights between the release height to the height at which the average vertical velocity within the plume reduces to the critical vertical velocity (<4.3 m/s), for both Stage 1 and 2. The results of this assessment are detailed below.

Stage 1 Average Plume Development

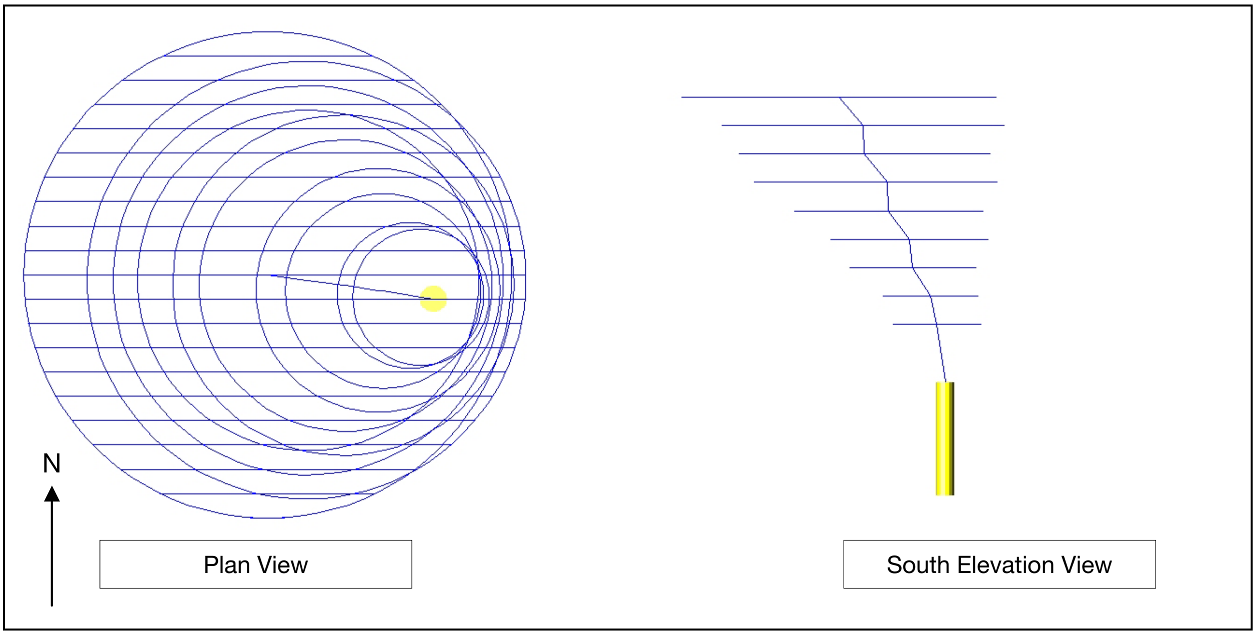
Table 2 details the calculated averages for Stage 1 Plume Rise at heights of 60 m, 70 m, 80 m, 90 m, 100 m, 110 m, 120 m, 130 m and 140 m.

Table 2 Average Plume Rise Development – Stage 1

Height AGL (m)	Average Vertical Velocity (m/s)	Average Horizontal Plume Radius (m)	Average Horizontal Wind Speed (m/s)	Average Horizontal Wind Direction (deg)	Average Time (s)
60	10.6	14	2.7	279	1
70	10.1	15	2.8	279	1
80	7.8	20	2.9	279	2
90	6.4	25	3.0	279	4
100	5.7	30	3.0	279	6
110	5.1	35	3.0	278	8
120	4.6	40	3.0	278	10
130	4.3	45	3.1	278	13
140	4.0	50	3.1	277	15

The data displayed in **Table 2** was then used to generate a three-dimensional representation of the average exhaust plume from the proposed power station. **Figure 12** illustrates the three dimensional plume in plan view, to the left, and side view from due south, to the right,

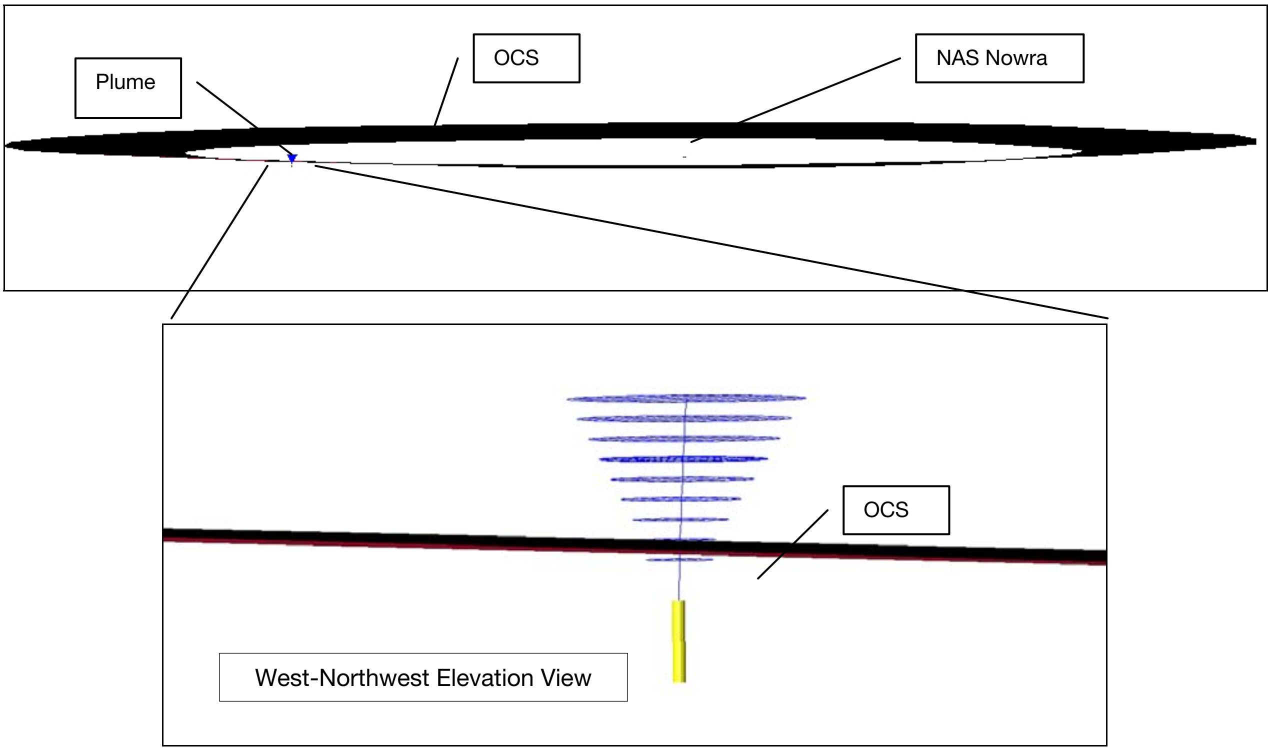
Figure 12 Three Dimensional View of Average Plume Rise



As previously discussed and shown in Figure 1, the OCS layer surrounds NAS Nowra and extends above the proposed power facility. The above three dimensional exhaust plume was combined with a three dimensional representation of the OCS to determine how the plume meets this surface.

Figure 13 illustrates the interaction between the average exhaust plume with the OCS layer. It is noted that the viewing direction of the plume in **Figure 13** is from the west-northwest.

Figure 13 Three Dimensional View of Average Plume Development and Interaction with OCS – Stage 1



Stage 2 Average Plume Development

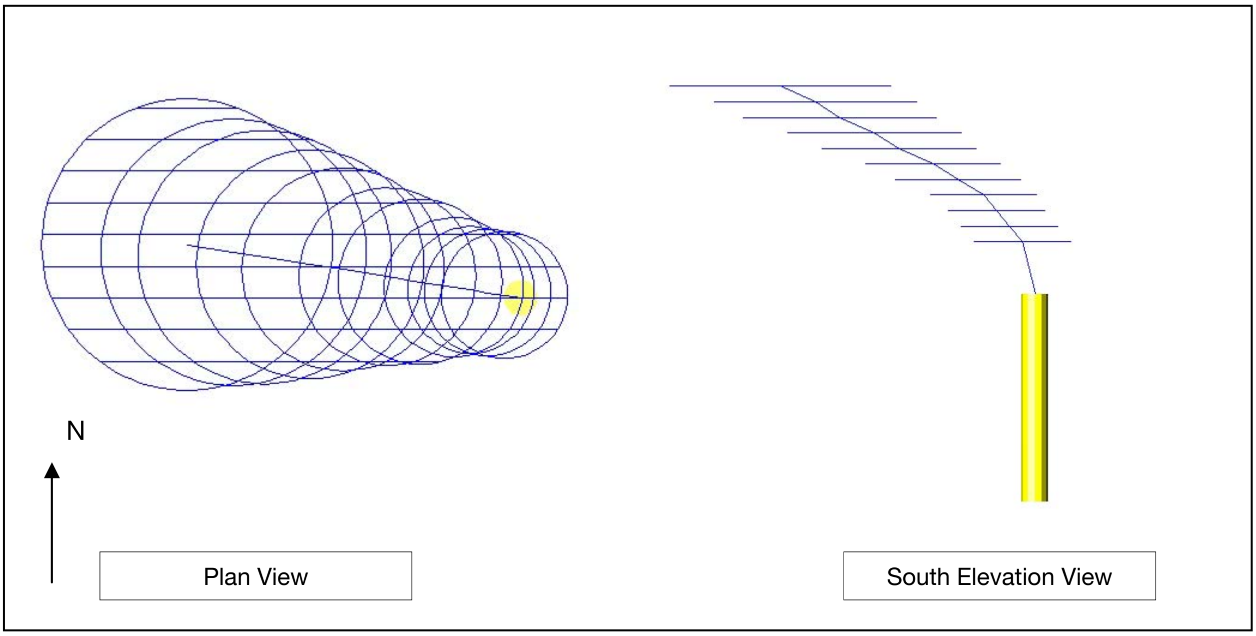
Table 3 details the calculated averages for Stage 2 Plume Development at heights of 50 m, 53 m, 56 m, 59 m, 62 m, 65 m, 68 m, 71 m, 74 m and 80 m.

Table 3 Average Plume Rise Development – Stage 2

Height AGL (m)	Average Vertical Velocity (m/s)	Average Horizontal Plume Radius (m)	Average Horizontal Wind Speed (m/s)	Average Horizontal Wind Direction (deg)	Average Time (s)
50	9.2	10	2.7	279	1
53	8.3	10	2.7	279	1
56	7.7	10	2.7	279	1
59	7.2	11	2.7	279	1
62	6.7	13	2.7	279	2
65	6.1	14	2.8	279	2
68	5.6	16	2.8	279	3
71	5.1	18	2.8	279	3
74	4.6	20	2.8	279	4
80	3.9	23	2.8	279	6

The data displayed in **Table 3** was then used to generate a three-dimensional representation of the average exhaust plume from the proposed power station. **Figure 14** illustrates the three dimensional plume in plan view, to the left, and side view from due south, to the right,

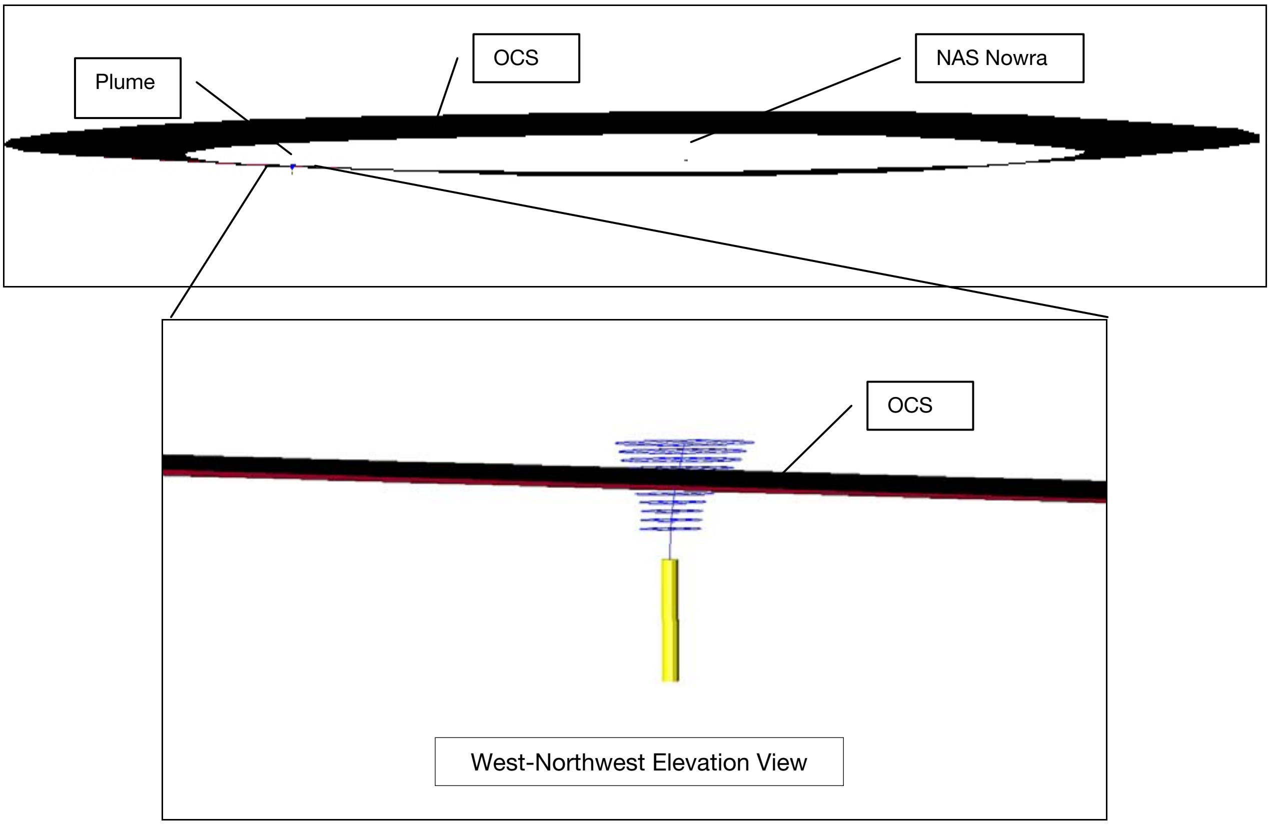
Figure 14 Three Dimensional View of Average Plume Rise – Stage 2



As previously discussed and shown in Figure 1, the OCS layer surrounds NAS Nowra and extends above the proposed power facility. The above three dimensional exhaust plume was combined with a three dimensional representation of the OCS to determine how the plume meets this surface.

Figure 15 illustrates the interaction between the average exhaust plume with the OCS layer. It is noted that the viewing direction of the plume in **Figure 15** is approximately from the west-northwest.

Figure 15 Three Dimensional View of Average Plume Development and Interaction with OCS – Stage 2



3.4.2 Plume Development in Excess of Critical Vertical Velocity

An assessment of plume development in excess of the critical vertical velocity (≥ 4.3 m/s) has been conducted by determining the peak vertical plume velocity and the corresponding predicted horizontal plume radius, wind speed and direction for heights between the release point and the height where the peak vertical velocity reduced to the critical velocity, for both Stage 1 and 2. The results of this assessment are detailed below.

Stage 1 Peak Plume Development

Table 4 details the peak vertical velocity and corresponding predicted horizontal meteorology conditions for each of 60 m, 100 m, 200 m, 300 m, 400 m, 500 m, 600 m, 800 m, 1000 m and 1100 m AGL.

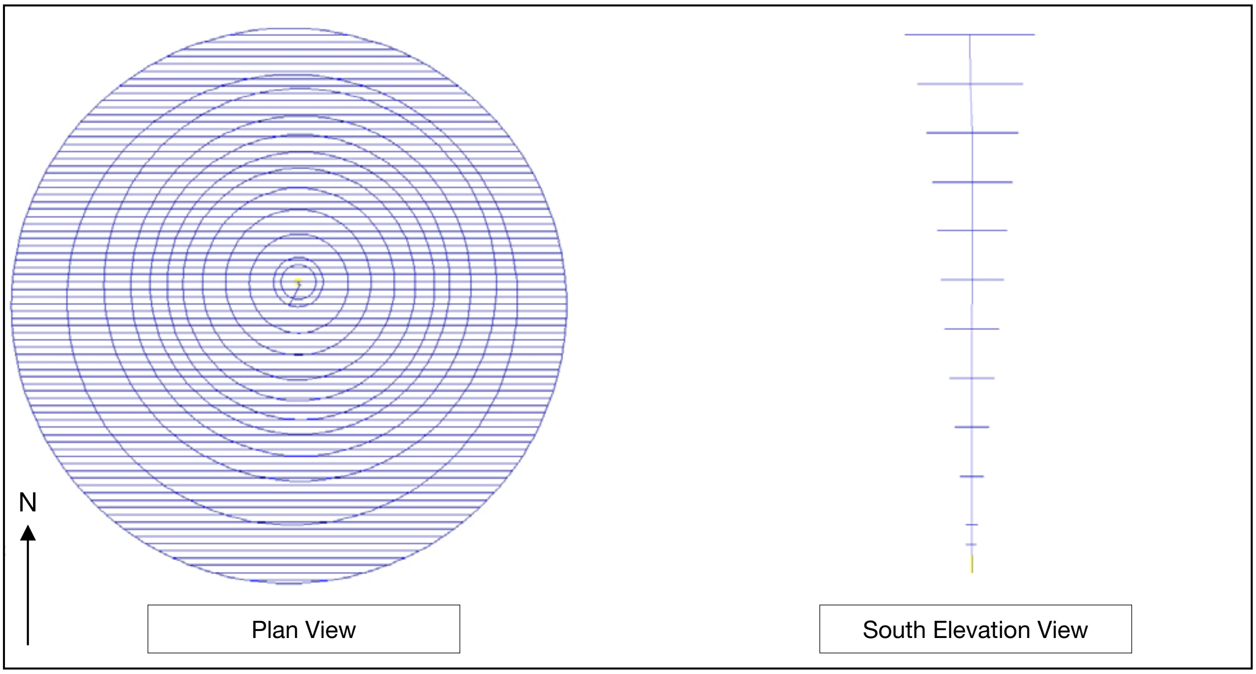
Table 4 presents worst-case peak plume rise, namely the highest exceedance of the critical vertical velocity with altitude for the entire modelling period. This corresponds to conditions at hour 11 on 9/9/2003.

Table 4 Worst-Case Peak Plume Rise Development – Stage 1

Height AGL (m)	Peak Vertical Velocity (m/s)	Horizontal Plume Radius (m)	Horizontal Wind Speed (m/s)	Horizontal Wind Direction (deg)	Time (s)
60	13.1	12	0.1	127	1
100	10.7	17	0.0	143	3
200	7.9	34	0.1	163	14
300	6.9	50	0.1	175	28
400	6.3	66	0.1	171	43
500	6.0	80	0.2	161	60
600	5.8	92	0.3	146	76
700	5.7	103	0.3	146	94
800	5.5	117	0.3	146	111
900	5.1	135	0.3	146	130
1000	4.6	155	0.7	242	150
1100	4.0	191	0.7	242	174

Figure 16 illustrates the worst-case plume in plan view, to the left, and south elevation to the right.

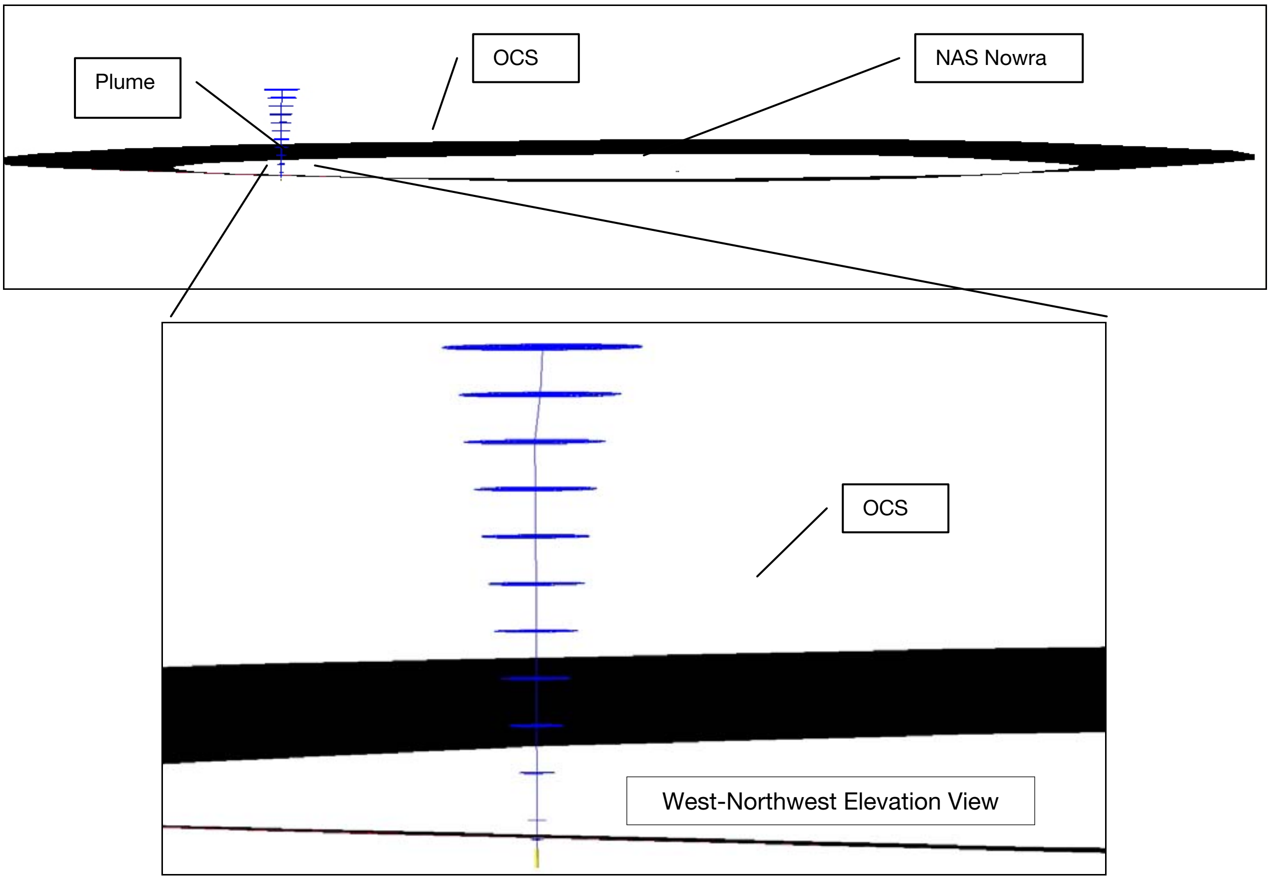
Figure 16 Three Dimensional View of Maximum Plume Development – Stage 1



As previously discussed and shown in **Figure 1**, the OCS layer surrounds NAS Nowra and extends above the proposed power facility. The above representation of the exhaust plume was combined with a three dimensional representation of the OCS to determine how the plume meets this surface.

Figure 17 illustrates the interaction between the worst case exhaust plume rise development, occurring at hour 11 on 9/9/2003, with the OCS layer. It is noted that the viewing direction of the plume in **Figure 17** is from the west-northwest.

Figure 17 Three Dimensional View of Maximum Plume Development and Interaction with OCS – Stage 1



Stage 2 Peak Plume Development

Error! Reference source not found. presents worst-case peak plume rise, namely the highest exceedance of the critical vertical velocity with altitude for the entire modelling period. This corresponds to conditions at hour 12 on 12/8/2000.

details the peak vertical velocity and corresponding predicted horizontal meteorology conditions for each of 50 m, 75 m, 100 m, 150 m, 200 m, 250 m, 300 m, 350 m and 400 m AGL.

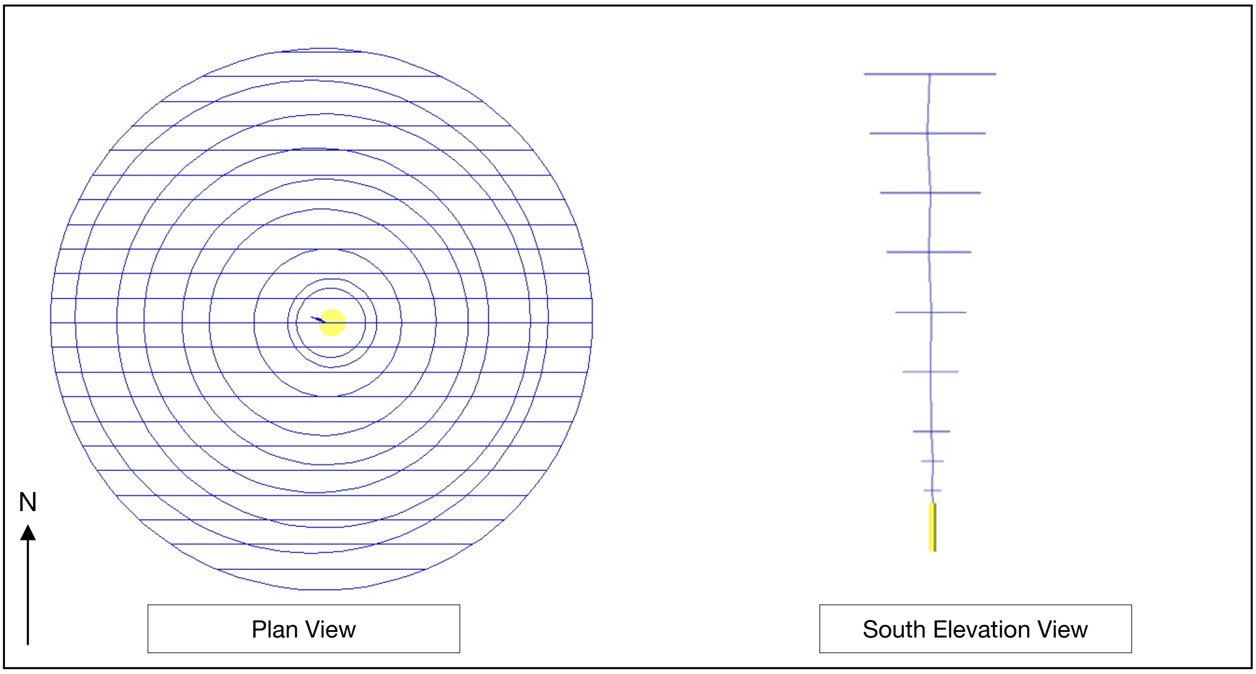
Error! Reference source not found. presents worst-case peak plume rise, namely the highest exceedance of the critical vertical velocity with altitude for the entire modelling period. This corresponds to conditions at hour 12 on 12/8/2000.

Table 5 Worst-Case Peak Plume Rise Development – Stage 2 – 12/8/2000, Hour 12

Height AGL (m)	Peak Vertical Velocity (m/s)	Horizontal Plume Radius (m)	Horizontal Wind Speed (m/s)	Horizontal Wind Direction (deg)	Time (s)
50	13.7	7	0.3	269	1
75	9.6	9	0.3	269	2
100	7.8	15	0.3	270	5
150	6.1	23	0.4	274	13
200	5.4	29	0.4	277	21
250	5.1	35	0.5	279	31
300	4.8	42	0.5	283	41
350	4.6	48	0.6	286	52
400	4.3	55	0.6	288	63

Figure 18 illustrates the three dimensional plume in plan view, to the left, and side view from due south, to the right.

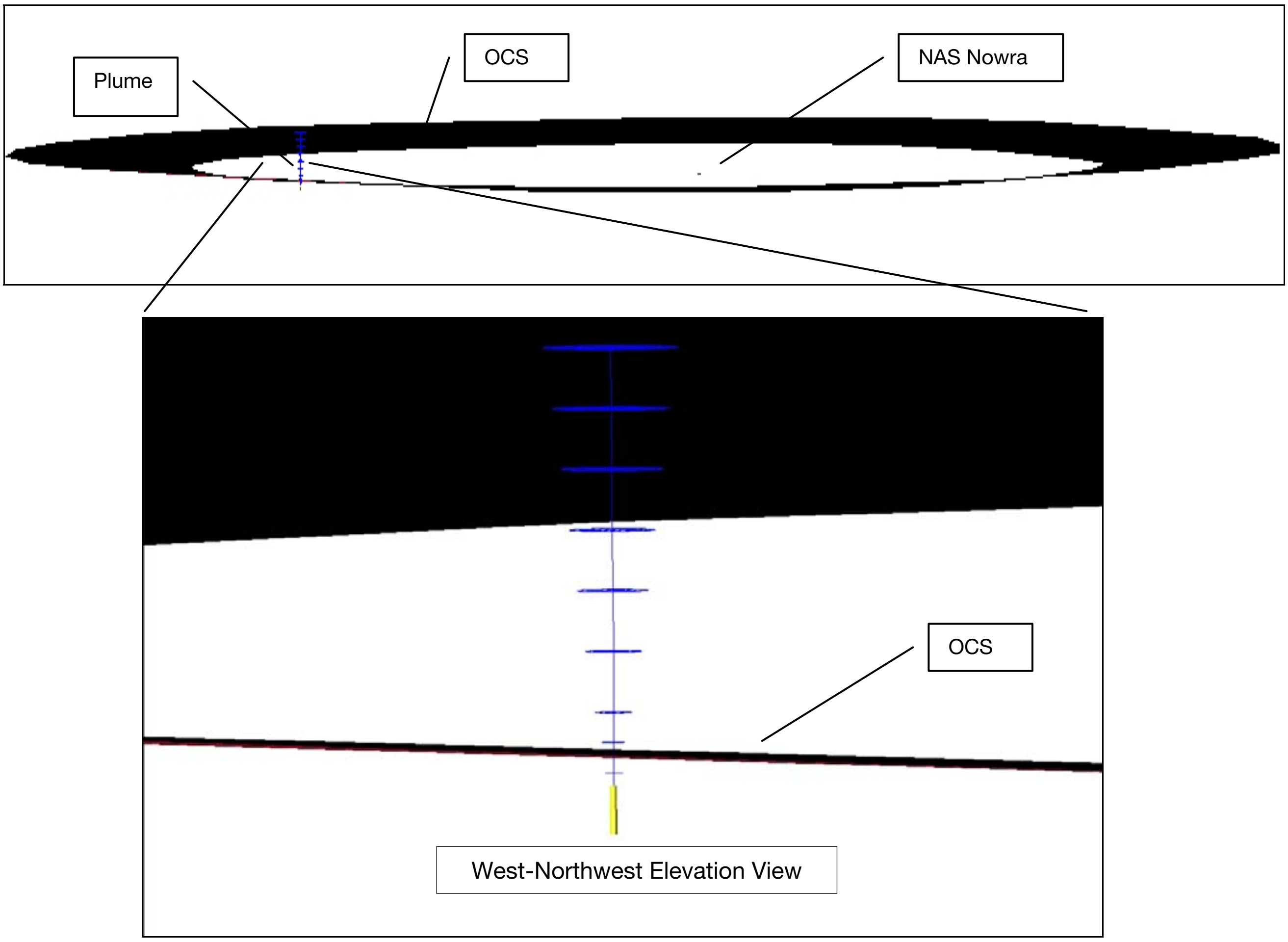
Figure 18 Three Dimensional View of Maximum Plume Development - Stage 2



As previously discussed and shown in **Figure 1**, the OCS layer surrounds NAS Nowra and extends above the proposed power facility. The above three dimensional exhaust plume was combined with a three dimensional representation of the OCS to determine how the plume meets this surface.

Figure 19 illustrates the interaction between the worst case exhaust plume rise development, occurring at hour 12 on 12/08/2000, with the OCS layer. It is noted that the viewing direction of the plume in **Figure 19** is from the west-northwest.

Figure 19 Three Dimensional View of Maximum Plume Development and Interaction with OCS – Stage 2



3.5 Frequency of Exceedance of Critical Vertical Velocity

As per CASA requirements, the frequency with which the average vertical plume velocity exceeds the critical vertical velocity has been calculated. **Table 6** details the percentage of time and height (AGL) that the average vertical velocity exceeds the critical vertical velocity for Stage 1 and 2, as a function of height. Furthermore, **Table 7** details the maximum, minimum and average heights (AGL) that the average vertical plume velocity exceeds the critical vertical velocity for both Stages.

Table 6 Frequency of Exceedance of Critical Vertical Velocity with Height

Frequency of Exceedance of Critical Velocity	Height AGL (m)	
	Stage 1	Stage 2
100%	63	53
90%	69	56
80%	75	58
70%	80	61
60%	84	63
50%	88	66
40%	92	69
30%	98	72
20%	121	77
10%	180	84
9%	191	85
8%	203	86
7%	219	86
6%	238	88
5%	260	89
4%	289	91
3%	329	94
2%	387	117
1%	493	131
0.5%	590	160
0.3%	655	184
0.2%	699	204
0.1%	764	235
0.05%	813	263

Table 7 Minimum, Average and Maximum Heights AGL of Average Plume Vertical Velocity Exceedances of Critical Vertical Velocity

	Height AGL (m)	
	Stage 1	Stage 2
Minimum	63	53
Average	112	70
Maximum	1,040	388

The results presented in **Table 6** suggest that at 100 m (60 m above stack height) the probability of exceedance of the critical velocity is approximately 30% and 3% for Stage 1 and Stage 2 respectively. At 200 m AGL (60 m above stack height) the probability of exceedance of the critical velocity decreases significantly to approximately 8% and 0.2% for Stage 1 and Stage 2 respectively.

4 CONCLUSIONS

An assessment has been conducted of the potential hazard that exhaust plumes from the proposed gas turbine power facility at Bamarang present to aviation activities in the surrounding region.

The Air Pollution Model (TAPM) was used in plume rise mode to analyse plume behaviour from the stacks during Stage 1 and Stage 2 operations for meteorological conditions predicted for the site over a modelling period of 5 years (2000-2004).

The plume rise from a single stack was modelled, and a plume rise enhancement factor was applied to the vertical velocity inputs to conservatively account for the impact of enhanced buoyancy as a result of the two plumes merging.

Results of the assessment indicate that the probability of an exceedance of the critical vertical velocity (4.3 m/s) decreases significantly with altitude, particularly between 100 m and 200 m AGL for Stage 1 and 50 m and 100 m AGL for Stage 2. Approximately 70% and 97% of all predicted exceedances of the critical vertical velocity occur beneath 100 m AGL, (60 m above stack height) for Stage 1 and Stage 2 respectively.

The maximum height at which the average vertical plume velocity is predicted to exceed the critical vertical velocity is 1,040 m and 388 m AGL for Stage 1 and 2 respectively. The frequency with which this was predicted to occur was less than 0.05% for both Stages.

The operations modelled in Stage 1 represent the power facility operating on a peak-load basis only, for approximately 440 hours per annum. The frequency of occurrence of an exceedance of the critical vertical velocity predicted within the Stage 1 modelling should therefore additionally be multiplied by the frequency of operation of the facility under these conditions to derive an overall likelihood that critical conditions may occur.

In view of the above, the probability of occurrence of a vertical velocity in excess of 4.3 m/s at 100 m AGL, (60 m above stack height) taking into account proposed hours of operation, is thus 1.5×10^{-2} for Stage 1 and 3.0×10^{-2} for Stage 2.

It is noted that the aviation authority will apply the information contained within this assessment to assess the probability of aircraft traversing each height band within the plume influence area. This then allows calculation of the combined probability of the two events – an aircraft being exposed to a vertical velocity in excess of 4.3 m/s. The acceptable risk criterion is one chance in 10,000 (1×10^{-4}) each year of having a fatality due to an aircraft accident. Depending on severity (eg the possibility of 100 fatalities due to a single aircraft crash) the acceptable frequency of an occurrence is reduced accordingly – in this instance, to 1×10^{-6} (Pers. Comm., Rehbein AOS, April 2006).

Using the example above, provided that the probability of aircraft traversing 60 m above the proposed stack height is less than 7×10^{-5} in any given year, the risk of exposure to the critical vertical velocity should be deemed acceptable for this height band.

Quantification of the probability of aircraft traversing within the plume influence area must necessarily be derived by a third party aviation expert. However, in view of the foregoing it is anticipated that the resultant combined probability of an aircraft being exposed to a vertical velocity (attributable to the gas turbine power facility stacks) in excess of 4.3 m/s will be acceptable in terms of the above risk criterion for both Stage 1 and Stage 2 operations.

5 REFERENCES

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