LONG-TERM SITE WIND DATA REPORT

Mt. Tom

January 1, 2005 – December 31, 2005

Prepared for

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February 13, 2006

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NOTICE AND ACKNOWLEDGEMENTS

This report was prepared by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst in the course of performing work sponsored by the Renewable Energy Trust (RET), as administered by the Massachusetts Technology Collaborative (MTC), pursuant to work order number 05-1. The opinions expressed in this report do not necessarily reflect those of MTC or the Commonwealth of Massachusetts, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it.

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EXECUTIVE SUMMARY

All the work presented in this Wind Data Report, including installation and decommissioning of the meteorological tower and instrumentation and the data analysis and reporting, were performed by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst.

This wind measurement station is installed on the FAA tower at Mt. Tom in Holyoke, MA. Installed in December of 1999, the station is in continuous operation to this day. Two sets of two anemometers and one wind vane are mounted at 24 m (78.7 ft) and 37 m (121.4 ft), respectively.

During the period covered by this yearly report, January 1, 2005 – December 31, 2005, the mean recorded wind speed for the entire year at the 37 m height was 5.9 m/s (13.1 mph)* and the prevailing wind direction based on the 24 m vane was west-northwest. The 37 m vane failed in mid-August, so the 24 m direction data has been reported and used in the icing test definition for data from August – December 2005. The gross data recovery percentage (the actual percentage of expected data received) was 100.00% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 97.65%. The high gross data recovery percentage indicates that the logger was performing well. The lower net data recovery percent is the result of winter icing events.

Additional information about interpreting the data presented in this report can be found in the Fact Sheet, "Interpreting Your Wind Resource Data," produced by RERL and the Massachusetts Technology Collaborative (MTC). This document is found through the RERL website:

http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_6_Wind_resource_interpretation.pdf

* 1m/s = 2.237 mph

SECTION 1 - Station Location

The Mt. Tom site is located at an existing FAA tower on top of Mt. Tom in Holyoke, MA. Some trees are located in the vicinity, as well as an ESI-80 wind turbine. The location of the tower base is at 42° 14’ 59.2” N, 72° 38’ 42.2” W (NAD 27).

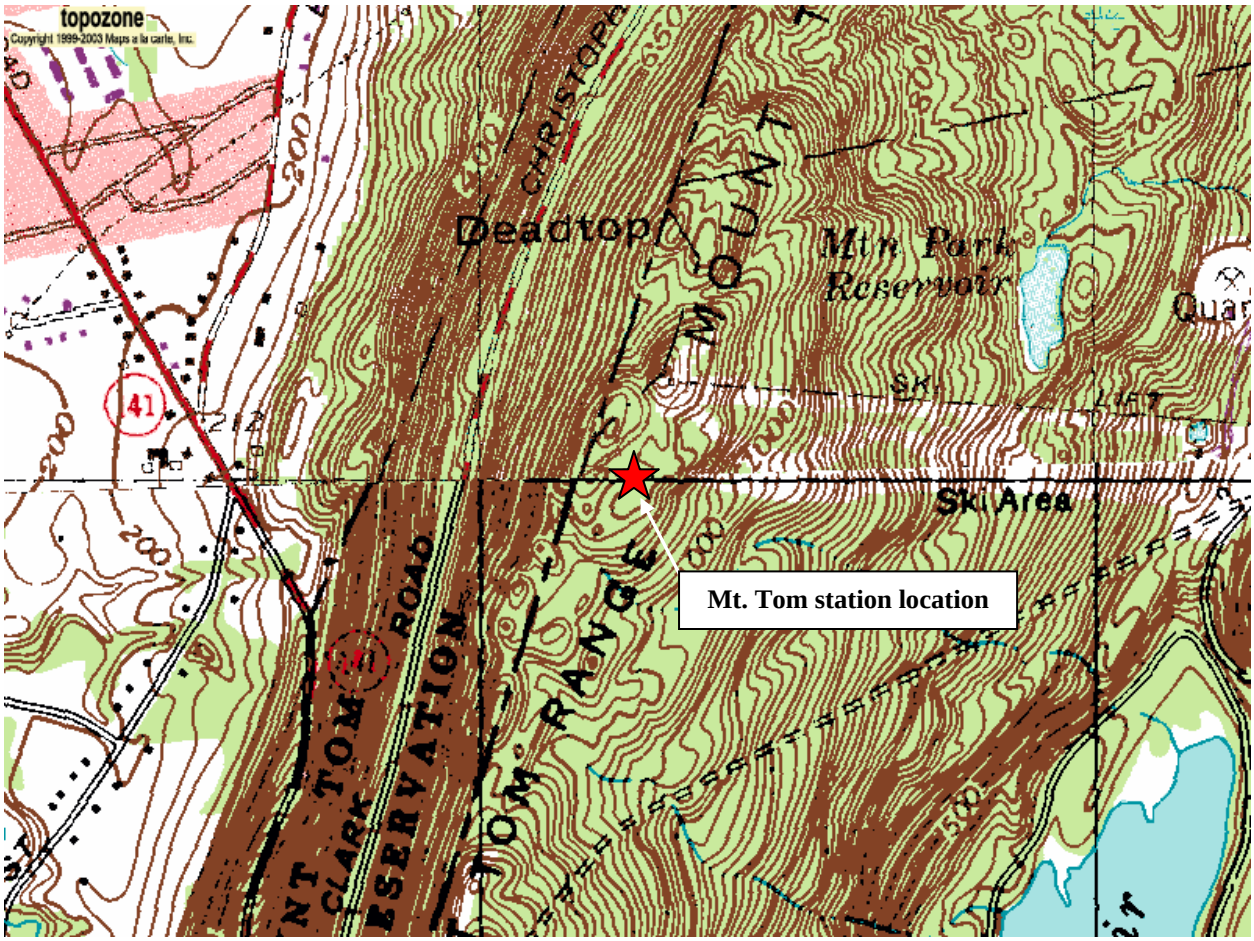

Figure 1 – Station location of Mt. Tom.

www.topozone.com

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on a 160 ft lattice tower. All the remaining monitoring equipment comes from NRG Systems and consists of the following items:

- Model 9302 Cellogger®, serial # 0656
- Electrical enclosure box
- Yagi directional antenna and mount
- 4 – #40 Anemometers, standard calibration (Slope - 0.765 m/s, Offset – 0.350 m/s). Two anemometers are located at both 37 m (121.4 ft) and 24 m (78.7 ft).
- 2 - #200P Wind direction vanes. They are located at 37 m (121.4 ft) and 24 m (78.7 ft).
- 4 – Sensor booms, 43" length
- Lightning rod and grounding cable
- Shielded sensor wire

The NRG 9302 system logger is equipped with a built-in cell phone so that the data can be transmitted weekly to a PC, located at the University of Massachusetts, Amherst. The logger samples the wind speed and direction at 1 Hz. These samples are then combined into 10-minute averages and, along with the standard deviation for those 10-minute periods, are put into a binary file. These binary files are converted to ASCII text files using the NRG software BaseStation®. These text files are then imported into a database software program where they are subjected to quality assurance (QA) tests prior to using the data.

SECTION 3 - Data Collection and Maintenance

The following maintenance/equipment problems occurred during the year of 2005, and the following corrective action was taken:

- On February 2, 2005, the data transmission was not successful when the logger cell phone made its weekly call to the RERL. The data card was manually swapped on February 9, 2005. The data transmission was again unsuccessful on March 2, 2005, so the data card was manually swapped on March 7, 2005.

- In order to remedy the data transmission problems, the two 9-volt batteries that power the logger were replaced. The cell phone's 12-volt battery power supply was also replaced. The data were successfully transmitted on the next scheduled logger cell phone call.

- Due to unsuccessful data transmission for several weeks, the data card was manually swapped on April 17, 2005, and March 28, 2005.

- On June 8, 2005, the cell phone antenna was repositioned 90º to the east in order to improve data transmission. The data successfully downloaded on June 15, 2005. However, attempts to download the data during the remainder of June were unsuccessful. On July 7, 2005, the data card was manually swapped.

- The logger cell phone was reprogrammed to call the RERL every two days, but subsequent attempts to download the data were still unsuccessful. The data card was manually swapped on August 3 and September 14, 2005.

- The August direction data was very different than usual, and with closer inspection, it was determined that the 37 m vane failed during the middle of the month. The 37 m vane is scheduled to be replaced in the spring of 2006.

- In order to decrease the interference of the Mt. Tom communications towers with the logger cell phone's attempt to transfer data, the logger cell phone was reprogrammed to call the RERL each week at 2:00 AM EST. With this modified schedule, the data was successfully downloaded via logger cell calls on September 21 and October 5, 2005.

- Subsequent October download attempts were unsuccessful, so the data card was manually swapped on October 28, 2005. The remainder of the October data was successfully downloaded via a logger cell phone call on November 16, 2005.

- There were no equipment or maintenance problems for the remainder of the year.

No measurement of wind speed can be perfectly accurate. Errors occur due to anemometer manufacturing variability, anemometer calibration errors, the response of anemometers to turbulence and vertical air flow and due to air flows caused by the anemometer mounting system. Every effort is made to reduce the sources of these errors. Nevertheless, the values reported in this report have an expected uncertainty of about ± 2% or ± 0.2 m/s.

The data statistics summary table gives the wind characteristics for each month of 2005 and also gives the overall annual 2005 wind characteristics, including mean wind speed, maximum wind speed, average turbulence intensity, prevailing wind direction, and net data recovery for the anemometer at each level with the highest percentage of good data. A complete description of net data recovery is given in Section 4. The sensor statistics for each month and the entire year of 2005 are in APPENDIX A. The 37 m prevailing wind direction for August – December 2005 are not listed because the vane at that height failed in mid-August. However, wind direction does not usually vary much with height, so the prevailing wind direction at 37 m is likely to be the same as the 24 m (as was the case for January – July 2005). For this reason, the 24 m vane data were also used in the 37 m icing test definition for data from August – December 2005.

Data Statistics Summary

Date	Mean Wind Speed	Max Wind Speed	Turbulence Intensity	Prevailing Wind Direction	Good Data	Mean Wind Speed	Max Wind Speed	Turbulence Intensity	Prevailing Wind Direction	Good Data
Heights, units	**37 m, [m/s]**	**37 m, [m/s]**	**37 m, [ ]**	**37 m, [ ]**	**37 m, [%]**	**24 m, [m/s]**	**24 m, [m/s]**	**24 m, [ ]**	**24 m, [ ]**	**24 m, [%]**
Jan 05	6.2	19.4	0.20	NW	79.2	5.3	16.1	0.25	WNW	85.0
Feb 05	6.4	18.7	0.18	WNW	85.8	5.6	16.9	0.23	WNW	91.2
Mar 05	7.3	23.2	0.19	WNW	93.8	6.3	20.3	0.24	WNW	96.3
Apr 05	6.0	16.7	0.22	SSE	98.9	5.2	14.4	0.26	SSE	98.5
May 05	4.8	18.5	0.25	N	99.8	4.2	15.9	0.29	N	99.5
Jun 05	4.3	16.0	0.24	S	99.9	3.7	13.3	0.28	S	99.7
Jul 05	4.9	15.6	0.22	S	99.9	4.2	14.0	0.28	S	99.9
Aug 05	4.5	12.9	0.23	–*	100.0	3.9	11.3	0.28	S	99.7
Sep 05	5.6	17.6	0.21	–	100.0	4.8	14.7	0.26	WNW	99.9
Oct 05	6.7	22.0	0.20	–	100.0	5.6	18.3	0.25	W	100.0
Nov 05	7.1	18.2	0.17	–	98.7	6.2	16.4	0.21	W	98.7
Dec 05	6.7	19.1	0.17	–	98.3	5.8	16.6	0.23	WSW	98.4
Jan 05 – Dec 05	5.9	23.2	0.21	–	96.2	5.1	20.3	0.25	WNW	97.2

* The 37 m wind vane failed some time in early August, so the prevailing directions are not all reported.

The data reported in the Data Statistics Summary table are only based on the percentages of good data indicated; missing data may skew these values.

SECTION 4- Data Recovery and Validation

All raw wind data are subjected to a series of tests and filters to weed out data that are faulty or corrupted. Definitions of these quality assurance (QA) controls are given below under Test Definitions and Sensor Statistics. These control filters were designed to automate the quality control process and used many of the previous hand-worked data sets made at UMass to affect a suitable emulation. The gross percentage of data recovered (ratio of the number of raw data points received to data points expected) and net percentage (ratio of raw data points which passed all QA control tests to data points expected) are shown below for the reporting period January 1 to December 31, 2005.

Gross Data Recovered [%]	100.00
Net Data Recovered [%]	97.65

The high gross data recovery percentage indicates that the logger was performing well. The lower net data recovery is the result of several icing events during the year, many of which were in January and February 2005. Due to the failed 37 m vane, data from August – December 2005 were re-tested with a modified icing test definition: the 24 m vane data were used to test for icing instead of the 37 m vane data.

Test Definitions

All raw data were subjected to a series of validation tests, as described below. The sensors tested and the parameters specific to each sensor are given in the Sensor Performance Report that is included in APPENDIX A. Data that were flagged as invalid were not included in the statistics presented in this report.

MinMax Test: All sensors are expected to report data values within a range specified by the sensor and logger manufacturers. If a value falls outside this range, it is flagged as invalid. A data value from the sensor listed in Test Field 1 (TF1) is flagged if it is less than Factor 1 (F1) or greater than Factor 2. This test has been applied to the following sensors (as applicable): wind speed, wind speed standard deviation, wind direction, temperature, and solar insolation.

$$F1 > TF1 > F2$$

MinMaxT Test: This is a MinMax test for wind direction standard deviation with different ranges applied for high and low wind speeds. A wind direction standard deviation data value (TF1) is flagged either if it is less than Factor 1, if the wind speed (TF2) is less than Factor 4 and the wind direction standard deviation is greater than Factor 2, or if the wind speed is greater than or equal to Factor 4 and the wind direction standard deviation is greater than Factor 3.

$$(TF1 < F1)$$
$$\text{or } (TF2 < F4 \text{ and } TF1 > F2)$$
$$\text{or } (TF2 \geq F4 \text{ and } TF1 > F3)$$

Icing Test: An icing event occurs when ice collects on a sensor and degrades its performance. Icing events are characterized by the simultaneous measurements of near-zero standard deviation of wind direction, non-zero wind speed, and near- or below-freezing temperatures. Wind speed, wind speed standard deviation, wind direction, and wind direction standard deviation data values are flagged if the wind direction standard deviation (CF1) is less than or equal to Factor 1 (F1), the wind speed (TF1) is greater than Factor 2 (F2), and the temperature (CF2) is less than Factor 3 (F3). To exit an icing event, the wind direction standard deviation must be greater than Factor 4.

$$CF1 \leq F1 \text{ and } TF1 > F2 \text{ and } CF2 < F3$$

CompareSensors Test: Where primary and redundant sensors are used, it is possible to determine when one of the sensors is not performing properly. For anemometers, poor performance is characterized by low data values. Therefore, if one sensor of the pair reports values significantly below the other, the low values are flagged. At low wind speeds (Test Fields 1 and 2 less than or equal to Factor 3) wind speed data are flagged if the absolute difference between the two wind speeds is greater than Factor 1. At high

wind speeds (Test Fields 1 or 2 greater than Factor 3) wind speed data are flagged if the absolute value of the ratio of the two wind speeds is greater is greater than Factor 2.

$$[\ TF1 \leq F3 \text{ and } TF2 \leq F3 \text{ and } abs(TF1 - TF2) > F1\ ]$$
$$\text{or } [\ (TF1 > F3 \text{ or } TF2 > F3) \text{ and } (abs(1 - TF1 / TF2) > F2 \text{ or } abs(1 - TF2 / TF1) > F2)\ ]$$

Sensor Statistics

Expected Data Points: the total number of sample intervals between the start and end dates (inclusive).

Actual Data Points: the total number of data points recorded between the start and end dates.

% Data Recovered: the ratio of actual and expected data points (this is the *gross data recovered percentage*).

Hours Out of Range: total number of hours for which data were flagged according to MinMax and MinMaxT tests. These tests flag data that fall outside of an expected range.

Hours of Icing: total number of hours for which data were flagged according to Icing tests. This test uses the standard deviation of wind direction, air temperature, and wind speed to determine when sensor icing has occurred.

Hours of Fault: total number of hours for which data were flagged according to CompareSensors tests. These tests compare two sensors (e.g. primary and redundant anemometers installed at the same height) and flag data points where one sensor differs significantly from the other.

% Data Good: the filter results are subtracted from the gross data recovery percentage to yield the *net data recovered percentage*.

SECTION 5 - Data Summary

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data at a height of 37 m (121.4 ft) for the entire year of 2005. The following graphs are included:

- Time Series – In Figure 2, 10-minute average wind speeds are plotted against time for all data starting on January 1, 2005, at midnight through December 31, 2005, at 11:50 P.M. The time series shows particularly high winds in March and November.

- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed is shown in Figure 3. This plot shows that the wind speeds ranged between 4 and 5 m/s (8.9 and 11.2 mph) 13.5 % of the time.

- Monthly Averages – A plot of the average monthly wind speed for each month of data is shown in Figure 4, starting January 2005, through December 2005. This graph shows that for Mt. Tom, the highest average monthly wind speed of 7.3 m/s (16.3 mph) was in March 2005. The lowest was in June 2005, with an average wind speed of 4.3 m/s (9.6 mph).

- Diurnal Average Wind Speeds– Figure 5 is a plot of the average wind speed for each hour of the day. The hourly average varied between 4.9 and 6.7 m/s (10.9 and 13.4 mph), with the highest average speeds between 7 PM and 10 PM. The lowest wind speeds where between 9 AM and 11 AM.

- Turbulence Intensity – A plot of turbulence intensity as a function of wind speed is shown in Figure 6. Turbulence Intensity is calculated as the standard deviation of the wind speed divided by the wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine. In general, turbulence intensities range from 0.1 to 0.4; for Mt. Tom, the average turbulence intensity was 0.21.

- Wind Rose – Figure 7 is a plot, by compass direction, showing the percentage of time that the wind comes from a given direction and the average wind speed in that direction at the 24 m level. This wind rose shows that the prevailing wind direction at the 24 m level is west-northwest. Wind blew from this direction 13.8% of the time with a mean wind speed of 7.1 m/s (15.8 mph).

SECTION 6 - Graphs

Data for the wind speed histogram and wind rose are included in APPENDIX B.

Wind Speed Time Series

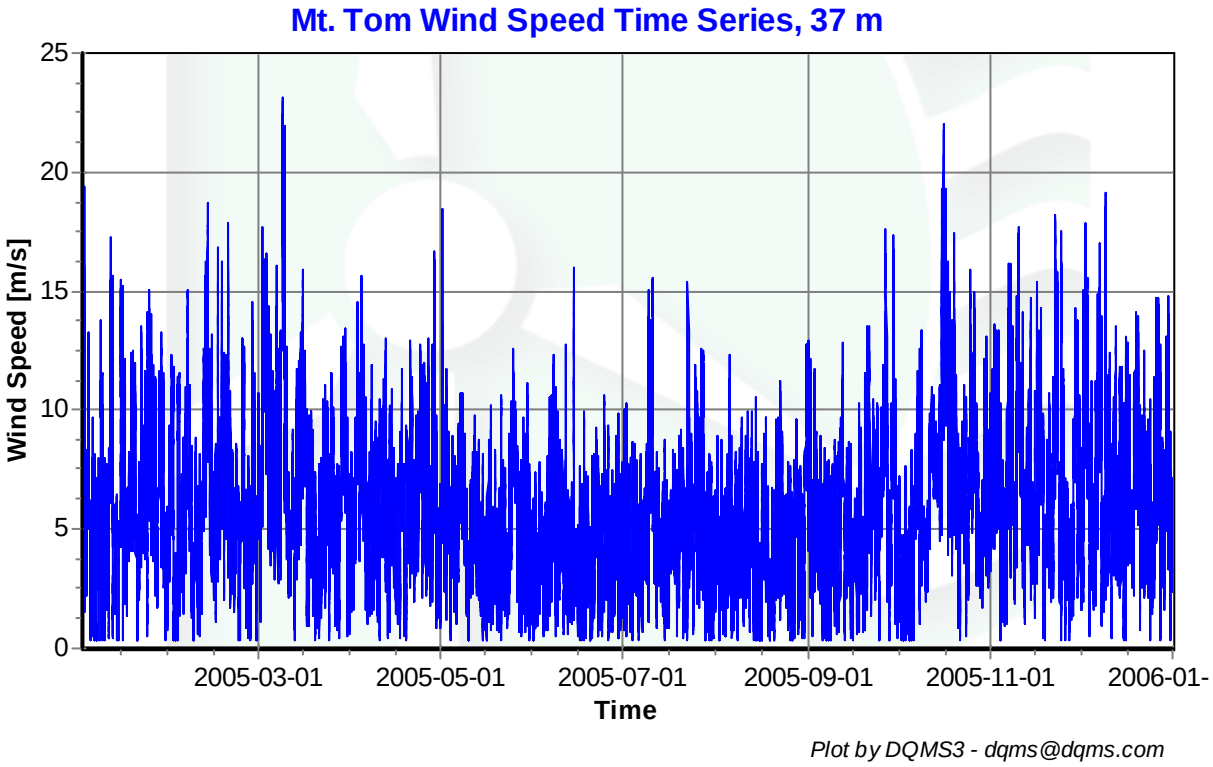

Figure 2 - Wind Speed Time Series, January 2005 – December 2005

Wind Speed Distribution

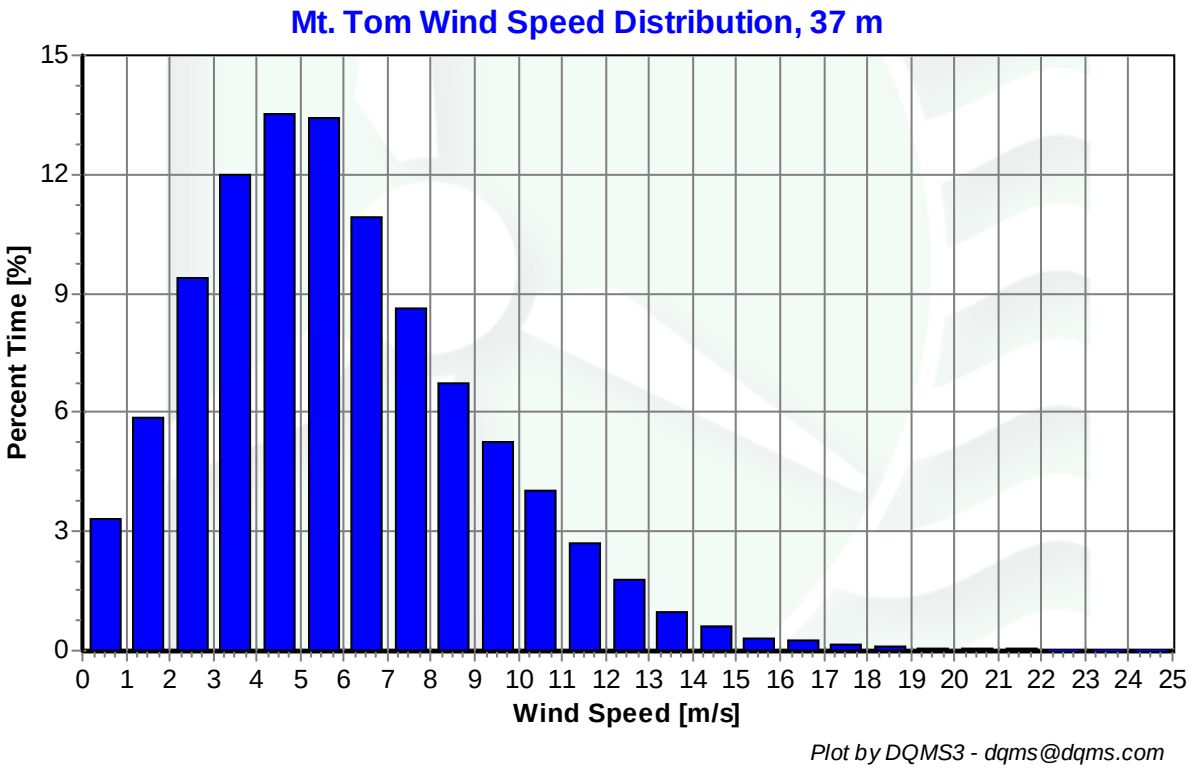

Figure 3 – Wind Speed Distribution, January 2005 – December 2005

Monthly Average Wind Speeds

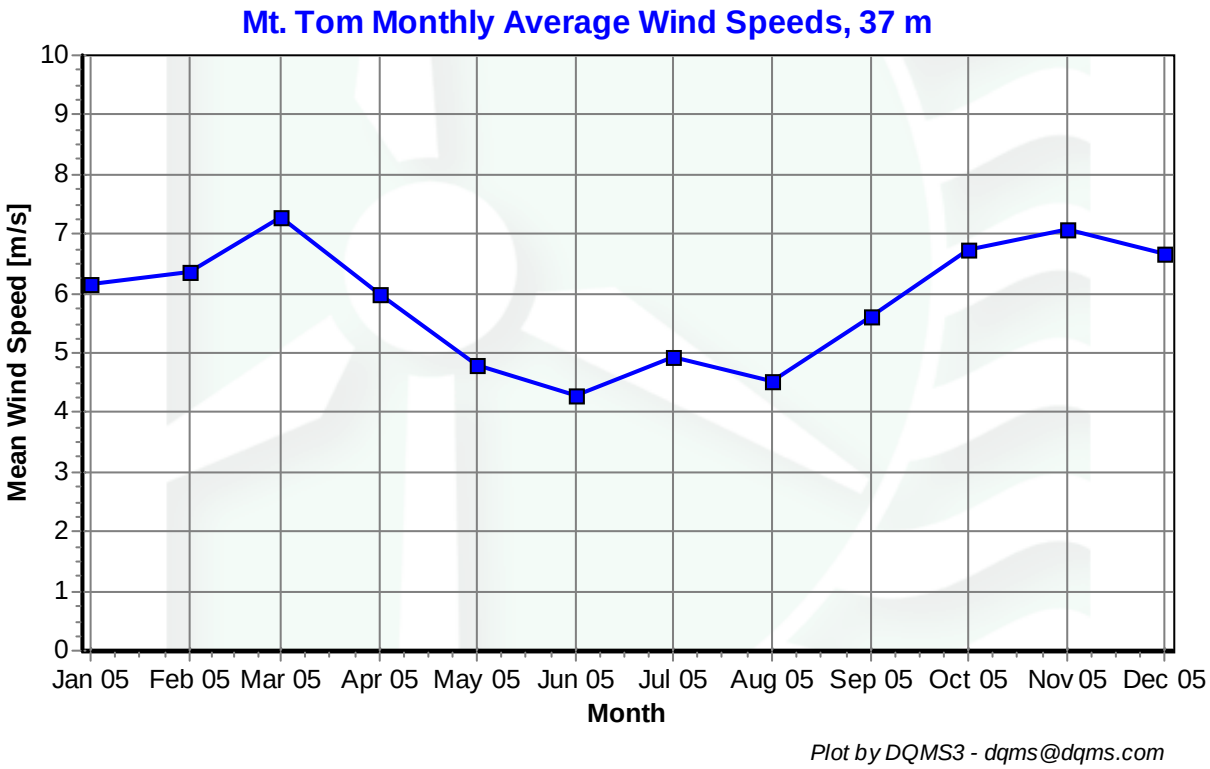

Figure 4 – Average Monthly Wind Speeds, January 2005 – December 2005

Diurnal Average Wind Speeds

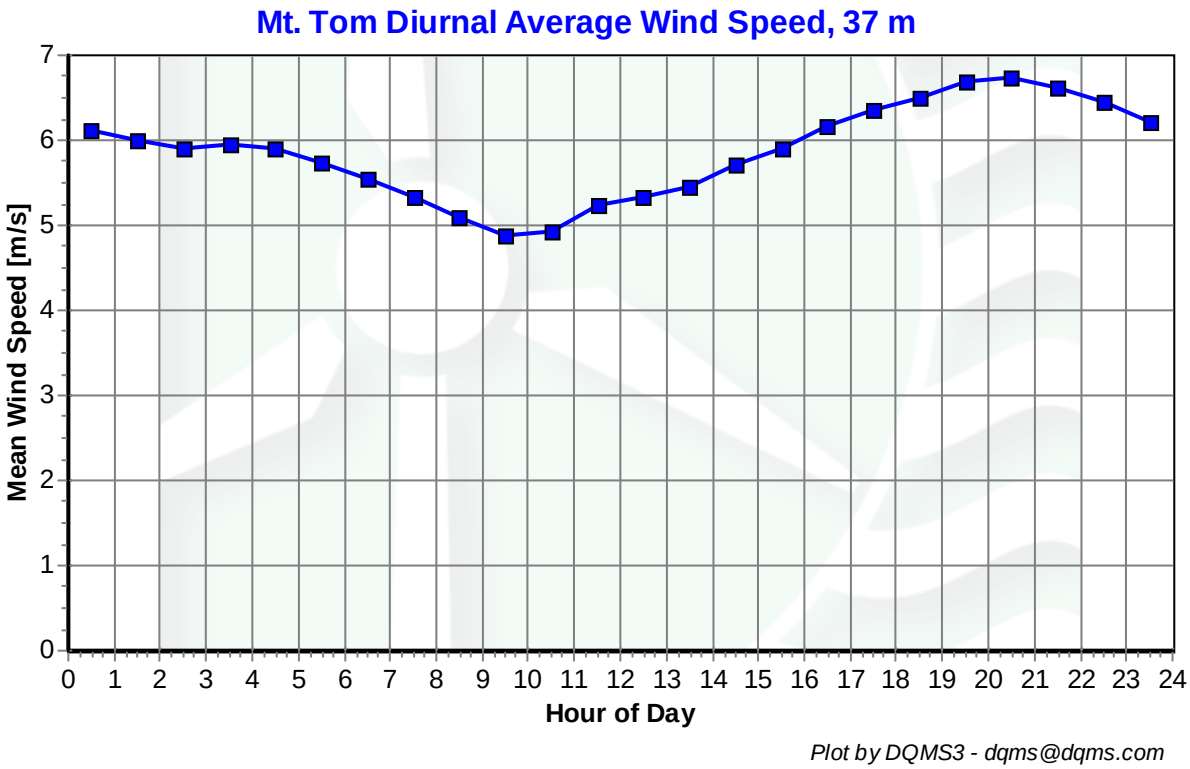

Figure 5 – Diurnal Average Wind Speeds, January 2005 – December 2005

Turbulence Intensities

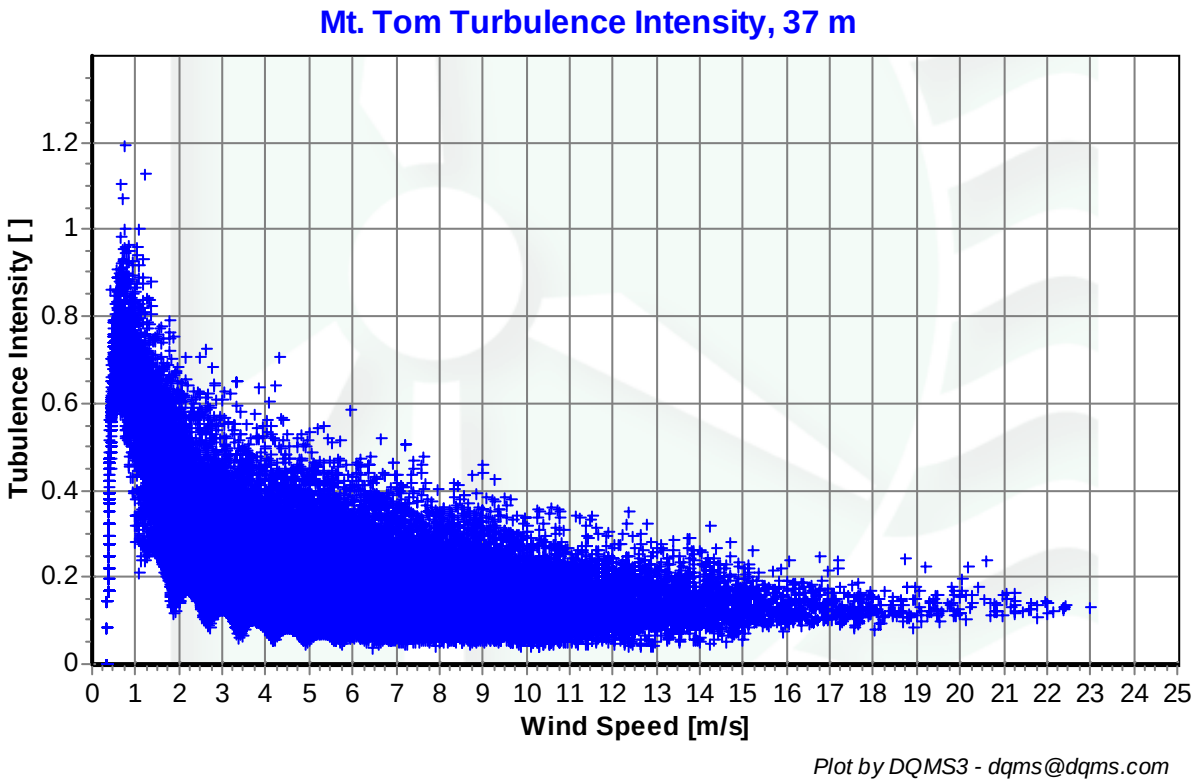

Figure 6 – Turbulence Intensity vs. Wind Speed, January 2005 – December 2005

Wind Rose

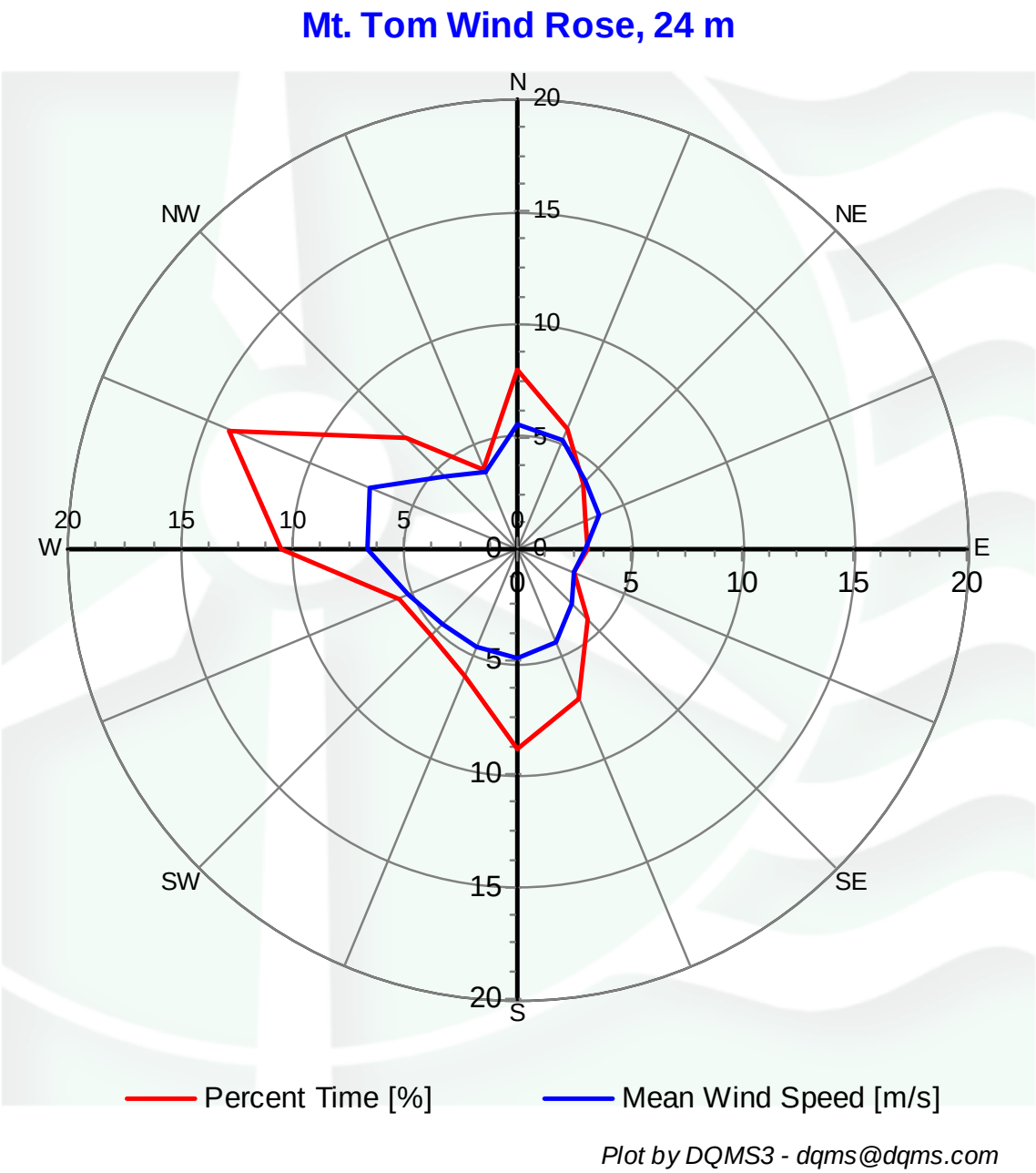

Figure 7 - Wind Rose, January 2005 – December 2005

APPENDIX A - Sensor Performance Report

Test Definitions

Test Order	TestField1	TestField2	TestField3	CalcField1	CalcField2	TestType	Factor1	Factor2	Factor3	Factor4
1						TimeTest Insert				
2	Itmp3aDEGC					MinMax	-30	60		
3	Batt3aVDC					MinMax	10.5	15		
4	Etmp3aDEGC					MinMax	-30	60		
5	EtmpSD3aDEGC					MinMax	0	4		
10	Anem24yMS					MinMax	0	90		
11	Anem37yMS					MinMax	0	90		
12	Anem24aMS					MinMax	0	90		
13	Anem24bMS					MinMax	0	90		
14	Anem37aMS					MinMax	0	90		
15	Anem37bMS					MinMax	0	90		
16	Anem18bMS					MinMax	0	90		
17	Anem21aMS					MinMax	0	90		
20	AnemSD24aMS					MinMax	0	7		
21	AnemSD24bMS					MinMax	0	7		
22	AnemSD37aMS					MinMax	0	7		
23	AnemSD37bMS					MinMax	0	7		
24	AnemSD18bMS					MinMax	0	7		
25	AnemSD21aMS					MinMax	0	7		
26	AnemSD24yMS					MinMax	0	7		
27	AnemSD37yMS					MinMax	0	7		
40	Pyro6aWMS					MinMax	0	1500		
41	PyroSD6aWMS					MinMax	0	1000		
50	Turb24zNONE					MinMax	0	2		
51	Turb37zNONE					MinMax	0	2		
60	Wshr0zNONE					MinMax	-100	100		
70	Pwrd24zWMC					MinMax	0	10000		
71	Pwrd37zWMC					MinMax	0	10000		
200	VaneSD24aDEG	Anem24yMS				MinMaxT	0	100	100	10
201	VaneSD37aDEG	Anem37yMS				MinMaxT	0	100	100	10
250	Vane24aDEG					MinMax	0	359.9		
251	Vane37aDEG					MinMax	0	359.9		
252	Vane19aDEG					MinMax	0	359.9		
300	Anem24aMS	AnemSD24aMS	Vane24aDEG	VaneSD24aDEG	Etmp3aDEGC	Icing	0.5	1	2	10
301	Anem24bMS	AnemSD24bMS	Vane24aDEG	VaneSD24aDEG	Etmp3aDEGC	Icing	0.5	1	2	10
302	Anem37aMS	AnemSD37aMS	Vane37aDEG	VaneSD37aDEG	Etmp3aDEGC	Icing	0.5	1	2	10
303	Anem37bMS	AnemSD37bMS	Vane37aDEG	VaneSD37aDEG	Etmp3aDEGC	Icing	0.5	1	2	10
400	Anem24aMS	Anem24bMS				CompareSensors	1	0.25	3	0
401	Anem37aMS	Anem37bMS				CompareSensors	1	0.25	3	0

Sensor Statistics: January 2005 – December 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	52560	52558	99.996	0.167	0	0	99.994
Batt3aVDC	52560	52558	99.996	0.333	0	0	99.992
Anem24aMS	52560	52558	99.996	0	210.333	30.333	97.249
AnemSD24aMS	52560	52558	99.996	0	210.333	30.333	97.249
Anem24bMS	52560	52558	99.996	0	205.167	97.167	96.545
AnemSD24bMS	52560	52558	99.996	0	205.167	97.167	96.545
Anem37aMS	52560	52558	99.996	0	315.833	15.333	96.216
AnemSD37aMS	52560	52558	99.996	0	315.833	15.333	96.216
Anem37bMS	52560	52558	99.996	0	293.5	166.5	94.745
AnemSD37bMS	52560	52558	99.996	0	293.5	166.5	94.745
Vane24aDEG	52560	52558	99.996	5.833	214	0	97.487
VaneSD24aDEG	52560	52558	99.996	5.833	214	0	97.487
Vane37aDEG	52560	52558	99.996	1.167	297.333	0	96.589
VaneSD37aDEG	52560	52558	99.996	1.167	297.333	0	96.589
Etmp3aDEGC	52560	52558	99.996	2	0	0	99.973
EtmpSD3aDEGC	52560	52558	99.996	0	0	0	99.996
Pyro6aWMS	52560	52558	99.996	0	0	0	99.996
PyroSD6aWMS	52560	52558	99.996	0	0	0	99.996
Total	**946080**	**946044**	**99.996**	**16.5**	**3072.333**	**618.667**	**97.645**

Sensor Statistics: January 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4464	100	0	0	0	100
Batt3aVDC	4464	4464	100	0	0	0	100
Anem24aMS	4464	4464	100	0	108.333	3	85.036
AnemSD24aMS	4464	4464	100	0	108.333	3	85.036
Anem24bMS	4464	4464	100	0	109.667	9.833	83.938
AnemSD24bMS	4464	4464	100	0	109.667	9.833	83.938
Anem37aMS	4464	4464	100	0	154	0.667	79.211
AnemSD37aMS	4464	4464	100	0	154	0.667	79.211
Anem37bMS	4464	4464	100	0	153.833	10	77.979
AnemSD37bMS	4464	4464	100	0	153.833	10	77.979
Vane24aDEG	4464	4464	100	0.333	109.833	0	85.193
VaneSD24aDEG	4464	4464	100	0.333	109.833	0	85.193
Vane37aDEG	4464	4464	100	0	154	0	79.301
VaneSD37aDEG	4464	4464	100	0	154	0	79.301
Etmp3aDEGC	4464	4464	100	0	0	0	100
EtmpSD3aDEGC	4464	4464	100	0	0	0	100
Pyro6aWMS	4464	4464	100	0	0	0	100
PyroSD6aWMS	4464	4464	100	0	0	0	100
Total	**80352**	**80352**	**100**	**0.667**	**1579.333**	**47**	**87.851**

Sensor Statistics: February 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4032	4032	100	0	0	0	100
Batt3aVDC	4032	4032	100	0	0	0	100
Anem24aMS	4032	4032	100	0	56.333	2.833	91.195
AnemSD24aMS	4032	4032	100	0	56.333	2.833	91.195
Anem24bMS	4032	4032	100	0	50.167	13.833	90.476
AnemSD24bMS	4032	4032	100	0	50.167	13.833	90.476
Anem37aMS	4032	4032	100	0	94.667	0.5	85.838
AnemSD37aMS	4032	4032	100	0	94.667	0.5	85.838
Anem37bMS	4032	4032	100	0	76.333	34.167	83.557
AnemSD37bMS	4032	4032	100	0	76.333	34.167	83.557
Vane24aDEG	4032	4032	100	0.333	56.333	0	91.567
VaneSD24aDEG	4032	4032	100	0.333	56.333	0	91.567
Vane37aDEG	4032	4032	100	0	94.667	0	85.913
VaneSD37aDEG	4032	4032	100	0	94.667	0	85.913
Etmp3aDEGC	4032	4032	100	0	0	0	100
EtmpSD3aDEGC	4032	4032	100	0	0	0	100
Pyro6aWMS	4032	4032	100	0	0	0	100
PyroSD6aWMS	4032	4032	100	0	0	0	100
Total	**72576**	**72576**	**100**	**0.667**	**857**	**102.667**	**92.061**

Sensor Statistics: March 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4464	100	0	0	0	100
Batt3aVDC	4464	4464	100	0.167	0	0	99.978
Anem24aMS	4464	4464	100	0	26.333	0.833	96.349
AnemSD24aMS	4464	4464	100	0	26.333	0.833	96.349
Anem24bMS	4464	4464	100	0	26.833	5.5	95.654
AnemSD24bMS	4464	4464	100	0	26.833	5.5	95.654
Anem37aMS	4464	4464	100	0	46.5	0	93.75
AnemSD37aMS	4464	4464	100	0	46.5	0	93.75
Anem37bMS	4464	4464	100	0	45.5	6.5	93.011
AnemSD37bMS	4464	4464	100	0	45.5	6.5	93.011
Vane24aDEG	4464	4464	100	0.333	27.167	0	96.304
VaneSD24aDEG	4464	4464	100	0.333	27.167	0	96.304
Vane37aDEG	4464	4464	100	0	46.5	0	93.75
VaneSD37aDEG	4464	4464	100	0	46.5	0	93.75
Etmp3aDEGC	4464	4464	100	0.167	0	0	99.978
EtmpSD3aDEGC	4464	4464	100	0	0	0	100
Pyro6aWMS	4464	4464	100	0	0	0	100
PyroSD6aWMS	4464	4464	100	0	0	0	100
Total	**80352**	**80352**	**100**	**1**	**437.667**	**25.667**	**96.533**

Sensor Statistics: April 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4320	4320	100	0	0	0	100
Batt3aVDC	4320	4320	100	0	0	0	100
Anem24aMS	4320	4320	100	0	1.833	9.833	98.38
AnemSD24aMS	4320	4320	100	0	1.833	9.833	98.38
Anem24bMS	4320	4320	100	0	1.833	9	98.495
AnemSD24bMS	4320	4320	100	0	1.833	9	98.495
Anem37aMS	4320	4320	100	0	2.167	5.833	98.889
AnemSD37aMS	4320	4320	100	0	2.167	5.833	98.889
Anem37bMS	4320	4320	100	0	2.167	15.833	97.5
AnemSD37bMS	4320	4320	100	0	2.167	15.833	97.5
Vane24aDEG	4320	4320	100	0.167	1.833	0	99.722
VaneSD24aDEG	4320	4320	100	0.167	1.833	0	99.722
Vane37aDEG	4320	4320	100	0.167	2.167	0	99.676
VaneSD37aDEG	4320	4320	100	0.167	2.167	0	99.676
Etmp3aDEGC	4320	4320	100	0.167	0	0	99.977
EtmpSD3aDEGC	4320	4320	100	0	0	0	100
Pyro6aWMS	4320	4320	100	0	0	0	100
PyroSD6aWMS	4320	4320	100	0	0	0	100
Total	**77760**	**77760**	**100**	**0.833**	**24**	**81**	**99.183**

Sensor Statistics: May 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4464	100	0	0	0	100
Batt3aVDC	4464	4464	100	0	0	0	100
Anem24aMS	4464	4464	100	0	0	3.5	99.53
AnemSD24aMS	4464	4464	100	0	0	3.5	99.53
Anem24bMS	4464	4464	100	0	0	4.5	99.395
AnemSD24bMS	4464	4464	100	0	0	4.5	99.395
Anem37aMS	4464	4464	100	0	0	1.5	99.798
AnemSD37aMS	4464	4464	100	0	0	1.5	99.798
Anem37bMS	4464	4464	100	0	0	18.167	97.558
AnemSD37bMS	4464	4464	100	0	0	18.167	97.558
Vane24aDEG	4464	4464	100	0.833	0	0	99.888
VaneSD24aDEG	4464	4464	100	0.833	0	0	99.888
Vane37aDEG	4464	4464	100	0.5	0	0	99.933
VaneSD37aDEG	4464	4464	100	0.5	0	0	99.933
Etmp3aDEGC	4464	4464	100	0.167	0	0	99.978
EtmpSD3aDEGC	4464	4464	100	0	0	0	100
Pyro6aWMS	4464	4464	100	0	0	0	100
PyroSD6aWMS	4464	4464	100	0	0	0	100
Total	**80352**	**80352**	**100**	**2.833**	**0**	**55.333**	**99.566**

Sensor Statistics: June 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4320	4320	100	0	0	0	100
Batt3aVDC	4320	4320	100	0	0	0	100
Anem24aMS	4320	4320	100	0	0	2.167	99.699
AnemSD24aMS	4320	4320	100	0	0	2.167	99.699
Anem24bMS	4320	4320	100	0	0	2.667	99.63
AnemSD24bMS	4320	4320	100	0	0	2.667	99.63
Anem37aMS	4320	4320	100	0	0	1	99.861
AnemSD37aMS	4320	4320	100	0	0	1	99.861
Anem37bMS	4320	4320	100	0	0	21.333	97.037
AnemSD37bMS	4320	4320	100	0	0	21.333	97.037
Vane24aDEG	4320	4320	100	0.333	0	0	99.954
VaneSD24aDEG	4320	4320	100	0.333	0	0	99.954
Vane37aDEG	4320	4320	100	0	0	0	100
VaneSD37aDEG	4320	4320	100	0	0	0	100
Etmp3aDEGC	4320	4320	100	0.333	0	0	99.954
EtmpSD3aDEGC	4320	4320	100	0	0	0	100
Pyro6aWMS	4320	4320	100	0	0	0	100
PyroSD6aWMS	4320	4320	100	0	0	0	100
Total	**77760**	**77760**	**100**	**1**	**0**	**54.333**	**99.573**

Sensor Statistics: July 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4464	100	0.167	0	0	99.978
Batt3aVDC	4464	4464	100	0.167	0	0	99.978
Anem24aMS	4464	4464	100	0	0	0.833	99.888
AnemSD24aMS	4464	4464	100	0	0	0.833	99.888
Anem24bMS	4464	4464	100	0	0	9.333	98.746
AnemSD24bMS	4464	4464	100	0	0	9.333	98.746
Anem37aMS	4464	4464	100	0	0	1	99.866
AnemSD37aMS	4464	4464	100	0	0	1	99.866
Anem37bMS	4464	4464	100	0	0	13.5	98.185
AnemSD37bMS	4464	4464	100	0	0	13.5	98.185
Vane24aDEG	4464	4464	100	0.833	0	0	99.888
VaneSD24aDEG	4464	4464	100	0.833	0	0	99.888
Vane37aDEG	4464	4464	100	0.333	0	0	99.955
VaneSD37aDEG	4464	4464	100	0.333	0	0	99.955
Etmp3aDEGC	4464	4464	100	0.667	0	0	99.91
EtmpSD3aDEGC	4464	4464	100	0	0	0	100
Pyro6aWMS	4464	4464	100	0	0	0	100
PyroSD6aWMS	4464	4464	100	0	0	0	100
Total	**80352**	**80352**	**100**	**3.333**	**0**	**49.333**	**99.607**

Sensor Statistics: August 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4464	100	0	0	0	100
Batt3aVDC	4464	4464	100	0	0	0	100
Anem24aMS	4464	4464	100	0	0	2.333	99.686
AnemSD24aMS	4464	4464	100	0	0	2.333	99.686
Anem24bMS	4464	4464	100	0	0	2.167	99.709
AnemSD24bMS	4464	4464	100	0	0	2.167	99.709
Anem37aMS	4464	4464	100	0	0	0.333	99.955
AnemSD37aMS	4464	4464	100	0	0	0.333	99.955
Anem37bMS	4464	4464	100	0	0	8.333	98.88
AnemSD37bMS	4464	4464	100	0	0	8.333	98.88
Vane24aDEG	4464	4464	100	1.333	0	0	99.821
VaneSD24aDEG	4464	4464	100	1.333	0	0	99.821
Vane37aDEG	4464	4464	100	0.167	0	0	99.978
VaneSD37aDEG	4464	4464	100	0.167	0	0	99.978
Etmp3aDEGC	4464	4464	100	0	0	0	100
EtmpSD3aDEGC	4464	4464	100	0	0	0	100
Pyro6aWMS	4464	4464	100	0	0	0	100
PyroSD6aWMS	4464	4464	100	0	0	0	100
Total	**80352**	**80352**	**100**	**3**	**0**	**26.333**	**99.781**

Sensor Statistics: September 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4320	4319	99.977	0	0	0	99.977
Batt3aVDC	4320	4319	99.977	0	0	0	99.977
Anem24aMS	4320	4319	99.977	0	0	0.667	99.884
AnemSD24aMS	4320	4319	99.977	0	0	0.667	99.884
Anem24bMS	4320	4319	99.977	0	0	6.167	99.12
AnemSD24bMS	4320	4319	99.977	0	0	6.167	99.12
Anem37aMS	4320	4319	99.977	0	0	0.167	99.954
AnemSD37aMS	4320	4319	99.977	0	0	0.167	99.954
Anem37bMS	4320	4319	99.977	0	0	5	99.282
AnemSD37bMS	4320	4319	99.977	0	0	5	99.282
Vane24aDEG	4320	4319	99.977	0.667	0	0	99.884
VaneSD24aDEG	4320	4319	99.977	0.667	0	0	99.884
Vane37aDEG	4320	4319	99.977	0	0	0	99.977
VaneSD37aDEG	4320	4319	99.977	0	0	0	99.977
Etmp3aDEGC	4320	4319	99.977	0.167	0	0	99.954
EtmpSD3aDEGC	4320	4319	99.977	0	0	0	99.977
Pyro6aWMS	4320	4319	99.977	0	0	0	99.977
PyroSD6aWMS	4320	4319	99.977	0	0	0	99.977
Total	**77760**	**77742**	**99.977**	**1.5**	**0**	**24**	**99.78**

Sensor Statistics: October 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4463	99.978	0	0	0	99.978
Batt3aVDC	4464	4463	99.978	0	0	0	99.978
Anem24aMS	4464	4463	99.978	0	0	0	99.978
AnemSD24aMS	4464	4463	99.978	0	0	0	99.978
Anem24bMS	4464	4463	99.978	0	0	15.167	97.939
AnemSD24bMS	4464	4463	99.978	0	0	15.167	97.939
Anem37aMS	4464	4463	99.978	0	0	0.167	99.955
AnemSD37aMS	4464	4463	99.978	0	0	0.167	99.955
Anem37bMS	4464	4463	99.978	0	0	1.667	99.754
AnemSD37bMS	4464	4463	99.978	0	0	1.667	99.754
Vane24aDEG	4464	4463	99.978	0.167	0	0	99.955
VaneSD24aDEG	4464	4463	99.978	0.167	0	0	99.955
Vane37aDEG	4464	4463	99.978	0	0	0	99.978
VaneSD37aDEG	4464	4463	99.978	0	0	0	99.978
Etmp3aDEGC	4464	4463	99.978	0	0	0	99.978
EtmpSD3aDEGC	4464	4463	99.978	0	0	0	99.978
Pyro6aWMS	4464	4463	99.978	0	0	0	99.978
PyroSD6aWMS	4464	4463	99.978	0	0	0	99.978
Total	**80352**	**80334**	**99.978**	**0.333**	**0**	**34**	**99.721**

Sensor Statistics: November 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4320	4320	100	0	0	0	100
Batt3aVDC	4320	4320	100	0	0	0	100
Anem24aMS	4320	4320	100	0	7.167	2.5	98.657
AnemSD24aMS	4320	4320	100	0	7.167	2.5	98.657
Anem24bMS	4320	4320	100	0	6.333	11.5	97.523
AnemSD24bMS	4320	4320	100	0	6.333	11.5	97.523
Anem37aMS	4320	4320	100	0	7.833	2.5	98.565
AnemSD37aMS	4320	4320	100	0	7.833	2.5	98.565
Anem37bMS	4320	4320	100	0	5.167	22.833	96.111
AnemSD37bMS	4320	4320	100	0	5.167	22.833	96.111
Vane24aDEG	4320	4320	100	0.167	8.167	0	98.843
VaneSD24aDEG	4320	4320	100	0.167	8.167	0	98.843
Vane37aDEG	4320	4320	100	0	0	0	100
VaneSD37aDEG	4320	4320	100	0	0	0	100
Etmp3aDEGC	4320	4320	100	0.167	0	0	99.977
EtmpSD3aDEGC	4320	4320	100	0	0	0	100
Pyro6aWMS	4320	4320	100	0	0	0	100
PyroSD6aWMS	4320	4320	100	0	0	0	100
Total	**77760**	**77760**	**100**	**0.5**	**69.333**	**78.667**	**98.854**

Sensor Statistics: December 2005

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Itmp3aDEGC	4464	4464	100	0	0	0	100
Batt3aVDC	4464	4464	100	0	0	0	100
Anem24aMS	4464	4464	100	0	10.333	1.833	98.365
AnemSD24aMS	4464	4464	100	0	10.333	1.833	98.365
Anem24bMS	4464	4464	100	0	10.333	7.5	97.603
AnemSD24bMS	4464	4464	100	0	10.333	7.5	97.603
Anem37aMS	4464	4464	100	0	10.667	1.667	98.342
AnemSD37aMS	4464	4464	100	0	10.667	1.667	98.342
Anem37bMS	4464	4464	100	0	10.5	9.167	97.357
AnemSD37bMS	4464	4464	100	0	10.5	9.167	97.357
Vane24aDEG	4464	4464	100	0.333	10.667	0	98.522
VaneSD24aDEG	4464	4464	100	0.333	10.667	0	98.522
Vane37aDEG	4464	4464	100	0	0	0	100
VaneSD37aDEG	4464	4464	100	0	0	0	100
Etmp3aDEGC	4464	4464	100	0.167	0	0	99.978
EtmpSD3aDEGC	4464	4464	100	0	0	0	100
Pyro6aWMS	4464	4464	100	0	0	0	100
PyroSD6aWMS	4464	4464	100	0	0	0	100
Total	**80352**	**80352**	**100**	**0.833**	**105**	**40.333**	**98.909**

APPENDIX B - Plot Data

Wind Speed Distribution Data

Bin Center Wind Speed [m/s]	Percent of Time [%]
0.5	3.32
1.5	5.84
2.5	9.38
3.5	12.01
4.5	13.52
5.5	13.4
6.5	10.9
7.5	8.63
8.5	6.73
9.5	5.25
10.5	4.02
11.5	2.69
12.5	1.76
13.5	0.99
14.5	0.61
15.5	0.31
16.5	0.23
17.5	0.17
18.5	0.08
19.5	0.06
20.5	0.05
21.5	0.03
22.5	0.02
23.5	0
24.5	0

Table 1: Wind Speed Distribution

Monthly Average Wind Speed Data

Date	Mean [m/s]
Jan 2005	6.15
Feb 2005	6.36
Mar 2005	7.28
Apr 2005	5.99
May 2005	4.80
Jun 2005	4.30
Jul 2005	4.92
Aug 2005	4.51
Sep 2005	5.61
Oct 2005	6.72
Nov 2005	7.09
Dec 2005	6.68

Table 2 - Wind Speed Averages

Diurnal Average Wind Speed Data

Hour of Day	Average Wind Speed [m/s]
0.5	6.11
1.5	6.00
2.5	5.91
3.5	5.95
4.5	5.90
5.5	5.73
6.5	5.54
7.5	5.33
8.5	5.10
9.5	4.88
10.5	4.92
11.5	5.23
12.5	5.33
13.5	5.46
14.5	5.70
15.5	5.91
16.5	6.16
17.5	6.37
18.5	6.49
19.5	6.70
20.5	6.74
21.5	6.63
22.5	6.44
23.5	6.21

Table 3 - Diurnal Average Wind Speeds

Wind Rose Data

Direction	Percent Time [%]	Mean Wind Speed [m/s]
N	7.99	5.51
NNE	5.81	5.20
NE	4.09	4.31
ENE	3.30	3.97
E	3.11	2.99
ESE	2.71	2.74
SE	4.41	3.45
SSE	7.17	4.49
S	8.93	4.86
SSW	6.12	4.67
SW	5.44	4.72
WSW	5.69	5.25
W	10.46	6.63
WNW	13.84	7.06
NW	7.04	4.54
NNW	3.88	3.67

Table 4: Wind Rose, Time Percentage and Mean Wind Speed by Direction