

ANNUAL WIND DATA REPORT

Old Rochester Regional High School Mattapoisett, Massachusetts

September 1, 2006 – August 31, 2007

Prepared for

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NOTICE AND ACKNOWLEDGEMENTS

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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 was performed by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst.

This report covers wind data measured at a meteorological tower installed at Old Rochester Regional High School in the town of Mattapoisett, MA. Installed on May 31st, 2006, the wind monitoring station has been in continuous operation to this day. Two sets of two anemometers and one wind vane are mounted at 49 m (160.7 ft) and 38 m (124.6 ft), and an additional anemometer and vane are mounted at 20 m (65.6 ft). Reports are made on a quarterly and annually basis; and this report is the first of the annual report for ORR.

The data covered by this final report is one calendar year from September 1st, 2006 until August 31st, 2007. Typically, met towers are removed for reuse at other sites after a one year period; however, due to issues with missing data during the beginning of the collection period, additional data was gathered in an attempt to allow for a complete dataset. The gross data recovery percentage (the actual percentage of expected data received) was 99.8% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 98.9% for the year covered in this report. The mean recorded wind speed for this year was 5.02 m/s (11.2 mph)¹ and the prevailing wind direction was from the south-southwest. Other nearby wind monitoring sites include Mattapoisett (5.74 m/s year 2006), and Thompson Island (5.9 m/s year 2005).

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

* 1 m/s = 2.237 mph.

¹ 1m/s=2.237 mph

SECTION 1 - Station Location

The ORR site is located at a wooded edge of an athletic field near the Old Rochester Regional High School in Mattapoisett, MA. Latitude and Longitude are $41^{\circ} 40.59'N$ and $70^{\circ} 46.94'W$, respectively, using the NAD 83 datum. Figure 1 marks the site on a topographic map.

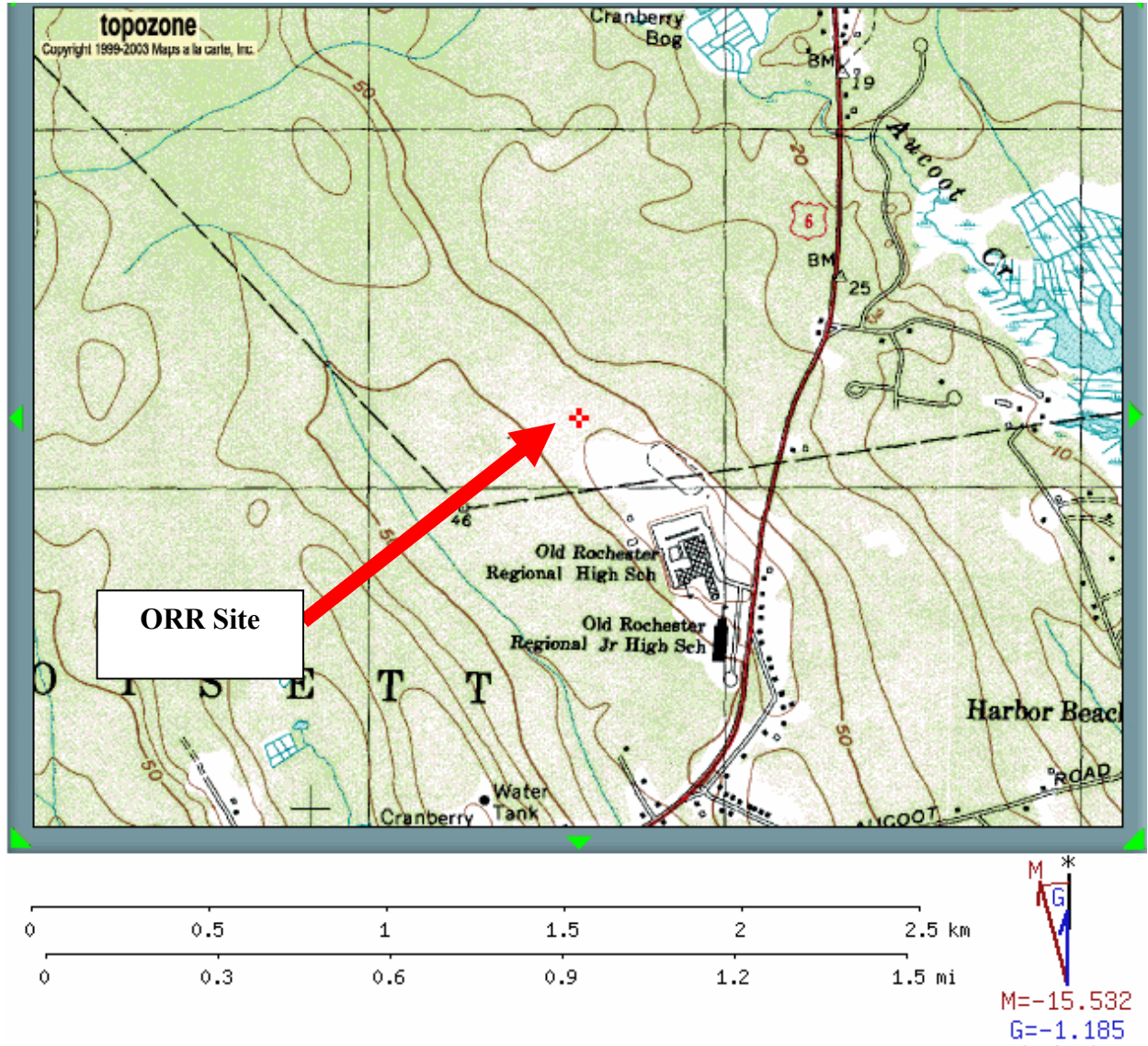


Figure 1 – Topographic Map Showing ORR Site Location--Source Topozone.com

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on a 50 m (164.0 ft) NRG tower. All other monitoring equipment also comes from NRG Systems, and consists of the following items:

- Symphonie Data Logger
- Electrical enclosure box
- 5 – #40 Anemometers, standard calibration (Slope - 0.765 m/s, Offset – 0.350 m/s). Two anemometers are located at 49 m (160.7 ft), two at 38 m (124.6 ft) and one at 20 m (65.6 ft).
- 3 - #200P Wind direction vanes. They are located at heights of 49 m (160.7 ft), 38 m (124.6 ft) and 20 m (65.6 ft) each.
- 5 – Sensor booms, 54” length
- Lightning rod and grounding cable
- 1 - #110S Temperature Sensor mounted at approximately 3 m (9.8 ft)
- Shielded sensor wire



Figure 2 – Raising the Met-tower at ORR Site

The data from the Symphonie logger is mailed to the Renewable Energy Research Laboratory at the University of Massachusetts, Amherst on a regular basis. The logger

samples wind speed and direction once every two seconds. These data 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 Summary

A summary of the wind speeds and wind directions measured during the reporting period is included in Table 1. Table 1 includes the mean wind speeds measured at each measurement height, the maximum instantaneous wind speed measured at each measurement height and the prevailing wind direction measured at each measurement height. These values are provided for each month of the reporting period and for the whole reporting period.

Table 1. Wind Speed and Direction Data Summary

Date	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction
Height Units	49 m [m/s]	49 m [m/s]	49 m	38 m [m/s]	38 m [m/s]	38 m	20 m [m/s]	20 m [m/s]	20 m
Sept-06	4.55	10.71	SSW	3.98	9.59	SSW	2.26	7.87	SSW
Oct-06	5.49	16.44	SSW	4.78	14.57	SW	3.00	11.50	SW
Nov-06	4.59	13.31	S	3.96	11.91	S	2.35	9.44	S
Dec-06	5.16	14.17	WSW	4.51	12.71	WSW	2.77	8.84	WSW
Jan-07	5.27	15.18	WSW	4.66	14.23	WSW	2.92	12.59	WSW
Feb-07	5.43	13.74	WSW	4.84	12.41	WSW	3.12	10.17	WSW
Mar-07	5.84	13.39	SW	5.17	11.73	SW	3.39	9.56	SW
Apr-07	5.40	20.84	S	4.86	19.20	S	3.27	16.57	S
May-07	4.86	10.75	SSW	4.32	9.76	SSW	2.74	7.11	SSW
June-07	4.94	10.59	S	4.36	9.55	S	2.69	7.91	S
July-07	4.38	10.27	SW	3.84	9.26	SW	2.39	6.65	SW
Aug-07	4.34	13.69	S	3.78	12.43	S	2.24	8.50	S
Sept 2006 – Aug 2007	5.02	20.84	SSW	4.42	19.20	SSW	2.76	16.57	SSW

Wind data statistics in the table are reported when more than 90% of the data during the reporting period are valid. In cases when a larger amount of data are missing, the percent of the available data that are used to determine the data statistics is noted.

No measurement of wind speed or direction can be perfectly accurate. Wind speed measurement 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 $\pm 2\%$ or ± 0.2 m/s, whichever is greater. Wind direction measurement errors occur due to sensor measurement uncertainty, tower effects, boom alignment measurement errors and twisting of pipe sections during the raising of a pipe tower. Efforts are also made to reduce these errors, but the reported wind directions are estimated to have an uncertainty of ± 5 degrees.

A summary of the turbulence intensity and mean wind shear measured at each measurement height during the reporting period is included in Table 3. These values are provided for each month of the reporting period and for the whole reporting period. Turbulence Intensity is calculated by dividing the standard deviation of the wind speed by the mean wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine. Turbulence intensity varies with wind speed. The average turbulence intensity presented in Table 3 is the mean turbulence intensity when the wind speed at each measurement height is between 10 and 11 m/s.

Shear coefficients provide a measure of the change in wind speed with height. When data at multiple heights are available, shear coefficients, α , have been determined. They can be used in the following formula to estimate the average wind speed, $U(z)$, at height z , when the average wind speed, $U(z_r)$, at height z_r is known:

$$U(z) = U(z_r) \left(\frac{z}{z_r} \right)^\alpha$$

The change in wind speed with height is a very complicated relationship related to atmospheric conditions, wind speed, wind direction, time of day and time of year. This formula will not always provide the correct answer at any given site. Nevertheless the calculated shear coefficient, based on measurements at two heights, can be used to characterize the degree of increase in wind speed with height at a site.

The mean wind shear coefficient that is provided here is calculated based on the mean wind speeds in Table 1, where z_{low} and z_{high} are the heights of the higher and lower mean wind speeds used in the calculation and $U(z_{low})$ and $U(z_{high})$ are the mean wind speeds at the two heights.

$$\alpha = \log \left(\frac{U(z_{high})}{U(z_{low})} \right) / \log \left(\frac{z_{high}}{z_{low}} \right)$$

Table 3. Shear and Turbulence Intensity Data Summary

Date	Turbulence Intensity at 10 m/s	Turbulence Intensity at 10 m/s	Turbulence Intensity at 10 m/s	Mean Wind Shear Coefficient, α
Height Units	49 m [-]	38 m [-]	20 m [-]	Between 49 m and 38 m [-]
Sept-06	0.229	--	--	0.527
Oct-06	0.232	0.260	0.212	0.545
Nov-06	0.233	0.243	--	0.581
Dec-06	0.225	0.254	--	0.533
Jan-07	0.234	0.232	0.161	0.490
Feb-07	0.237	0.255	0.216	0.458
Mar-07	0.235	0.246	--	0.482
Apr-07	0.235	0.257	0.228	0.414
May-07	0.213	--	--	0.463
June-07	0.204	--	--	0.492
July-07	0.185	--	--	0.509
Aug-07	0.221	0.280	--	0.544
Sept 2006 -Aug 2007	0.233	0.252	0.216	0.502

SECTION 4- Capacity Factor

The capacity factor of a wind turbine at a given site depends on the hub height, wind speed distribution at the hub height, the wind turbine power curve and any assumptions about down time and losses due to wake effects from upwind wind turbines, etc. If the hub height wind speed is estimated from data at lower heights, then the capacity factor will also depend on the estimated wind shear and the wind speeds measured at lower heights. No simple estimate of capacity factor at a site could take all of these effects and choices into account. Nevertheless, an estimate of the capacity factor of a wind turbine at this site is provided here to help the reader understand the order of magnitude of the wind resource at this site.

The estimates assume a hub height of 77 m, a 1.5 MW wind turbine with a rotor diameter of 80 m and the mean wind speed at the highest measurement height and the mean wind shear at the site, in order to determine the mean hub height wind speed. The capacity factor (CF) is then estimated from (see G.M. Masters, Renewable and Efficient Electric Power Systems, Wiley, 2004):

$$CF=(0.087)U_{hub} - \frac{P_{rated}}{D^2}$$

where U_{hub} is the mean annual hub height wind speed in m/s (in this case estimated at 6.41 m/s), P_{rated} is the rated power of the wind turbine in kW and D is the diameter of the rotor in meters. Based on this equation, the estimated capacity factor of a wind turbine at this site would be about 0.30.

SECTION 5- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from one calendar year (September 1st, 2006 to August 31st, 2007). The following graphs are included:

- Time Series – 10-minute average wind speeds are plotted against time. This graph includes all of the collected data.
- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed.
- Monthly Average – A plot of the monthly average wind speed over a 12-month period. This graph shows the monthly trends in the wind speed.
- Diurnal – A plot of the average wind speed for each hour of the day.
- Turbulence Intensity – A plot of turbulence intensity as a function of wind speed. 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.
- Wind Rose – 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.

Immediately obvious in the Wind Speed Time-Series graph (figure 3) are the two high wind events on October 27th and April 16th. Figure 4 shows that the wind speed was between 5 m/s and 6 m/s (11.2 mph 13.4 mph) about 20% of the time. Figure 5 shows that the monthly average wind speeds were generally near 5 m/s (11.2 mph). Figure 6 shows that the wind speed was generally higher during the midday hours. Figure 7 shows that the site turbulence intensity at 49 m was generally fairly high presumably due to effects caused by nearby trees. Figure 8 shows that though the highest average wind speeds were from the west-northwest: 5.43 m/s (12.1 mph), the wind speeds were fairly well distributed across the compass rose; and shows that the wind blew primarily (i.e. 16.7% of the time) from the south-southwest.

Data for the wind speed histograms, monthly and diurnal average plots, and wind roses are included in APPENDIX B.

Wind Speed Time Series

ORR Wind Speed Time Series, 49 m

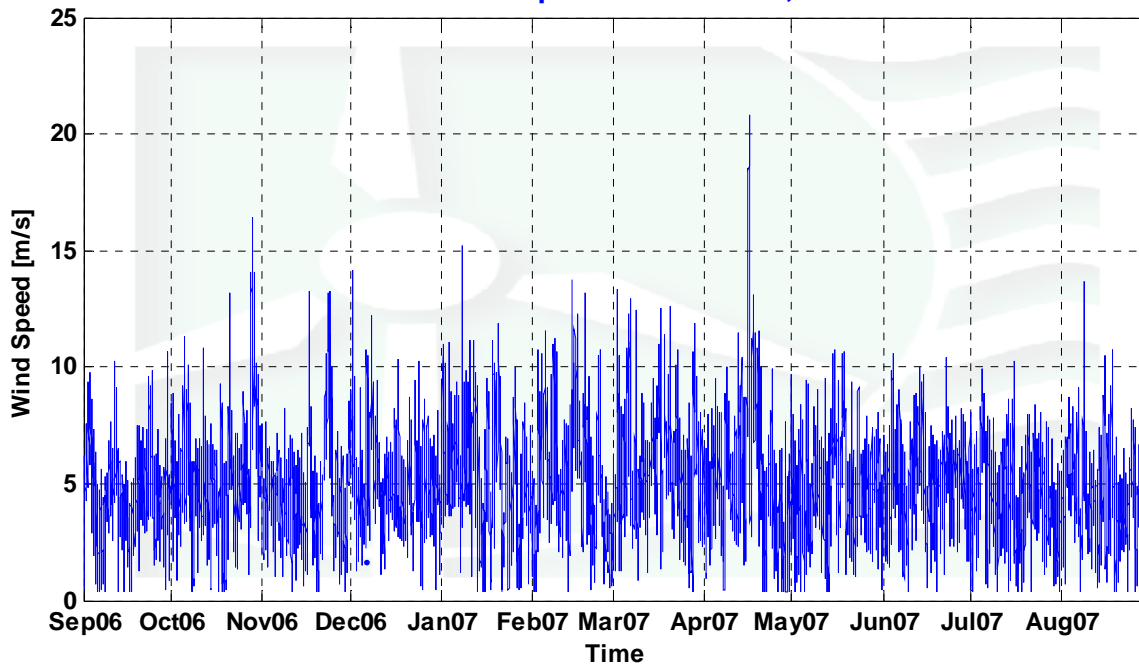


Figure 3 - Wind Speed Time Series, September 1, 2006 through August 31, 2007

Wind Speed Distributions

ORR Wind Speed Distribution, 49 m

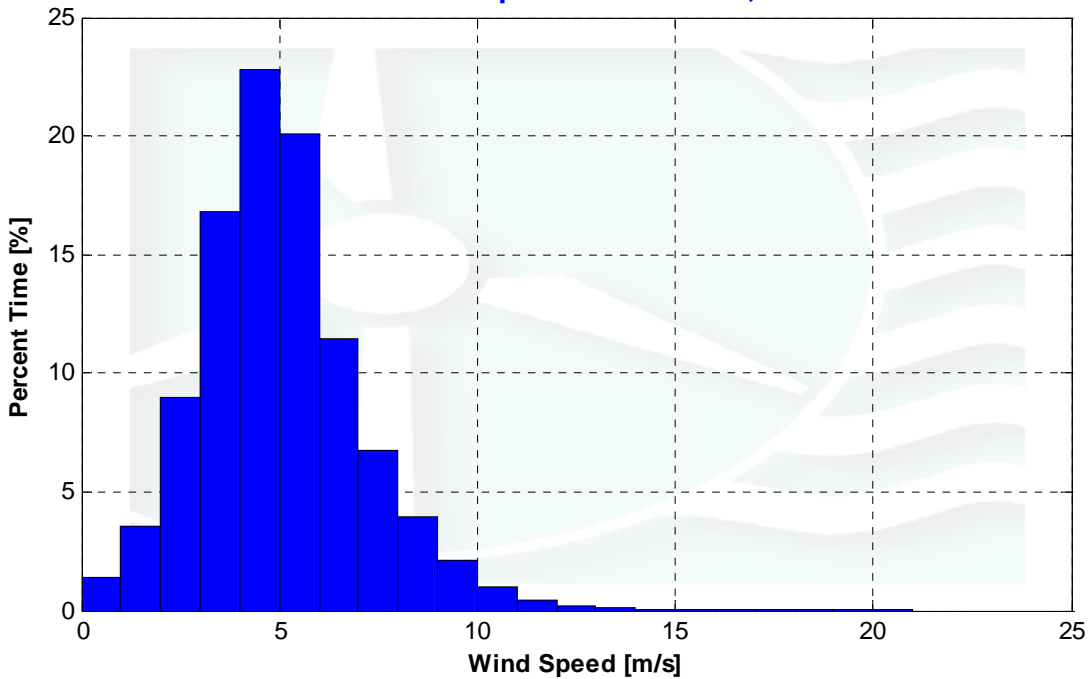


Figure 4 - Wind Speed Distribution, September 1, 2006 through August 31, 2007

Monthly Average Wind Speeds

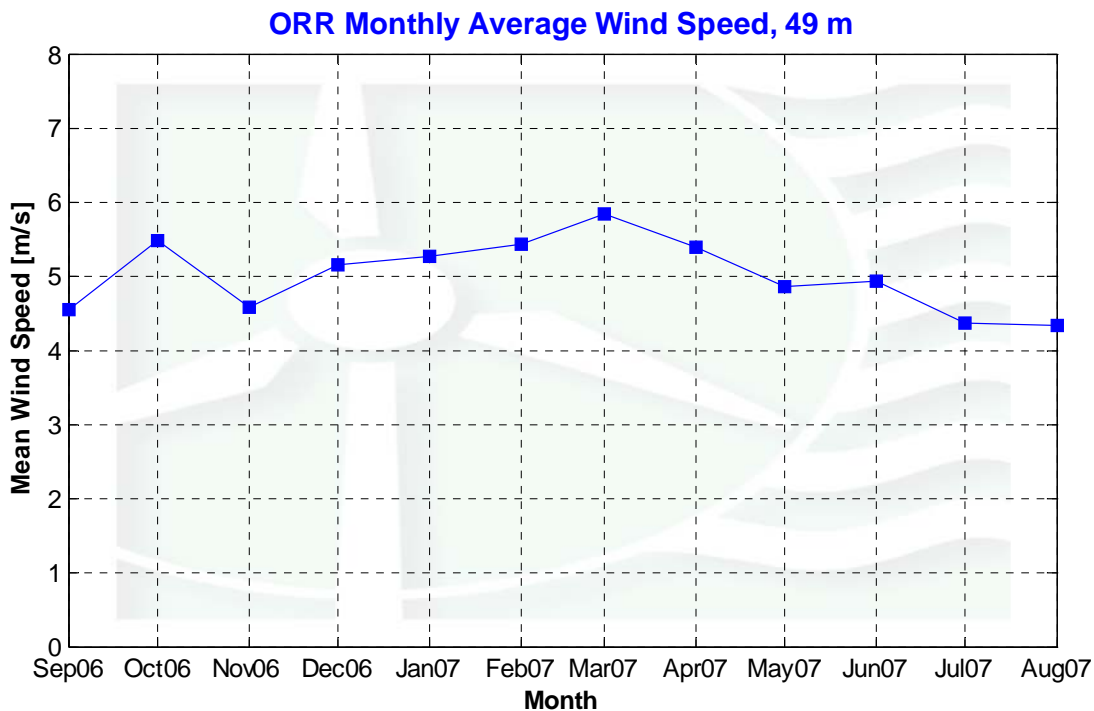


Figure 5 - Monthly Average Wind Speed

Diurnal Average Wind Speeds

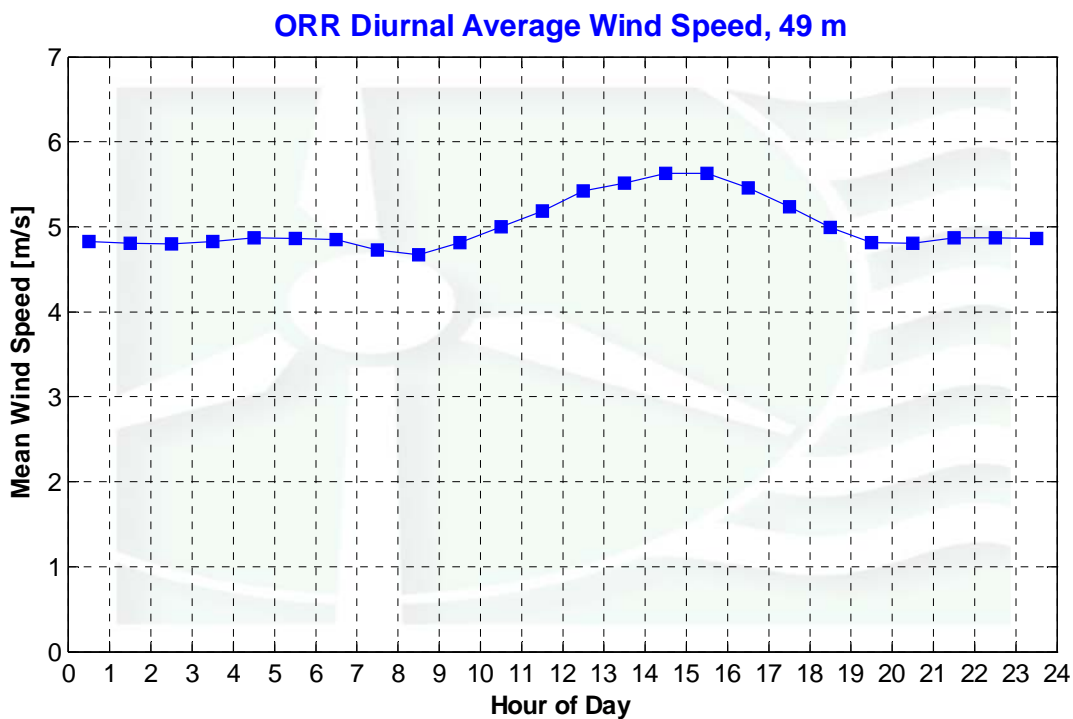


Figure 6 - Diurnal Average Wind Speed, September 1, 2006 through August 31, 2007

Turbulence Intensities

ORR Turbulence Intensity, 49 m

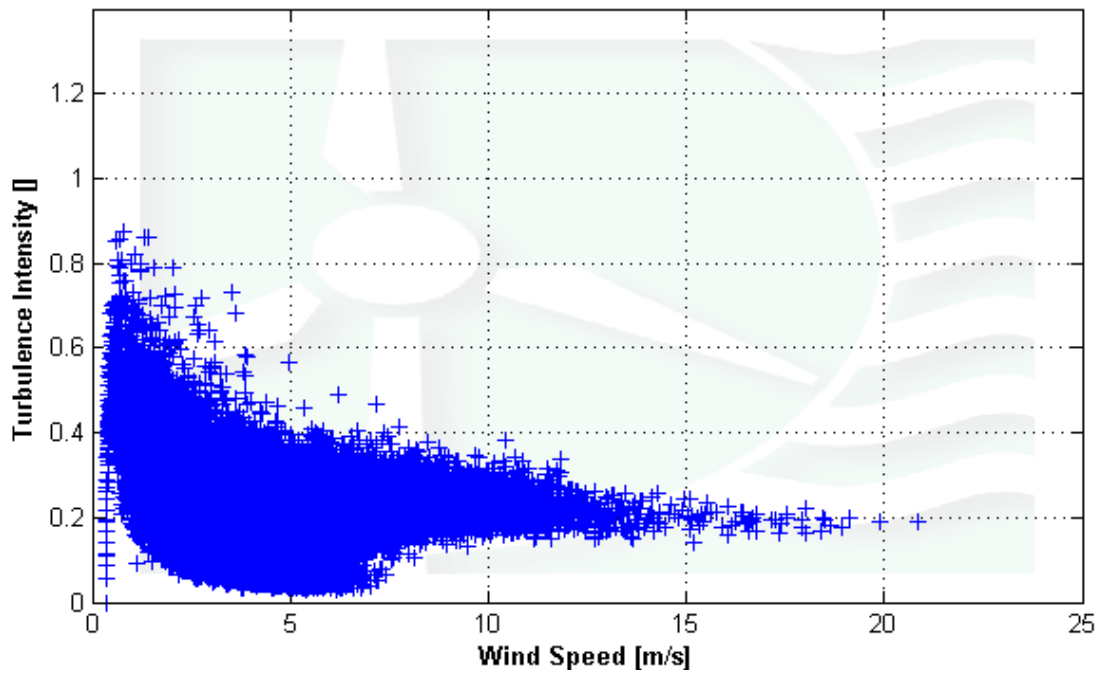


Figure 7 - Turbulence Intensity, September 1, 2006 through August 31, 2007

Wind Roses

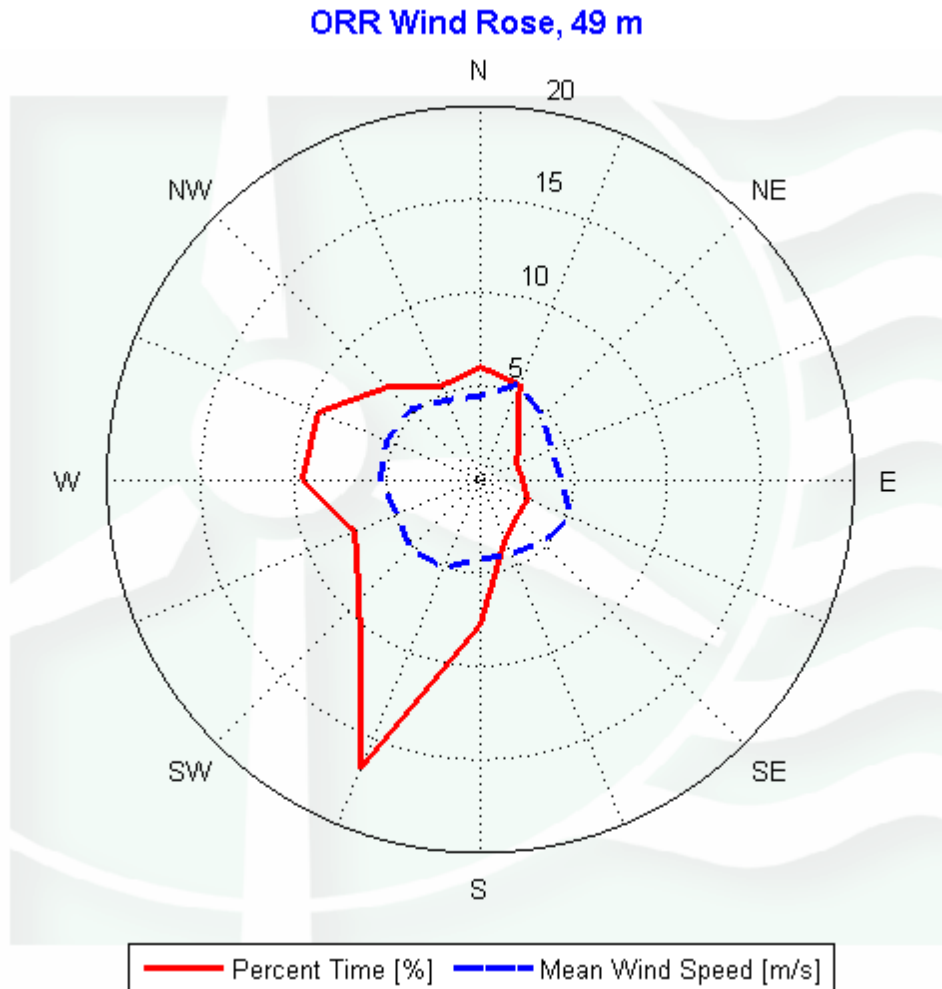


Figure 8 - Wind Rose, September 1, 2006 through August 31, 2007

SECTION 6 - Significant Meteorological Events

Except for a storm affecting ORR with high winds over a three-day period starting October 27th and a storm causing high winds on April 16th, there were no major meteorological events that would have caused notable fluctuations in wind speed measurements during the year.

Source: <http://wunderground.com/history/airport/KORE>

SECTION 7 - Data Collection and Maintenance

Although there have been a few short duration sensor-icing events, that have cause minor data loss, there has been no data loss large enough to substantially affect wind speed statistics during the calendar year covered in this report.

SECTION 8 - 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.

Gross Data Recovered [%]	99.840
Net Data Recovered [%]	98.889

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 which is included in APPENDIX A. Data which 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.

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

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.

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

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 than Factor 2.

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

Sensor Statistics

A summary of the results of the data collection and filtering are given in the Sensor Performance Report which is included in APPENDIX A. The following categories of information, tabulated for each sensor, are included in that report.

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 which 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*.

APPENDIX A - Sensor Performance Report

Test Definitions

Test Order	TestField1	TestField2	TestField3	CalcField1	Calc Field2	Calc Field3	TestType	Factor1	Factor2	Factor3	Factor4
1							TimeTest Insert	0	0	0	0
2	Etmp2aDEGC						MinMax	-30	60	0	0
3	Etmx2aDEGC						MinMax	-30	60	0	0
4	Etmn2aDEGC						MinMax	-30	60	0	0
5	EtmpSD2aDEGC						MinMax	-30	60	0	0
10	Anem49aMS						MinMax	0	90	0	0
11	Anem49bMS						MinMax	0	90	0	0
12	Anem38aMS						MinMax	0	90	0	0
13	Anem38bMS						MinMax	0	90	0	0
14	Anem20aMS						MinMax	0	90	0	0
20	AnemSD49aMS						MinMax	0	4	0	0
21	AnemSD49bMS						MinMax	0	4	0	0
22	AnemSD38aMS						MinMax	0	4	0	0
23	AnemSD38bMS						MinMax	0	4	0	0
24	AnemSD20aMS						MinMax	0	4	0	0
30	Vane49aDEG						MinMax	0	359.9	0	0
31	Vane38aDEG						MinMax	0	359.9	0	0
32	Vane20aDEG						MinMax	0	359.9	0	0
50	Turb49zNONE						MinMax	0	2	0	0
51	Turb38zNONE						MinMax	0	2	0	0
52	Turb20zNONE						MinMax	0	2	0	0
60	Wshr0zNONE						MinMax	-100	100	0	0
200	VaneSD49aDEG	Anem49yMS					MinMaxT	0	100	100	10
201	VaneSD38aDEG	Anem38yMS					MinMaxT	0	100	100	10
202	VaneSD20aDEG	Anem20aMS					MinMax	0	100	100	10
300	Anem49aMS	AnemSD49aMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
301	Anem49bMS	AnemSD49bMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
302	Anem38aMS	AnemSD38aMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
303	Anem38bMS	AnemSD38bMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
304	Anem20aMS	AnemSD20aMS	Vane20aDEG	VaneSD20aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
400	Anem49aMS	Anem49bMS					CompareSensors	1	0.25	3	0
401	Anem38aMS	Anem38bMS					CompareSensors	1	0.25	3	0
500	Amax49aMS						MinMax	0	90	0	0
501	Amax49bMS						MinMax	0	90	0	0
502	Amax38aMS						MinMax	0	90	0	0
503	Amax38bMS						MinMax	0	90	0	0
504	Amax20aMS						MinMax	0	90	0	0

510	Amin49aMS					MinMax	0	90	0	0
511	Amin49bMS					MinMax	0	90	0	0
512	Amin38aMS					MinMax	0	90	0	0
513	Amin38bMS					MinMax	0	90	0	0
514	Amin20aMS					MinMax	0	90	0	0
520	Vmax49aDEG					MinMax	0	359.9	0	0
521	Vmax38aDEG					MinMax	0	359.9	0	0
522	Vmax20aDEG					MinMax	0	359.9	0	0
530	Vmin49aDEG					MinMax	0	359.9	0	0
531	Vmin38aDEG					MinMax	0	359.9	0	0
532	Vmin20aDEG					MinMax	0	359.9	0	0

Sensor Statistics

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Anem49aMS	52560	52476	99.84	0	107	21.833	98.369
AnemSD49aMS	52560	52476	99.84	0	107	7.5	98.533
Anem49bMS	52560	52476	99.84	0	113.5	3.333	98.506
AnemSD49bMS	52560	52476	99.84	0	113.5	2.833	98.512
Anem38aMS	52560	52476	99.84	0	106.667	0	98.623
AnemSD38aMS	52560	52476	99.84	0	106.667	0	98.623
Anem38bMS	52560	52476	99.84	0	96.333	4.167	98.693
AnemSD38bMS	52560	52476	99.84	0	96.333	1.833	98.72
Anem20aMS	52560	52476	99.84	0	95.5	17.333	98.552
AnemSD20aMS	52560	52476	99.84	0	95.5	1.833	98.729
Vane49aDEG	52560	52476	99.84	0	94.833	0	98.758
VaneSD49aDEG	52560	52476	99.84	0	94.833	0	98.758
Vane38aDEG	52560	52476	99.84	0	28.333	0	99.517
VaneSD38aDEG	52560	52476	99.84	0	28.333	0	99.517
Vane20aDEG	52560	52476	99.84	1.167	113.833	0	98.527
VaneSD20aDEG	52560	52476	99.84	1.333	113.833	0	98.525
Etmp2aDEGC	52560	52476	99.84	1	97	0	98.721
EtmpSD2aDEGC	52560	52476	99.84	1.167	97	0	98.72
Anem49yMS	52560	52476	99.84	2.333	28.333	0	99.49
AnemSD49yMS	52560	52476	99.84	3.167	28.333	0	99.481
Anem38yMS	52560	52476	99.84	0	0	0	99.84
AnemSD38yMS	52560	52476	99.84	0	0	0	99.84
Total	1156320	1154472	99.84	10.167	1762.667	60.667	98.889

APPENDIX B - Plot Data

Wind Speed Distribution Data

Bin Center Wind Speed [m/s]	Percent of Time [%]
0.5	1.43
1.5	3.62
2.5	9.07
3.5	16.91
4.5	22.83
5.5	20.07
6.5	11.42
7.5	6.71
8.5	3.96
9.5	2.05
10.5	1.00
11.5	0.47
12.5	0.22
13.5	0.10
14.5	0.04
15.5	0.03
16.5	0.03
17.5	0.02
18.5	0.01
19.5	0.00
20.5	0.00
21.5	0.00
22.5	0.00
23.5	0.00
24.5	0.00

Monthly Average Wind Speed Data

Date	10 min Mean [m/s]
Sept-06	4.55
Oct-06	5.49
Nov-06	4.59
Dec-06	5.16
Jan-07	5.27
Feb-07	5.43
Mar-07	5.84
Apr-07	5.40
May-07	4.86
June-07	4.94
July-07	4.38
Aug-07	4.34

Diurnal Average Wind Speed Data

Hour of Day	Average Wind Speed [m/s]
0.5	4.83
1.5	4.80
2.5	4.80
3.5	4.83
4.5	4.87
5.5	4.86
6.5	4.85
7.5	4.73
8.5	4.67
9.5	4.82
10.5	5.00
11.5	5.19
12.5	5.42
13.5	5.52
14.5	5.63
15.5	5.63
16.5	5.46
17.5	5.23
18.5	4.99
19.5	4.81
20.5	4.81
21.5	4.87
22.5	4.87
23.5	4.86

Wind Rose Data

Direction	Percent Time [%], 49 m	Mean Wind Speed [m/s], 49 m
N	6.02	4.47
NNE	5.49	5.54
NE	2.82	4.71
ENE	2.12	4.14
E	2.25	4.34
ESE	2.74	5.23
SE	2.78	4.75
SSE	3.46	4.28
S	7.76	4.28
SSW	16.73	5.10
SW	9.16	5.30
WSW	7.29	4.84
W	9.55	5.36
WNW	9.39	5.43
NW	7.01	5.30
NNW	5.42	4.61