APPENDIX 2DD

EVALUATION OF METEOROLOGICAL DATA USED IN COOLING TOWER PLUME ANALYSES

2DD.1 Purpose

The SACTI model requires hourly surface meteorological data in a format provided by the U.S.

National Climatic Data Center (NCDC) in Asheville, NC or in Nuclear Regulatory Commission (NRC) format for on-site data. The William States Lee III Nuclear Station (Lee Nuclear Station) (WLS) on-site meteorological database is preferred for this analysis but less than five years of site data is available. Therefore, data from the National Weather Service (NWS) station at Charlotte, NC was selected for the analysis. A 5-year database (i.e., 2001 - 2005) containing the parameters needed by the SACTI model was used. Seasonal mixing height values for Greensboro, NC, the nearest upper air observation location to the site, were also used in the SACTI model. The acceptability of the Charlotte, NC data as a reasonable representation of the conditions expected at the Lee Nuclear Station site is evaluated in this Appendix.

2DD.2 Data Evaluation

The weather station at the Charlotte-Douglas Airport (CLT) is located approximately 35 miles northeast of the site. The ground elevation of the CLT airport is approximately 740 feet above mean sea level (msl). The weather station at the Greenville-Spartanburg Airport (Greer, GSP) is located approximately 40 miles southwest of the site. The ground elevation of the GSP airport is approximately 940 feet above mean sea level (msl). The plant elevation is approximately 590 feet msl with the circular mechanical draft cooling towers being located at a grade elevation of approximately 610 feet msl and the top of the towers at 701 feet msl. The onsite meteorological tower (i.e., Tower 2) is located at a base elevation of approximately 611 feet msl with instrumentation levels of 644 ft msl and 808 ft msl. Because the CLT weather station is in reasonable proximity to the site and is located at fairly similar elevations above sea level, the data from CLT are judged to be representative of the site. The following comparison of CLT and Lee Nuclear Station meteorological data supports this conclusion.

Table 2DD-201 gives a comparison of the meteorological data for the CLT and GSP weather stations and the Lee Nuclear Station site data (all data is from December 2005 through November 2006). The data comparison shows that the annual average wind speeds are very similar among the locations, with Charlotte and Lee Nuclear Station annual average wind speeds very similar and slightly lower than Greer.

The annual average humidity data (i.e., relative humidity and dew point) compared in Table 2DD-201, as well as Figure 2DD-202 and Figure 2DD-203 indicates that the Lee Nuclear Station site has higher humidity than the other two locations and that Charlotte humidity is closer than Greer to Lee Nuclear Station humidity for the period. The dry bulb temperatures are compared between the CLT, Lee Nuclear Station and GSP in Table 2DD-201 and Figure 2DD-204. The annual average temperature values are very similar among all three sites, with Charlotte being almost equal to the Lee Nuclear Station annual average temperature.

The stability class frequencies for the CLT weather station, the GSP weather station and Lee Nuclear Station site are compared in Table 2DD-201 and Figure 2DD-201. Stability class is determined at the NWS sites by the STAR method, which uses wind speed, cloud cover, and ceiling height data in the calculation. The two NWS sites (i.e., Charlotte and Greer) have similar frequency distributions with fewer occurrences of the extreme unstable and stable classes (i.e., A and G stability class) for Greenville and more occurrences of neutral stability (i.e., D stability class). The Lee Nuclear Station stability classes, based on the vertical temperature difference (Delta-T) method, exhibit much more frequently occurring G stability class and stable classes (i.e., E, F, and G) in general with approximately 54 percent occurrence of the stable classes versus 44 percent for Charlotte and 44 percent for Greer. Therefore, the Lee Nuclear Station onsite stability class distribution would tend to produce lower plume rises. The differences between stability class frequencies between the NWS sites and the Lee Nuclear Station site is attributable to the location of the Lee Nuclear Station site in a shallow river valley, as well as the different methods used to determine the stability classes.

Figure 2DD-205, Sheets 1 through 3, shows the wind rose for each of the three sites, providing a comparison between the wind speed and wind direction frequencies. The wind roses indicate that the Lee Nuclear Station site has a much higher frequency of NW winds due to the local terrain than the other two locations, although there is a secondary maximum in the Charlotte data from the NW direction. Thus, in this respect, it is closer to the prevailing wind direction at Lee Nuclear Station. The Greer data show strong prevailing southwest and northeast winds. The Charlotte data is more from the S - SSW. Also note that at higher wind speeds, the similarity of the Lee Nuclear Station winds to the SW - S and NE - N regional wind pattern improves. This is demonstrated by a comparison of the Lee Nuclear Station wind rose with low wind speeds (< 5 mph) removed (Figure 2DD-206) with the CLT wind rose given in Figure 2DD-205, (page 2 of 3).

Based on the above comparisons, it is concluded that use of the five-year meteorological dataset from the Charlotte (2001-2005) NWS weather station is reasonably representative of the conditions expected at the Lee Nuclear Station site. The CLT data is similar to Lee Nuclear Station in wind speeds, the occurrence of NW winds, and humidity. Since five years of onsite data was not available for SACTI modeling, five years of data from Charlotte NWS was used instead. Sensitivity studies were performed to address the differences in SACTI results for the three data sets.

Plume Length and Height

The SACTI visible plume results for the Charlotte-Douglas (CLT), Greenville-Spartanburg (GSP), and Lee Nuclear Station onsite meteorological data are summarized in Tables 2DD-202, 2DD-203, and 2DD-204, respectively. Table 2DD-205 provides a comparison of the frequency of occurrence of visible plume dimensions for the three meteorological databases. These tables provide a range of frequency of occurrence of visible plume dimensions (i.e., length, width, and height) in meters from the towers for each season of the year and for the annual period.

On an annual average basis, 40 percent of the plumes reach 400 m downwind for all three meteorological databases. Twenty percent of the plumes reach a length of 4600 m using the CLT database, 5400m using the GSP database and 800m using the Lee Nuclear Station data. This is the only case in which the plume length based on GSP data exceeds the length using the CLT data. On an annual average basis, 40 percent of the plumes reach a maximum of 170 m in height for the CLT database (160 m for GSP and 100 m for Lee Nuclear Station). The visible plumes predicted with the Lee Nuclear Station database are noticeably lower in height compared to the NWS databases. This could be due to higher wind speeds calculated by SACTI at plume height, which cause the plumes to bend over further, or a result of the greater frequency of G stability class in the Lee Nuclear Station meteorological dataset. Comparison of the plume length and height shows that CLT gives a reasonably conservative estimate of the plume extent offsite.

The largest visible plumes shown in Tables 2DD-202, 2DD-203, and 2DD-204 reach a distance of 9,900 m downwind of the towers and a height of approximately 1,700 m and occur approximately 1 percent of the time. The longer plumes occur a little less frequently with the Lee Nuclear Station database compared to the NWS databases, with the approximately 8000-meter visible plumes occurring less than 20 percent of the time. Note that the longest visible plumes occur during conditions of high ambient relative humidity that are conducive to natural fog formation and poor visibility conditions. Under these conditions, the atmosphere is either already at or near saturation. Therefore, the largest plumes may not be discernable from the ambient fogging conditions and present less of an aesthetic impact.

The SACTI results for three different meteorological databases (i.e., CLT, GSP, and Lee Nuclear Station) indicate that the majority (i.e., >50 percent) of the visible plumes extend less than 1,000 m downwind and 200 m in height. It also shows that the longest and largest visible plumes occur in the winter with smaller plumes occurring in the spring and fall seasons due to the cold air in winter causing condensation of the moist plumes more readily than in the warmer seasons (i.e., cold air has a much smaller capacity of holding water vapor). The summer visible plumes are noticeably smaller since warmer ambient air results in less condensation of the moist plumes, due to its ability to maintain higher water vapor concentrations.

Plume Shadowing

Consistent with the visible plume frequency results, the most plume shadowing occurs in the winter season with lesser amounts in the spring and fall and the least amounts in the summer. Plume shadowing effects reach 1,000 m downwind less than 2 percent of the time with the farthest impact reaching approximately 4,600 m in the winter for approximately 0.5% of the time (i.e., CLT meteorological database). The farthest extent of the winter plume shadowing effects is smaller for the GSP and Lee Nuclear Station meteorological databases with distances of 2,600 m and 2,400 m, respectively.

On an annual average basis, plume shadowing effects reach 1,000 m downwind 1 percent of the time with the effects reaching 3,200 m 0.5 percent of the time using the CLT meteorological database. The annual average shadowing effects are less extensive for the GSP and Lee Nuclear Station meteorological databases with 1 percent distances of 600 m and 800 m and 0.5 percent distances of 1,200 m and 1,400 m, respectively.

Ground-level Fogging/Icing

The SACTI output for the CLT and GSP data shows that there are virtually no occurrences of ground level fogging. Plume fogging occurred almost entirely in the Spring with the CLT meteorological data, with periods of fogging ranging from 0.5 to 2 hours in the south sector and a maximum of 2 hours at 500 m. Other sectors impacted were SSW (200 m) and SW (300-700 m) with 0.1 hour to 1.0 hour of fogging. Using GSP meteorological data, fogging occurred only in the Spring and Winter with 1.0 to 2.0 hours in the Spring in the SW downwind sector over a range of 300-700 m and 0.5 to 1.0 hour in the Winter in two downwind sectors (i.e., NNE and ENE).

The SACTI results for the Lee Nuclear Station data indicate that the maximum number of hours of ground level fogging is 362 hours over the 2-year 2006-2007 meteorological database (i.e., 2% of the time) for all directions occurring at a downwind distance of 400 m. However, many of those fogging occurrences are within the property boundary (i.e., onsite) leaving a maximum of 82 hours per 2-year period (i.e., 0.5% of the time) at a downwind distance of 500 m. The SACTI output for the CLT, GSP and Lee Nuclear Station meteorological data indicate no occurrences of ground level icing.

Salt Deposition

The SACTI output for CLT, GSP, and Lee Nuclear Station was also reviewed to determine whether or not a CLT salt deposition analysis was valid. The CLT data was determined valid for use in the Lee Nuclear Station salt deposition assessment since it produced bounding results when compared to GSP and Lee Nuclear Station data. The maximum annual salt drift deposition amounts are over five times smaller for the GSP and Lee Nuclear Station meteorological database than for CLT, whereby the maximum annual concentrations amounts are 0.16 kg/km2/month (0.000016 mg/cm2/month) for both GSP and Lee Nuclear Station and 0.82 kg/km2/month (0.000082 mg/cm2/month) for CLT. Maximum seasonal and annual salt deposition impacts occurred at distances of 200-300m using CLT and GSP datasets, and 600-700m using the WLS onsite meteorological dataset. Impacts were larger with the CLT meteorological data, thus CLT is appropriate to use for design purposes.

2DD.3 Conclusion

Based on the above comparisons, it is concluded that use of the five-year meteorological dataset from the Charlotte (2001-2005) NWS weather station is reasonably representative of the conditions expected at the Lee Nuclear Station site. The comparison of the meteorological variables between CLT and Lee Nuclear Station datasets, as well as the resulting SACTI outputs, support the use of a 5-year dataset from CLT as input to the SACTI modeling for the Lee Nuclear Station site.

TABLE 2DD-201
Meteorological Data Comparison
(Dec 2005 to Nov 2006)

Parameter	Lee Onsite Data	Charlotte Data	Greer Data
Annual Average Wind Speed (m/s)	2.45	2.67	2.97
Annual Average Temperature (°C)	15.6	15.5	15.9
Annual Average Dew Point (°C)	9.6	8.4	7.8
Annual Average RH (%)	70.9	65.7	62.4
Stability Class Frequency			
A	7.90%	3.60%	4.10%
B	6.10%	9.80%	9.90%
C	7.20%	11.60%	12.10%
D	25.60%	30.90%	29.70%
E	21.70%	18.00%	17.40%
F	11.90%	18.10%	17.50%
G	19.60%	8.00%	9.30%

TABLE 2DD-202
Visible Plume Frequency of Occurrence by Season Using
2001-2005 Charlotte Meteorological Data (All wind directions)

Percent Frequency of Occurrence

	100%	**80%**	**60%**	**40%**	**20%**	**1%**
Winter:						
length (m)	100	200	400	900	5,100	9,900
height (m)	40	120	160	370	1,400	1,400
radius (m)	25	45	60	85	520	1,400
Spring:						
length (m)	100	200	250	300	4,800	9,900
height (m)	40	110	120	160	1,400	1,400
radius (m)	25	35	45	60	470	650
Summer:						
length (m)	100	150	200	250	600	9,800
height (m)	40	110	120	130	330	1,400
radius (m)	25	35	40	45	75	650
Fall:						
length (m)	100	200	250	400	4,700	9,900
height (m)	40	110	125	160	1,400	1,400
radius (m)	25	35	45	60	435	1,400
Annual:						
length (m)	100	200	250	400	4,600	9,900
height (m)	40	110	120	170	1,400	1,400
radius (m)	25	35	40	65	435	1,400

TABLE 2DD-203
Visible Plume Frequency of Occurrence by Season Using
2001-2005 Greenville-Spartanburg Meteorological Data (All wind directions)

	Percent Frequency of Occurrence					
	100%	**80%**	**60%**	**40%**	**20%**	**1%**
Winter:						
length (m)	<100	250	400	700	9,700	9,900
height (m)	<10	80	160	290	1,400	1,700
radius (m)	<5	35	60	80	560	710
Spring:						
length (m)	100	200	250	300	5,300	9,800
height (m)	30	75	85	120	1,400	1,700
radius (m)	20	30	35	55	390	710
Summer:						
length (m)	100	200	250	300	600	9,800
height (m)	40	75	85	90	240	1,600
radius (m)	25	27	30	35	75	710
Fall:						
length (m)	100	200	250	400	5,400	9,800
height (m)	40	80	85	160	1,400	1,600
radius (m)	25	30	35	60	475	710
Annual:						
length (m)	100	200	250	400	5,400	9,800
height (m)	40	80	85	160	1,400	1,600
radius (m)	25	30	35	60	475	710

TABLE 2DD-204
Visible Plume Frequency of Occurrence by Season Using
2006-2007 Lee Onsite Meteorological Data (All wind directions)

Percent Frequency of Occurrence

	100%	**80%**	**60%**	**40%**	**20%**	**1%**
Winter:						
length (m)	100	300	400	500	8,000	9,900
height (m)	10	80	100	120	960	1,400
radius (m)	5	35	50	60	330	640
Spring:						
length (m)	100	200	250	300	450	9,900
height (m)	10	40	70	90	120	1,400
radius (m)	5	25	30	45	60	640
Summer:						
length (m)	100	150	250	300	500	9,900
height (m)	10	40	70	90	120	1,400
radius (m)	5	20	30	35	60	640
Fall:						
length (m)	100	200	300	400	700	9,900
height (m)	10	50	80	100	190	1,400
radius (m)	5	25	35	50	70	640
Annual:						
length (m)	100	200	300	400	800	9,900
height (m)	10	50	80	100	210	1,400
radius (m)	5	25	35	50	75	640

TABLE 2DD-205
Visible Plume Frequency of Occurrence by Season
Comparison of Meteorological Databases (All wind directions)
Percent Frequency of Occurrence

		100%	**80%**	**60%**	**40%**	**20%**	**1%**
Winter:							
length (m)	CLT	100	200	400	900	5,100	9,900
	GSP	<100	250	400	700	9,700	9,900
	WLS	100	300	400	500	8,000	9,900
height (m)	CLT	40	120	160	370	1,400	1,400
	GSP	<10	80	160	290	1,400	1,700
	WLS	10	80	100	120	960	1,400
radius (m)	CLT	25	45	60	85	520	1,400
	GSP	<5	35	60	80	560	710
	WLS	5	35	50	60	330	640
Spring:							
length (m)	CLT	100	200	250	300	4,800	9,900
	GSP	100	200	250	300	5,300	9,800
	WLS	100	200	250	300	450	9,900
height (m)	CLT	40	110	120	160	1,400	1,400
	GSP	30	75	85	120	1,400	1,700
	WLS	10	40	70	90	120	1,400
radius (m)	CLT	25	35	45	60	470	650
	GSP	20	30	35	55	390	710
	WLS	5	25	30	45	60	640
Summer:							
length (m)	CLT	100	150	200	250	600	9,800
	GSP	100	200	250	300	600	9,800
	WLS	100	150	250	300	500	9,900
height (m)	CLT	40	110	120	130	330	1,400
	GSP	40	75	85	90	240	1,600
	WLS	10	40	70	90	120	1,400
radius (m)	CLT	25	35	40	45	75	650
	GSP	25	27	30	35	75	710
	WLS	5	20	30	35	60	640
Fall:							
length (m)	CLT	100	200	250	400	4,700	9,900
	GSP	100	200	250	400	5,400	9,800
	WLS	100	200	300	400	700	9,900
height (m)	CLT	40	110	125	160	1,400	1,400
	GSP	40	80	85	160	1,400	1,600
	WLS	10	50	80	100	190	1,400
radius (m)	CLT	25	35	45	60	435	1,400
	GSP	25	30	35	60	475	710
	WLS	5	25	35	50	70	640
Annual:							
length (m)	CLT	100	200	250	400	4,600	9,900
	GSP	100	200	250	400	5,400	9,800
	WLS	100	200	300	400	800	9,900
height (m)	CLT	40	110	120	170	1,400	1,400
	GSP	40	80	85	160	1,400	1,600
	WLS	10	50	80	100	210	1,400
radius (m)	CLT	25	35	40	65	435	1,400
	GSP	25	30	35	60	475	710
	WLS	5	25	35	50	75	640

Figure 2DD-201
Stability Class Comparison
(Dec 2005 to Nov 2006)

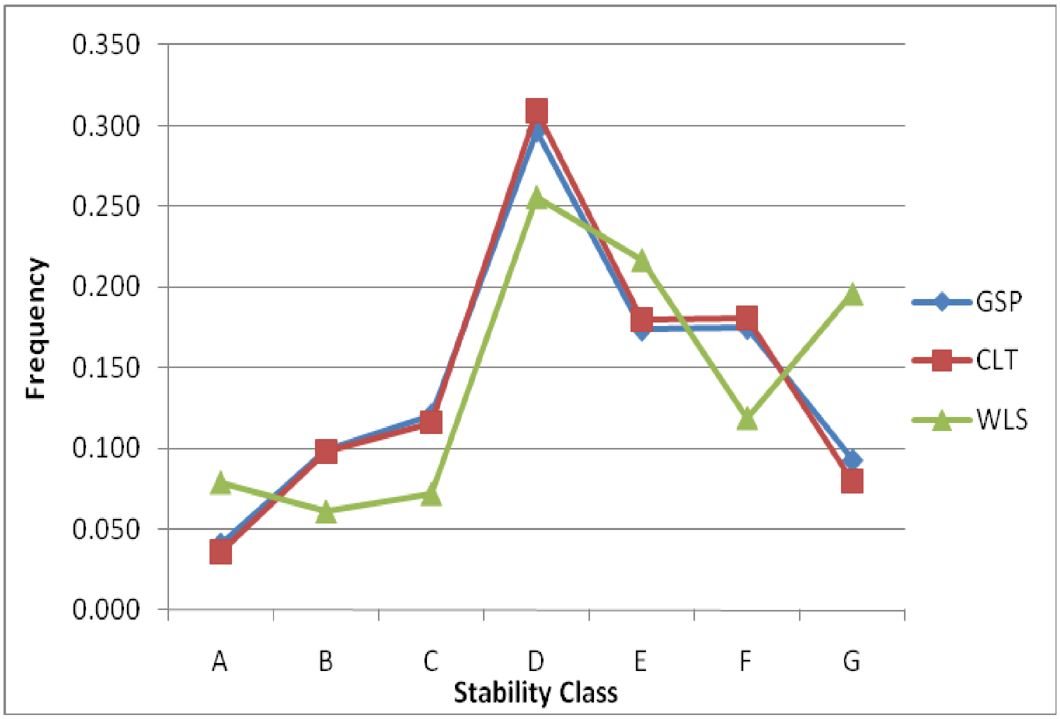

Figure 2DD-202
Relative Humidity Comparison
(Dec 2005 to Nov 2006)

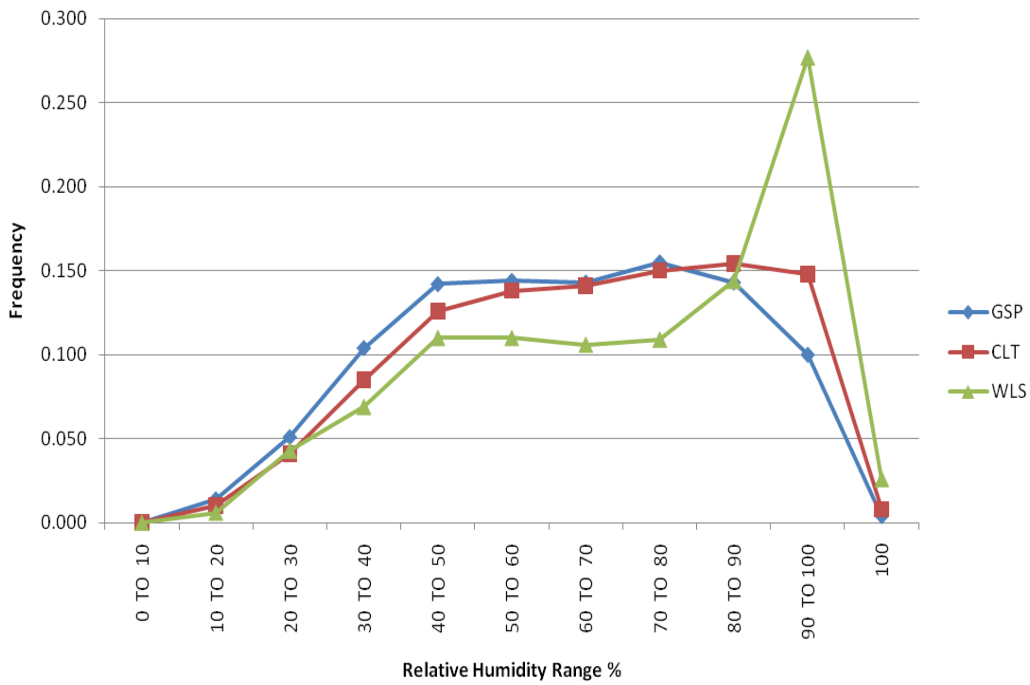

Figure 2DD-203
Dew Point Comparison
(Dec 2005 to Nov 2006)

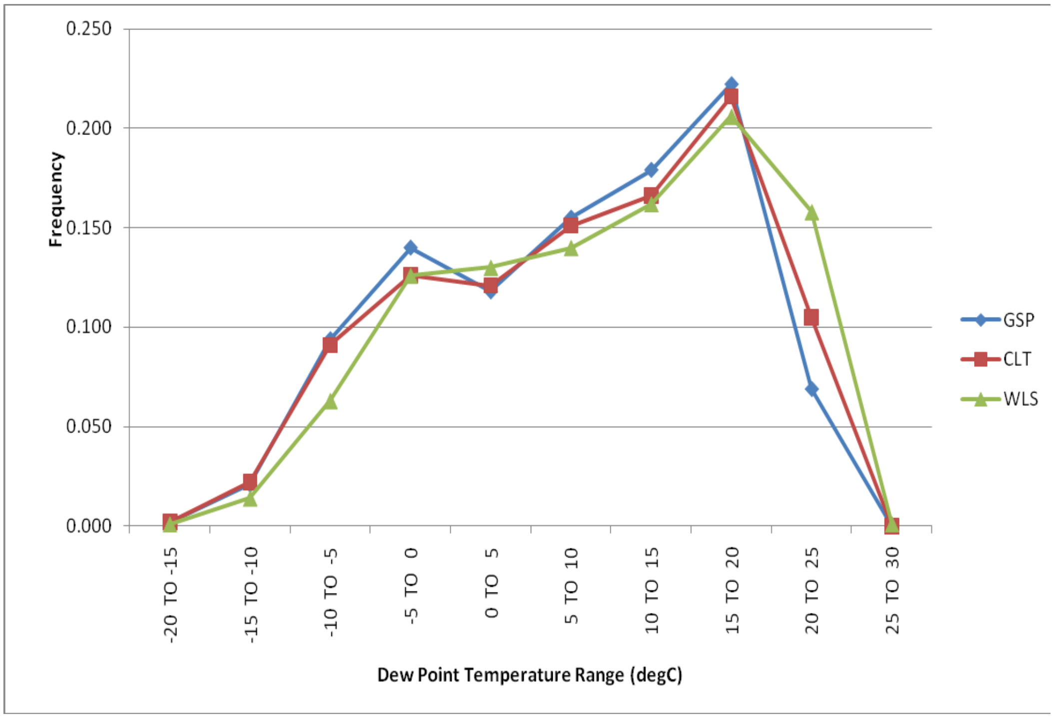

Figure 2DD-204
Dry Bulb Temperature Comparison
(Dec 2005 to Nov 2006)

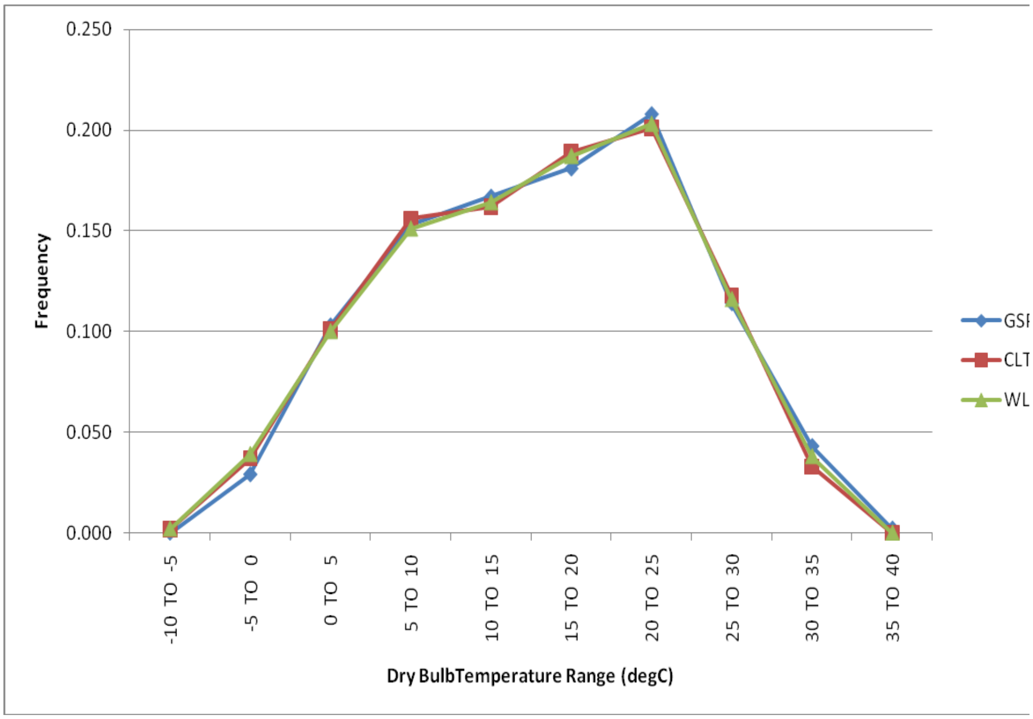

Figure 2DD-205
(page 1 of 3)
Wind Direction Frequency
WLS Data (Dec 2005 to Nov 2007)

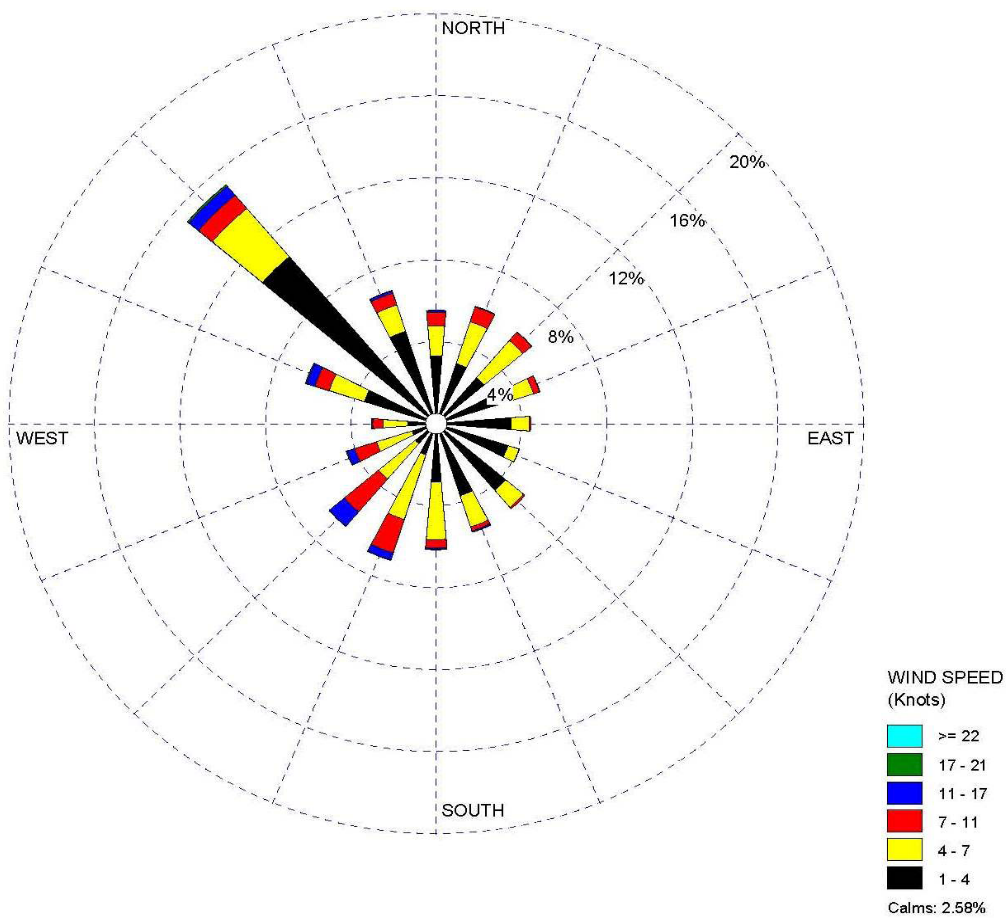

Figure 2DD-205
(page 2 of 3)
Wind Direction Frequency
CLT Data (Dec 2005 to Nov 2006)

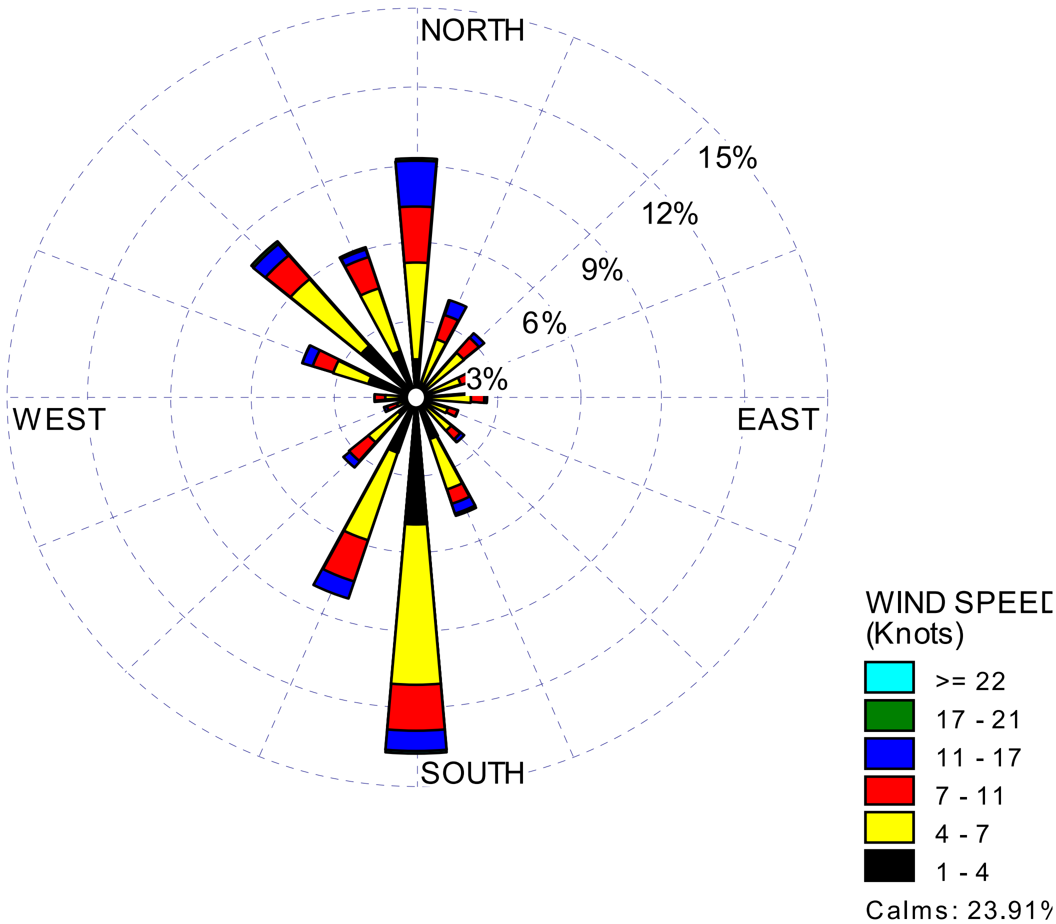

Figure 2DD-205
(page 3 of 3)
Wind Direction Frequency
GSP Data (Dec 2005 to Nov 2006)

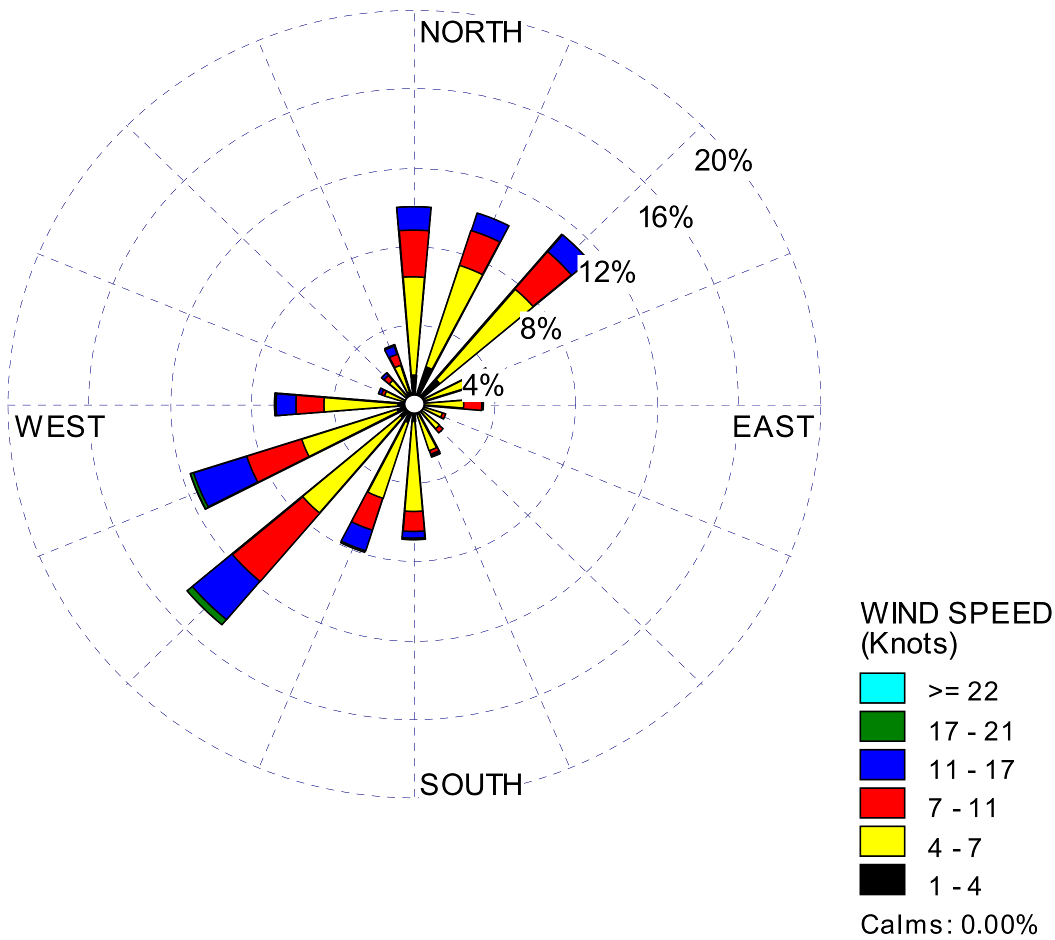

Figure 2DD-206
Wind Direction Frequency
WLS Data (Dec 2005 to Nov 2007)
[with low windspeeds (<5 mph or <4.3 knots) removed]