

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 586 feet msl and the top of the towers at 671 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 400-500 m downwind for all three meteorological databases. Twenty percent of the plumes reach a length of 4900 m using the CLT database, 6400m using the GSP database and 1100m 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 230 m in height for the CLT database (190 m for GSP and 130 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 5200-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 do not exceed 1,000 m downwind and 300 m in height. 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 800 m downwind less than 2 percent of the time with the farthest impact reaching approximately 6000 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 3,800 m and 3,600 m, respectively.

On an annual average basis, plume shadowing effects reach 1,200 m downwind 1 percent of the time with the effects reaching 4,000 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 800 m and 800 m and 0.5 percent distances of 1,800 m and 2,000 m, respectively.

Ground-level Fogging/Icing

The SACTI output for the CLT, GSP and Lee Nuclear Station data shows that there are no occurrences of ground-level or plume fogging. 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 two times smaller for the GSP and Lee Nuclear Station meteorological database than for CLT, whereby the maximum annual concentrations amounts are 0.18 kg/km²/month (0.000018 mg/cm²/month) for GSP and 0.26 kg/km²/month (0.000026 mg/cm²/month) for the Lee Nuclear Station and 0.71 kg/km²/month (0.000071 mg/cm²/month) for CLT. Maximum seasonal and annual salt deposition impacts occurred at distances of 200m using CLT, 400m GSP dataset, and 500m using the WLS onsite meteorological dataset. Impacts were larger with the CLT meteorological data, thus CLT is appropriate to use for design purposes.

Water Deposition

The highest water deposition rate from among the three meteorological databases is 960 kg/km²/month in the fall for the Lee Nuclear Station data. This amount of water is the rainfall equivalent of 0.00004 inches per month based on the density of water (i.e., 1,000 kg/m³), which is a trivial amount compared to the normal monthly precipitation at Charlotte of 3 to 4 inches. The NWS considers

precipitation of less than 0.01 inches as a trace amount. While Lee Nuclear Station meteorological data results in a slightly higher water deposition rate than Charlotte (740 kg/km²/month) the total rainfall equivalents from both datasets are still insignificant.

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	300	500	3,300	5,900	9,900	
height (m)	60	160	200	1,200	1,400	1,600	
radius (m)	30	50	65	320	540	1,200	
Spring:							
length (m)	100	200	300	500	5,100	9,900	
height (m)	60	150	170	200	1,400	1,600	
radius (m)	30	45	50	65	470	900	
Summer:							
length (m)	100	200	250	300	700	9,800	
height (m)	60	150	170	190	350	1,600	
radius (m)	30	40	45	50	85	880	
Fall:							
length (m)	100	250	300	500	4,900	9,900	
height (m)	60	150	170	220	1,400	1,600	
radius (m)	30	45	50	70	420	1,200	
Annual:							
length (m)	100	200	300	500	4,900	9,900	
height (m)	60	150	180	230	1,400	1,600	
radius (m)	30	45	50	70	435	1,200	

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	300	500	900	9,600	9,900	
height (m)	<10	120	190	340	1,400	1,700	
radius (m)	<5	45	60	85	570	870	
Spring:							
length (m)	100	200	300	500	5,600	9,900	
height (m)	40	100	120	170	1,400	1,700	
radius (m)	25	35	40	55	420	870	
Summer:							
length (m)	100	200	250	300	700	9,900	
height (m)	60	100	110	130	250	1,700	
radius (m)	25	35	40	45	75	870	
Fall:							
length (m)	100	200	300	500	6,400	9,900	
height (m)	40	100	120	190	1,400	1,700	
radius (m)	25	35	40	60	475	870	
Annual:							
length (m)	100	200	300	500	6,400	9,900	
height (m)	40	100	120	190	1,400	1,700	
radius (m)	25	35	40	60	475	870	

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	250	300	800	5,200	9,900	
height (m)	40	100	120	230	980	1,500	
radius (m)	25	45	50	70	425	800	
Spring:							
length (m)	100	200	250	300	700	9,800	
height (m)	20	90	100	110	230	1,500	
radius (m)	20	30	40	45	70	790	
Summer:							
length (m)	100	200	250	300	500	9,800	
height (m)	20	90	100	110	160	1,500	
radius (m)	20	30	35	45	55	790	
Fall:							
length (m)	100	200	250	300	1,000	9,800	
height (m)	20	90	100	120	320	1,500	
radius (m)	20	35	45	50	80	790	
Annual:							
length (m)	100	200	300	400	1,100	9,900	
height (m)	20	90	100	130	350	1,500	
radius (m)	20	35	45	50	85	790	

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	300	500	3,300	5,900	9,900
	GSP	<100	300	500	900	9,600	9,900
	WLS	100	250	300	800	5,200	9,900
height (m)	CLT	60	160	200	1,200	1,400	1,600
	GSP	<10	120	190	340	1,400	1,700
	WLS	40	100	120	230	980	1,500
radius (m)	CLT	30	50	65	320	540	1,200
	GSP	<5	45	60	85	570	870
	WLS	25	45	50	70	425	800
Spring:							
length (m)	CLT	100	200	300	500	5,100	9,900
	GSP	100	200	300	500	5,600	9,900
	WLS	100	200	250	300	700	9,800
height (m)	CLT	60	150	170	200	1,400	1,600
	GSP	40	100	120	170	1,400	1,700
	WLS	20	90	100	110	230	1,500
radius (m)	CLT	30	45	50	65	470	900
	GSP	25	35	40	55	420	870
	WLS	20	30	40	45	70	800
Summer:							
length (m)	CLT	100	200	250	300	700	9,800
	GSP	100	200	250	300	700	9,900
	WLS	100	200	250	300	500	9,800
height (m)	CLT	60	150	170	190	350	1,600
	GSP	60	100	110	130	250	1,700
	WLS	20	90	100	110	160	1,500
radius (m)	CLT	30	40	45	50	85	880
	GSP	25	35	40	45	75	870
	WLS	20	30	35	45	55	790
Fall:							
length (m)	CLT	100	250	300	500	4,900	9,900
	GSP	100	200	300	500	6,400	9,900
	WLS	100	200	250	300	1,000	9,800
height (m)	CLT	60	150	170	220	1,400	1,600
	GSP	40	100	120	190	1,400	1,700
	WLS	20	90	100	120	320	1,500
radius (m)	CLT	30	45	50	70	420	1,200
	GSP	25	35	40	60	475	870
	WLS	20	35	45	50	80	790
Annual:							
length (m)	CLT	100	200	300	500	4,900	9,900
	GSP	100	200	300	500	6,400	9,900
	WLS	100	200	300	400	1,100	9,900
height (m)	CLT	60	150	180	230	1,400	1,600
	GSP	40	100	120	190	1,400	1,700
	WLS	20	90	100	130	350	1,500
radius (m)	CLT	30	45	50	70	435	1,200
	GSP	25	35	40	60	475	870
	WLS	20	35	45	50	85	790

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

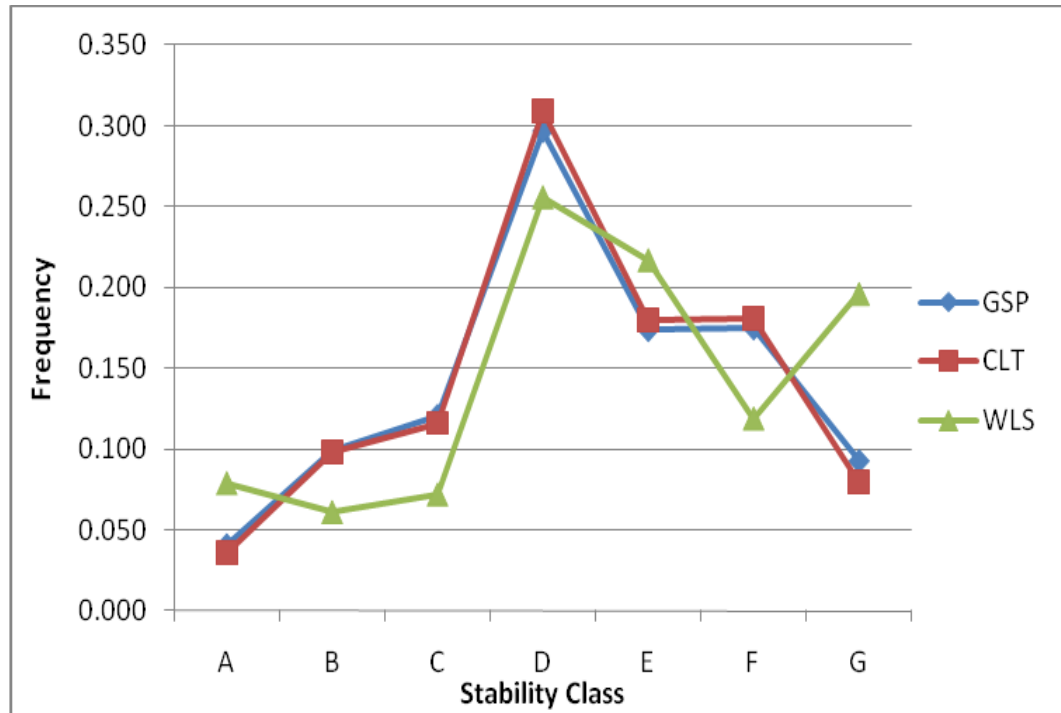


Figure 2DD-202
Relative Humidity Comparison
(Dec 2005 to Nov 2006)

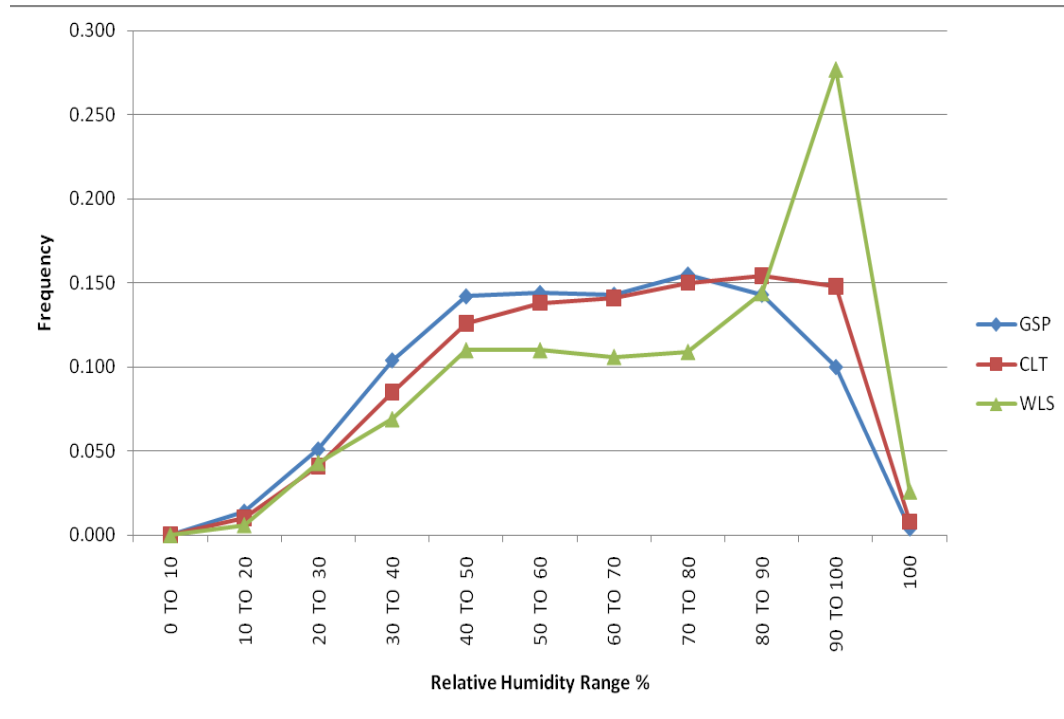


Figure 2DD-203
Dew Point Comparison
(Dec 2005 to Nov 2006)

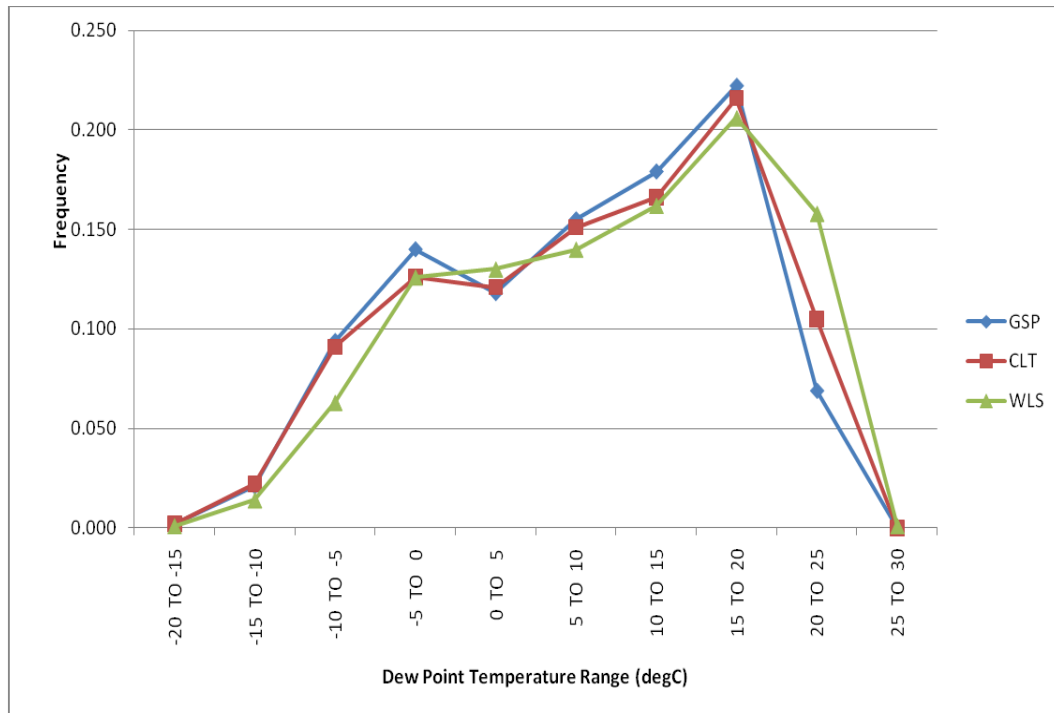


Figure 2DD-204
Dry Bulb Temperature Comparison
(Dec 2005 to Nov 2006)

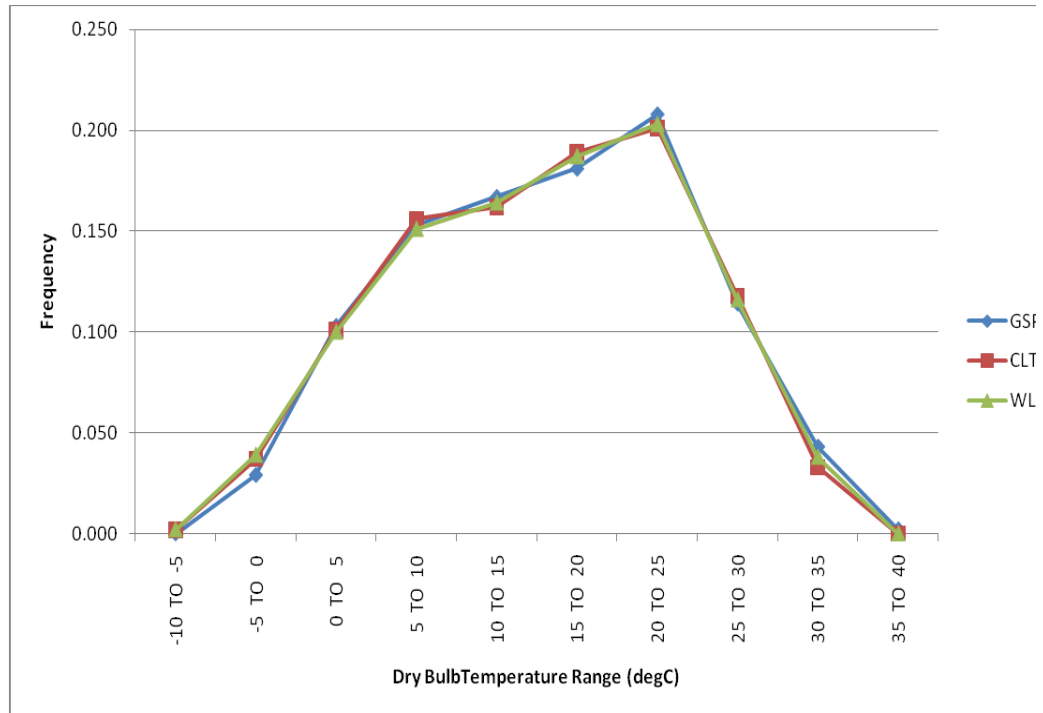


Figure 2DD-205
 (page 1 of 3)
 Wind Direction Frequency
 WLS Data (Dec 2005 to Nov 2007)

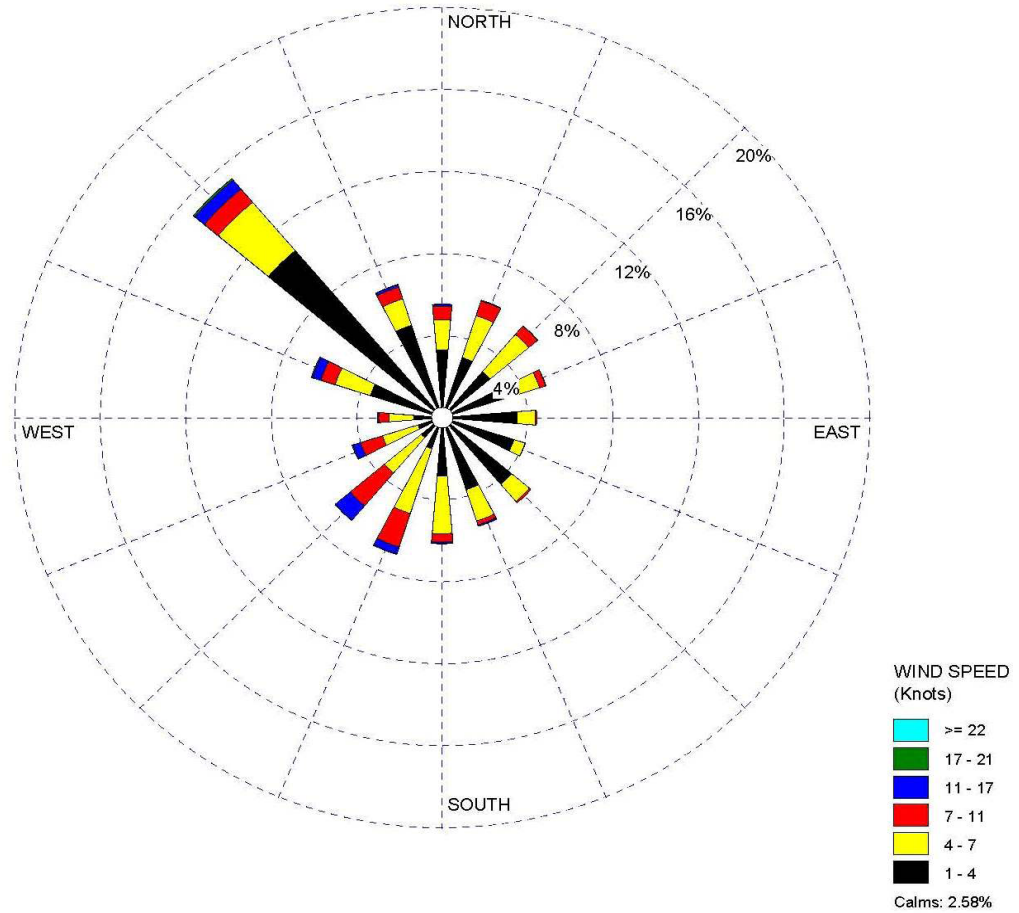


Figure 2DD-205
 (page 2 of 3)
 Wind Direction Frequency
 CLT Data (Dec 2005 to Nov 2006)

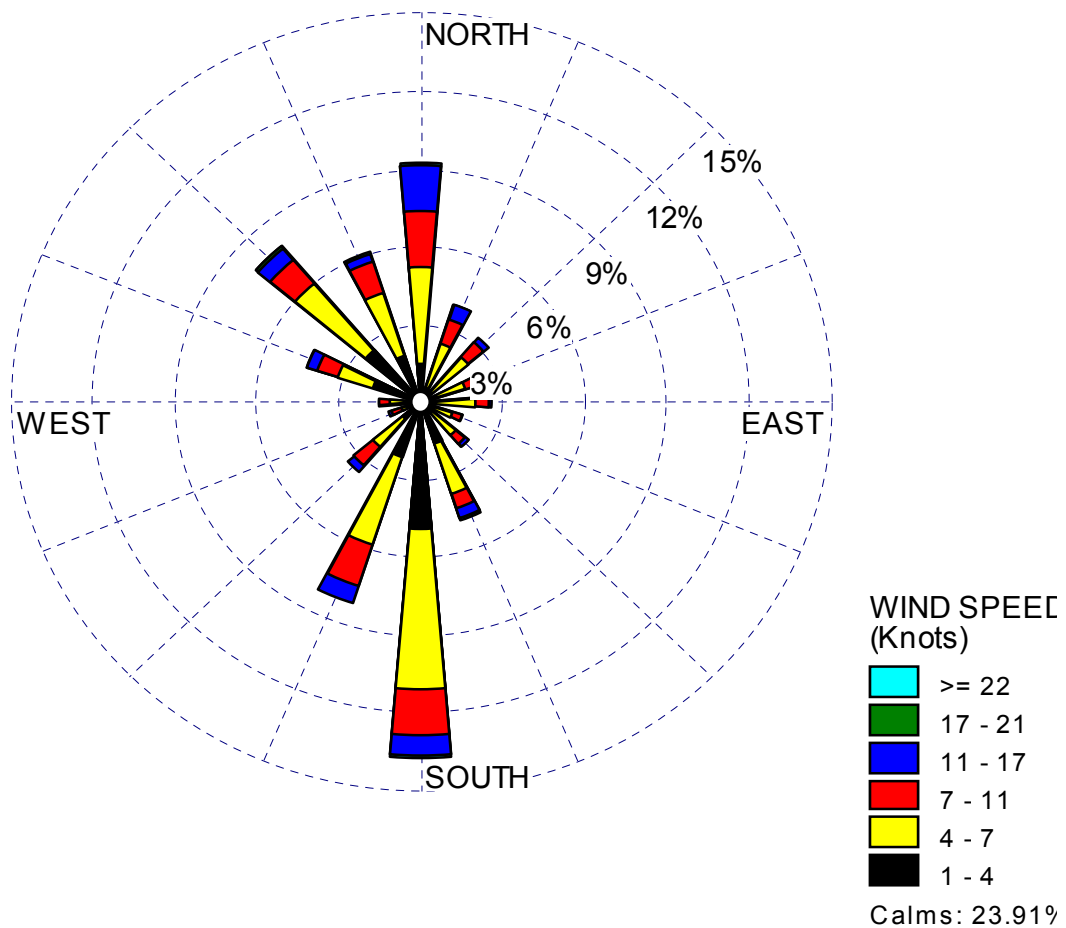


Figure 2DD-205
 (page 3 of 3)
 Wind Direction Frequency
 GSP Data (Dec 2005 to Nov 2006)

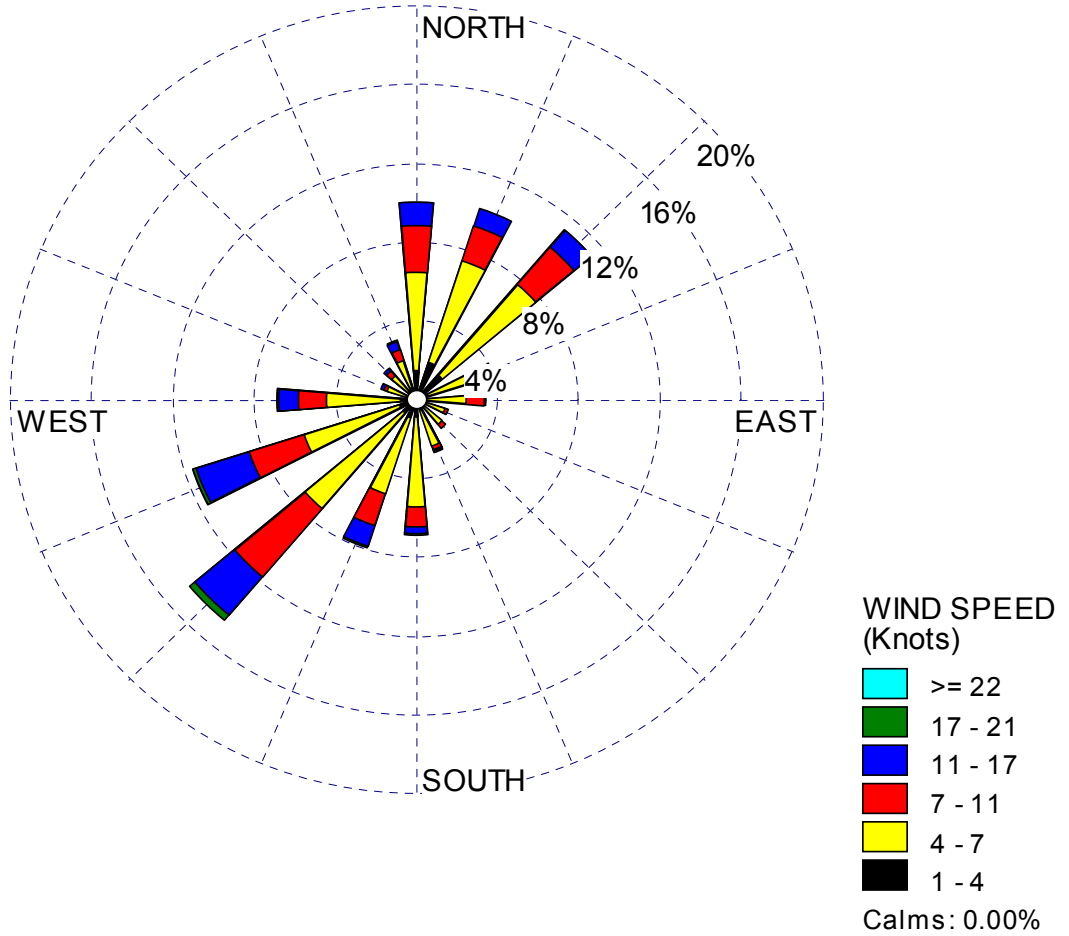


Figure 2DD-206
 Wind Direction Frequency
 WLS Data (Dec 2005 to Nov 2007)
 [with low windspeeds (<5 mph or <4.3 knots) removed]

