ENGINEERING WEATHER DATA

INTRODUCTION

Background. The data in this handbook were compiled by the Air Force Combat Climatology Center (AFCCC) at the request of the Air Force Civil Engineer Support Agency (HQ AFCESA). Sites were identified by AFCESA, US Army Corps of Engineers (USACE), and the Naval Facilities Engineering Command (NAVFACENGCOM). Final site selection was based upon availability of climatological data. Most sites are located at military installations supporting airfield operations or at local airports/airfields.

Forward questions regarding operation of this CD-ROM or any problems identified to the following address:

National Climatic Data Center
Climate Services Division
Veach-Baley Federal Building
151 Patton Ave, Rm 120
Asheville NC 28801-5001
Phone: (828) 271-4702
email: orders@ncdc.noaa.gov

Department of Defense agencies and DoD contractors should contact the following:

AFCCC/DOO
151 Patton Avenue, Rm 120
Asheville NC 28801-5002
Phone: (828) 271-4291
email: doo@afccc.af.mil

The information in Engineering Weather Data (EWD) is organized by location. The data for each location is contained in an 18-page Adobe PDF document. The following sections describe each of the products contained in EWD. The page number refers to its location in the document.

CLIMATE SUMMARY (page 1)

Location Information. This section contains a summary table which includes site name, location, elevation (above mean sea level), World Meteorological Organization (WMO) number, period of record (POR), and average (atmospheric) pressure not corrected to sea level (higher elevations result in lower pressures). The WMO number is a unique number assigned to every location in the world that takes and transmits regular weather observations. The POR is the time frame over which the data used to compute the statistics in this handbook was compiled.

Design Values. Design values are provided for dry-bulb temperature, wet-bulb temperature, and humidity ratio at specific percentile frequencies of occurrence. The old EWD summer design values of 1, 2.5, and 5 percent were based on the warmest four months of the year. In the United States this was standardized as June through September. The new design values of 0.4, 1, and 2 percent are based on the entire year. The old winter design values of 99 and 97.5 percent were based on the three coldest months of the year (December through February). The new winter design values of 97.5, 99.6 and 99 percent are based on the entire year. In other words, the new design values are **annual** values not **seasonal** values.

In general, for mid-latitude locations with continental climates (hot summer – cold winter), there are some *generalizations* that can be made about the differences between the old and new values. The new 0.4% annual value is comparable to the old 1% seasonal value. The new 1% annual value is usually about a degree cooler than the old 2.5% seasonal value. The new 2% annual value is similar to the old 5% seasonal value. The new 99.6% and 99% annual values are generally cooler than the old 99% and 97.5% seasonal values; however, there is more variability between stations.

The new design values were instituted for several reasons. At some locations, the warmest or coldest months of the year do not fall into the months listed above. It is easier to compare locations that are in tropical or marine climates where there is less seasonal variability. It is also more straightforward to compare Southern Hemisphere locations. Finally, this is the same convention used by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) in their 1997 Handbook of Fundamentals.

Dry-bulb Temperature:

Median of Extreme Highs (or Lows). The dry-bulb temperature extreme high (or low) is determined for each calendar year of the POR along with the coincident values for wet-bulb temperature, humidity ratio, wind speed, and prevailing wind direction. Median values are determined from the distribution of extreme highs (or lows).

0.4%, 1.0%, 2.0%, 97.5%, 99.0%, and 99.6% Occurrence Design Values. Listed is the dry-bulb temperature corresponding to a given annual cumulative frequency of occurrence and its respective mean coincident values for wet-bulb temperature, humidity ratio, wind speed, and prevailing wind direction. This represents the dry-bulb threshold which exceeded its respective percent of time, taking into account the entire POR. For example, the 1.0% occurrence design value temperature has been exceeded only 1% of the time during the entire POR. All the observations occurring within one degree of the design value are grouped, and the coincident mean values for wet-bulb temperature, humidity ratio, and wind speed are calculated. The prevailing wind direction (the 'mode' of the wind direction distribution) is also calculated.

Mean Daily Range. The mean daily range (difference between daily maximum and daily minimum temperatures) is the average of all daily dry-bulb temperature ranges for the POR.

Wet-Bulb Temperature:

Median of Extreme Highs for wet-bulb temperature is the highest annual extreme wet-bulb temperature averaged over the POR. The corresponding mean coincident values are determined the same way as for dry-bulb temperature. **0.4%, 1.0 %, 2.0%** occurrence wet-bulb temperature design values and the corresponding mean coincident values for dry-bulb temperature are determined the same way as for dry-bulb temperature.

Humidity Ratio:

Median of Extreme Highs for humidity ratio is the highest annual extreme averaged over the POR. The corresponding mean coincident values are determined the same way as for dry-bulb temperature.

Design values are provided for "Humidity Ratio" at the **0.4%, 1.0%, and 2.0%** occurrence and the corresponding mean coincident values for dry-bulb temperature, vapor pressure, wind speed, and wind prevailing direction.

Air Conditioning/Humid Area Criteria:
These are the number of hours, on average, that dry-bulb temperatures of 93 ºF (34 ºC) and 80 ºF (27 ºC) and wet-bulb temperatures of 73 ºF (23 ºC) and 67 ºF (19 ºC) are equaled or exceeded during the year.

Other Site Data:
This information is provided *for general reference only, and should NOT be used as the basis fordesign.* There are some locations for which this data is not available. In these cases, that portion of the table will be left blank.

Weather Region. There are eleven weather regions developed by the Department of Energy. The regions are defined by the range of cooling-degree and heating-degree days.

Ventilation Cooling Load Index. The VCLI is a two-part index which defines the total annual cooling load for ventilation air by calculating sensible heat load separately from the latent heat load (moisture). The results are expressed in ton-hours per cubic feet per minute per year of latent and sensible load. Values for sensible heat load are calculated by comparing the outdoor temperature to indoor conditions (75 ºF and 60% relative humidity [RH]), and calculating how much energy is required to bring the outdoor air to the indoor temperature. The latent load is calculated similarly. Separate calculations are made for each hour of the year, and them summed to form the annual VCLI (Harriman 1997).

Average Annual Freeze-Thaw Cycles. This is simply the average number of times per year that the air temperature first drops below freezing and then rises above freezing, regardless of the duration of either the freezing or thawing. The number of cycles is summed per year, and averaged over the entire POR. Days with high temperatures or low temperatures at 32 °F (0 ºC) are not counted for a freeze-thaw cycle. A cycle is counted only when the temperature drops below freezing (31 °F [-0.5 ºC] or colder) or goes above freezing (33 °F [0.5 ºC] or warmer).

Other Values. The following are derived from sources other than the AFCCC. Engineers and architects should contact the organizations listed below for current values, including background information and complete guidelines for use of these data elements.

Groundwater:
The National Groundwater Educational Foundation, 601 Dempsey Road, Westerville OH 43081-8978
Phone: (800) 551-7379

Note: Average groundwater temperature parallels long-term average air temperature, because soil at a depth of 50 feet (15 meters) does not undergo significant temperature change over the course of a year. Soil temperature at 50 feet stays slightly warmer than average annual air temperature by about 2.5 degrees Fahrenheit (1.4 degrees Celsius).

Rain Rate:
International Plumbing Code, BOCA International, 4051 West Flossmoor Road, Country Club Hills IL 60478, Phone: (708) 799-2300

Frost Depth, Basic Wind Speed, Ground Snow Loads:

ANSI/ASCE 7-95
American Society of Civil Engineers
1015 15th Street NW, Suite 600
Washington DC 20005
(800) 548-2723

Note: Frost depth penetration data was obtained from TI 809-01, Load Assumptions for Buildings (1986) which is published by the Army Corps of Engineers. Wind and snow load data are provided by the American Society of Civil Engineers (1995); where snow load data was not available from ASCE, TI-809-01 (1986) was used. However, since the completion of this project, a new version of TI-809-01 has also been completed. Many of the new snow loads have changed. Current values can be obtained at http://www.hnd.usace.army.mil/techinfo/ti/809-01.pdf.

Suggestions for Use. The dry bulb, wet bulb, and humidity ratio values shown are peak load conditions and are used for sizing mechanical equipment. Design guidance determines the level of occurrence applied.

The 0.4% Dry Bulb Temperature value is seldom used for sizing conventional comfort control systems, but is sometimes appropriate for mission-critical systems where equipment failure due to high heat would be unacceptable. Using the 0.4% value for equipment sizing requires that the engineer consider its operation at less-than-peak design conditions. In the past, oversized cooling equipment has been incapable of modulating during the more common range of operating conditions, yielding comfort control problems. Also, over-sized equipment cycles on and off more frequently, increasing maintenance costs and failing to remove enough moisture to maintain humidity control.

Similar cautionary notes apply to the extreme low dry bulb temperature. Heating equipment designed for extreme conditions must be carefully evaluated to ensure that they will modulate properly to maintain comfort at less extreme outdoor temperatures that occur 99.6% of the hours during the year.

The mean coincident value for humidity at the 0.4% peak dry bulb temperature is not the highest moisture value, and must not be used for design of humidity control systems. The mean coincident value is the arithmetic average of all the moisture levels which occur when the dry bulb temperature is high. However, the highest moisture values typically occur when the dry bulb temperatures are lower.

High wet bulb temperature is used for sizing cooling towers and other evaporative equipment.

Peak humidity ratio is used for sizing dehumidification systems. Peak moisture conditions usually represent a higher enthalpy (total heat) than peak dry bulb conditions. Consequently, engineers use the peak moisture condition to cross-check operation of a system which may be primarily intended to control temperature.

Coincident wind speed allows the engineer to accurately estimate latent loads due to infiltration of humid air in the summer and infiltration of dry air during the winter.

Cautionary Note: The same precautions that apply to heating and cooling equipment also apply to dehumidification and humidification systems. Oversized equipment may not control properly under typical operating conditions without special attention from the engineer.

Figure 1. Sample Data Set Page 1

SCOTT AFB/BELLEVILLE IL	
Latitude = 38.55 N	WMO No. 724338
Longitude = 89.85 W	Elevation = 453 feet
Period of Record = 1967 to 1996	Average Pressure = 29.52 inches Hg

Design Criteria Data

		Mean Coincident (Average) Values			
Dry Bulb Temperature (T)	**Design Value (^oF)**	Wet Bulb Temperature (^oF)	Humidity Ratio (gr/lb)	Wind Speed (mph)	Prevailing Direction (NSEW)
Median of Extreme Highs	99	78	110	7.3	SSW
0.4% Occurrence	95	78	117	7.6	S
1.0% Occurrence	92	76	115	7.7	S
2.0% Occurrence	90	75	111	7.6	S
Mean Daily Range	19	-	-	-	-
97.5% Occurrence	16	14	8	7.6	NW
99.0% Occurrence	9	8	6	7.6	NW
99.6% Occurrence	3	2	4	7.5	NNW
Median of Extreme Lows	-3	-4	3	7.0	NW

		Mean Coincident (Average) Values			
Wet Bulb Temperature (T_{wb})	**Design Value (^oF)**	Dry Bulb Temperature (^oF)	Humidity Ratio (gr/lb)	Wind Speed (mph)	Prevailing Direction (NSEW)
Median of Extreme Highs	82	92	146	6.8	S
0.4% Occurrence	80	91	136	6.6	S
1.0% Occurrence	78	88	128	6.6	S
2.0% Occurrence	77	87	125	6.4	S

		Mean Coincident (Average) Values			
Humidity Ratio (HR)	**Design Value (gr/lb)**	Dry Bulb Temperature (^oF)	Vapor Pressure (in. Hg)	Wind Speed (mph)	Prevailing Direction (NSEW)
Median of Extreme Highs	153	89	1.00	6.0	S
0.4% Occurrence	142	87	0.94	5.2	S
1.0% Occurrence	134	85	0.88	5.8	S
2.0% Occurrence	129	84	0.85	5.2	S

Air Conditioning/ Humid Area Criteria		$T \geq 93^oF$	$T \geq 80^oF$	$T_{wb} \geq 73^oF$	$T_{wb} \geq 67^oF$
	# of Hours	84	1033	773	1897

Other Site Data

Weather Region	Rain Rate 100 Year Recurrence (in./hr)	Basic Wind Speed 3 sec gust @ 33 ft 50 Year Recurrence (mph)	Ventilation Cooling Load Index (Ton-hr/cfm/yr) Base 75^oF-RH 60% Latent + Sensible
7	3.3	90	2.7 + 1.1
Ground Water Temperature (^oF) 50 Foot Depth *	**Frost Depth 50 Year Recurrence (in.)**	**Ground Snow Load 50 Year Recurrence (lb/ft^2)**	**Average Annual Freeze-Thaw Cycles (#)**
57.9	38	15	53

*Note: Temperatures at greater depths can be estimated by adding 1.5^oF per 100 feet additional depth.

Average Annual Climate (page 2)

Explanation of Graph. The graph shows the monthly mean temperature, dewpoint, and precipitation. The bar graph representing precipitation uses the scale on the right side of the chart (inches or centimeters). Lines of temperature and dew point use the scale on the left side of the chart (degrees Fahrenheit or Celsius). These charts have fixed maximum and minimum values on their axes for easy comparison between different sites. The precipitation chart is capped at a maximum of 15 inches (45 centimeters) per month. A few sites may exceed this value; but to keep the graph readable, a fixed maximum value was used. There are a number of sites for which accurate precipitation data was not available. If this is the case, then no bars are printed on the chart.

Suggestions for Use:

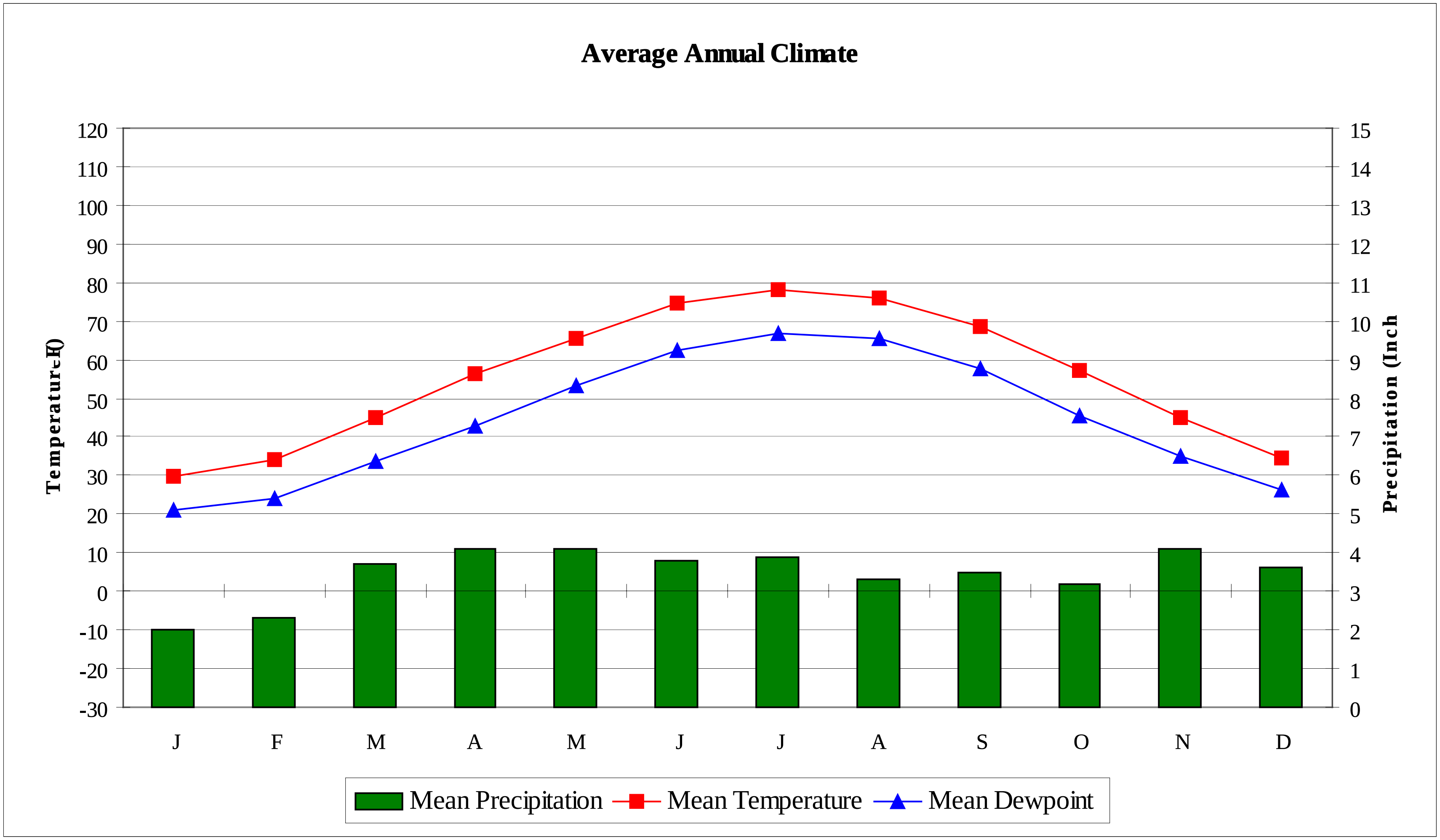
This graph displays the average behavior of weather over a single year. An architect can compare rainfall patterns at one station with another to evaluate differences in gutter and drain sizing, and also the relative importance of water resistance for the exterior envelope. An engineer can compare the temperature and moisture patterns to understand the relative importance of sensible heat loads vice latent loads at this location.

With averages displayed by month, it is relatively easy to comprehend seasonal variations of each variable, and also understand which specific months are likely to be hot or cold; humid or dry, or have high precipitation. This can be helpful for mission planning, as well as for planning construction and building operation.

Cautionary Note: This graph displays averages, not extreme values. Data shown should not be used to size equipment or building envelopes for peak loads. Peak load data appears on page 1 of each station record in this handbook.

Figure 2. Sample Data Set Page 2

SCOTT AFB/BELLEVILLE IL WMO No. 724338



Long Term PSYCHROMETRIC SUMMARY (page 3)

Explanation of Graph:

The graph displays the joint cumulative percent frequency of temperature and humidity ratio. Hourly observations are binned into groups of 5 °F and 10 grains per pound (gr/lb) (or 3 °C and 1.5 grams per kilogram [g/kg]), centered on each value of temperature or humidity ratio. For example, the 70 °F temperature bin collects all observations between 67.5 °F and 72.5 °F. The bin is depicted as a gridline on the chart; the vertical lines represent the temperature bins and the horizontal lines represent the humidity ratio bins. The intersection of temperature and humidity ratio lines represent a further sub-setting of the observations into groups meeting both temperature and humidity ratio criteria. For example, the intersection of the 70 °F bin line and the 40 gr/lb bin line represent the observations when temperature was between 67.5 °F and 72.4 °F and the humidity ratio was between 35 gr/lb and 44 gr/lb. Thus, a joint-frequency table is created for all temperature and humidity ratio bin combinations.

Suggestions for Use:

This graphic displays the long-term history of temperature and moisture at each station (a total of 262,800 hourly observations if the POR is 30 years and if the data is complete over that period). The engineer can use this graph to ascertain the most common temperature and moisture conditions which will be encountered over the operating life of mechanical equipment.

It is often useful to calculate the behavior of the proposed system at “most-common” conditions, in addition to the traditional peak design calculations. This will help ensure that the selected equipment and controls are capable of modulation and control at all points of operation rather than simply at extreme conditions.

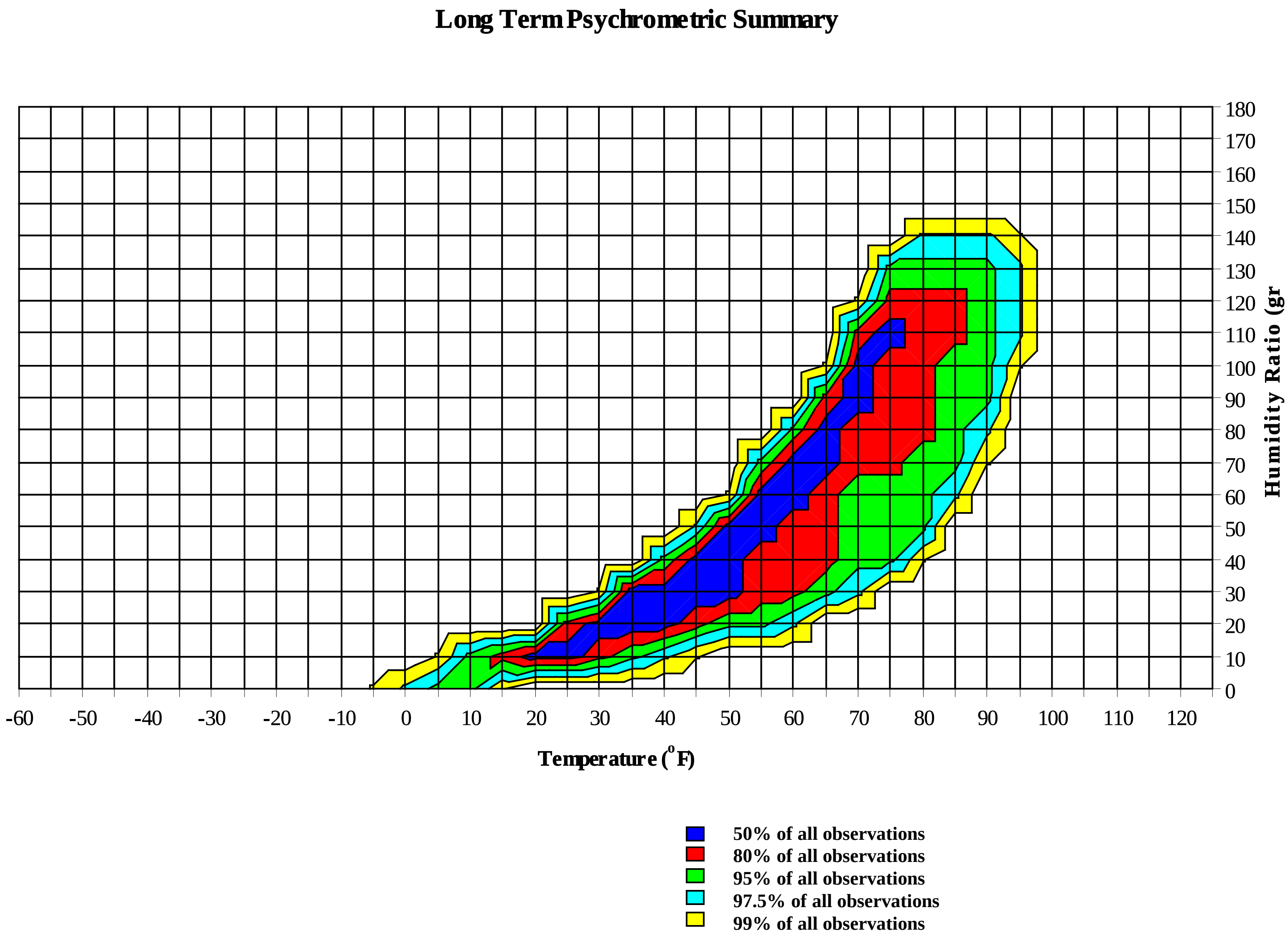
Cautionary Note: The psychrometric graph is intended as a visual tool only. Its purpose is to allow quick visual comparison between climates at different locations. Extrapolation of data directly from the graph is not advised due to the approximate plotting routine used to generate the graph from the binned data. This is evident where values of humidity appear past their saturation point. This discrepancy between the actual data and the graph is the result of the plotting routine used to generate the graph and not from errors in the original hourly data used to create the binned summary.

The contours on this chart represent the areas containing 99%, 97.5%, 95%, 80%, and 50% of all observations (cumulative percent frequency or percentiles). The contours are centered on the most frequently occurring bins (50% contour), spreading outward until almost all observations (99%) are grouped. Contours are defined by calculating a percent frequency for each bin (relative to the others), and then accumulating these percent frequencies (from most frequent to least frequent) until the 50% value is passed, and thus the first set of bins is grouped. The accumulating continues until the 80% value is passed, and the second group of bins is grouped. This continues until the 95%, 97.5%, and 99% values are passed.

Thus, the least frequent (most extreme) bins, which when accumulated amount to less than 1% of the total observations, are outside of the 99% contour. Any bins outside the 99% contour thus have either not occurred, or have occurred so infrequently that they should not be taken into consideration for sizing equipment.

Figure 3. Sample Data Set Page 3

SCOTT AFB/BELLEVILLE IL WMO No. 724338



PSYCHROMETRIC DISPLAY OF DESIGN VALUES

Explanation of Chart. Similar to Page 3, this chart depicts the saturation curve (when RH = 100%) along with peak design values. The design values are calculated as in the table on Page 1, but this chart shows their relationships graphically, depicting their position relative to each other and relative to the saturation curve.

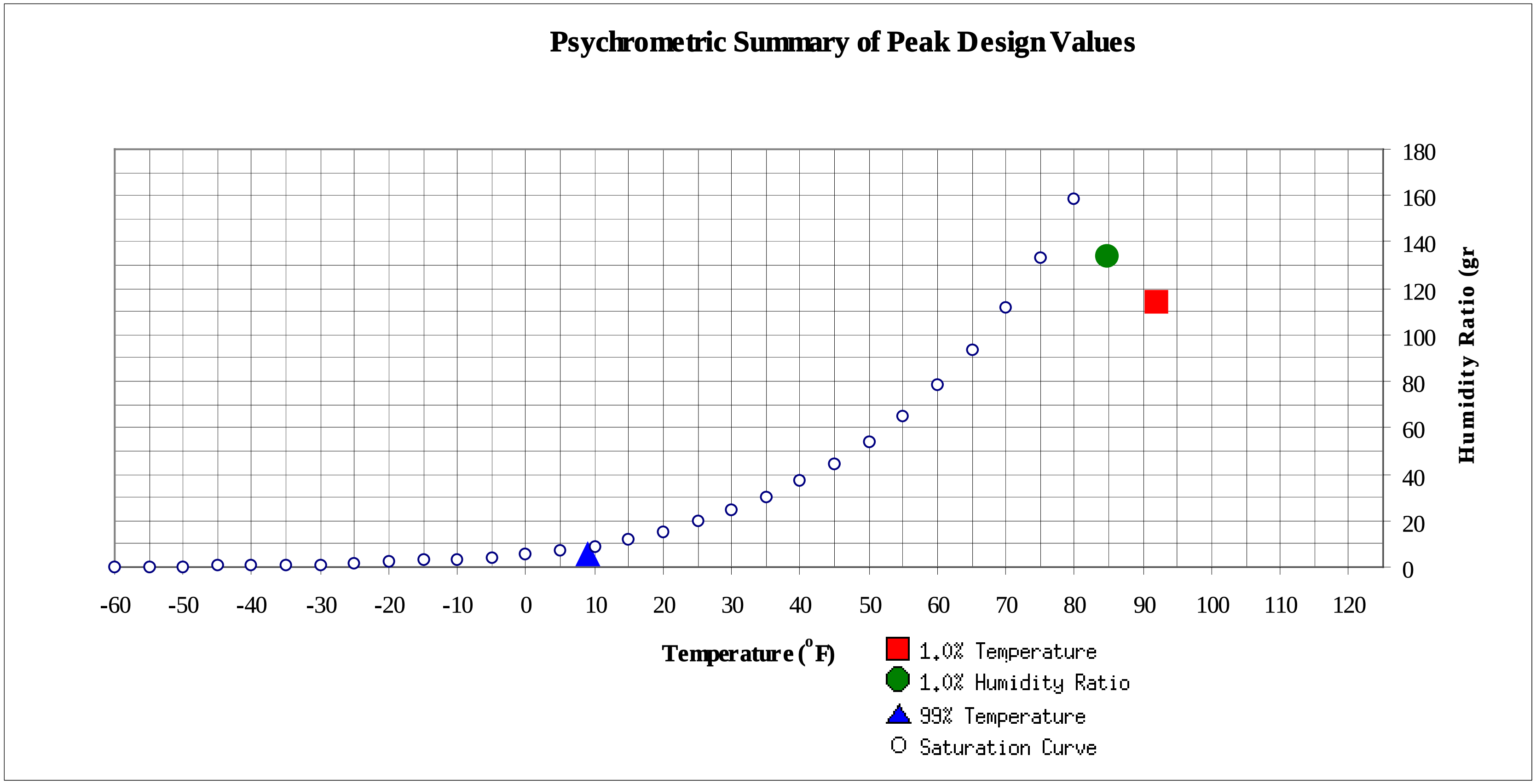
Above and to the left of saturation curve, RH would be greater than 100 percent (not possible). The area below and to the right of the curve (including the points on the curve itself) represent the area where RH is less than or equal to 100 percent, and thus where all observations occur. Note that since the humidity ratio is a function of pressure, and pressure varies with elevation, different sites will have different saturation curves.

The dry bulb temperature is the horizontal coordinate on this scatter plot, and the humidity ratio is the vertical coordinate. Peak design values are depicted by the red square (1.0% Dry Bulb Temperature), the green circle (1.0% Humidity Ratio), and the blue diamond (99% Dry Bulb Temperature).

The table below the chart shows the exact values of 99% dry bulb temp, 1.0% humidity ratio, and 1.0% dry bulb temperature, along with calculated values of enthalpy, mean coincident wet bulb temperature, and humidity ratio (as applicable). The value of enthalpy coincident to each temperature/humidity ratio is created using the psychometric functions provided by the Linric Company, Bedford, New Hampshire. The dry bulb temperature and humidity ratios are used to calculate enthalpy using the Linric algorithms.

Figure 4. Sample Data Set Page 4

SCOTT AFB/BELLEVILLE IL WMO No. 724338



	(°F)	MCHR (gr/lb)	Enthalpy (btu/lb)
99% Dry Bulb	9	5.6	3.0

	(gr/lb)	MCDB (°F)	MCWB (°F)	MC Dewpt (°F)	Enthalpy (btu/lb)
1.0% Humidity Ratio	133.7	84.8	77.6	75	41.3

	(°F)	MCHR (gr/lb)	MCWB (°F)	Enthalpy (btu/lb)
1.0% Dry Bulb	92	113.8	76.3	40.0

BINNED TEMPERATURE DATA (pages 5-9)

Explanation of Tables. Identical to those in AFM 88-29, these tables show the number of hours that temperatures in 5 °F (3 °C) bins occur during a given month, and during 8-hour periods during the days of that month. The 8-hour periods are based upon a 24-hour clock and displayed in Local Standard Time (LST). The total numbers of observations (hours) in each temperature bin are summed horizontally in the "Total Obs" column for the month. The mean coincident wet bulb temperature is the mean value of all those wet bulb temperatures that occur coincidentally with the dry bulb temperatures in the particular 5-degree temperature interval. At the upper or warmer end of the mean coincident wet bulb distribution, the values occasionally reverse their trend because the highest wet bulb temperatures do not necessarily occur with the highest dry bulb temperatures. There are thirteen such tables, one for each month, and one representing the overall annual summary (Data Set Page 9).

Suggestions for Use. Binned summaries are used by many different technical disciplines for different purposes. They are useful in making informal estimates of energy consumption by cooling and heating equipment, and for gaining a general understanding of patterns of temperature and moisture at different times of the day, month, and year.

Cautionary Note: Do not use these binned summaries to calculate moisture loads. These particular summaries are based on the dry bulb temperature. After each of the one-hour observations has been placed into a dry bulb BIN, the average humidity ratio is calculated for all observations in each BIN. Consequently, dry bulb BINs underestimate the magnitude of dehumidification and humidification loads, because the averaging calculation "flattens" the peaks and valleys of humidity ratios. The amount of the underestimation varies according to the desired humidity control level.

Figure 5. Sample Data Set Pages 5-9

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Dry-Bulb Temperature Hours For An Average Year (Sheet 1 of 5)
Period of Record = 1967 to 1996

	January					February					March				
	Hour Group (LST)				MCWB	Hour Group (LST)				MCWB	Hour Group (LST)				MCWB
Temperature Range (°F)	01 To 08	09 To 16	17 To 00	Total Obs	(°F)	01 To 08	09 To 16	17 To 00	Total Obs	(°F)	01 To 08	09 To 16	17 To 00	Total Obs	(°F)
100 / 104															
95 / 99															
90 / 94															
85 / 89												0	0	0	65.0
80 / 84												3	0	3	64.4
75 / 79							0	0	1	60.7		6	1	7	62.2
70 / 74		1		1	59.5		2	0	2	58.2	0	12	5	17	60.3
65 / 69	0	1	0	2	58.0		4	1	5	54.8	2	16	12	30	57.2
60 / 64	1	4	1	6	54.6	1	8	4	13	53.0	9	21	17	47	54.2
55 / 59	2	7	4	13	51.7	4	12	8	24	50.2	14	27	24	65	50.3
50 / 54	4	11	7	22	46.9	5	15	11	31	45.5	21	33	33	87	46.2
45 / 49	5	18	12	35	42.1	9	22	19	50	41.8	33	35	37	105	42.3
40 / 44	17	30	26	72	38.1	22	33	29	84	37.8	38	34	38	111	37.8
35 / 39	34	38	40	112	33.7	39	38	41	119	33.7	43	31	34	108	33.4
30 / 34	51	42	51	143	29.5	42	30	39	111	29.2	43	19	28	89	29.2
25 / 29	35	34	34	102	24.5	37	25	28	90	24.5	28	9	13	50	24.5
20 / 24	32	24	28	84	19.7	21	16	17	54	19.7	11	2	3	16	20.1
15 / 19	25	18	21	64	15.1	15	9	13	37	15.1	3	1	1	5	15.4
10 / 14	18	10	13	41	10.4	14	7	8	29	10.6	1	0	1	2	11.0
5 / 9	12	6	7	26	5.7	9	2	4	15	6.0	1	0	0	1	6.3
0 / 4	7	3	4	13	0.9	4	1	1	6	1.4	0			0	0.5
-5 / -1	3	1	1	5	-3.3	1	0	0	1	-2.8					
-10 / -6	2	0	0	2	-7.4	1	0	0	1	-7.9					
-15 / -11	0	0	0	1	-12.7	0			0	-11.4					
-20 / -16	0		0	0	-16.9										

Caution: This summary reflects the typical distribution of temperature in a typical year. It does not reflect the typical moisture distribution. Because wet bulb temperatures are averaged, this summary understates the annual moisture load. For accurate moisture load data, see the long-term humidity summary and the ventilation and infiltration load pages in this manual.

Figure 1.5. Sample Data Set Pages 5-9 (Continued)

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Dry-Bulb Temperature Hours For An Average Year (Sheet 2 of 5)

Period of Record = 1967 to 1996

	April					May					June				
	Hour Group (LST)				M C W B	Hour Group (LST)				M C W B	Hour Group (LST)				M C W B
Temperature Range (^oF)	01 To 08	09 To 16	17 To 00	Total Obs	(^oF)	01 To 08	09 To 16	17 To 00	Total Obs	(^oF)	01 To 08	09 To 16	17 To 00	Total Obs	(^oF)
100 / 104												1	0	1	75.6
95 / 99							0		0	76.0		4	1	5	75.6
90 / 94		1	0	1	70.9		4	1	4	72.7	0	28	8	35	75.1
85 / 89		3	1	4	67.7		18	4	22	70.6	1	54	21	76	73.1
80 / 84		13	3	16	65.8	0	34	13	47	68.2	9	60	40	109	70.5
75 / 79	0	20	9	29	63.9	5	43	27	75	65.7	32	47	55	134	68.6
70 / 74	4	28	19	52	60.8	19	49	42	110	63.2	68	29	56	153	66.6
65 / 69	13	34	31	78	58.1	46	43	51	140	60.5	60	11	34	105	62.8
60 / 64	31	39	36	105	54.7	55	32	46	134	56.8	41	5	18	64	58.4
55 / 59	34	35	41	109	50.5	48	18	35	100	52.6	21	1	5	28	54.3
50 / 54	41	30	37	107	46.5	37	5	21	63	48.1	6		1	7	49.7
45 / 49	46	21	30	97	42.4	27	2	7	36	43.9	1			1	46.3
40 / 44	35	12	20	66	38.1	8	0	2	10	39.2					
35 / 39	21	4	9	34	33.8	3		0	3	35.1					
30 / 34	13	1	4	18	29.8	0			0	30.8					
25 / 29	3	0	0	3	25.3										
20 / 24	0			0	21.5										
15 / 19															
10 / 14															
5 / 9															
0 / 4															
-5 / -1															
-10 / -6															
-15 / -11															
-20 / -16															

Caution: This summary reflects the typical distribution of temperature in a typical year. It does not reflect the typical moisture distribution. Because wet bulb temperatures are averaged, this summary understates the annual moisture load. For accurate moisture load data, see the long-term humidity summary and the ventilation and infiltration load pages in this manual.

Figure 1.5. Sample Data Set Pages 5-9 (Continued)

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Dry-Bulb Temperature Hours For An Average Year (Sheet 3 of 5)

Period of Record = 1967 to 1996

	July					August					September				
	Hour Group (LST)				MCWB	Hour Group (LST)				MCWB	Hour Group (LST)				MCWB
Temperature Range (^{o}F)	01 To 08	09 To 16	17 To 00	Total Obs	(^{o}F)	01 To 08	09 To 16	17 To 00	Total Obs	(^{o}F)	01 To 08	09 To 16	17 To 00	Total Obs	(^{o}F)
100 / 104		2	0	2	77.5		1	0	1	77.8					
95 / 99		14	3	18	77.9		10	1	12	78.4		2	0	2	76.7
90 / 94	0	49	15	64	76.9		35	8	43	77.1		11	2	12	75.1
85 / 89	2	68	31	102	74.6	1	61	21	83	74.3	0	28	6	34	72.6
80 / 84	19	63	56	138	72.6	9	65	45	118	72.0	1	46	17	64	70.0
75 / 79	63	34	67	163	71.1	43	46	64	153	70.6	11	48	35	94	68.1
70 / 74	86	14	48	149	68.3	76	25	60	160	67.8	41	44	51	137	65.7
65 / 69	48	3	20	71	63.7	61	6	32	99	63.5	46	30	44	120	61.8
60 / 64	22	1	6	29	58.9	38	1	13	52	59.2	46	18	38	103	57.6
55 / 59	7		1	8	54.8	16	0	3	19	54.9	42	8	27	77	53.4
50 / 54	1		0	1	51.2	3		0	4	50.4	30	3	14	47	49.1
45 / 49						0		0	0	45.8	16	0	5	21	44.9
40 / 44											6		2	7	40.2
35 / 39											1		0	2	36.1
30 / 34											0			0	31.5
25 / 29															
20 / 24															
15 / 19															
10 / 14															
5 / 9															
0 / 4															
-5 / -1															
-10 / -6															
-15 / -11															
-20 / -16															

Caution: This summary reflects the typical distribution of temperature in a typical year. It does not reflect the typical moisture distribution. Because wet bulb temperatures are averaged, this summary understates the annual moisture load. For accurate moisture load data, see the long-term humidity summary and the ventilation and infiltration load pages in this manual.

Figure 1.5. Sample Data Set Pages 5-9 (Continued)

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Dry-Bulb Temperature Hours For An Average Year (Sheet 4 of 5)

Period of Record = 1967 to 1996

	October					November					December				
	Hour Group (LST)				M C W B	Hour Group (LST)				M C W B	Hour Group (LST)				M C W B
Temperature Range (^oF)	**01 To 08**	**09 To 16**	**17 To 00**	**Total Obs**	**(^oF)**	**01 To 08**	**09 To 16**	**17 To 00**	**Total Obs**	**(^oF)**	**01 To 08**	**09 To 16**	**17 To 00**	**Total Obs**	**(^oF)**
100 / 104															
95 / 99															
90 / 94		0		0	69.4										
85 / 89		4	0	4	68.0										
80 / 84		13	1	14	66.7		0		0	61.2					
75 / 79	1	26	6	33	64.3		3	0	3	62.8					
70 / 74	3	35	19	57	62.1	0	8	2	11	61.9		1	0	1	62.9
65 / 69	17	41	33	91	59.6	2	15	8	26	59.4	1	3	1	4	59.5
60 / 64	30	43	39	112	55.6	12	23	18	53	56.5	2	8	3	13	56.2
55 / 59	37	37	47	121	51.3	15	28	22	65	51.0	6	11	8	26	52.4
50 / 54	44	29	40	113	47.1	23	32	29	84	46.7	8	17	11	36	46.7
45 / 49	46	15	34	95	43.0	31	38	36	105	42.6	12	27	18	58	42.6
40 / 44	36	4	19	59	39.0	39	39	42	119	38.0	27	40	35	102	38.1
35 / 39	23	1	8	33	34.6	44	31	41	117	33.7	42	48	50	140	33.9
30 / 34	9	0	2	11	30.5	40	14	28	82	29.5	52	41	48	140	29.5
25 / 29	2		0	2	25.9	20	5	10	35	25.0	39	23	34	96	24.7
20 / 24						9	2	4	14	20.3	25	12	17	54	20.1
15 / 19						3	1	1	5	15.4	16	7	9	33	15.4
10 / 14						1	0	0	2	10.8	9	6	6	20	10.6
5 / 9						0			0	7.5	4	2	3	10	5.9
0 / 4											3	1	2	6	1.2
-5 / -1											2	1	1	3	-3.5
-10 / -6											1	0	1	2	-7.3
-15 / -11											0	0	0	1	-12.0
-20 / -16															

Caution: This summary reflects the typical distribution of temperature in a typical year. It does not reflect the typical moisture distribution. Because wet bulb temperatures are averaged, this summary understates the annual moisture load. For accurate moisture load data, see the long-term humidity summary and the ventilation and infiltration load pages in this manual.

Figure 1.5. Sample Data Set Pages 5-9 (Continued)

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Dry-Bulb Temperature Hours For An Average Year (Sheet 5 of 5)

Period of Record = 1967 to 1996

Annual Totals

Temperature Range (°F)	Hour Group (LST) 01 To 08	09 To 16	17 To 00	Total Obs	MCWB (°F)
100 / 104		3	0	3	77.1
95 / 99		31	5	37	77.7
90 / 94	0	127	32	160	76.3
85 / 89	4	236	84	325	73.5
80 / 84	37	296	176	509	70.8
75 / 79	154	274	263	690	68.7
70 / 74	298	247	303	848	65.7
65 / 69	296	207	267	770	61.1
60 / 64	288	201	241	730	56.5
55 / 59	246	184	224	654	51.8
50 / 54	223	175	205	602	47.0
45 / 49	228	179	197	603	42.7
40 / 44	227	192	211	631	38.1
35 / 39	250	192	224	667	33.8
30 / 34	251	146	199	596	29.4
25 / 29	163	95	120	379	24.6
20 / 24	99	54	69	222	19.9
15 / 19	63	36	46	145	15.2
10 / 14	43	24	28	95	10.5
5 / 9	26	11	14	51	5.9
0 / 4	14	5	7	25	1.1
-5 / -1	6	2	2	10	-3.3
-10 / -6	3	1	1	6	-7.5
-15 / -11	1	0	0	2	-12.2
-20 / -16	0		0	0	-16.9

Caution: This summary reflects the typical distribution of temperature in a typical year. It does not reflect the typical moisture distribution. Because wet bulb temperatures are averaged, this summary understates the annual moisture load. For accurate moisture load data, see the long-term humidity summary and the ventilation and infiltration load pages in this manual.

ANNUAL TEMPERATURE SUMMARY (page 10)

Explanation of Chart. This chart shows a week-by-week summary of dry bulb temperatures for the given site. The observations are grouped into seven-day periods (approximate calendar weeks). For example, observations from 1-7 January from all years are grouped, 8-14 January are grouped, and so on, overlapping the end of one month and beginning of the next month where necessary. For each of the seven-day periods, the following statistics are shown.

1% Temperature is the dry bulb temperature that is exceeded one percent of the time during that calendar week.

MCWB @ 1% Temp is the mean of wet bulb temperatures coincident with 1% dry bulb temperatures during the same week

Mean Max Temp is the daily maximum dry bulb temperature, averaged by week over the POR.

Mean Min Temp is the daily minimum dry bulb temperature, averaged by week over the POR.

99% Temp is the daily dry bulb temperature that is at or above this value 99 percent of the time, or below this value one percent of the time.

Note: The information in this chart is calculated on a weekly basis; information on a climate summary (Data Set Page 1) is calculated on an annual basis.

Suggestions for Use. The weekly 1% and 99% temperatures are useful for understanding the probable temperature extremes that can occur during a given week of the year. The weekly dry bulb temperatures are useful for understanding the change of seasons at a given location. The display is helpful for mission planning and construction project planning.

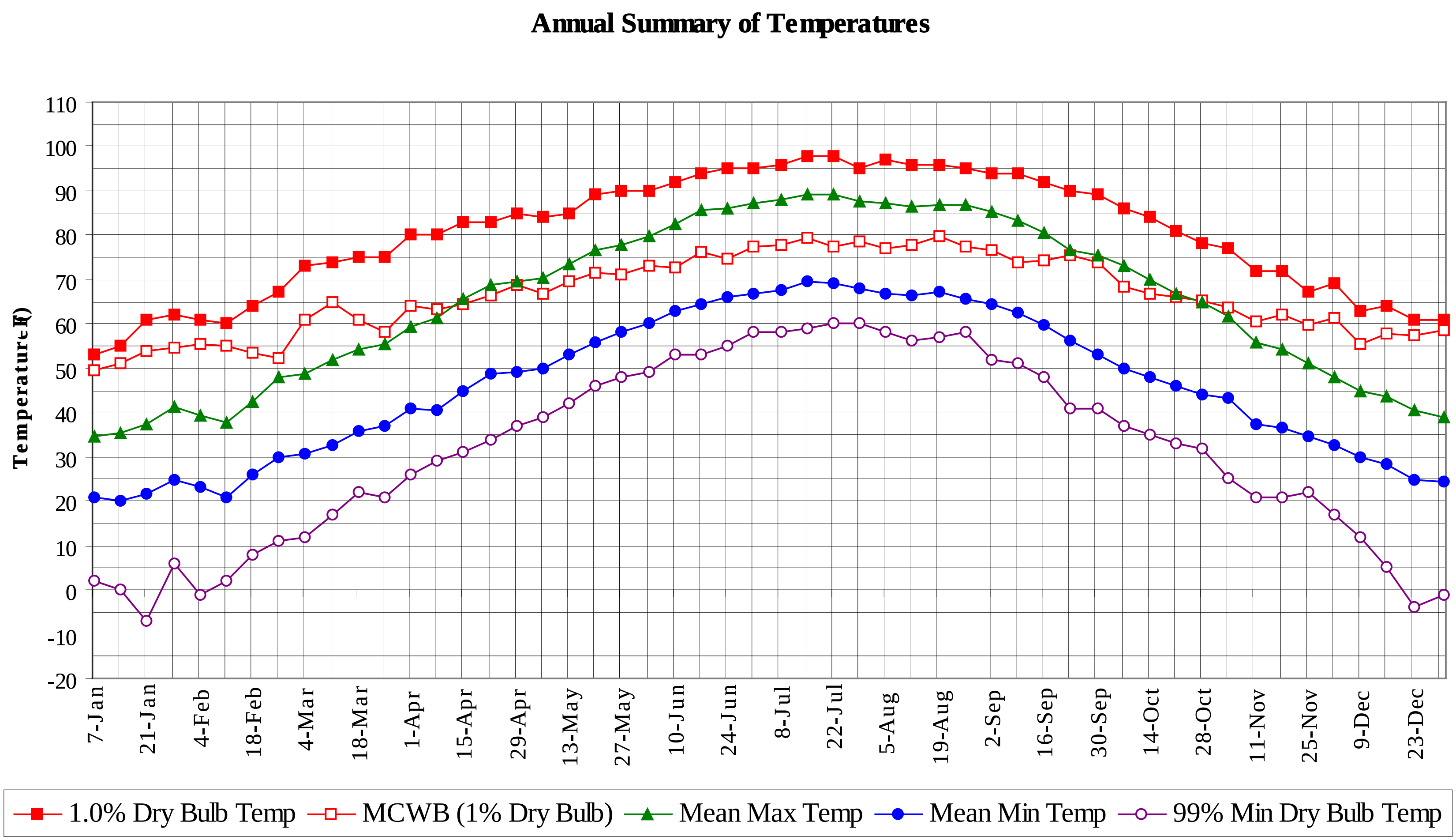
Cautionary Notes:

Designers. The values displayed here are based on the 30-year record. It is important that designers NOT base equipment selection on the "highest" or "lowest" recorded temperature at the station. That error would result in selecting equipment extremely costly to install, which would operate inefficiently for all but the very hottest or coldest single hour in 30 years. See the design criteria data page (Page 1) in this handbook for appropriate maximum and minimum temperatures for sizing equipment.

Construction and Operation Planners. The mean maximum and minimum temperatures shown for each week seldom occur in the same year. Keep in mind these are mean values useful for understanding the typical range of temperatures in a given week. The difference does NOT represent the actual day-night temperature swing in a given week.

Figure 6. Sample Data Set Page 10

SCOTT AFB/BELLEVILLE IL WMO No. 724338



SCOTT AFB/BELLEVILLE IL WMO No. 724338

ANNUAL HUMIDITY SUMMARY (page 11)

Explanation of Chart. Similar to the annual temperature summary (Data Set Page 10), this chart depicts mean maximum and minimum values of humidity ratio, plus the 1% maximum humidity ratio, along with its mean coincident dry bulb temperature, summarized by calendar week. The chart uses two vertical axes: On the left are the humidity ratio values and on the right is a temperature scale for the mean coincident dry bulb temperature.

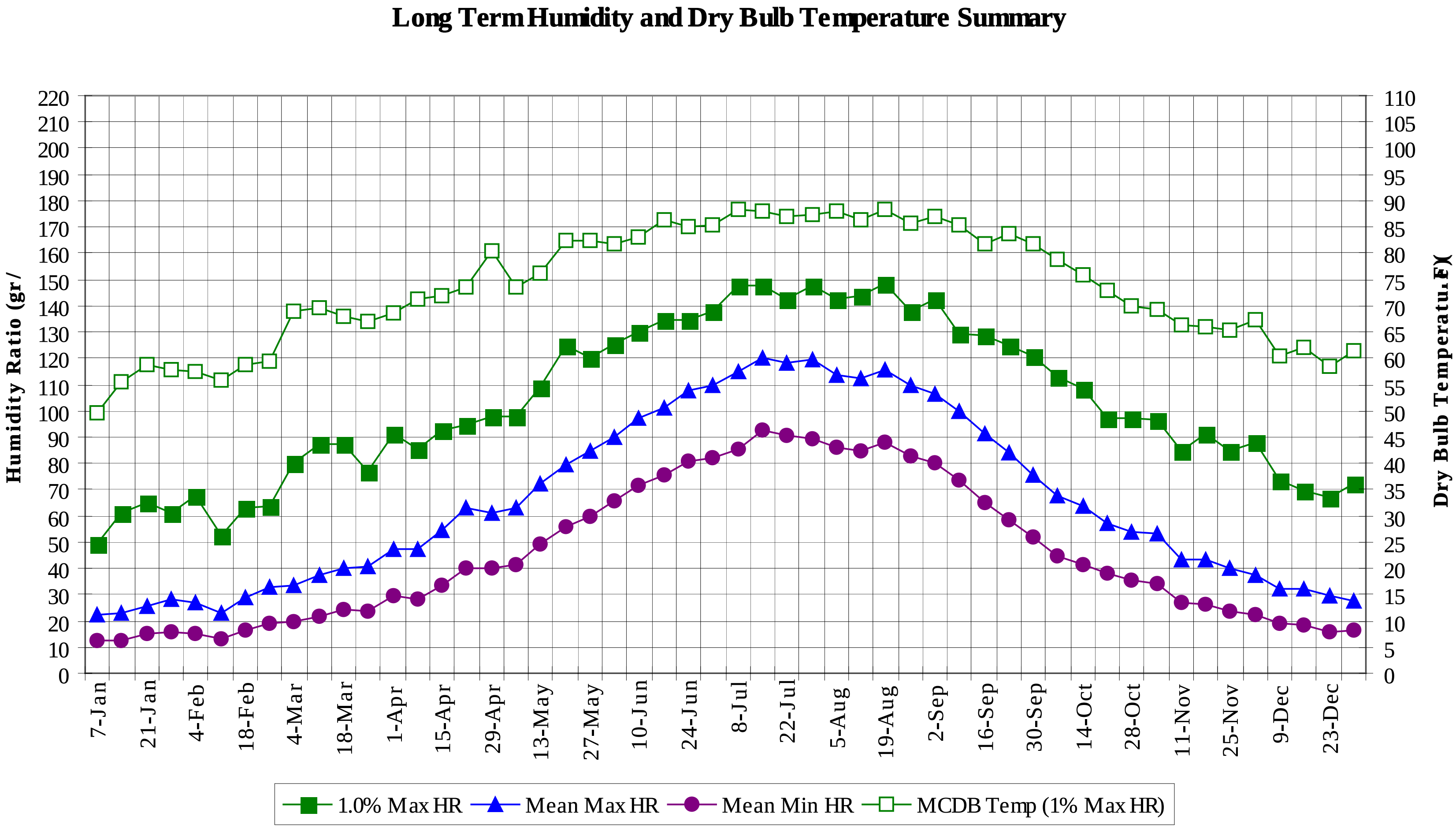
Suggestions for Use. Weekly humidity ratios are useful for understanding the change of seasons at a given location, and the probable high and low moisture levels during a given week of the year. The display is helpful for planning humidity-controlled storage projects, and for understanding factors contributing to atmospheric corrosion. Humidity also affects the deterioration rate of building materials and weathering of military equipment and structures exposed to the elements.

Cautionary Notes:

Designers. The values displayed here are based on the 30-year record. It is important that designers NOT base equipment selection on the “highest” or “lowest” recorded humidity at the station. That error would result in selecting oversized equipment, which would increase costs and may result in control problems at other than extreme conditions. Use design values on Data Set Page 1 for equipment sizing.

Construction and Operation Planners. The high and low humidity ratios shown for each week seldom occur in the same year. Keep in mind that these are mean values that are useful for understanding the typical range of humidity ratio in a given week. The difference does NOT represent the actual day-night humidity ratio swing in a given week.

Figure 7. Sample Data Set Page 11



ANNUAL DRY BULB TEMPERATURE AND HUMIDITY SUMMARY (page 12)

1.22. Explanation of Tables. These tables show the values used to plot the charts on Data Set Pages 10 and 11. The left half of the table uses Data Set Page 10 and the right half uses Data Set Page 11.

Figure 8. Sample Data Set Page 12

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Long Term Dry Bulb Temperature and Humidity Summary

Week Ending	1.0% Temp (^oF)	MCWB @ 1% Temp (^oF)	Mean Max Temp (^oF)	Mean Min Temp (^oF)	99% Temp (^oF)	1.0% HR (gr/lb)	MCDB @ 1% HR (^oF)	Mean Max HR (gr/lb)	Mean Min HR (gr/lb)
7-Jan	53.0	49.4	34.7	20.9	2.0	49.0	49.6	22.6	12.8
14-Jan	55.0	50.9	35.2	20.1	0.0	60.9	55.6	22.7	12.2
21-Jan	61.0	53.8	37.2	21.7	-7.0	65.1	58.9	25.8	14.8
28-Jan	62.0	54.6	41.4	24.9	6.0	60.9	57.9	28.2	15.8
4-Feb	61.0	55.4	39.2	23.1	-1.0	67.9	57.4	26.6	15.4
11-Feb	60.0	55.2	37.7	21.0	2.0	52.5	55.8	23.2	13.1
18-Feb	64.0	53.6	42.4	25.9	8.0	63.0	58.8	28.6	16.7
25-Feb	67.0	52.4	47.9	30.0	11.0	63.7	59.4	32.8	19.2
4-Mar	73.0	61.1	48.6	30.6	12.0	79.8	69.1	33.3	19.8
11-Mar	74.0	64.8	51.7	32.5	17.0	87.5	69.5	37.5	21.9
18-Mar	75.0	61.0	54.4	35.6	22.0	87.5	68.1	40.2	24.1
25-Mar	75.0	58.3	55.6	36.9	21.0	77.0	67.0	40.6	24.0
1-Apr	80.0	64.0	59.3	40.8	26.0	91.0	68.6	47.2	29.8
8-Apr	80.0	63.3	61.4	40.6	29.0	85.4	71.3	47.3	28.0
15-Apr	83.0	64.4	65.5	44.9	31.0	92.4	71.8	54.6	33.7
22-Apr	83.0	66.4	68.8	48.7	34.0	94.5	73.4	62.9	39.9
29-Apr	85.0	68.9	69.5	49.1	37.0	98.0	80.3	61.4	39.9
6-May	84.0	66.9	70.3	49.9	39.0	98.0	73.7	63.2	41.2
13-May	85.0	69.5	73.6	53.2	42.0	109.2	76.3	72.6	49.5
20-May	89.0	71.6	76.6	55.6	46.0	124.6	82.5	79.7	55.6
27-May	90.0	71.3	77.9	58.1	48.0	120.4	82.3	84.5	59.9
3-Jun	90.0	72.9	79.7	60.1	49.0	125.3	81.8	90.1	65.4
10-Jun	92.0	72.7	82.7	62.9	53.0	130.2	83.2	97.4	71.8
17-Jun	94.0	76.0	85.6	64.4	53.0	134.4	86.4	100.9	75.5
24-Jun	95.0	74.8	86.2	66.0	55.0	134.4	85.0	107.7	80.7
1-Jul	95.0	77.5	87.3	66.8	58.0	137.9	85.3	109.6	82.2
8-Jul	96.0	77.8	88.0	67.7	58.0	147.7	88.4	114.8	85.5
15-Jul	98.0	79.3	89.0	69.6	59.0	147.7	87.9	119.9	92.4
22-Jul	98.0	77.3	89.0	69.0	60.0	142.8	86.9	117.9	90.8
29-Jul	95.0	78.7	87.6	68.2	60.0	147.7	87.2	119.4	89.2
5-Aug	97.0	76.9	87.0	66.8	58.0	142.8	88.1	113.5	86.0
12-Aug	96.0	77.7	86.4	66.4	56.0	143.5	86.4	112.6	84.9
19-Aug	96.0	79.6	86.8	67.0	57.0	148.4	88.2	115.6	88.3
26-Aug	95.0	77.6	86.7	65.6	58.0	137.9	85.6	109.9	82.6
2-Sep	94.0	76.6	85.1	64.5	52.0	142.8	87.1	106.3	80.3
9-Sep	94.0	73.9	83.3	62.5	51.0	129.5	85.4	99.7	73.6
16-Sep	92.0	74.3	80.5	59.6	48.0	128.8	81.6	91.1	65.2
23-Sep	90.0	75.6	76.7	56.0	41.0	124.6	83.7	84.0	58.2
30-Sep	89.0	74.1	75.5	53.1	41.0	121.1	81.9	75.5	52.0
7-Oct	86.0	68.4	73.1	49.8	37.0	112.7	78.9	67.9	44.9
14-Oct	84.0	66.7	69.9	47.8	35.0	108.5	76.0	63.9	41.7
21-Oct	81.0	66.1	66.7	45.9	33.0	97.3	73.0	57.4	37.9
28-Oct	78.0	65.1	64.7	44.2	32.0	97.3	69.8	54.1	35.5
4-Nov	77.0	63.6	61.6	43.1	25.0	96.6	69.3	53.3	34.1
11-Nov	72.0	60.5	55.9	37.3	21.0	84.7	66.5	43.0	26.6
18-Nov	72.0	62.1	54.4	36.8	21.0	91.0	66.0	43.4	26.5
25-Nov	67.0	59.6	51.3	34.7	22.0	84.7	65.4	40.4	23.6
2-Dec	69.0	61.3	48.0	32.7	17.0	88.2	67.2	37.7	22.1
9-Dec	63.0	55.5	44.9	29.9	12.0	73.5	60.5	32.2	19.3
16-Dec	64.0	57.9	43.7	28.3	5.0	69.3	62.2	32.0	18.5
23-Dec	61.0	57.4	40.3	24.6	-4.0	67.2	58.4	29.3	15.9
31-Dec	61.0	58.5	38.9	24.6	-1.0	72.1	61.4	27.7	16.4

BUILDING ENVELOPE LOADS (page 13)

Explanation of Charts:

Cooling degree-days are derived by multiplying the number of hours that the outdoor temperature is above 65 °F (18 ºC) times the number of degrees of that temperature difference. For example, if one hour was observed at a temperature of 78 °F, that observation adds 13 degree-hours to the annual total. The sum of the degree-hours is divided by 24 to yield degree-days.

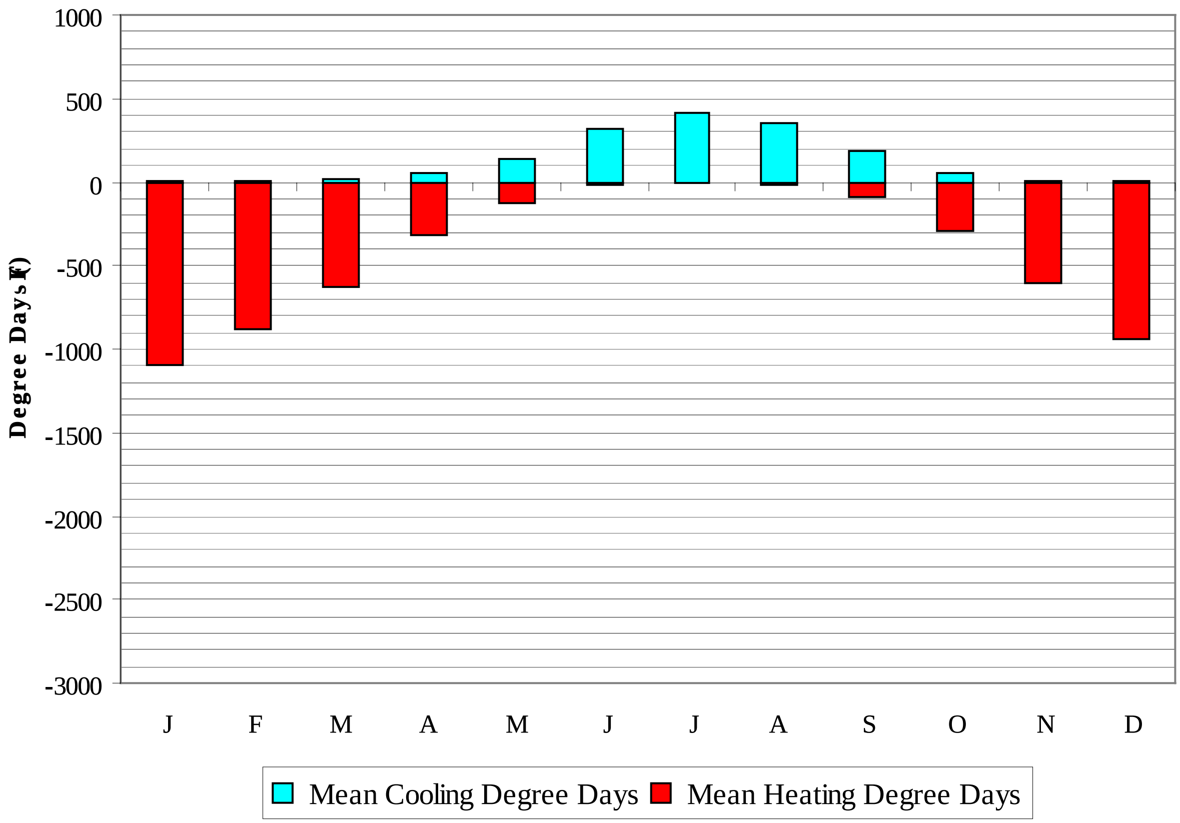
Heating degree-days are calculated similarly, against an inside temperature of 65 °F. So a one-hour observation of 62 °F adds 3 degree-hours to the annual total. Heating degree-days are summed separately from the cooling degree-days. Hot and cold hours do not cancel each other out, as both heating and cooling conditions may occur over the course of a given day.

Suggestions for Use. Degree-days are used to estimate the sensible heat and sensible cooling loads on the building envelope. Degree-day loads can be used to estimate the annual energy consumption of a building, provided that the loads from ventilation and infiltration air are also considered (see next section).

Figure 9. Sample Data Set Page 13

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Degree Days, Heating and Cooling
(Base 65°F)



	Mean Cooling Degree Days (°F)	Mean Heating Degree Days (°F)
JAN	0	1094
FEB	1	879
MAR	13	634
APR	50	312
MAY	137	122
JUN	314	21
JUL	418	6
AUG	354	14
SEP	188	87
OCT	52	298
NOV	7	608
DEC	0	942
ANN	1534	5017

VENTILATION AND INFILTRATION LOADS (page 14)

Explanation of Charts:

The graph and table display the independent loads imposed by heating, cooling, humidifying, and dehumidifying outside air as it is brought into a building. The calculation assumes that air inside the building is maintained at 68 ºF (20 ºC)/30% RH during the winter and 75 ºF (24 ºC)/60% RH during the summer. For the purposes of these calculations, when the outside air is within that range of temperature and moisture, any incoming air is assumed not to impose any load.

These values are calculated with the methodology used to calculate the annual VCLI Index on page one, except that values on this page are computed by month, and the result is displayed as British thermal units (Btu) per cubic foot per minute (cfm) rather than as ton-hours per cfm per year. The heating and humidifying loads are shown as negative values. Cooling and dehumidifying loads are displayed as positive values.

Suggestions for Use. Bringing fresh ventilation air into a building, or allowing air to infiltrate into buildings through cracks imposes heating, cooling, dehumidification, and humidification loads on the mechanical system. This display helps the architect, engineers, and operating personnel understand the nature and magnitude of those loads on an annual basis. It also shows how the loads vary from month to month throughout the year.

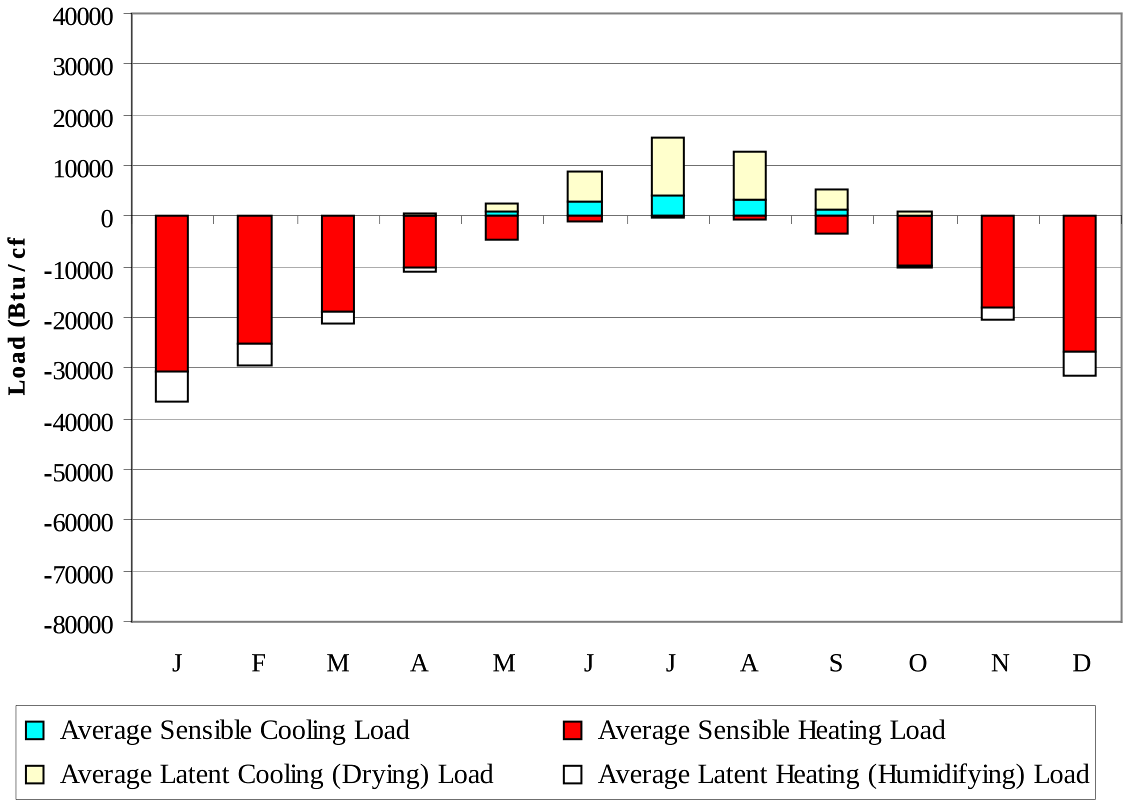
Comments. These calculations are based on the load created when one cubic foot of fresh air is brought into the building each minute. The results of the calculation include the moisture load or deficit, and the sensible heat load or deficit created by that cubic foot of air during each month of the year. Note that most months have both a load and a deficit for temperature and moisture. The monthly deficit and load do not "cancel" from the perspective of the mechanical system, because temperature and moisture loads will often occur at different times of the day.

Cautionary Note: The values displayed here assume that the inside air is maintained at 68 °F/30% RH during the winter and at 75 °F, 60% RH during the summer. If the inside conditions are held in a different range of temperature or moisture, the loads will be different. For example, in calculating loads for humidity-controlled, but unheated storage, the loads vary according to the change in both temperature and humidity, since the inside temperature varies, but the inside humidity is held constant. For estimating loads in that or similar applications, the engineer may obtain better results from using the average maximum weekly humidity data shown on sample pages 11 and 12.

Figure 10. Sample Data Set Page 14

SCOTT AFB/BELLEVILLE IL WMO No. 724338

Average Ventilation and Infiltration Loads
(Outside Air vs. 75°F, 60% RH summer; 68°F, 30% RH winter)



	Average Sensible Cooling Load (Btu/cfm)	Average Sensible Heating Load (Btu/cfm)	Average Latent Cooling Load (Btu/cfm)	Average Latent Heating Load (Btu/cfm)
JAN	0	-30775	1	-5940
FEB	0	-24966	3	-4532
MAR	34	-18713	57	-2613
APR	227	-9959	222	-826
MAY	843	-4462	1787	-87
JUN	2828	-981	6087	-1
JUL	4255	-341	11159	0
AUG	3285	-705	9343	0
SEP	1350	-3230	3729	-24
OCT	215	-9619	515	-527
NOV	8	-18010	85	-2268
DEC	0	-26811	10	-4609
ANN	13045	-148572	32998	-21427

SOLAR RADIATION DATA (pages 15-16)

Explanation of Charts:

This data is reproduced courtesy of the National Renewable Energy Laboratory (NREL). The data were first published in their *Solar Radiation Data Manual for Buildings* (1995). The user should refer to that publication for a complete description of how to use this data.

The site used in each station record is the nearest NREL-published site available within a 1.5º latitude radius from the desired location. Therefore, some sites may be several miles away, and in some cases the NREL location may be in a neighboring state. Caution should be used when the nearest site available is not in the same city as the desired location, as significant differences in cloud climatology can exist over short distances.

When this handbook was prepared, the only sites available from NREL were the 50 states, Puerto Rico, and Guam. These pages are blank at locations where solar radiation data is not available. For these locations, users may wish to contact NREL directly to obtain advice concerning data not published in the NREL solar radiation data manual.

Suggestions for Use. The solar data presented here can be used for calculating solar radiation cooling loads on building envelopes, and also for estimating the value of solar illumination for daylighting calculations. Again, the user should refer to the *Solar Radiation Data Manual for Buildings* for a complete description of how to use this data.

Cautionary Note: The data source for the NREL reports comes from the National Solar Radiation Database — not the data set used to calculate peak design values and other monthly temperature and moisture data in this handbook. The two data sets will differ for many reasons, including different periods of record, measurement locations, sampling methodology and frequency, and differences in calculation methodology. Consequently, the user should expect differences in degree-days, min/max temperatures, and humidities between this data and that calculated by the AFCCC. For design criteria, use the temperature and moisture values presented on the Design Criteria Data page of this handbook. These were calculated more recently, and used a longer POR. Also, they are taken from records at DoD locations rather than from civilian locations near — but not always identical to — the military data collection points.

Figure 11. Sample Data Set Pages 15-16

Average Annual Solar Radiation – Nearest Available Site

(Source: National Renewable Energy Laboratory, Golden CO, 1995)

City:	ST. LOUIS
State:	MO
WBAN No:	13994
Lat(N):	38.75
Long(W):	90.38
Elev(ft):	564

Stn Type:	Secondary
SHADING GEOMETRY IN DIMENSIONLESS UNITS	
Window:	1
Overhang:	0.498
Vert Gap:	0.314

AVERAGE INCIDENT SOLAR RADIATION (Btu/sq.ft./day), Percentage Uncertainty = 9

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
HORIZ	Global	690	930	1230	1590	1860	2030	2020	1800	1460	1100	720	580	1340
	Std Dev	56	69	98	135	138	114	120	110	112	98	69	57	42
	Minimum	550	800	1060	1370	1550	1830	1750	1570	1190	870	590	490	1280
	Maximum	780	1070	1430	1930	2180	2350	2240	1960	1690	1250	870	710	1480
	Diffuse	340	460	590	710	810	840	810	730	600	430	350	300	580
Clear Day	Global	950	1300	1760	2230	2520	2630	2550	2290	1870	1400	1000	840	1780
NORTH	Global	210	280	360	440	550	630	600	490	380	290	220	190	390
	Diffuse	210	280	360	430	500	530	520	460	380	290	220	190	370
Clear Day	Global	190	250	330	430	580	680	630	470	360	270	200	170	380
EAST	Global	460	590	750	920	1060	1140	1130	1050	880	710	470	390	800
	Diffuse	260	340	440	530	600	640	620	570	470	360	270	230	440
Clear Day	Global	710	910	1150	1340	1440	1460	1430	1340	1170	940	730	640	1110
SOUTH	Global	1080	1110	1060	970	830	780	820	950	1110	1220	1020	940	990
	Diffuse	370	440	500	540	560	570	570	560	520	440	360	330	480
Clear Day	Global	1930	1970	1770	1380	1040	890	950	1210	1580	1840	1870	1860	1520
WEST	Global	470	600	740	920	1040	1110	1120	1030	880	700	480	390	790
	Diffuse	260	340	440	530	610	650	630	580	480	360	270	230	450
Clear Day	Global	710	910	1150	1340	1440	1460	1430	1340	1170	940	730	640	1110

Figure 1.11. Sample Data Set Pages 15-16 (Continued)

Average Annual Solar Heat and Illumination – Nearest Available Site
(Source: National Renewable Energy Laboratory, Golden CO, 1995)

AVERAGE TRANSMITTED SOLAR RADIATION (Btu/sq.ft./day) FOR DOUBLE GLAZING, Percentage Uncertainty = 9														
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
HORIZ	Unshaded	450	640	870	1150	1350	1480	1470	1300	1040	770	480	370	950
NORTH	Unshaded	150	190	250	300	370	410	390	330	260	200	150	130	260
	Shaded	130	170	220	270	330	370	350	300	240	180	140	110	230
EAST	Unshaded	320	410	530	660	750	810	810	750	620	500	320	270	560
	Shaded	290	370	470	570	650	700	700	650	550	450	290	240	490
SOUTH	Unshaded	810	810	740	630	510	470	490	600	750	870	760	700	680
	Shaded	790	750	590	420	350	360	360	390	550	770	730	680	560
WEST	Unshaded	320	420	520	650	740	790	800	740	620	490	330	270	560
	Shaded	290	370	460	570	640	680	690	640	550	440	300	240	490

AVERAGE INCIDENT ILLUMINANCE (klux-hr) FOR MOSTLY CLEAR AND MOSTLY CLOUDY CONDITIONS, Percentage Uncertainty = 9											
				March					June		
		9am	11am	1pm	3pm	5pm	9am	11am	1pm	3pm	5pm
HORIZ.	M.Clear	40	73	82	64	26	48	84	101	96	67
	M.Cloudy	23	45	52	40	16	32	61	76	71	49
NORTH	M.Clear	10	14	15	13	8	19	16	17	17	15
	M.Cloudy	9	16	17	14	7	15	18	19	19	16
EAST	M.Clear	75	56	15	13	8	78	72	31	17	15
	M.Cloudy	25	30	17	14	7	40	49	27	19	16
SOUTH	M.Clear	40	73	82	64	26	12	31	45	41	19
	M.Cloudy	17	36	43	32	12	12	26	37	33	18
WEST	M.Clear	10	14	24	67	64	12	16	17	53	78
	M.Cloudy	9	16	21	33	22	12	18	19	41	50
M.Clear	(% hrs)	32	28	27	28	29	43	39	32	29	34
				Sept					Dec		
		9am	11am	1pm	3pm	5pm	9am	11am	1pm	3pm	5pm
HORIZ.	M.Clear	29	68	86	78	47	16	42	48	30	2
	M.Cloudy	17	42	58	53	31	9	25	28	17	2
NORTH	M.Clear	9	14	16	15	12	6	10	11	8	1
	M.Cloudy	7	15	18	17	12	4	10	11	7	1
EAST	M.Clear	65	70	28	15	12	42	39	11	8	1
	M.Cloudy	23	36	23	17	12	11	18	11	7	1
SOUTH	M.Clear	21	57	75	67	37	39	82	88	63	6
	M.Cloudy	11	31	45	41	21	10	29	32	20	2
WEST	M.Clear	9	14	16	54	74	6	10	22	50	9
	M.Cloudy	7	15	18	35	35	4	10	14	17	2
M.Clear	(% hrs)	47	47	41	41	43	31	30	30	30	32

WIND SUMMARY (pages 17-18)

Explanation of Charts:

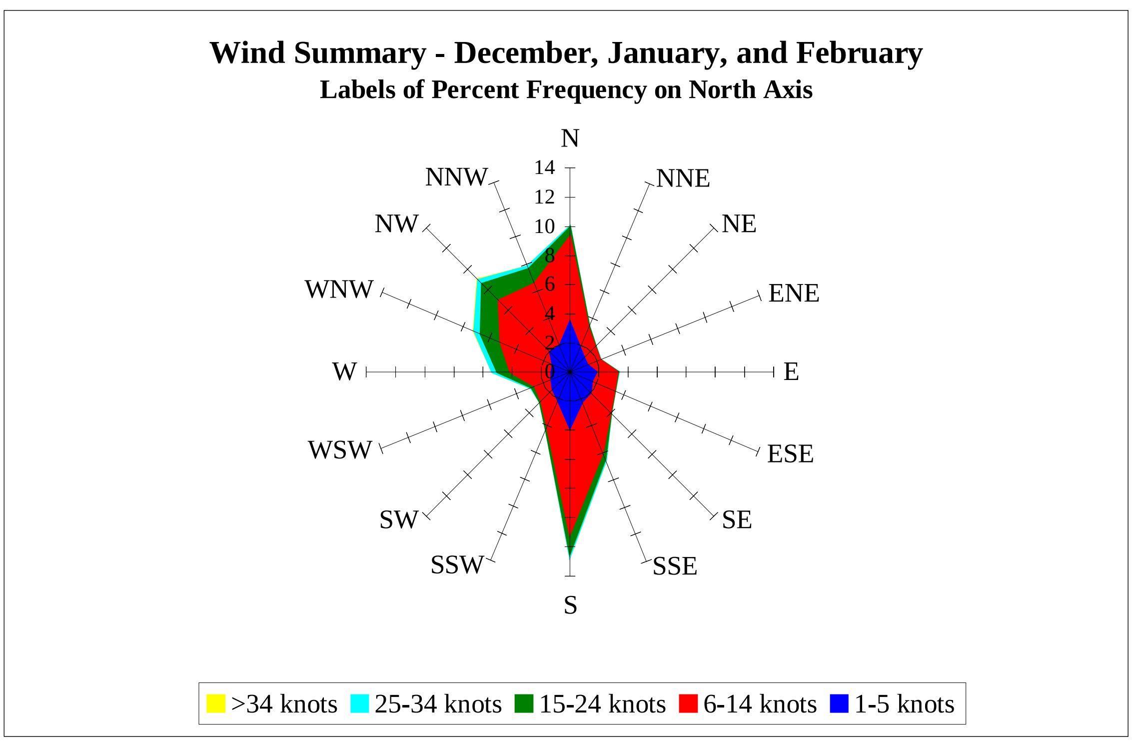
These charts depict the frequency of different wind direction and wind speed combinations. The observations are binned into the sixteen cardinal compass directions and five speed categories (1-5 knots, 6-14 knots, 15-24 knots, 25-34 knots, and greater than 34 knots). The frequency of direction and the tick marks indicating that value lie along each 'spoke' of the wind chart. The wind speed bins for each direction are color-coded by the legend at the bottom of the chart.

To determine the percent frequency of a particular wind direction, look for the tick mark bounding the outer edge of a colored (wind speed) area. In the case of the first wind speed bin (1-5 knots), the percent frequency is simply the value of the tick mark on the outer edge of the 1-5 knot region. For the higher speed bins (6-14 knots or greater), subtract the earlier spoke values from the value shown to get the frequency for the speed bin in question.

The values for percent frequency have been summed by direction, so to determine the total percent frequency for all speeds from a particular direction, look up the tick mark (or interpolated value) bounding the outermost colored area along that spoke. That tick mark represents the total percent frequency of wind from that direction.

Since the calm condition has no direction, the percent occurrence of calm conditions is displayed immediately below the chart.

Sample Wind Summary Chart. The wind summary charts are prepared by three-month seasons, over all hours (December, January, February for northern hemisphere winter or southern hemisphere summer; March, April, May for northern hemisphere spring or southern hemisphere fall, and so on). See the following sample wind summary chart for an example of determining percent frequencies.



Percent Calm = 12.82

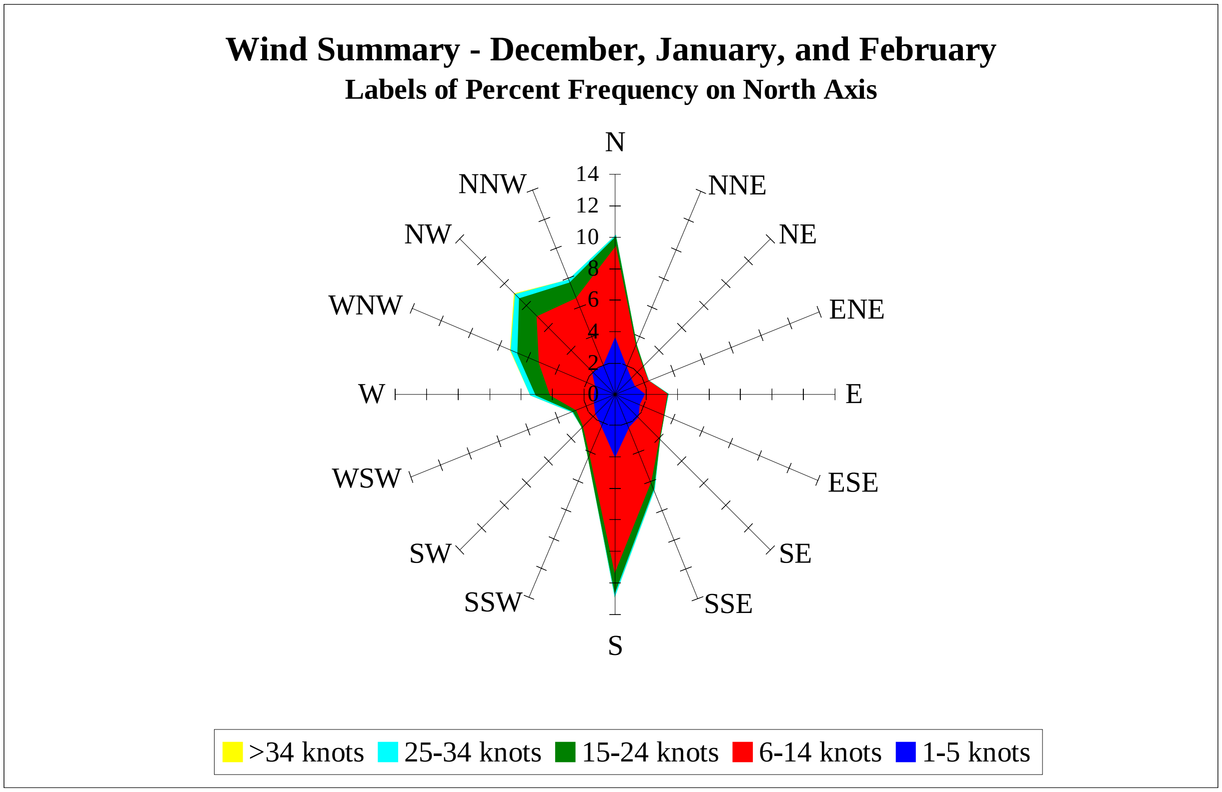
From the above sample wind summary chart, the percent frequency of wind between 1-5 knots and from the north (N) is about 3%. The percent frequency of wind between 6-14 knots and from the northwest (NW) is about 5% (7% - 2%). The percent frequency of all wind speeds from the south (S) is about 12%. The percent frequency of all wind directions from the west through north (W, WNW, NW, NNW, and N) is about 38% (5% + 7% + 8% + 8% + 10%, respectively). It is easy to determine that wind speeds greater than 34 knots almost never occur (or are such a small frequency from any direction), because the colored area (yellow) is not shown or is indistinguishable because it is so small.

The percent of time the wind is calm is indicated in the lower left corner of the chart, in this case 12.82%. When the outermost value from each of the 16 directions are summed and added to the percent calm the result is 100% (allowing for rounding). Occurrences of variable wind direction are omitted from the sample before computing percent frequency by direction.

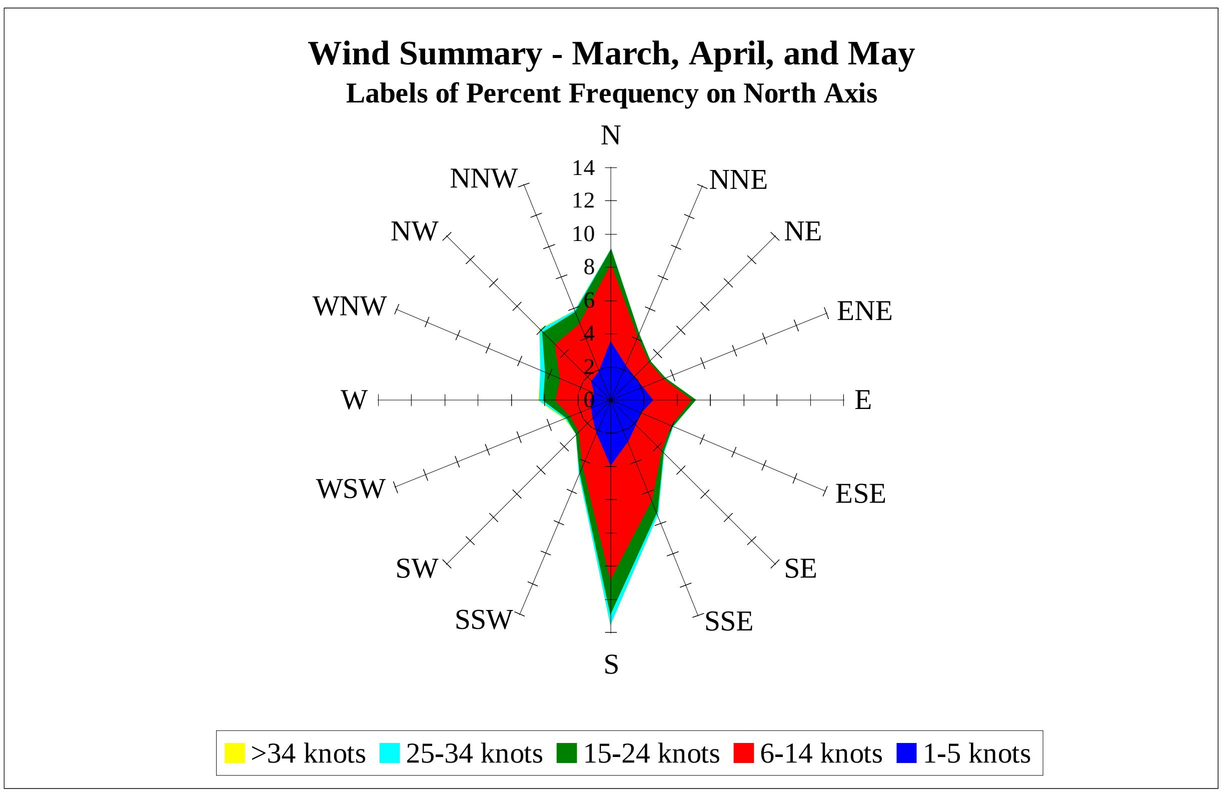
Suggestions for Use. Knowing the probable wind speed and direction in a particular season can be helpful in construction and mission planning as well as in designing structures which must face severe wind-driven rain or drifting snow. Engineers designing heating and air conditioning systems which draw fresh air from the weather, and exhaust-contaminated building air can use these data to minimize the potential for cross-contamination between supply and exhaust air streams. Also, when accumulation on roofs of drifting snow is likely, this information can be helpful for locating inlet and exhaust ducts so they are less likely to be covered by snowdrifts.

Cautionary Note: The wind currents around any building are strongly affected by the geometry of the building and the topography of the site as well as any surrounding buildings. The wind data used for these wind summaries are typical of flat and open airfields, where there are no obstructions near the observation point.

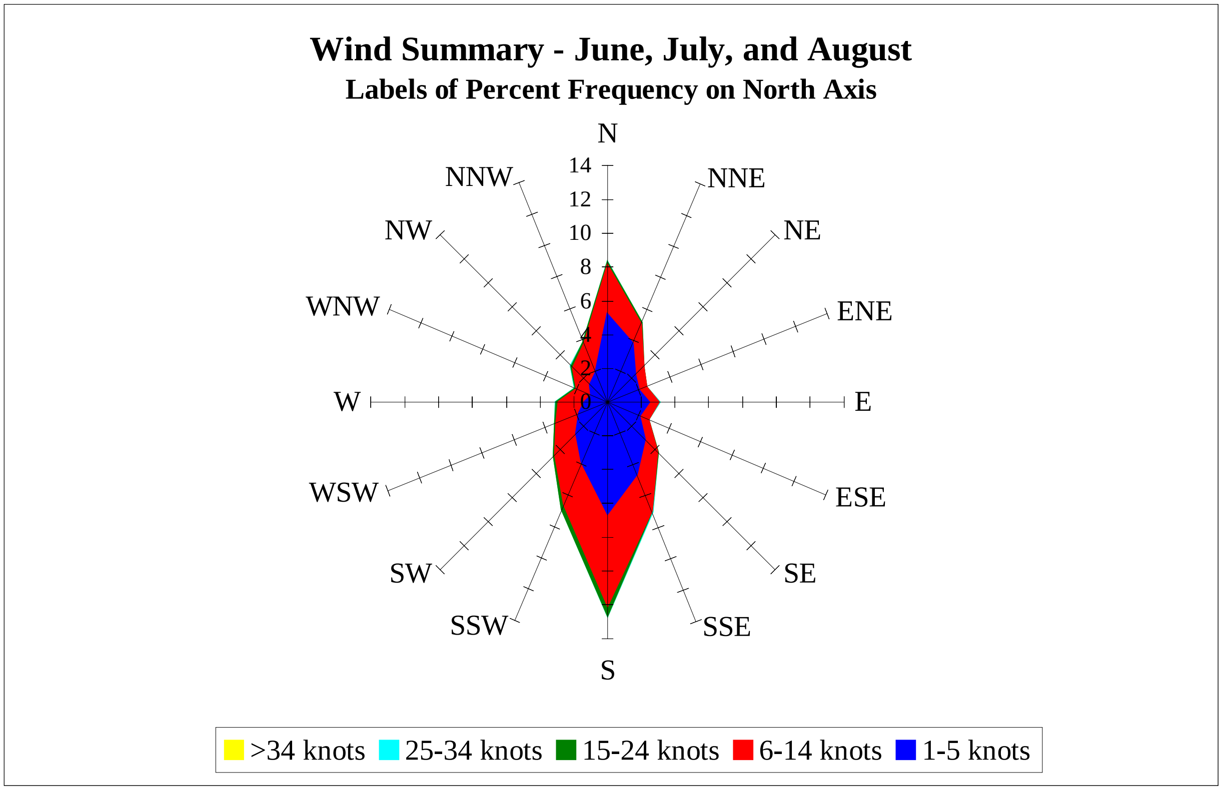
Figure 12. Sample Data Set Pages 17-18



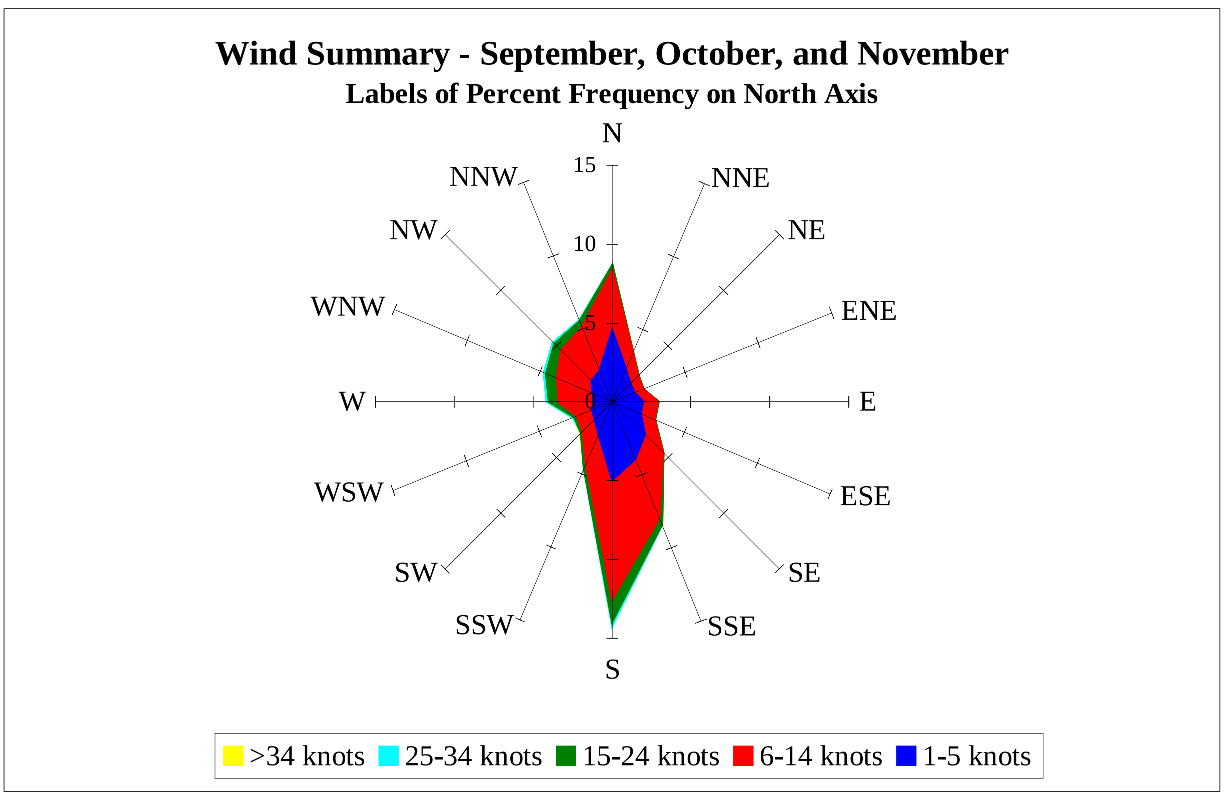
Percent Calm = 12.82



Percent Calm = 14.93



Percent Calm = 25.11



Percent Calm = 20.73

REFERENCES AND SUPPORTING INFORMATION

Section A—References

1997 ASHRAE Handbook: Fundamentals, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA

Anderson, Keith E., *Ground Water Handbook*, National Ground Water Association, Dublin, OH

Fact Book of the Society of American Military Engineers, Society of American Military Engineers, June 1995 (Prince Street, Bldg 607, Alexandria, VA 22314 [Tel: 1-800-336-3097])

Harriman, Plager, and Kosar, "Dehumidification and Cooling Loads from Ventilation Air," *ASHRAE Journal*, November, 1997, pp: 37-45, American Society of Heating, Air Conditioning and Refrigerating Engineers, Atlanta, GA, 1997

International Plumbing Code, Building Officials and Code Administrators (BOCA) International, Inc., Country Club Hills, IL, 1995

Judge, James, P.E., *PSYFUNC Algorithms*, LINRIC Co., Bedford, NH, 1996

Minimum Design Loads for Buildings and Other Structures, ANSI/ASCE 7-95, American Society of Civil Engineers, New York, NY

Solar Radiation Data Manual for Buildings, National Renewable Energy Laboratory, Golden, CO, 1995

TI 809-01, Load Assumptions for Buildings, 1986, U.S. Army Corps of Engineers

Section B— Abbreviations and Acronyms

Btu/lb—British thermal units per pound of air (enthalpy)

Btu/sq ft/day—Btu per square foot per day (solar radiation)

cm—Centimeter (frost depth)

cm/hr—Centimeters per hour (rain rate)

gr/lb—Grains per pound (humidity ratio, grains of water vapor per pound of air)

gr/kg—Grams per kilogram (humidity ratio, grams of water vapor per kilogram of air)

in Hg—Inches of mercury (atmospheric pressure)

in—Inches (frost depth)

in/hr—Inches per hour (rain rate)

kBtu/cfm —Thousands of Btu per cubic foot per minute (sensible or latent heating or cooling loads)

klux-hr—Thousands of lux-hours (average incident illuminance)

lb/sq ft—pounds per square foot (snow load)

mb Hg—millibars of mercury (atmospheric pressure)

mph—miles per hour (wind speed)

ton-hrs/cfm/yr—ton-hours of load per cubic foot per minute per year (Btu÷12,000)