

SECTION 11

Cooling Towers

FIG. 11-1
Nomenclature

AVR = actual volumetric flow rate of air-vapor mixture, m^3/h	kg_s = kilograms of dry air
akw = air power, kW	kg_w = kilograms of water
AWB = ambient wet bulb temperature, $^{\circ}\text{C}$	L = water rate, $\text{kg}/(\text{m}^2 \cdot \text{h})$
B = combined water loss through blowdown and windage, % of circulating water or m^3/h	L/G = liquid to gas ratio, kg/kg
CWT = cold water temperature, $^{\circ}\text{C}$	MCDB = mean coincident dry bulb temperature, $^{\circ}\text{C}$
DB = dry bulb temperature, $^{\circ}\text{C}$	MCWB = mean coincident wet bulb temperature, $^{\circ}\text{C}$
E = water evaporated, % of circulating water or m^3/h	Q = m^3/h
G = air rate, $\text{kg}/(\text{m}^2 \cdot \text{h})$	PF = performance factor, dimensionless
h_a = specific enthalpy of dry air, kJ/kg	R = cooling tower range, $^{\circ}\text{C}$
h_{as} = $h_s - h_a$, kJ/kg	V = air velocity, m/h
h_s = enthalpy of moist air at saturation per kg of dry air, kJ/kg	v_a = specific volume of dry air, m^3/kg
HWT = hot water temperature, $^{\circ}\text{C}$	v_{as} = $v_s - v_a$, m^3/kg
	v_s = volume of moist air at saturation per kg of dry air, m^3/kg
	W_s = kg_w/kg_a , humidity ratio at saturation
	WB = wet bulb temperature, $^{\circ}\text{C}$

DEFINITIONS OF WORDS AND PHRASES USED IN COOLING TOWERS

Air inlet: Opening in a cooling tower through which air enters. Sometimes referred to as the louvered face on induced draft towers.

Air power: The power output developed by a fan in moving a given air rate against a given resistance.

Air rate: Mass flow of dry air per square foot of cross-sectional area in the tower's heat transfer region per hour.

Air velocity: Velocity of air-vapor mixture through a specific region of the tower (i.e. the fan).

Ambient wet-bulb temperature: The wet-bulb temperature of the air encompassing a cooling tower, not including any temperature contribution by the tower itself. Generally measured upwind of a tower, in a number of locations sufficient to account for all extraneous sources of heat.

Approach: Difference between the cold water temperature and the entering wet-bulb temperature.

Approach (Wet Surface Air Cooler): Difference between the process outlet fluid and the ambient inlet wet-bulb temperature.

Blowdown: Water discharged from the system to control concentrations of salt or other impurities in the circulating water.

Capacity: The amount of water that a cooling tower will cool through a specified range, at a specified approach and wet-bulb temperature.

Capacity: (Wet Surface Air Cooler) The total amount of heat rejected by the wet surface air cooler to atmosphere.

Cell: Smallest tower subdivision which can function as an independent unit with regard to air and water flow; it is bounded by either exterior walls or partition walls. Each cell may have one or more fans and one or more distribution systems.

Circulation rate: Actual water flow rate through a given tower.

Circulation rate: (Wet Surface Air Cooler) Actual water flow over the top of the tube bundles.

Cold water temperature: Temperature of the water leaving the collection basin, exclusive of any temperature effects incurred by the addition of makeup and/or the removal of blowdown.

Collection basin: Chamber below and integral with the tower where water is transiently collected and directed to the sump or pump suction line.

Counterflow: Air flow direction through the fill is countercurrent to that of the falling water.

Crossflow: Air flow direction through the fill is essentially perpendicular to that of the falling water.

Distribution basin: Shallow pan-type elevated basin used to distribute hot water over the tower fill by means of orifices in the basin floor. Application is normally limited to crossflow towers.

Double-flow: A crossflow cooling tower where two opposed fill banks are served by a common air plenum.

Drift: Circulating water loss from the tower as liquid droplets entrained in the exhaust air stream. Units percent of circulating water rate or gpm. [For more precise work, an L/G parameter is used, and drift becomes kilograms of water per million kilograms of exhaust air (ppmw).]

Drift eliminators: An assembly of baffles or labyrinth passages through which the air passes prior to its exit from the tower, for the purpose of removing entrained water droplets from the exhaust air.

Dry-bulb temperature: The temperature of the entering or ambient air adjacent to the cooling tower as measured with a dry-bulb thermometer.

Evaporation loss: Water evaporated from the circulating water into the air stream in the cooling process.

Face area: (Wet Surface Air Cooler) The area over the top of the tube bundles open to atmosphere.

Fan cylinder: Cylindrical or venturi-shaped structure in which a propeller fan operates. Sometimes referred to as a fan “stack” on larger towers.

Fan deck: Surface enclosing the top of an induced draft cooling tower, exclusive of the distribution basins on a crossflow tower.

Fan pitch: The angle which the blades of a propeller fan make with the plane of rotation, measured at a prescribed point on each blade.

Fill: That portion of a cooling tower which constitutes its primary heat transfer surface. Sometimes referred to as “packing.”

Forced draft: Refers to the movement of air under pressure through a cooling tower. Fans of forced draft towers are located at the air inlets to “force” air through the tower.

Hot water temperature: Temperature of circulating water entering the cooling tower’s distribution system.

Induced draft: Refers to the movement of air through a cooling tower by means of an induced partial vacuum. Fans of induced draft towers are located at the air discharges to “draw” air through the tower.

Liquid-to-gas ratio: A ratio of the total mass flows of water and dry air in a cooling tower. (See Air Rate and Water Rate)

Louvers: Blade or passage type assemblies installed at the air inlet face of a cooling tower to control water splashout and/or promote uniform air flow through the fill. In the case of film-type crossflow fill, they may be integrally molded to the fill sheets.

Louvers: (Wet Surface Air Cooler) Blade or passage type assemblies that are used to potentially block off a fan or section of the fan plenum to prevent short circuiting. Louvers would be installed above the drift eliminators and below the fan. Louvers are not always required in a WSAC.

Makeup: Water added to the circulating water system to replace water lost by evaporation, drift, windage, blowdown, and leakage.

Natural draft: Refers to the movement of air through a cooling tower purely by natural means. Typically, by the driving force of a density differential.

Net effect volume: That portion of the total structural volume within which the circulating water is in intimate contact with the flowing air.

Performance factor: Variable used in determining performance characteristics in cooling towers.

Psychrometer: An instrument incorporating both a dry-bulb and a wet-bulb thermometer, by which simultaneous dry-bulb and wet-bulb temperature readings can be taken.

Range: Difference between the hot water temperature and the cold water temperature.

Recirculation: Describes a condition in which a portion of the tower’s discharge air re-enters the air inlets along with the fresh air. Its effect is an elevation of the average entering wet-bulb temperatures compared to the ambient.

Series flow: (Wet Surface Air Cooler) When approach temperatures are small, several stages may need to be incorporated to achieve proper cooling. Most cases require a two stage series flow and incorporate a hot side and cold side of the cooler.

Water basin: (Wet Surface Air Cooler) The lower section of the cooler used to hold recirculation water.

Water rate: Mass flow of water per square foot of fill plan area of the cooling tower per hour.

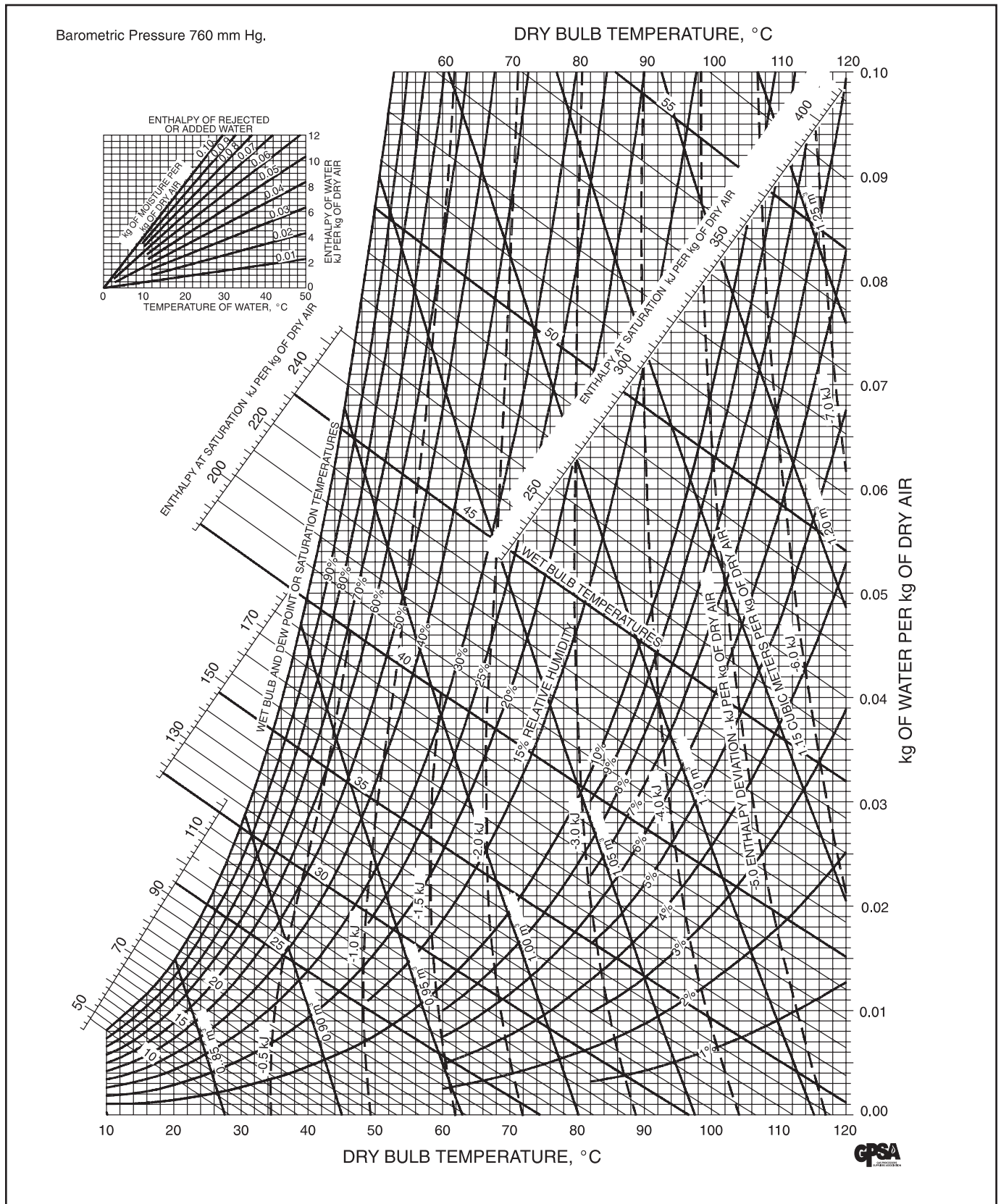
Wet-bulb temperature: the temperature of the entering or ambient air adjacent to the cooling tower as measured with a wet-bulb thermometer.

Wet-Bulb thermometer: A thermometer whose bulb is encased within a wetted wick.

Windage: Water lost from the tower because of the effects of wind.

Wind load: The load imposed upon a structure by a wind blowing against its surface.

FIG. 11-2
Psychrometric Chart



INTRODUCTION

The purpose of this section is to provide a basic understanding of the design and operation of a cooling tower. A cooling tower allows water to be cooled by ambient air through evaporation.

COOLING TOWER PSYCHROMETRICS

Psychrometry is the study of cooling by evaporation. Maximum evaporation takes place when water, in the form of tiny droplets, is exposed to the maximum air flow for the longest possible time. The process of evaporation through removal of latent heat allows the water to be cooled below the ambient dry-bulb temperature. The dry air enters the cooling tower and begins to gain moisture and enthalpy in an effort to reach equilibrium with the water. The water may be cooled 8 °C or more while the air mass dry-bulb temperature may increase only slightly. A psychrometric chart (Fig. 11-2) may be used to illustrate the relationships between wet- and dry-bulb temperatures. All nomenclature is indicated in Fig. 11-1.

Wet-bulb Temperature

The basis for thermal design of an evaporative type cooling tower is the wet-bulb temperature of the air entering the tower. Water cannot be cooled below the wet-bulb temperature by evaporation. The air entering the tower at a temperature of 24 °C and 100% relative humidity has a 24 °C “wet-bulb” temperature. The wet-bulb temperature is usually measured using a sling psychrometer. Wet bulb and dry bulb data for various locations around the world are shown in Fig. 11-3.

A cooling tower is sized to reject a given amount of heat (kJ/h) at a given wet bulb temperature (WB) — typically for the warmest time of year or as defined by ASHRAE. By definition, the wet bulb is the 100% saturated temperature for a given air sample. The dry bulb temperature will generally be a value higher than the WB. As the relative humidity (RH%) increases toward 100%, the difference between WB and DB decreases, until at 100% RH when the wet bulb equals the dry bulb.

As the relative humidity of air changes, so does the corresponding WB. Since the cooling tower unit operates with respect to WB, the RH of the air is not directly related to the amount of water evaporated. What does occur is that as the RH of the air decreases so does the WB.

Types of Cooling Systems

Cooling water is circulated through equipment to absorb and carry away heat. The basic cooling systems are shown in Fig. 11-4. The open recirculating system is the most common for industrial plants.

The open recirculating system routes cooled water through the heat-exchange equipment. Effluent warm water then is cooled by contact with air in a cooling tower. The cooling effect is produced by evaporation of a portion of the circulating water, and this evaporation causes the dissolved solids in the water to become concentrated. Water lost by evaporation must be replaced by makeup water. But water lost through entrainment of droplets in the circulating air (windage or drift) tends to limit the degree of concentration since the entrained droplets also contain dissolved solids. Windage loss varies with the type of tower.

Typical windage losses, expressed as percentages of the total system water circulation rate, for different evaporative equipment are as follows:

Spray ponds	1.0 to 5.0%
Atmospheric-draft towers	0.3 to 1.0%
Mechanical-draft towers	0.1 to 0.3%

$$\text{Total Makeup} = \text{Evaporation Rate} + \text{Blowdown} + \text{Drift}$$

In any cooling tower systems, evaporation is based on the amount of heat rejected, therefore 2326 kJ are required to evaporate 1 kg of water. Evaporation can be estimated by doing a simple conversion of latent heat of evaporation of water (2326 kJ/kg) and converting it to m³/h. The derivation is as follows:

$$\text{Evaporation rate} = \frac{\text{Total Heat Load (kJ/h)}}{2326 \text{ kJ/kg} \cdot 1000 \text{ kg/m}^3}$$

$$\text{Rate} = \frac{\text{Total Heat Load (kJ/h)}}{2326000} = \text{m}^3/\text{h}$$

A closed loop evaporative process cooler, sometimes referred to as a Wet Surface Air Cooler (WSAC) can be used in a variety of applications in place of a cooling tower / heat exchanger or finned air cooled exchanger. A WSAC can cool process fluids directly based on an approach to the ambient wet bulb temperature. Operational characteristics are similar to a cooling tower, but combine features of a shell & tube heat exchanger in one piece of equipment. There are several key advantages in using a WSAC in a given application.

- Lower process outlet temperatures
- Lower operational horsepower
- Reduced water consumption due to reduced drift losses

When the Wet Surface Air Cooler is operating at a WB level below the design value, it continues to remove heat and reduce the temperature of the fluid being cooled by approximately the same amount as it does at the design WB. Additionally, the approach temperature (the difference between the WB and fluid exit temperature from the unit) also remains the same. It is useful to remember that the heat transfer surface area within the unit remains constant; thereby the capacity to remove heat does not change as long as there are temperature gradients between the various fluids. The efficiency at which heat is removed does fluctuate somewhat and shows up as a lower overall heat coefficient at the lower temperatures.

Tower Location

Local heat sources upwind of the cooling tower can elevate the wet-bulb temperature of the air entering the tower. Interference occurs when a portion of the saturated air upwind of the tower contaminates the ambient air of a downwind tower. Drift and condensed water can cause corrosion problems with downwind equipment.

FIG. 11-3
Dry Bulb/Wet Bulb Temperature Data for Selected Locations²

Meaning of acronyms:
 DB: Dry bulb temperature, °C
 MCWB: Mean coincident wet bulb temperature, °C
 The Dry Bulb and Wet Bulb temperatures which are equalled
 or exceeded by the given percentage, on average, of the time
 during the warmest consecutive four months.

Lat: Latitude, °
 Long: Longitude, °
 MCDB: Mean coincident dry bulb temperature, °C
 WB: Wet bulb temperature, °C
 Elev: Elevation, m

Station	Lat	Long	Elev	Cooling DB/MCWB		Evaporation WB/MCDB		1%	2%	0.4%	1%
				1%	2%	1%	2%				
United States of America											
Alabama											
AUBURN OPELIKA ROBE	32.62N	85.43W	237	33.0	23.5	32.3	23.3	25.5	31.3	25.0	30.7
BIRMINGHAM MUNI	33.56N	86.75W	192	33.9	23.6	32.7	23.5	25.8	31.4	25.3	30.9
CAIRNS AAF	31.28N	85.71W	92	34.6	24.7	33.4	24.5	27.3	31.9	26.6	31.3
GADSDEN MUNI	33.97N	86.08W	173	32.9	23.6	32.2	23.5	25.6	31.7	25.1	31.1
HUNTSVILLE/MADISON	34.64N	86.79W	196	33.8	23.7	32.6	23.4	25.8	31.3	25.3	30.9
MAXWELL AFB	32.38N	86.36W	52	35.2	24.8	34.1	24.6	27.0	32.9	26.5	32.3
MOBILE/BATES FIELD	30.69N	88.25W	67	33.3	24.7	32.5	24.5	26.7	31.4	26.2	30.7
MONTGOMERY/DANNELLY	32.30N	86.39W	62	34.7	24.4	33.7	24.3	26.5	32.6	25.9	31.8
TUSCALOOSA RGNL	33.21N	87.62W	57	34.6	24.4	33.5	24.2	26.4	32.6	25.8	31.8
Alaska											
FAIRBANKS INTL ARPT	64.82N	147.86W	138	25.7	15.5	23.8	14.8	17.3	25.0	16.4	23.5
FT. RICHARDSON/BRYA	61.27N	149.65W	115	22.0	14.9	20.1	13.9	16.5	22.6	15.4	20.8
ANCHORAGE/ELMENDORF	61.25N	149.79W	65	22.0	14.3	20.0	13.5	16.0	21.1	15.2	19.6
ANCHORAGE INTL ARPT	61.18N	149.99W	40	20.1	14.1	18.8	13.5	15.8	20.5	14.9	19.0
MERRILL FLD	61.22N	149.86W	42	21.3	14.6	19.9	13.9	16.3	21.3	15.4	19.8
JUNEAU	58.36N	134.58W	7	21.2	14.5	19.2	13.7	16.2	21.8	15.3	19.7
Arizona											
DAVIS MONTHAN AFB	32.17N	110.88W	824	39.8	18.2	38.0	18.0	22.9	28.4	22.4	29.2
FLAGSTAFF AIRPORT	35.14N	111.67W	2139	28.5	12.8	27.3	12.7	16.3	22.8	15.6	22.5
LUKE AFB	33.54N	112.38W	331	42.6	21.5	41.3	21.4	25.0	36.5	24.3	35.8
PHOENIX/SKY HARBOR	33.44N	111.99W	337	42.4	20.8	41.3	20.7	24.4	35.4	23.9	35.2
ERNEST A LOVE FLD	34.65N	112.42W	1540	33.1	15.7	32.2	15.5	19.2	27.4	18.5	26.7
TUCSON INTL	32.13N	110.96W	779	39.8	18.9	38.6	18.7	22.6	31.4	22.1	31.1
YUMA INTL AIRPORT	32.65N	114.60W	63	42.6	23.0	41.5	22.6	26.6	36.0	25.8	35.6
Arkansas											
BENTONVILLE MUNI THA	36.35N	94.22W	395	32.9	23.9	32.2	23.6	25.3	32.1	24.7	31.2
FORT SMITH MUNI	35.33N	94.37W	141	36.0	24.7	34.4	24.5	26.5	33.6	25.9	32.9
JONESBORO MUNI	35.83N	90.65W	84	34.5	24.6	33.3	24.3	26.8	32.9	26.1	32.3
ADAMS FLD	34.75N	92.23W	78	35.3	25.2	34.0	24.7	26.8	33.3	26.2	32.8
LITTLE ROCK/ADAMS F	34.83N	92.25W	173	33.9	24.6	32.7	24.2	26.2	32.4	25.6	31.6
GRIDER FLD	34.18N	91.94W	65	35.0	25.2	33.9	24.9	26.9	33.3	26.3	32.8
ROGERS MUNI CARTER F	36.37N	94.10W	412	32.8	23.3	31.9	23.1	25.1	31.2	24.4	30.2
TEXARKANA RGNL WEBB	33.45N	94.01W	122	35.7	24.6	34.2	24.5	26.4	33.0	25.9	32.3
California											
ALAMEDA(USN)	37.73N	122.32W	4	26.1	17.5	24.1	16.9	19.1	25.9	18.4	24.5
BAKERSFIELD/MEADOWS	35.43N	119.06W	150	38.0	20.8	36.8	20.3	23.1	36.4	22.2	35.4
BEALE AFB	39.14N	121.44W	34	36.7	20.7	35.0	20.0	22.8	35.6	21.8	34.2
BURBANK/GLENDALE	34.20N	118.36W	223	34.3	19.3	32.7	19.0	22.5	32.0	21.6	30.8
CAMP PENDLETON MCAS	33.30N	117.35W	24	31.1	18.7	29.0	18.6	22.0	28.7	21.3	27.8
MC CLELLAN PALOMAR	33.13N	117.28W	100	27.1	17.5	25.1	17.7	21.1	24.8	20.4	24.0
CASTLE AFB/MERCED	37.37N	120.57W	60	36.1	20.7	34.7	20.2	22.4	34.9	21.6	34.1
FRESNO AIR TERMINAL	36.78N	119.72W	100	38.2	20.7	37.0	20.1	23.0	36.4	22.2	35.1
FULLERTON MUNICIPAL	33.87N	117.98W	29	32.6	19.3	31.1	19.3	22.4	30.3	21.7	29.1
IMPERIAL CO	32.83N	115.58W	-17	44.0	22.7	42.8	22.6	42.1	22.5	27.3	36.3
LANCASTER/FOX FIELD	34.74N	118.22W	713	39.1	18.9	37.8	18.0	36.5	17.5	20.3	35.5
LEMOORE NAS	36.33N	119.95W	71	39.5	22.0	37.9	21.2	36.9	20.6	23.7	36.4
LOMPOC	34.67N	120.47W	27	27.5	16.0	25.1	16.1	23.1	15.7	18.5	24.1
LONG BEACH/LB AIRP.	33.83N	118.16W	12	32.8	19.3	30.9	19.2	28.9	18.8	22.2	28.4
LOS ANGELES INTL	33.94N	118.41W	99	28.7	17.4	26.9	17.5	25.3	17.9	21.1	25.1
MC CLELLAN AFLD	38.67N	121.40W	23	38.9	21.2	37.4	20.7	35.6	20.0	22.4	36.4
MODESTO CITY CO HAR	37.63N	120.95W	30	38.7	21.3	37.1	20.3	35.4	19.7	22.3	35.9
MONTEREY PENINSULA	36.59N	121.85W	67	26.1	15.7	22.9	15.1	22.0	14.9	17.1	22.4
NAPA CO	38.21N	122.28W	17	33.0	18.8	30.8	18.5	28.0	17.6	20.2	30.3
SAN BERNARDINO INTL	34.08N	117.23W	353	39.4	20.9	37.9	20.8	36.3	20.4	23.6	35.0
OAKLAND/METROP. OAK	37.76N	122.22W	27	27.9	18.0	25.9	17.4	23.6	16.9	19.1	25.8
ONTARIO INTL ARPT	34.05N	117.57W	287	37.8	21.1	36.4	20.5	34.8	20.2	23.3	34.2
PALM SPRINGS INTL	33.83N	116.51W	137	44.0	21.8	42.8	21.6	42.2	21.5	26.2	37.4
POINT ARGUELLO	34.57N	120.63W	34	21.7	N/A	198	N/A	18.4	N/A	N/A	N/A
REDDING MUNICIPAL	40.52N	122.31W	153	41.1	20.5	39.0	19.8	37.4	19.0	22.1	36.2
RIVERSIDE MUNI	33.95N	117.44W	253	37.8	20.8	36.9	20.5	34.8	19.9	22.9	34.3

FIG. 11-3 (Cont'd)
Dry Bulb/Wet Bulb Temperature Data for Selected Locations²

Meaning of acronyms:

DB: Dry bulb temperature, °C

MCWB: Mean coincident wet bulb temperature, °C

The Dry Bulb and Wet Bulb temperatures which are equalled or exceeded by the given percentage, on average, of the time during the warmest consecutive four months.

Lat: Latitude, °

Long: Longitude, °

MCDB: Mean coincident dry bulb temperature, °C

WB: Wet bulb temperature, °C

Elev: Elevation, m

Station	Lat	Long	Elev	Cooling DB/MCWB				Evaporation WB/MCDB			
				1%	2%	DB/MCWB	DB/MCWB	0.4%	1%	WB/MCDB	WB/MCDB
United States of America											
California (Con't)											
SACRAMENTO INTL	38.70N	121.59W	10	38.0	21.4	36.8	20.9	34.9	20.2	22.9	35.9
SAN DIEGO/LINDBERGH	32.74N	117.17W	9	28.4	18.3	26.8	18.5	25.4	18.6	21.6	25.3
NORTH ISLAND NAS	32.70N	117.20W	8	28.6	17.9	27.1	18.4	25.6	18.4	21.6	25.1
MONTGOMERY FLD	32.82N	117.14W	129	32.4	18.8	30.1	18.5	27.9	18.1	21.8	28.1
SAN FRANCISCO INTL	37.62N	122.40W	6	28.2	17.1	25.6	16.6	23.5	16.2	18.6	25.5
SAN LUIS CO RGNL	35.24N	120.64W	63	32.0	17.8	29.1	17.3	27.4	17.1	19.6	28.4
SANTA BARBARA MUNI	34.43N	119.84W	6	28.1	17.5	26.3	17.5	24.9	17.2	20.2	25.0
SANTA MARIA PUBLIC	34.92N	120.47W	73	28.8	16.6	26.5	16.1	24.6	15.8	18.8	25.4
STOCKTON/METROPOLIT	37.89N	121.24W	8	38.2	21.1	36.6	20.5	34.9	20.1	23.0	35.5
FAIRFIELD/TRAVIS AF	38.27N	121.95W	22	37.4	19.5	35.1	19.0	32.9	18.5	20.9	34.3
VISALIA MUNI	36.32N	119.38W	90	37.7	22.1	37.0	21.7	35.3	20.8	23.8	35.1
Colorado											
BUCKLEY AFB	39.70N	104.75W	1726	34.1	14.8	32.8	14.8	32.0	14.8	18.0	25.8
COLORADO SPRINGS/MU	38.81N	104.71W	1881	32.5	14.9	31.1	14.7	29.5	14.6	17.4	25.8
DENVER INTERNATIONAL	39.83N	104.66W	1655	34.6	15.5	33.2	15.5	31.8	15.4	18.3	27.1
CENTENNIAL	39.57N	104.85W	1776	33.0	15.5	32.1	15.4	30.3	15.2	18.4	27.2
FORT COLLINS (AWOS)	40.45N	105.00W	1529	34.2	15.9	32.7	15.8	31.2	15.7	18.4	27.8
GRAND JUNCTION/WALK	39.13N	108.54W	1475	36.5	16.4	35.0	15.9	33.6	15.5	18.4	29.8
GREELEY WELD CO	40.44N	104.62W	1417	35.2	16.8	33.0	16.7	32.1	16.7	19.5	29.1
PUEBLO MEMORIAL(AW)	38.29N	104.50W	1439	36.9	16.9	35.4	16.8	33.8	16.6	19.4	29.5
Connecticut											
BRIDGEPORT/IGOR I.	41.18N	73.15W	5	31.0	22.8	29.1	22.0	27.8	21.3	24.4	28.3
HARTFORD/BRADLEY IN	41.94N	72.68W	55	33.0	23.0	31.4	22.2	29.7	21.4	24.6	30.4
HARTFORD BRAINARD	41.74N	72.65W	6	32.6	22.9	31.2	22.4	29.2	21.6	25.0	29.8
WATERBURY OXFORD	41.48N	73.13W	221	30.9	22.6	28.8	21.8	27.4	20.9	24.1	28.5
WINDHAM AIRPORT	41.74N	72.18W	75	32.2	22.8	30.2	22.2	28.7	21.6	24.4	29.4
Delaware											
DOVER AFB	39.12N	75.47W	9	32.8	24.2	32.0	23.9	30.1	23.1	25.8	30.3
WILMINGTON NEW CAST	39.67N	75.60W	24	33.3	23.9	31.9	23.3	30.5	22.8	25.6	30.7
Florida											
DAYTONA BEACH INTL	29.18N	81.06W	13	33.8	24.9	32.7	24.9	32.0	24.9	26.7	31.1
FORT LAUDERDALE HOL	26.07N	80.15W	3	33.2	25.7	32.6	25.7	32.2	25.6	27.3	31.1
FORT MYERS/PAGE FLD	26.59N	81.86W	6	34.2	24.8	33.6	24.9	32.9	24.9	26.8	31.2
GAINESVILLE RGNL	29.69N	82.27W	50	34.1	24.7	33.3	24.5	32.5	24.4	26.5	31.3
HOMESTEAD ARB	25.48N	80.38W	2	32.5	25.9	32.2	25.9	31.4	25.8	27.4	29.8
JACKSONVILLE/INTNL	30.49N	81.69W	10	34.8	25.2	33.8	25.0	32.8	24.8	26.7	32.0
MACDILL AFB/TAMPA	27.85N	82.50W	4	33.7	25.3	32.8	25.3	32.4	25.3	27.5	30.4
MIAMI	25.82N	80.30W	9	33.2	25.3	32.7	25.3	32.2	25.3	26.8	30.5
NAPLES MUNI	26.15N	81.78W	7	32.9	25.4	32.5	25.4	32.2	25.4	27.1	30.8
OCALA INTL J TAYLOR	29.17N	82.22W	27	34.1	24.2	33.0	24.1	32.6	24.0	26.2	31.0
ORLANDO/JETPORT	28.43N	81.33W	32	34.3	24.7	33.6	24.6	32.8	24.4	26.4	30.9
PANAMA CITY BAY CO	30.21N	85.68W	6	33.7	24.9	32.8	24.9	32.3	24.9	27.5	30.5
PENSACOLA RGNL	30.47N	87.19W	36	34.4	25.4	33.3	25.2	32.4	25.0	27.2	31.4
SARASOTA BRADENTON	27.40N	82.56W	8	33.5	26.0	32.8	26.0	32.4	25.9	28.1	31.5
ST PETERSBURG CLEAR	27.91N	82.69W	3	33.4	25.4	32.8	25.4	32.4	25.4	27.6	30.7
TALLAHASSEE MUNICIP	30.39N	84.35W	21	35.5	24.7	34.3	24.4	33.4	24.2	26.9	31.1
TAMPA INTL AIRPORT	27.96N	82.54W	3	33.6	25.1	33.0	25.1	32.4	25.1	26.9	31.1
TYNDALL AFB	30.07N	85.58W	5	32.9	26.0	32.4	26.0	31.6	25.9	28.1	30.9
WEST PALM BEACH/IN	26.69N	80.10W	6	33.0	25.4	32.4	25.4	31.9	25.4	26.8	30.9
Georgia											
ALBANY MUNICIPAL	31.54N	84.19W	59	36.1	24.5	34.9	24.5	33.8	24.1	26.5	32.5
ATHENS MUNICIPAL	33.95N	83.33W	244	35.3	23.8	33.9	24.5	33.8	24.1	25.4	31.8

FIG. 11-3 (Cont'd)
Dry Bulb/Wet Bulb Temperature Data for Selected Locations²

Meaning of acronyms:
 DB: Dry bulb temperature, °C
 MCWB: Mean coincident wet bulb temperature, °C
 The Dry Bulb and Wet Bulb temperatures which are equalled
 or exceeded by the given percentage, on average, of the time
 during the warmest consecutive four months.

Lat: Latitude, °
 Long: Longitude, °
 MCDB: Mean coincident dry bulb temperature, °C
 WB: Wet bulb temperature, °C
 Elev: Elevation, m

Station	Lat	Long	Elev	Cooling DB/MCWB			Evaporation WB/MCDB			
				1%	2%		0.4%	1%		
				DB/MCWB	DB/MCWB		WB/MCDB	WB/MCDB		
United States of America										
<i>Georgia (Cont.)</i>										
ATLANTA MUNICIPAL	33.64N	84.43W	313	34.4	23.4	33.1	23.3	32.1	23.0	25.2
AUGUSTA/BUSH FIELD	33.37N	81.97W	45	36.3	24.4	34.9	24.4	33.7	24.1	26.4
COLUMBUS METROPOLIT	32.52N	84.94W	120	35.9	23.7	34.6	23.6	33.5	23.4	25.6
MARIETTA/DOBBINS AF	33.92N	84.52W	326	34.2	23.4	33.0	23.5	32.0	23.2	25.2
FORT BENNING	32.33N	85.00W	71	36.2	24.5	34.8	24.5	33.0	24.3	27.2
MACON/LEWIS B. WILSO	32.69N	83.65W	110	36.0	24.2	34.7	24.1	33.5	23.8	26.1
MOODY AFB/VALDOSTA	30.97N	83.19W	72	35.6	24.8	34.5	24.6	33.6	24.4	26.8
ROME/RUSSELL(RAMOS)	34.35N	85.16W	196	35.9	23.7	34.1	23.4	32.9	23.2	25.6
SAVANNAH MUNICIPAL	32.12N	81.20W	16	35.3	25.1	34.1	24.9	33.0	24.6	26.8
VALDOSTA RGNL	30.78N	83.28W	60	34.2	24.7	33.4	24.5	26.9	32.2	26.3
<i>Hawaii</i>										
KALAELOA ARPT	21.30N	158.07W	10	32.2	22.9	31.6	22.8	25.5	29.9	24.9
HILO INTL	19.72N	155.05W	11	29.3	23.2	28.8	23.1	24.8	27.8	24.4
HONOLULU INTL	21.33N	157.94W	5	31.6	23.1	31.2	22.9	25.1	29.3	24.6
KANEHOE BAY (MCAF)	21.45N	157.77W	6	28.9	23.4	28.5	23.2	25.1	27.7	24.6
<i>Idaho</i>										
BOISE MUNICIPAL	43.57N	116.22W	874	35.2	17.2	33.6	16.6	19.0	33.5	18.2
CALDWELL (AWOS)	43.64N	116.63W	741	33.9	18.2	32.5	17.7	20.1	33.5	19.2
COEUR D'ALENE AIR TE	47.77N	116.82W	707	31.4	16.9	29.0	16.1	18.8	30.2	17.8
IDAHO FALLS RGNL	43.52N	112.07W	1446	32.0	15.9	30.2	15.3	18.0	28.6	17.1
JOSLIN FLD MAGIC VA	42.48N	114.49W	1277	32.9	16.8	32.1	16.6	19.1	31.6	18.3
LEWISTON NEZ PERCE	46.38N	117.01W	438	34.7	18.0	32.7	17.3	19.7	33.5	18.8
POCATELLO MUNICIPAL	42.92N	112.57W	1365	33.0	16.0	31.5	15.5	18.4	30.4	17.4
<i>Illinois</i>										
AURORA MUNICIPAL	41.77N	88.48W	218	31.2	23.0	29.1	22.0	25.3	30.2	24.3
CAHOKIA/ST. LOUIS	38.57N	90.16W	126	33.0	24.6	32.3	24.2	26.7	32.4	25.8
CHICAGO/O'HARE ARPT	41.99N	87.91W	205	31.5	22.9	30.0	22.1	25.4	31.0	24.4
DECATUR	39.98N	88.87W	207	32.5	24.2	31.3	23.5	26.3	32.1	25.5
GLENVIEW NAS	42.08N	87.82W	199	32.3	23.0	30.6	22.3	25.5	32.3	24.5
MOLINE/QUAD CITY	41.47N	90.52W	181	32.3	23.8	30.9	22.9	26.2	31.8	25.2
GREATER PEORIA MUNI	40.67N	89.68W	202	32.1	23.9	30.7	23.1	26.2	31.4	25.3
QUINCY RGNL BALDWIN	39.94N	91.19W	234	32.3	24.1	30.9	23.4	25.9	31.7	25.2
SCOTT AFB MIDAMERIC	38.53N	89.83W	140	33.0	24.2	32.3	24.0	26.8	31.4	25.9
SPRINGFIELD/CAPITAL	39.85N	89.68W	187	32.4	24.1	31.1	23.4	26.3	31.9	25.5
<i>Indiana</i>										
EVANSVILLE REGIONAL	38.04N	87.54W	118	33.0	24.3	32.0	23.8	26.3	32.2	25.7
FORT WAYNE/BAER FLD	41.01N	85.21W	252	31.2	22.8	29.7	22.1	25.3	30.4	24.4
GRISSOM ARB	40.65N	86.15W	247	31.5	23.7	30.1	22.8	26.3	31.0	25.2
INDIANAPOLIS/I.-MUN	39.71N	86.27W	246	31.5	23.4	30.2	22.7	25.7	30.8	24.9
PURDUE UNIV	40.41N	86.94W	194	32.1	23.6	30.8	22.9	25.9	31.3	25.0
MONROE CO	39.14N	86.62W	258	32.0	24.1	30.8	23.4	25.9	30.5	25.2
SOUTH BEND/ST.JOSEP	41.71N	86.33W	236	31.1	22.5	29.5	21.8	25.2	30.2	24.1
TERRE HAUTE INTL HU	39.45N	87.30W	180	32.2	24.3	31.0	23.6	26.4	31.5	25.5
<i>Iowa</i>										
AMES MUNI	41.99N	93.62W	291	31.2	23.7	29.1	22.7	26.1	30.6	25.1
ANKENY REGIONAL ARP	41.69N	93.55W	277	32.4	23.8	30.9	23.0	25.7	31.3	24.9
BOONE MUNI	42.05N	93.84W	354	31.9	24.7	30.0	23.3	26.9	31.3	25.8
CEDAR RAPIDS MUNI	41.88N	91.71W	266	31.1	23.6	29.5	22.6	25.8	30.5	24.9
DAVENPORT MUNI	41.61N	90.59W	230	31.1	23.9	29.0	22.7	25.7	30.4	24.9
DES MOINES INTL	41.54N	93.67W	294	32.0	23.9	30.5	23.0	25.8	31.4	25.1
DUBUQUE MUNICIPAL	42.40N	90.70W	329	29.9	22.9	28.4	21.8	25.2	29.7	24.1
SIOUX CITY MUNI	42.39N	96.38W	336	32.3	23.4	30.9	22.8	25.9	31.2	25.1
WATERLOO MUNICIPAL	42.55N	92.40W	268	31.3	23.2	29.8	22.3	25.9	30.8	24.8

FIG. 11-3
Dry Bulb/Wet Bulb Temperature Data for Selected Locations²

Meaning of acronyms:
 DB: Dry bulb temperature, °C
 MCWB: Mean coincident wet bulb temperature, °C
 The Dry Bulb and Wet Bulb temperatures which are equalled
 or exceeded by the given percentage, on average, of the time
 during the warmest consecutive four months.

Lat: Latitude, °
 Long: Longitude, °
 MCDB: Mean coincident dry bulb temperature, °C
 WB: Wet bulb temperature, °C
 Elev: Elevation, m

Station	Lat	Long	Elev	Cooling DB/MCWB			Evaporation WB/MCDB				
				1%	2%		0.4%	1%			
United States of America											
Kansas											
FT RILEY/MARSHALL A	39.06N	96.76W	324	35.9	24.0	34.2	23.8	25.9	33.3	25.2	32.9
LAWRENCE MUNI	39.01N	95.21W	254	34.8	24.7	32.8	24.2	26.7	33.5	25.8	32.6
MANHATTAN RGNL	39.13N	96.68W	326	36.0	24.4	33.7	23.8	25.9	33.7	25.4	33.0
MC CONNELL AFB	37.62N	97.27W	418	35.8	23.2	33.9	23.1	25.4	32.8	24.8	32.0
JOHNSON CO EXECUTIVE	38.85N	94.74W	327	32.9	24.6	32.2	24.2	26.2	32.2	25.5	31.6
SALINA MUNI	38.81N	97.66W	391	36.7	23.2	34.8	22.9	25.2	33.6	24.5	32.6
FORBES FLD	38.95N	95.66W	329	33.7	24.0	32.3	23.7	25.8	32.3	25.2	31.7
TOPEKA/BILLARD MUNI	39.07N	95.63W	270	34.4	24.4	32.8	23.9	26.1	33.0	25.5	32.3
WICHITA/MID-CONTINE	37.65N	97.43W	408	36.1	23.2	34.1	23.1	25.4	32.5	24.7	31.9
COL JAMES JABARA	37.75N	97.22W	433	36.0	23.5	33.6	23.3	25.2	32.9	24.6	32.1
Kentucky											
BOWLING GREEN WARRE	36.98N	86.44W	164	32.8	24.0	32.0	23.7	25.8	31.4	25.2	30.7
CINCINNATI/GREATER	39.04N	84.67W	269	31.8	23.0	30.4	22.5	25.2	30.6	24.5	29.4
FORT CAMPBELL (AAF)	36.67N	87.50W	174	32.8	24.5	32.1	24.3	26.5	30.9	25.8	30.3
HENDERSON CITY CO	37.81N	87.68W	118	32.8	24.5	32.2	24.1	26.4	32.8	25.6	31.7
LEXINGTON/BLUE GRAS	38.04N	84.61W	301	32.0	23.1	30.7	22.7	25.2	30.8	24.5	29.6
BOWMAN FLD	38.23N	85.66W	170	32.8	23.7	32.0	23.4	25.8	31.4	25.2	30.7
LOUISVILLE/STANDIFO	38.18N	85.73W	149	33.1	23.9	32.0	23.4	25.9	31.7	25.3	31.0
SOMERSET PULASKI CO	37.05N	84.60W	283	33.1	23.5	32.4	23.1	25.6	32.5	24.9	31.3
Louisiana											
ALEXANDRIA INT	31.34N	92.56W	24	34.8	25.2	33.8	24.9	27.1	32.0	26.5	31.9
BARKSDALE AFB	32.50N	93.66W	51	35.0	24.7	33.8	24.7	26.7	32.7	26.1	32.2
BATON ROUGE METRO R	30.54N	91.15W	23	33.9	25.2	33.0	25.0	26.9	31.6	26.5	31.2
LAFAYETTE RGNL	30.21N	91.99W	13	33.8	25.3	32.9	25.1	27.0	31.6	26.7	31.3
LAKE CHARLES MUNI	30.13N	93.23W	3	33.8	25.4	32.9	25.4	27.4	31.4	26.9	30.9
MONROE RGNL	32.51N	92.04W	25	35.1	25.4	33.9	25.0	27.2	33.0	26.7	32.5
NEW ORLEANS/MOISANT	29.99N	90.25W	6	33.5	25.4	32.6	25.3	27.2	31.6	26.8	31.1
LAKEFRONT	30.04N	90.03W	3	33.2	25.7	32.6	25.5	27.5	31.8	27.0	31.3
SHREVEPORT REGIONAL	32.45N	93.82W	79	35.5	24.6	34.2	24.5	26.3	32.9	25.9	32.2
Maine											
AUBURN LEWISTON MUNI	44.05N	70.28W	88	28.7	20.7	27.2	19.7	23.1	28.5	21.9	26.8
BANGOR INTL	44.81N	68.82W	59	29.0	20.5	27.3	19.4	22.9	28.4	21.8	27.0
BRUNSWICK (NAS)	43.90N	69.93W	23	28.2	20.5	26.9	19.6	23.1	28.0	21.9	26.6
PORTLAND/INTNL. JET	43.64N	70.30W	19	28.6	21.1	26.9	20.1	23.4	28.4	22.3	26.8
SANFORD RGNL	43.39N	70.70W	74	29.5	20.8	27.8	19.9	23.4	29.2	22.3	27.7
Maryland											
ANDREWS AFB/CAMP SP	38.82N	76.85W	88	32.3	23.0	31.1	22.7	25.3	30.3	24.6	29.4
BALTIMORE-WASHINGTO	39.17N	76.68W	47	32.9	23.4	31.5	22.8	25.6	31.5	24.9	30.3
THOMAS POINT	38.90N	76.43W	12	29.4	23.6	28.4	23.3	26.5	28.2	25.5	27.5
Massachusetts											
BOSTON/LOGAN INTL	42.36N	71.01W	9	30.9	22.1	29.0	21.2	24.4	29.8	23.5	28.3
LAWRENCE MUNI	42.72N	71.12W	45	31.1	22.2	28.9	21.5	24.3	29.3	23.5	28.2
MARTHAS VINEYARD	41.39N	70.62W	21	27.4	21.8	26.2	21.1	24.0	27.1	23.3	25.9
NEW BEDFORD RGNL	41.68N	70.96W	24	28.9	22.0	27.6	21.2	24.3	28.7	23.5	27.1
NORWOOD MEM	42.19N	71.17W	15	31.1	22.5	28.9	21.6	24.7	29.8	23.9	28.3
PLYMOUTH MUNICIPAL	41.91N	70.73W	45	29.1	22.0	27.8	21.1	24.3	28.9	23.6	27.4
SOUTH WEYMOUTH NAS	42.15N	70.93W	49	31.0	22.4	29.3	21.5	25.0	30.5	23.8	28.8
WORCESTER REGIONAL ARPT	42.27N	71.88W	310	28.3	20.9	27.1	20.0	23.3	27.6	22.4	26.4
Michigan											
DETROIT/METROPOLITA	42.22N	83.35W	202	30.9	22.6	29.3	21.7	25.0	30.2	23.9	28.6
WILLOW RUN	42.24N	83.53W	218	31.0	22.5	29.1	21.5	24.8	30.2	23.8	28.7
FLINT/BISHOP INTL	42.97N	83.75W	234	30.4	22.2	28.8	21.3	24.6	29.6	23.5	28.3
GRAND RAPIDS/KENT C	42.88N	85.52W	245	30.3	22.1	28.8	21.2	24.6	29.5	23.6	28.1
GROSSE ILE MUNI	42.10N	83.17W	180	30.0	23.1	28.0	22.1	25.5	29.1	24.6	28.2
JACKSON CO REYNOLDS	42.26N	84.46W	311	29.8	22.2	28.2	21.2	24.4	29.1	23.5	27.9
KALAMAZOO BATTLE CR	42.24N	85.55W	266	30.9	22.1	28.8	21.4	24.4	29.2	23.5	28.2
LANSING/CAPITAL CIT	42.78N	84.58W	266	30.2	22.2	28.7	21.2	24.6	29.6	23.5	28.1
OAKLAND CO INTL	42.67N	83.42W	299	30.1	21.8	28.6	21.1	24.1	29.3	23.0	27.9

FIG. 11-3 (Cont'd)
Dry Bulb/Wet Bulb Temperature Data for Selected Locations²

Meaning of acronyms: DB: Dry bulb temperature, °C MCWB: Mean coincident wet bulb temperature, °C The Dry Bulb and Wet Bulb temperatures which are equalled or exceeded by the given percentage, on average, of the time during the warmest consecutive four months.				Lat: Latitude, ° Long: Longitude, ° MCDB: Mean coincident dry bulb temperature, °C WB: Wet bulb temperature, °C Elev: Elevation, m							
Station	Lat	Long	Elev	Cooling DB/MCWB			Evaporation WB/MCDB				
				1%	2%		0.4%	1%			
				DB/ MCWB	DB/ MCWB		WB/MCDB		WB/MCDB		
United States of America											
Michigan (Cont.)											
SELFRIDGE ANGB	42.60N	82.83W	177	30.3	22.2	28.8	21.5	24.3	29.4	23.4	28.3
ST CLAIR CO INTL	42.91N	82.52W	198	29.9	21.7	28.0	20.8	24.3	29.2	23.2	27.7
Minnesota											
SKY HARBOR	46.72N	92.03W	186	27.8	20.8	26.3	19.7	24.2	28.1	22.8	26.4
DULUTH INTL AIRPORT	46.84N	92.19W	432	27.4	19.6	25.8	18.6	22.5	27.3	21.2	25.7
FLYING CLOUD	44.83N	93.47W	288	31.2	22.6	29.0	21.5	25.2	30.5	24.0	28.9
MANKATA RGNL ARPT	44.22N	93.92W	311	30.0	21.9	28.0	20.8	24.8	29.3	23.6	28.1
ANOKA CO BLAINE	45.15N	93.20W	278	30.9	22.8	28.8	21.7	25.4	29.8	24.1	28.5
CRYSTAL	45.06N	93.35W	265	31.2	22.2	29.0	21.2	24.8	30.2	23.6	28.8
MINNEAPOLIS/ST.PAUL	44.88N	93.23W	255	31.1	22.2	29.3	21.3	24.9	30.6	23.8	28.9
ROCHESTER MUNICIPAL	43.90N	92.49W	402	29.3	22.1	27.9	21.2	24.8	29.0	23.6	27.6
SOUTH ST PAUL MUNI	44.85N	93.03W	250	31.1	22.1	29.0	21.0	25.0	29.7	23.7	28.3
ST. CLOUD MUNICIPAL	45.55N	94.05W	312	30.3	21.6	28.7	20.5	24.6	30.0	23.4	28.6
ST PAUL DOWNTOWN HO	44.93N	93.05W	217	31.0	22.3	28.9	21.3	24.9	30.0	23.7	28.7
Mississippi											
HATTIESBURG LAUREL	31.47N	89.34W	91	34.0	23.9	32.9	23.8	25.8	32.1	25.4	31.6
JACKSON/ALLEN C. TH	32.32N	90.08W	101	34.4	24.6	33.4	24.4	26.5	32.4	26.0	31.6
KEESLER AFB	30.41N	88.92W	10	33.1	26.2	32.5	26.0	28.4	32.1	27.7	31.2
MERIDIAN/KEY FIELD	32.33N	88.75W	95	34.4	24.4	33.3	24.3	26.4	32.1	25.9	31.4
MERIDIAN NAS	32.55N	88.57W	97	35.1	24.8	33.9	24.3	26.8	33.1	26.1	32.5
TUPELO/C.D. LEMONS	34.26N	88.77W	110	34.2	24.2	33.1	24.1	26.2	32.2	25.7	31.5
Missouri											
CAPE GIRARDEAU RGNL	37.23N	89.57W	107	33.5	24.9	32.4	24.5	26.8	32.4	26.0	31.5
COLUMBIA REGIONAL	38.82N	92.22W	274	32.9	24.4	31.5	23.8	26.3	31.8	25.5	31.0
JEFFERSON CITY MEM	38.59N	92.16W	175	33.0	24.2	32.3	23.9	26.4	31.9	25.6	31.3
JOPLIN RGNL	37.15N	94.50W	300	34.1	24.2	32.8	23.9	25.9	32.4	25.4	32.0
CHARLES B WHEELER D	39.12N	94.59W	229	34.0	24.4	32.7	24.1	26.4	33.2	25.7	32.1
KANSAS CITY INTL	39.30N	94.72W	312	33.6	24.6	32.1	24.1	26.6	32.5	25.7	31.6
SPRINGFIELD MUNI	37.24N	93.39W	387	33.1	23.7	31.8	23.5	25.4	31.6	24.9	30.9
ST. LOUIS/LAMBERT	38.75N	90.37W	216	33.9	24.5	32.6	23.9	26.4	32.7	25.6	31.8
SPIRIT OF ST LOUIS	38.66N	90.66W	141	33.7	24.6	32.4	24.0	26.6	32.7	25.7	31.7
Montana											
BILLINGS/LOGAN INT.	45.81N	108.54W	1088	32.9	16.6	31.1	16.3	19.0	29.6	18.1	28.8
GALLATIN FLD	45.79N	111.15W	1356	31.5	15.9	29.4	15.3	18.0	28.5	17.1	27.6
BERT MOONEY	45.95N	112.51W	1687	29.1	13.6	27.6	13.2	15.8	26.1	15.0	25.3
GREAT FALLS	47.45N	111.38W	1130	30.5	15.2	28.7	14.9	17.4	28.3	16.5	27.0
MALMSTROM AFHP	47.50N	111.19W	1058	31.6	16.1	29.7	15.7	18.1	29.3	17.3	28.5
MISSOULA/JOHNSON-BE	46.92N	114.09W	972	32.1	16.4	30.0	15.8	18.4	29.6	17.4	28.7
Nebraska											
GRAND ISLAND COUNTY	40.96N	98.31W	566	33.6	22.9	31.9	22.2	25.2	31.7	24.4	30.9
LINCOLN MUNICIPAL	40.83N	96.76W	362	34.0	23.6	32.4	23.1	25.7	32.6	25.0	31.7
OFFUTT AFB	41.12N	95.90W	321	32.8	23.9	31.4	23.2	26.5	31.3	25.5	30.3
OMAHA/EPPLEY FIELD	41.31N	95.90W	299	33.0	24.0	31.5	23.2	26.3	32.0	25.3	31.0
OMAHA	41.37N	96.02W	406	32.7	23.7	31.1	22.8	25.4	31.7	24.6	30.7
Nevada											
LAS VEGAS/MCCARRAN	36.08N	115.16W	665	41.3	19.5	40.0	19.1	22.5	35.9	21.7	35.1
NELLIS AFB	36.24N	115.03W	569	41.7	19.4	40.4	19.0	22.3	35.1	21.7	35.3
RENO/CANNON INTL	39.48N	119.77W	1341	34.1	15.7	32.8	15.2	17.8	31.8	16.9	30.9
New Hampshire											
CONCORD MUNICIPAL	43.20N	71.50W	106	30.6	21.1	28.9	20.4	23.8	29.4	22.8	27.9
JAFFREY ARPT SILVER	42.81N	72.00W	317	28.7	20.5	27.4	19.5	22.8	27.3	22.0	26.2
MANCHESTER	42.93N	71.44W	71	31.4	21.4	29.8	20.8	24.2	29.8	23.2	28.4
PEASE INTL TRADEPOR	43.08N	70.82W	31	30.0	21.8	28.0	20.8	24.1	29.4	23.1	27.9
New Jersey											
ATLANTIC CITY INTL	39.46N	74.58W	20	31.9	23.2	30.3	22.7	25.5	30.8	24.8	29.4
MONMOUTH EXECUTIVE	40.19N	74.12W	49	31.3	22.4	29.1	21.6	24.6	30.4	23.8	29.0
MC GUIRE AFB	40.02N	74.58W	40	32.3	23.7	31.0	23.2	26.2	30.8	25.4	29.8
MILLVILLE MUNI	39.37N	75.08W	23	32.1	23.4	30.7	22.8	25.6	30.7	24.9	29.5
NEWARK INTL AIRPORT	40.68N	74.17W	9	32.8	22.8	31.3	22.2	25.4	31.5	24.6	29.9