Chapter Three { TC "Chapter Three " \l 1 }

Data Acquisition

3.1 Weather data{ TC "3.1 Weather data" \l 2 }

3.1.1 Meteorological data from the nearest weather station { TC "3.1.1 Meteorological data from the nearest weather station " \l 3 }

Meteorological data that are measured near the power plant site are crucial for calibration of the computer models for the outdoor cooling equipment, namely cooling towers and cooling pond. Unfortunately not all of the needed parameters are measured directly at the plant site. It is therefore necessary to find a data source that provides weather data that are close to the conditions at the plant. The nearest weather bureau station is located at the Madison Dane County Airport that is 20 miles to the south of the Columbia Generating Station. The data that are measured there include all important parameters and are available on an hourly basis. Following are the weather parameters that are measured at the airport station:

- Air dry bulb temperature
- Air wet bulb temperature
- Solar Radiation on a horizontal surface
- Wind speed
- Wind direction
- Cloud cover
- Ceiling height
- Atmospheric pressure

Except for the air dry bulb temperature none of the mentioned ambient parameters are measured at the plant site.

The problem with using the weather data from the airport weather station is that there can be a significant difference in ambient conditions between the two sites due to the relatively large physical distance. This fact is illustrated if the dry bulb temperature that is measured at the plant is compared with the wet bulb temperature from the weather station. Figure 3.1 shows the two air temperatures for a period of July 1995. It can be seen that at certain times, from hour 18 to 36 in the chart, the wet bulb temperature from the airport exceeds the dry bulb measured at the plant. This circumstance rises some doubts to whether the airport weather station provides an appropriate source of data for the task of this work. It is possible that the measurement at the plant is not correct. Unfortunately, there is no other source of weather data measurement that would make it possible to validate one or the other source. Therefore, the airport data were adjusted so that whenever the wet bulb

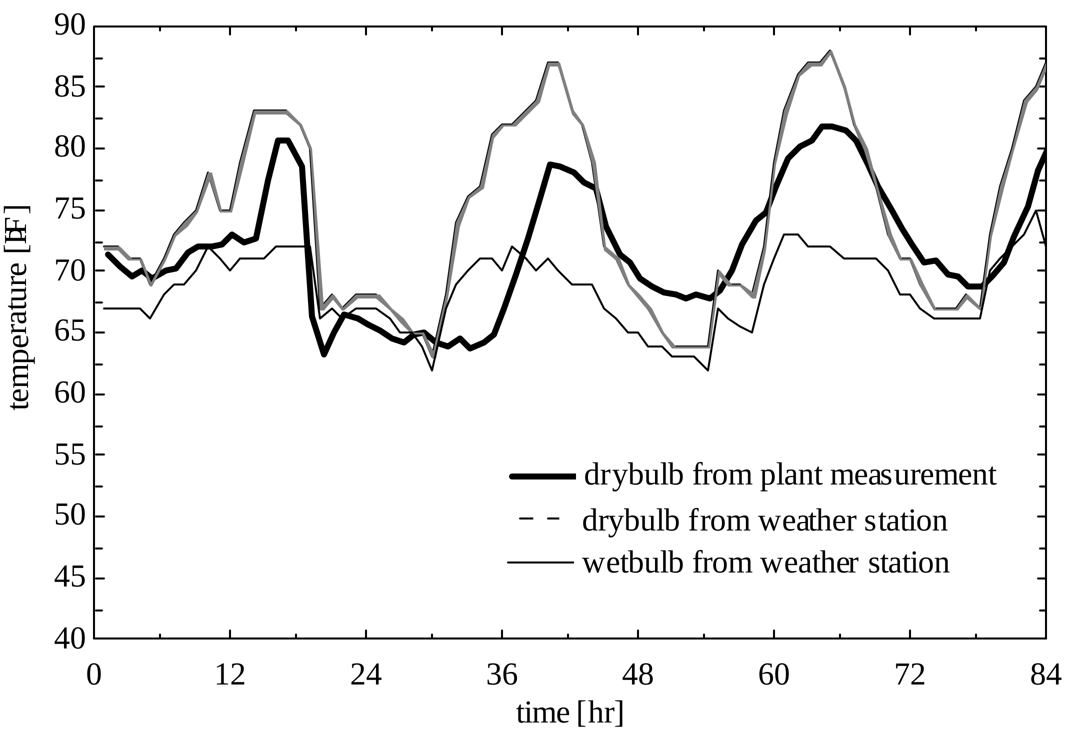

Figure 3.1 Ambient Temperatures for the Period of July 22 0:00 { TC "Figure 3.1

Ambient Temperatures for the Period of July 22 0:00 " \l 5 }

to July 25 12:00;;

temperature exceeded the dry bulb temperature measured at the plant, the wet bulb temperature was corrected downward and a saturated air condition was assumed. For comparison the dry bulb temperature measured at the airport weather station is shown in the plot, too. There is also a difference between the airport drybulb temperature and the plant measurement, with the temperature from the weather station having a higher amplitude over the day.

Another parameter that is crucial especially for heat transfer calculations across the pond surface and for spraying systems is the wind speed and direction. The Wisconsin Power & Light Company performed a wind characteristics study in the years from 1979 to 1983 that used data obtained from high towers located near WP&L's power plants [2]. Two of these towers were located near the Columbia Generating Station. One of these towers, denoted CAM2 in the study, had a wind sampling height above the surface of 10 m. The final report of the study [2] compares the average wind speed measured at CAM2 with the average wind speed measured at the Dane County Airport in Madison, as both measurements are obtained at 10 m elevation above ground. Table 3.2 shows both measured average wind speeds.

Station	Elevation [m]	Average wind speed [m/s]	Average wind speed [mph]
CAM2	10	3.3	7.4
Airport station	10	4.2	9.3

Table 3.1 Comparison Of Wind Speed Measurements{ TC "Table 3.1 Comparison Of Wind Speed Measurements" \l 4 }

On average the wind velocity measured near the plant site is about one m/s lower than at the airport. The difference may be due to differences in sampling methods and type of locations. The WP&L data are based upon continuous monitoring systems. The airport data are estimated hourly wind speeds based upon a one-to-three minute observation of the wind during the hour. This alone could account for the discrepancy in speed. Also, airport wind speed monitoring sites usually have a good low level exposure to the possible surrounding winds. That is, they tend to have less distracting local surface features than do the 10 m WP&L samples [2]. The difference between wind speed at the airport and at the plant site has to be considered when the weather station data are used to calibrate the computer models and a correction has to be applied.

The wind characteristics study also provides a chart that summarizes the frequency of wind directions. Figure 3.2 shows the frequency distribution determined over the period from 1979 to 1983. The chart shows that the main wind directions are South to South West, for a 10m elevation. There is no data available about average wind direction frequencies from the airport weather station, only hourly data is given. Wind direction becomes especially important for the selection of the orientation of a spray canal.

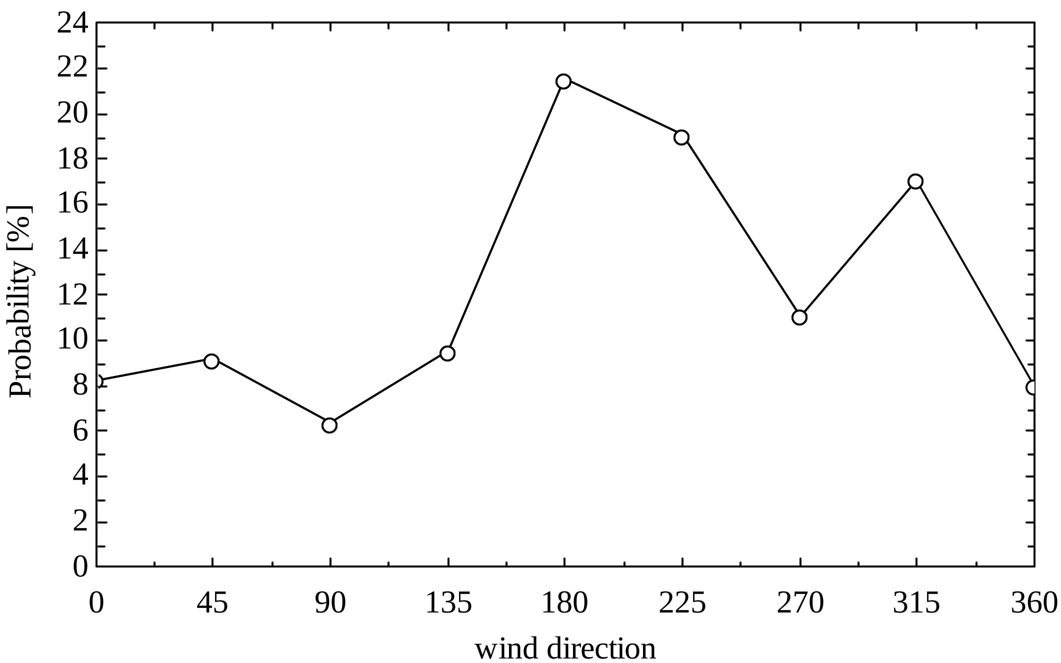

Figure 3.2 Frequency of Wind Direction at the Columbia Station. { TC "Figure 3.2 Frequency of Wind Direction at the Columbia Station. " \l 5 }

0 indicates north, 90 east etc.

Solar radiation is a significant parameter that influences especially the cooling pond behavior. As there is a negligible difference in latitude between the power plant site and the airport, it is assumed that the measured solar radiation from the airport does not differ much from the actual solar radiation at Columbia. Of course, atmospheric conditions such as cloud cover and air moisture content, which can differ between the two sites, influence the amount of incident radiation. But, as there is no way of validating the measured solar radiation values, the solar radiation from the airport station is used directly for the Columbia site. The same is assumed for the remaining weather parameters mentioned at the beginning of this chapter.

3.1.2 Typical Meteorological Year Weather Files{ TC "3.1.2 Typical Meteorological Year Weather Files" \l 3 }

The **T**ypical **M**eteorological **Y**ear or **TMY** files are provided by USNOAA in Asheveille North Carolina. Each TMY file contains approximately 24 different weather variables for one whole year at one hour time intervals. Information from solar radiation to occurrences of precipitation is given. The typical meteorological year data was derived from 30 years of measured solar radiation, temperatures and other weather variables for 26 locations. The TMY data that will be used in this work is derived for Madison, Wisconsin.

Not all weather variables supplied in the TMY file are used for the simulations performed for this study. Only the parameters discussed in 3.1.1 are extracted from TMY data. Instead of wet bulb temperatures dew point temperatures are given in TMY files, which are converted by using the dry bulb temperature into the appropriate psychrometric information.

The TMY files provide different measures for solar radiation. They contain, among others, direct normal and corrected global horizontal surface radiation data. For the energy balance of a cooling pond only global horizontal surface radiation is of interest.

3.1.3 Selection of a data set for further simulation{ TC "3.1.3 Selection of a data set for further simulation" \l 3 }

For calibration purposes for the computer models it is only feasible to use actual weather data that are obtained, in this case, at the airport weather station. Once the models are calibrated it depends on the scenario to be examined which source of weather information is used for simulation.

It is reasonable to use TMY data to examine how the system will behave in an average year. This is particularly useful if the general design of a system is to be evaluated. The disadvantage of TMY data is that it contains no extremes as the TMY files are especially designed to fit the average observed weather conditions.

To get an estimate of how the system behaves in severe weather conditions a special set of data has to be used. Severe weather means for a cooling cycle of the kind examined here that the temperatures stay high over a longer period of time, which means over more than one week, and that the moisture content of the air is near saturation. If the last years of operation of the Columbia Station are considered, years 1988 and 1995 were the worst with respect to bad weather conditions for the cooling cycle. Especially in summer 1995 the very hot and humid weather forced the plant operators to reduce power production as the cooling water temperature rose that high that the turbine back pressure limit of 6 "Hg was reached. One other reason why hot weather can cause problems for power production is that hot ambient temperatures usually cause high plant loads due to higher power consumption for air conditioning. The coincidence of extremely high load and bad operating conditions makes it particularly useful to run simulations with actual weather data that is obtained from the airport weather station. For the simulation in chapter 5 data from 1988 will be used, as this data is easier to access. In this way system improvements can be evaluated in extreme operating conditions.

For the simulations performed in this work, first the TMY files are used to get a general evaluation of the system at standard conditions. In addition simulations are run with weather data from 1995 to examine if the cooling system could have performed better if changes had been made. Although weather data for the whole year is available from all sources, simulations are only run for summer months, as in winter time and in spring and fall the cooling system performs well enough and there is no urgent need to examine the system behavior further in these time periods.

3.2 On Site Data Acquisition{ TC "3.2 On Site Data Acquisition" \l 2 }

3.2.1 Plant Data Collecting System{ TC "3.2.1 Plant Data Collecting System" \l 3 }

The Columbia Generating Station uses a data collecting system that collects all important operation parameters and makes these data accessible for further processing and evaluation. Among the great number of parameters that are measured the ones that are used for this work are summarized in table 3.2.

The variables listed in table 3.2 are measured on a two minute basis. To make the data compatible with weather data, that is in the form of hourly averages, hourly averages are also taken for the plant operation data. In addition some of the plant data are measured at several locations and averages have to be determined.

The turbine gross or unit load is monitored by the on-line measurement system, and the same is true for the auxiliary power. In addition, during the heat rate tests that are frequently performed at the power plant, a meter is used to determine the load and auxiliary power. The amount of coal is determined from measurements at the coal feeders that feed the coal into the furnace. The mass flow of coal is then converted into an equivalent amount of energy fed into the furnace using the heating value.

Throttle steam flow rate defines the flow rate of steam that flows to the high pressure turbine and is measured at one location. Steam exhaust temperatures after the low pressure turbine and back pressures are measured in each condenser shell and are then averaged for the condenser. The steam exhaust temperature is assumed to be equal to the condenser shell temperature as the steam is in a below saturated state when it leaves the turbine. The exhaust steam flow rates from each low pressure turbine are measured and added to get the total heat load on the condenser. The condensate or hot well temperature is determined at one location at the bottom of the condenser shell.

Variable	Unit
Unit Load	MW
Auxiliary power	MW
Amount of coal burned	Btu/hr
Throttle steam flow rate	klb/hr
Exhaust steam temperature	F
Condenser back pressure	“Hg
Exhaust steam flow rate	klb/hr
Condensate temperature	F
Circulating water inlet temperature	F
Circulating water outlet temperature	F
Ambient dry bulb temperature	F
Cooling tower inlet	F
Cooling tower outlet	F
Pond (return) temperature	F

Table 3.2 Measured Variables from Plant **{** TC "Table 3.2 Measured Variables from Plant " \l 4 **}**

Measurement System

The circulating water outlet temperatures are measured at four locations for each condenser shell. Thus there is a total of eight outlet temperature measurement points for each condenser. The water inlet temperature is measured at one point in each supply pipe for each shell, so that there are two inlet water temperature measurements for each condenser. One measurement point per pipe for the intake water is considered sufficient as the circulating pumps generate a well mixed flow pattern in the pipe. Simple averages are taken for the water in- and outlet temperatures. The water inlet temperature also reflects the mixed cold temperatures of pond and towers.

Cooling tower water in- and outlet temperatures are only monitored for tower A as tower B is not connected to the on-line measuring system. The inlet temperature is measured at one point in the supply pipe for the same reason mentioned for the circulating water inlet measurement. It is reasonable to assume, that the water inlet temperatures for both towers are equal. The cooling tower outlet temperature is determined from an average of three measurements distributed across the discharge channel of tower A. There is a small difference between the condenser circulating outlet temperature and the tower inlet temperature observed. This difference is due to the low head cycle flow as the low head water discharge temperature is not necessarily equal to the condenser discharge temperature (see section 2.2). Both condenser cooling water and low head circuit water are mixed before the water is pumped to the cooling towers. The discharge temperature of the low head cycle water is not directly accessible. The ambient dry bulb temperature is measured at one point near the cooling towers (see also 3.1.1).

The pond temperature is measured at only one point in the plant intake section of the pond before the pond water is mixed with the cooling tower discharge. This measurement is probably the most inaccurate of the system, although it is very crucial for calibration purposes. The temperature sensor is located approximately 10 ft from the pond shore and only half a ft below the water surface. It is possible that this sensor does not provide an adequate average of the pond temperature in the intake section as a greater number of sensors would be required to generate an appropriate average. Another critical point is, that the sensor is only slightly submerged and measures the temperature of the upper water layer. Ambient conditions are therefore likely to influence the measurement to a certain extent. In a comparison of the measured temperature of this sensor with another thermometer it was also observed that the pond sensor temperature was off by 5 F (see 3.2.2). Thus the temperature has to be adjusted for further use. The assumption is made that the adjusted pond temperature is reasonably close to the actual water temperature, despite the uncertainties mentioned above. Another obstacle in data acquisition was that the measurement system was not working for several weeks during summer 1995. Therefore a string of data is missing that would have been useful to examine the pond behavior during the hot summer of 1995.

3.2.2 Pond Survey{ TC "3.2.2 Pond Survey" \l 3 }

During three pond surveys the temperature distribution in the pond was determined along the flow path. Also the depth of the pond was measured at several measuring points distributed over the whole pond extension. The pond surveys were carried out from a boat. For temperature measurements a thermocouple was used that was attached to the tip of a rod. The rod was also used to determine the probe depth at which the temperature was measured. Temperatures were measured at the surface and at one depth during the first two surveys and at two different depths during the last survey. The pond depth was measured using a sonar device.

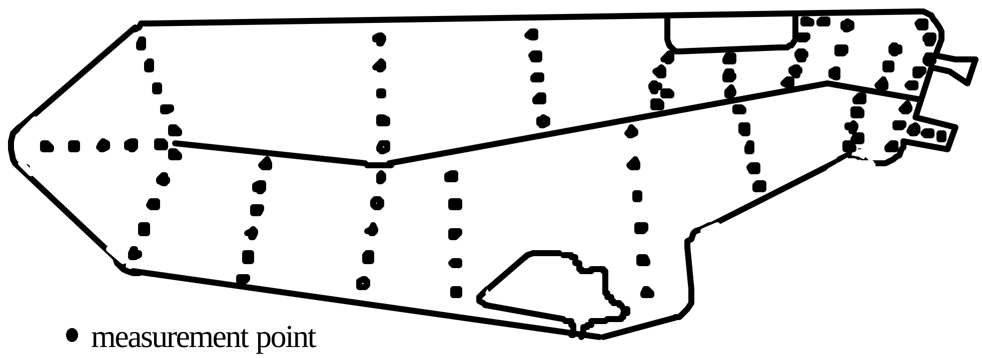

Figure 3.3 Measurement Points of Lake Survey

Figure 3.3 shows the locations where water temperatures and pond depth were measured. It has to be mentioned that the positions are only approximations as navigation on the pond was not very accurate as only eyesight was used during the survey. But the locations are assumed to be accurate within 40 ft in the main section of the pond. In the inflow and discharge section and around the settling basin the accuracy is better, as the points for orientation are closer together. For a pond of an extension of 9500 ft the accuracy is good enough, as the main intention of the pond survey was to get a measure of how fast the water cools down and if stratification takes place.

The depth distribution as determined in the surveys was shown in figure 2.6. Figures 3.4.a through 3.4.c show the temperature distribution in the pond. Pond surveys were carried out on three dates, September 11 1992, October 21 1992 and on July 25 1995. The charts show temperatures that are averaged over the pond width at the corresponding locations shown in figure 3.3. Distance is measured from the plant discharge section.

All charts show a fully mixed discharge section. As the flow proceeds, stratification occurs, which shows the highest temperature difference between surface and bottom at a distance of 3000 ft. As this observation was made in all three surveys, the assumption is that the physical shape of the pond is the reason for this observations. If the pond depth profile from figure 2.6 is recalled, it can be seen that the intake section is about 10 ft deep. After that the pond gets shallower, to about 6 ft, to become deeper again to 10 ft nearly at the same location at which the stratification occurs. As a fully mixed water body that rejects heat only at the top surface would not stratify because of density gradients but instead stay mixed, the shallow area behind the pond inflow section is believed to cause the stratification. The shallow area functions as a barrier that leads the warm water stream over the colder bottom water. The cold water stays at the bottom. The length over which the water stays stratified varies for all three observation times. In the July survey, the temperature difference between top and bottom is only 8 F and the temperatures level out after 7000 ft. The observed stratification at 9000 ft is due to the same phenomena described above, as figure 2.6 shows a shallow area at 9000 ft. In the September survey the pond stays stratified for a much longer distance and reaches a fully mixed state again after 17000 ft. This may be due to weather conditions that influence the rate of heat rejection across the surface. What is also observed is a higher temperature difference between top and bottom in September that is in the range of 15 F at its maximum. In the October survey the temperature difference is 10 F and a fully mixed condition is reached after 9000 ft. The main factors for this slightly different behavior at different times are ambient conditions, as the ambient conditions influence the rate at which heat is rejected to the environment (see chapter 4). Another factor is the amount of heat added to the cooling water in the plant, that is the heat load on the cooling system.

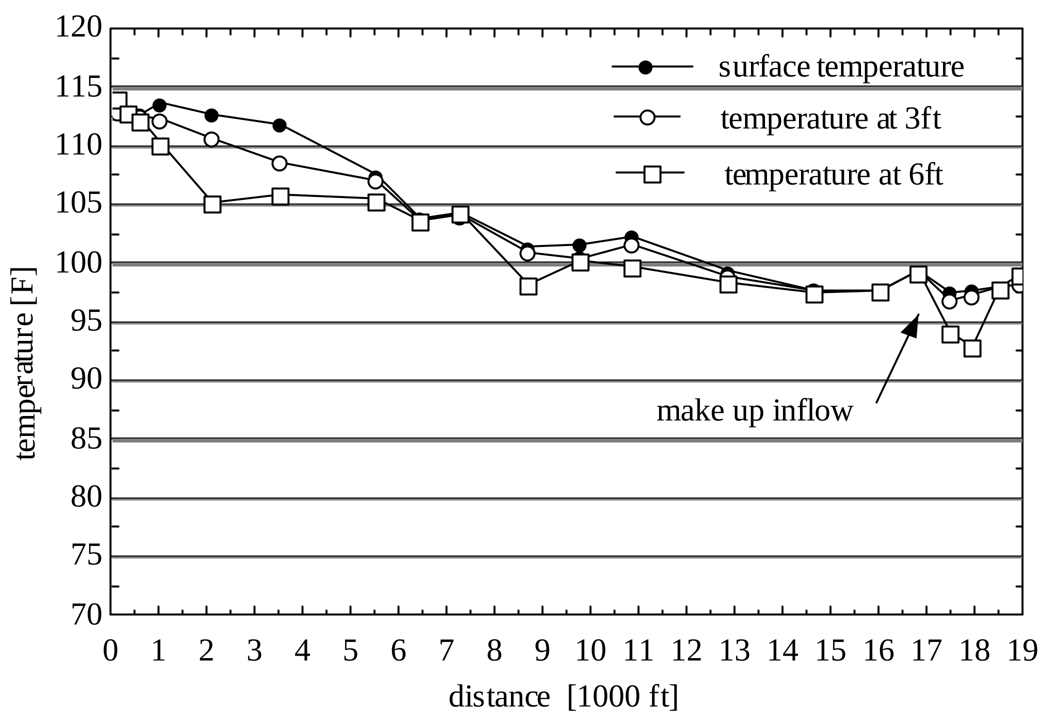

Figure 3.4 a Temperature Distribution in Cooling Pond from Pond Survey on **{** TC "Figure 3.4 a Temperature Distribution in Cooling Pond from Pond Survey on " \l 5 **}**
July 25 1995

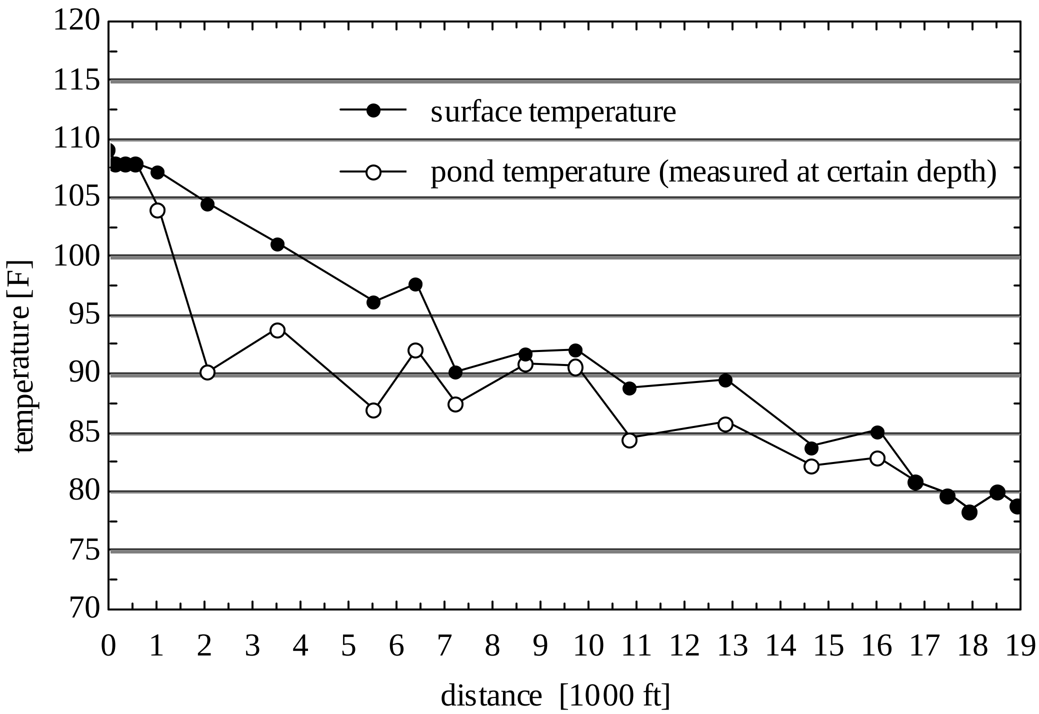

Figure 3.4 b Temperature Distribution in Cooling Pond from Pond Survey on { TC "Figure 3.4 b Temperature Distribution in Cooling Pond from Pond Survey on " \l 5 }
September 11 1992

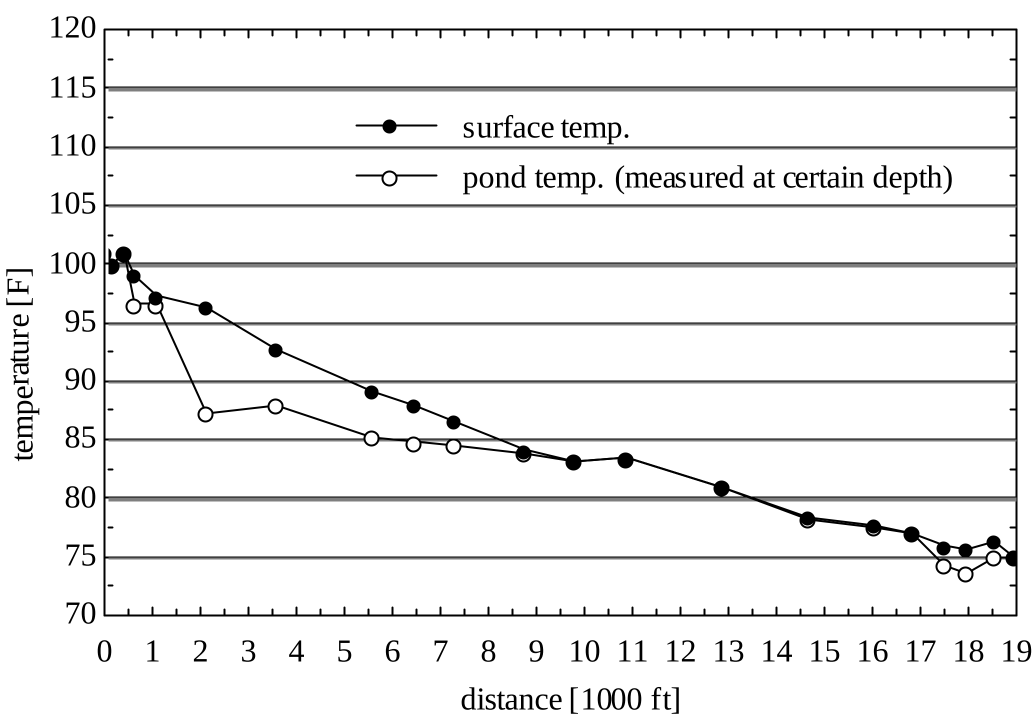

Figure 3.4 c Temperature Distribution in Cooling Pond from Pond Survey on { TC "Figure

3.4 c Temperature Distribution in Cooling Pond from Pond Survey on " \l 5 }
October 21 1992

All charts have in common that at the location of the make up inflow the temperature drops. Some care must be taken in evaluating this observation. The charts show the temperatures at a certain depth but do not indicate how thick a certain temperature layer is. Therefore the effect of make up inflow may be overestimated considering only the temperature indicated in the charts. The July measurement shows a decrease in bottom temperature after the make up inflow point and a temperature difference between top and bottom right after the make up inflow section of about 5 F. The temperature levels out after a short distance. This is an indicator that the colder make up water first sinks to the ground and than quickly mixes with the remaining warmer pond water. As can be seen in the charts, the surface temperature even rises towards the plant intake section or the end of the pond.

The overall temperature level of the pond is dependent on the season. In summer the pond temperature is higher than in fall. If the range is examined, that is the difference between inflow and outflow temperature, it can be seen, that in July the range is on the order of 15 F while in September and October it is in the range of 25 to 30 F. Not only weather conditions influence the range but also the water flow rate and plant load, which determines the heat load on the pond.

The slope of the temperature profiles with respect to distance provides a measure of how fast the pond water cools down, if an at average constant water flow rate is assumed. All three temperature curves show a higher decrease of temperature with distance in the first part of the pond. The slope than levels off along the flow direction. This observation is an indicator that the cooling pond is more effective in the first part, while the second half of it provides less cooling potential. For example, in the July survey the temperature fell by 12 F in the first pond half and by only 3 F in the second half.

Another observation is, that the temperature profile in the pond is not uniformly decreasing, that means that in some cases the temperature further downstream is higher than upstream. This is due to the fact that the plant discharge temperature is not constant over time. Figure 3.5 shows plant discharge temperatures over three days in advance to the July 1995 survey. In general, discharge temperatures rise during the day and are colder in the night. The observation of sections with higher temperatures further downstream indicates that there is little mixing in the flow direction. (See also 3.2.3)

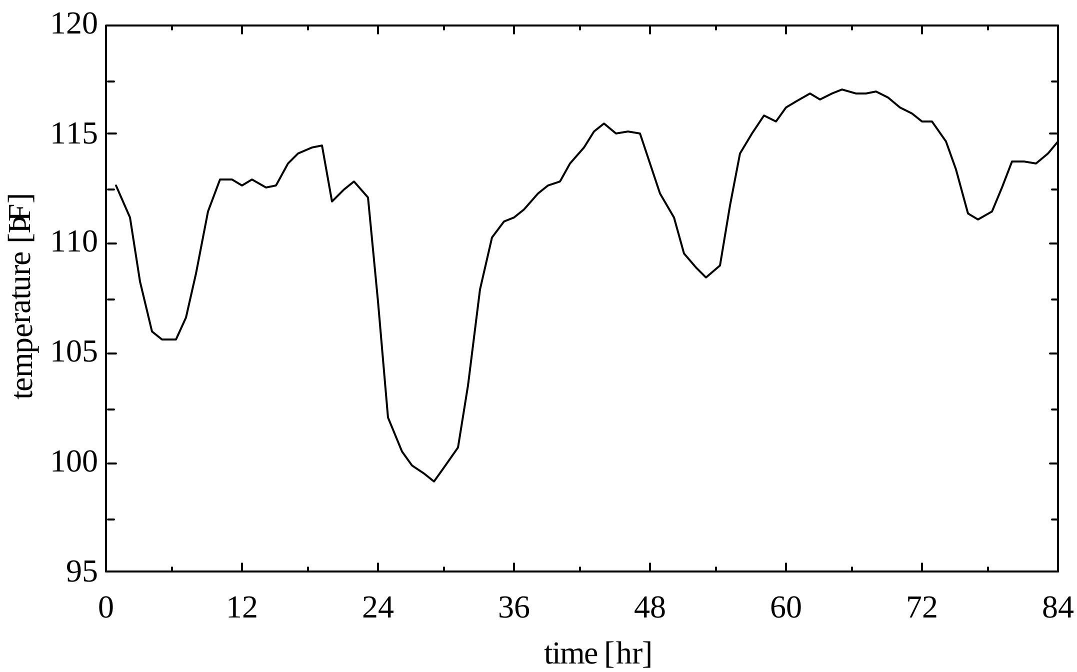

Figure 3.5 Discharge Temperature over the Period of July 22:00:00 { TC "Figure 3.5 Discharge Temperature over the Period of July 22:00:00 " \l 5 }

to July 25:12:00 1995

During the pond survey in July 1995, a difference between the pond temperatures measured in the survey and the temperature indicated by the plant measurement system was noticed. The survey value was 97 F while the on-line system showed 92 F. As the discharge temperatures from both measurements corresponded to each other, it was concluded that the on-line temperature sensor was not calibrated right. This assumption was validated when the on-line pond temperature sensor was checked against a third thermometer and the same discrepancy occurred. This observation, discussed already in 3.2.1, leads to a upward correction of the on-line measured pond temperature by 5 F.

Figure 3.3 Thermal picture of plant discharge{ TC "Figure 3.3 Thermal picture of plant discharge" \l 5 }

3.2.3 Infrared Images of the Pond{ TC "3.2.3 Infrared Images of the Pond" \l 3 }

In addition to the pond surveys an infrared camera was used to take thermal pictures of the pond. The device was brought to the roof of the power plant from where a good sight on the pond is possible. A problem in taking thermal pictures from the plant roof is that the pond is looked at from a low angle. At such a low angle the calibration of the camera is not correct and the indicated temperatures hold no longer true due to the large distance between camera and pond surface. To get an accurate temperature measurement an airplane ought to be used. But, even if the absolute temperature values are not applicable, a good picture of the qualitative temperature distribution in the pond could be produced.

Figure 3.6 shows the plant discharge section of the pond. The lower left corner of the picture shows the inflow channel or plant discharge. The flow direction is indicated in the lower figure. Colors indicate temperatures in the way that blue and green mean colder temperatures and yellow over red to white indicate higher temperatures. It can be seen that the isotherms are nearly perpendicular to the flow path when the flow proceeds into the main pond section shown in the upper part of the picture. The picture also shows cooling of the pond water as it proceeds on the flow path. This observation will be used for setting up a computer model of the pond, see chapter 4.

3.2.4 Cooling Tower Performance Test{ TC "3.2.4 Cooling Tower Performance Test" \l 3 }

In 3.1.1 it was discussed that there can be a difference in meteorological data between the airport weather station and the plant site. Other crucial parameters that are needed for calibration particularly of the cooling tower model are cooling tower water and air flow rates. These values were determined experimentally in calibration tests. In September 1995 a cooling tower performance test was conducted that yielded on site measurements of cooling tower operation parameters. The test was performed for each tower on two different days.

Inlet air wet bulb temperature was measured with nine psychrometers on each side of the tower, which yielded 18 data points for each tower. The exit wet bulb temperature was measured near each fan, which accounts for seven data points per tower. The hot water inlet temperature was determined on top of the tower right where the water leaves the header pipe. A well mixed flow is assumed in the supply pipe, so that the hot water temperature is measured at one location only. Across the outflow channel, the outlet temperature was measured at 10 equally distributed locations. Wind speed and direction were also monitored. During the test, inlet wet bulb, water in- and outlet temperatures and wind data were measured in five minute intervals over one hour, while the exit wet bulb temperature was only measured once per test. The water flow rate was determined with a Pitot tube in both riser pipes of the tower. The water flow rate was only measured once for each flow condition. Measurements were conducted for two water flow rates, or one and two tower pump operation, respectively, as explained in 2.4. At each time both towers were operated and all fans were on. Average values are calculated from the measured data. The air flow rate can be determined from an overall energy balance using the measured data. For this calculation a water evaporation loss of 3% is assumed (see 4.3). In addition to temperatures and flow rates the required fan power was determined, although pump power was not measured.

The cooling tower performance test yielded exact measurements of cooling tower behavior for the given operation conditions, so that reliable data is available for calibration of the tower model. Table 3.3 summarizes the results of the test. The top part of the table shows the inlet and exit temperatures of air and water. These temperatures are crucial for the calibration of the cooling tower model (see section 4.2).

Water flow rates were measured for the whole tower and not for individual cells. The results for water flow show that cooling tower A receives more water in both pump

Air and water temperatures

		Wet Bulb Exit [F]	Wet Bulb Inlet [F]	Water Inlet [F]	Water outlet [F]
Tower A	1 Pump	80.14	51.07	96.91	69.49
	2 Pump	86.03	51.98	93.83	75.90
Tower B	1 Pump	81.97	49.55	96.45	67.46
	2 Pump	89.09	51.21	97.46	75.47

Water flow rates and flow rate ratios for one and two pump operation, values per tower

		measured flow rate [gpm]	total meas. flow rate [gpm]	design total flow rate [gpm]	Flow ratio $\frac{\text{1 pump}}{\text{2 pump}}$
Tower A	1 Pump	57,846	111,358	92,500	0.521
	2 Pump	110,924	215,396	185,000	
Tower B	1 Pump	53,512	111,358	92,500	0.512
	2 Pump	104,472	215,396	185,000	

Air flow rates and fan power, average for one tower cell

		measured air flow rate [10^6 ft^3/min]	design air flow rate [10^6 ft^3/min]	average wind speed [ft/min]	fan power measured [kW]
Tower A	1 Pump	1.21	1.37	364	172.1
	2 Pump	1.25		375	
Tower B	1 Pump	1.05	1.37	393	171.5
	2 Pump	1.25		527	

Table 3.3 Summary of Cooling Tower Performance Test Results{ TC "Table 3.3 Summary of Cooling Tower Performance Test Results" \l 4 }

operation modes than tower B. This observation is reasonable, as tower A is nearer to the pumps and therefore less pressure drop occurs between the pump and tower A than in between pumps and tower B. Aside from measured data, the design pump flow rates are given in the table. It is interesting to note that the actual flow rate is significantly higher than the design flow rate, which means a higher heat load on the towers. The ratio of flow rates for one and two pump operation is not equal to 0.5, as was assumed previously. In fact the ratio is around 0.52, which means that at one pump operation a flow rate is achieved that reaches 52% of the flow at two pump operation. This is due to the fact, that at lower flow rates the pressure drop in the pipes is lower, too.

The air flow rates determined are not equal for both towers, although both towers have the same kind of fans and fan drives. The fill is identical except for the two tower cells of tower B that have a different kind of fill. The difference in air flow rate between one and two pump operation observed for tower B is due to a difference in wind speed between the two tests. The wind at the time of the test was blowing from the North side so that the wind forced the air directly into the towers. Higher average wind speed at the two pump test for tower B is responsible for a higher air flow rate. An interesting fact is, that although the fans were upgraded, the determined air flow rate is still lower than its design value that was given for the original fans (see 2.2).

The measured fan power is almost equal for both towers. The average fan power is around 172 kW. This value is close to the motor nameplate information that indicates a fan drive power of 178 kW for each fan.

3.3 Summary{ TC "3.3 Summary" \l 2 }

As stated at the beginning of this chapter measured data are crucial to calibrate the computer models that will be developed in chapter 4. Although the weather data from the airport weather station can differ from the local weather data at the plant site, the weather station data will be used to calibrate the cooling pond model as the data is assumed to be accurate enough for the task of this work.

The cooling tower performance test yielded rather exact measurements of cooling tower behavior so that the test results will be used to build a well calibrated cooling tower model. The performance test results are the most reliable data as they were obtained directly at the plant site with no time delay.

The online plant measurements will be used to build models mainly of the power plant components such as condenser and turbine. The plant measurements also provide circulating water temperatures that are important to calibrate the pond model.

It is important to realize that the reliability of some data sources is in question. The measurement with the biggest uncertainty in this manner is the pond temperature (see section 3.2.1 and 3.2.2). Considering the errors associated with data acquisition the accuracy of the results of the simulations can only be as good as the data used to calibrate them. Therefore same care must be taken when the simulations are performed and the results are evaluated.