PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

GUDDU 600 MW COMBINED CYCLE POWER PLANT PROJECT

USAID CONTRACT NO. 391-0473-C-00-3045-00

GIBBS & HILL JOB NO. 3572

TASK ORDER NO. 948

PLANT POWER AUGMENTATION USING INLET AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

MARCH 1991

GIBBS & HILL, INC.
ENGINEERS & DESIGNERS

BEST AVAILABLE DOCUMENT

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

GUDDU 600 MW COMBINED CYCLE POWER PLANT PROJECT

PLANT POWER AUGMENTATION USING INLET AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

CONTENTS

		Page No.
1.0	Introduction	1
2.0	Methodology	2
3.0	Input Data and Assumptions	2
4.0	Results and Conclusions	6
	References	

Table

Table 4-1 EIRR Analysis Results

Figures

Figure 1 Temperature and Humidity Data, Rohri Meteorological Station
Figure 2 Guddu Combined Cycle Power Plant, Output versus Ambient Temperature (without inlet air cooling)
Figure 3 Guddu Combined Cycle Power Plant, Average Increase in Base Load Power Output with Inlet Air Cooling
Figure 4 Guddu Combined Cycle Power Plant, Typical Daily Power Output Increase with Inlet Air Cooling

Appendices

Appendix A Meteorological Data
Appendix B Power Increases Attributable to Inlet Air Evaporative Cooling
Appendix C Plant Outages
Appendix D Economic Dispatch Loading

BEST AVAILABLE DOCUMENT

GUDDU 600 MW COMBINED CYCLE POWER PLANT
CONTRACT NO. 391-0473-C-00-3045-00
TASK ORDER NO. 848

PLANT POWER AUGMENTATION USING INLET AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

1.0 Introduction

1.1 The Guddu 600 MW Combined Cycle Power Plant consists of two General Electric STAG Units. Each unit includes two GE Frame 9 gas turbine-generators, two vertical forced circulation heat recovery steam generators and one tandem high/low pressure double exhaust steam turbine-generator. The plant commenced simple cycle operation in 1986 and has been operating in the combined cycle mode since 1988.

1.2 The power output of a gas turbine is proportional to the mass flow of combustion air which is passed to the turbine by the compressor. As the ambient temperature increases, the turbine power output decreases because of the reduced air density and consequential decrease in air mass flow through the compressor. Therefore an increase in power output will result if the gas turbine inlet air temperature can be lowered below the ambient air temperature. In a combined cycle plant the steam turbine output will also increase because of the increase in gas flow through the heat recovery steam generators. The output of the Guddu gas turbines is limited during the hot season (April to October) by high to extremely high ambient temperatures. Ambients in excess of 35°C are normal during the hot months and temperatures as high as 45°C are sometimes experienced. The fairly low ambient relative humidities at Guddu during the summer render evaporative cooling of the gas turbine inlet air an attractive means of increasing plant output.

1.3 The power increases which can be anticipated with inlet air evaporative cooling at Guddu, the equipment required, and the capital and operating costs of the retrofit installation are addressed in an earlier Gibbs & Hill report (reference 1). A simple analysis presented in that report indicated that the air cooler installations would be cost-effective. However, there are many individual plant usage and plant site climatic factors that result in considerable variations in the economic benefits obtained from the use of evaporative coolers. This variability indicated the desirability of performing a more comprehensive analysis utilizing the extensive economic, operational and climatic data which are available for the Guddu installation.

1.4 This report has been prepared as a response to requests by the United States Agency for International Development (USAID) and the Pakistan Water and Power Development Authority (WAPDA) that Gibbs & Hill

BEST AVAILABLE DOCUMENT

prepare an analysis of the economic internal rate of return (EIRR) which would result from the installation of evaporative inlet air coolers on the Guddu 600 MW Combined Cycle Power Plant gas turbines. The report is intended to assist USAID and WAPDA in assessing the economic benefits which would result following the installation of evaporative coolers at Guddu.

2.0 Methodology

2.1 The methodology employed was based on a conventional EIRR analysis format suitable for tax exempt business entities such as WAPDA. Although WAPDA is not subject to corporate income taxes it is responsible for the payment of customes duties and related taxes on imported equipment. This was accounted for in the analysis.

2.2 Several of the key parameters which define the EIRR calculation are subject to daily, seasonal and annual variations. Climatic conditions (specifically wet and dry bulb ambient temperatures) are an example. In addition there are variations in scheduled and forced outage rates and the economic dispatch loading of the plant. These three variables, climatic conditions, plant outages and economic dispatch requirements, determine the actual internal rate of return (IRR) which would result from the use of gas turbine inlet air evaporative coolers.

3.0 Input Data and Assumptions

3.1 The following data and assumptions were used in the analysis:

3.1.1 Meteorological Data

There are no detailed meteorological data available for the Guddu site. Extensive data for the Pakistan Government Meteorological Station at Rohri were obtained by G&H personnel based in Pakistan. Rohri is situated on the left bank of the River Indus opposite the city of Sukkur and is about 150 km. south of Guddu. Rohri experiences a climate which is very similar to that of the Guddu area. The Rohri data were therefore used for the analysis. The base data consist of dry bulb and wet bulb temperatures taken every three hours over a twelve month period (5,840 readings). The data and the processing methods employed are presented and discussed in Appendix A.

Monthly averages of dry bulb temperature, wet bulb temperature and relative humidity at Rohri over the period August 1989 to July 1990 are shown in figure 1. Dry bulb temperatures peak during the months of May and June. The wet bulb depression (i.e., the difference between the dry and wet bulb temperature) reaches a peak in May, decreases through August and incraases to reach a lesser, secondary peak in October. The reduced wet bulb depression (i.e., higher relative humidity) over the period from July to September is attributed to monsoon effects, although Guddu itself is outside the monsoon rainfall area. The seasonal variation in the dry/wet bulb temperature difference is of interest because the power increase which can be obtained from evaporative cooling is proportional to wet bulb depression.

BEST AVAILABLE DOCUMENT

TEMPERATURE AND HUMIDITY DATA

ROHRI METEOROLOGICAL STATION

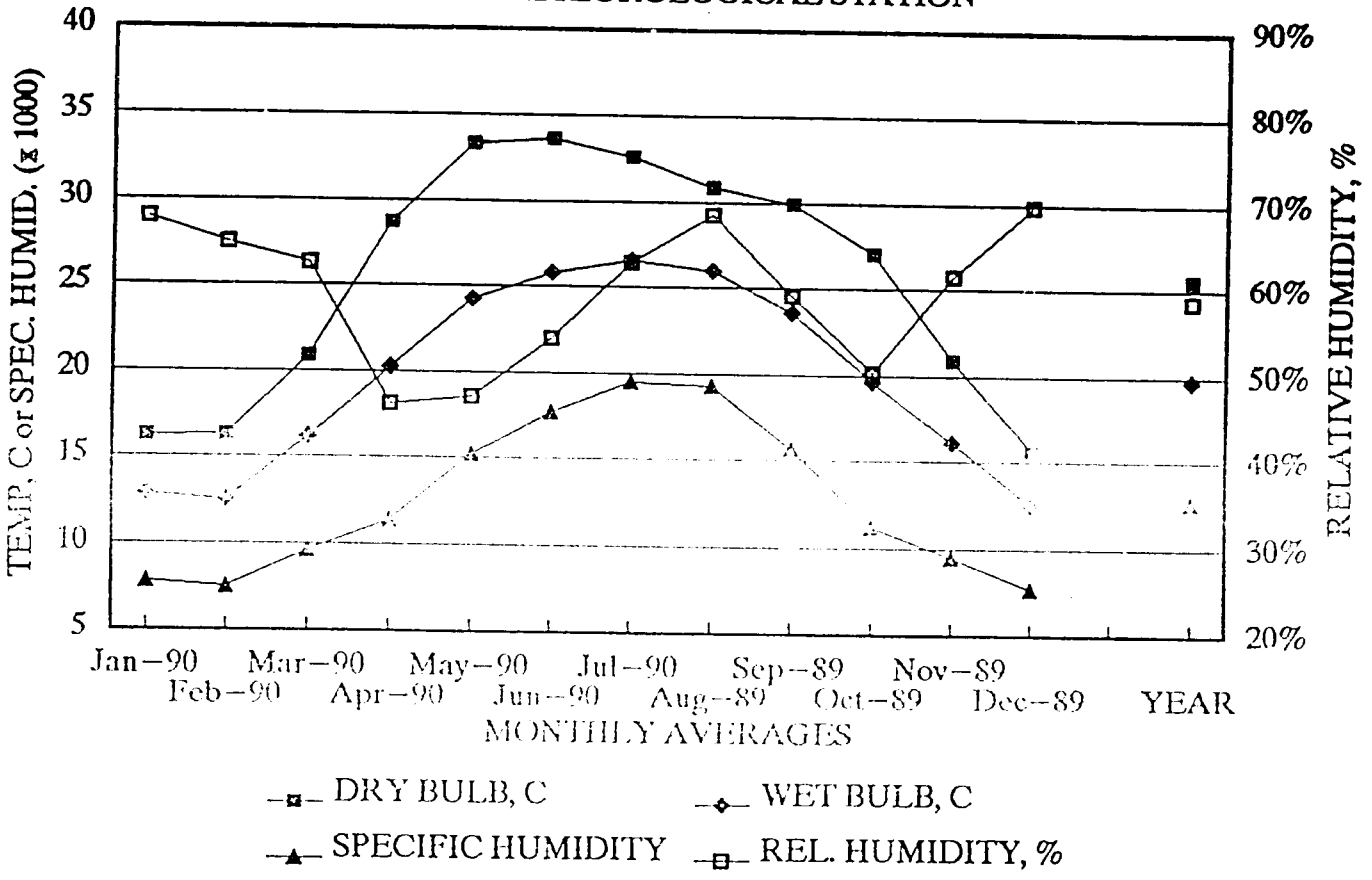


FIGURE 1

BEST AVAILABLE DOCUMENT

- 26 -

3.1.2 Power Increase Attributable to Inlet Air Evaporative Cooling

The method by which the power increases attributable to evaporative cooling were calculated is discussed in detail in Appendix B. Combined cycle power plant base load output was plotted against ambient temperature using data obtained from the plant operations logs (see figure 2). The slope of the straight line relationship obtained is in close agreement with data provided by General Electric.

This relationship can be used to calculate power outputs with inlet air cooling, since, for any given ambient temperature, the power output which can be obtained from inlet air cooling is defined by the power output corresponding to the cooled air temperature.

A computer model was developed to calculate the increases in power output which can be achieved through evaporative cooling. The model uses the power output-temperature relationships discussed above and is based upon the assumption that the evaporative coolers operate at an efficiency of 80 percent, (i.e. the inlet air is cooled by 80 percent of the wet bulb depression. It might be noted that a 90 percent efficiency was used in the reference 1 report. Although this efficiency can be achieved with new media a more conservative approach is considered appropriate for the present analysis). The model also accounts for the slight loss in efficiency resulting from the increase in inlet air pressure drop caused by the evaporative media.

Calculated increases in base load power output for each month over the year for which meteorological data were obtained are shown in figure 3. These increases are on the basis of average monthly dry and wet bulb temperatures. A typical daily power increase curve is shown in figure 4. The calculated average yearly power increase, on the basis of a base loaded plant and without consideration of outages and power reductions, is 14.0 MW.

3.1.3 Cost of Gas Fuel

The cost of the gas fuel required for the generation of the additional power obtained through inlet air cooling was taken to be 0.119 Rs/KWh. This is the figure for Mari gas, as utilized by the Guddu Combined Cycle Plant, quoted by the Asian Development Bank in their Project Completion Report (reference 2).

3.1.4 Plant Outages

Plant outages were based on plant data for the year 1989-1990. The cumulative outage rate was 10.9 percent which is in line with U.S. experience. It should be noted that the loss in output is somewhat greater than that suggested by the 10.9 percent outage figure since the loss of output from a gas turbine results in the loss of 50 percent of the output from the associated steam turbine. This was accounted for in the analysis. The outage data are presented in Appendix C. Plant outages have the effect of reducing the calculated yearly average power increase

BEST AVAILABLE DOCUMENT

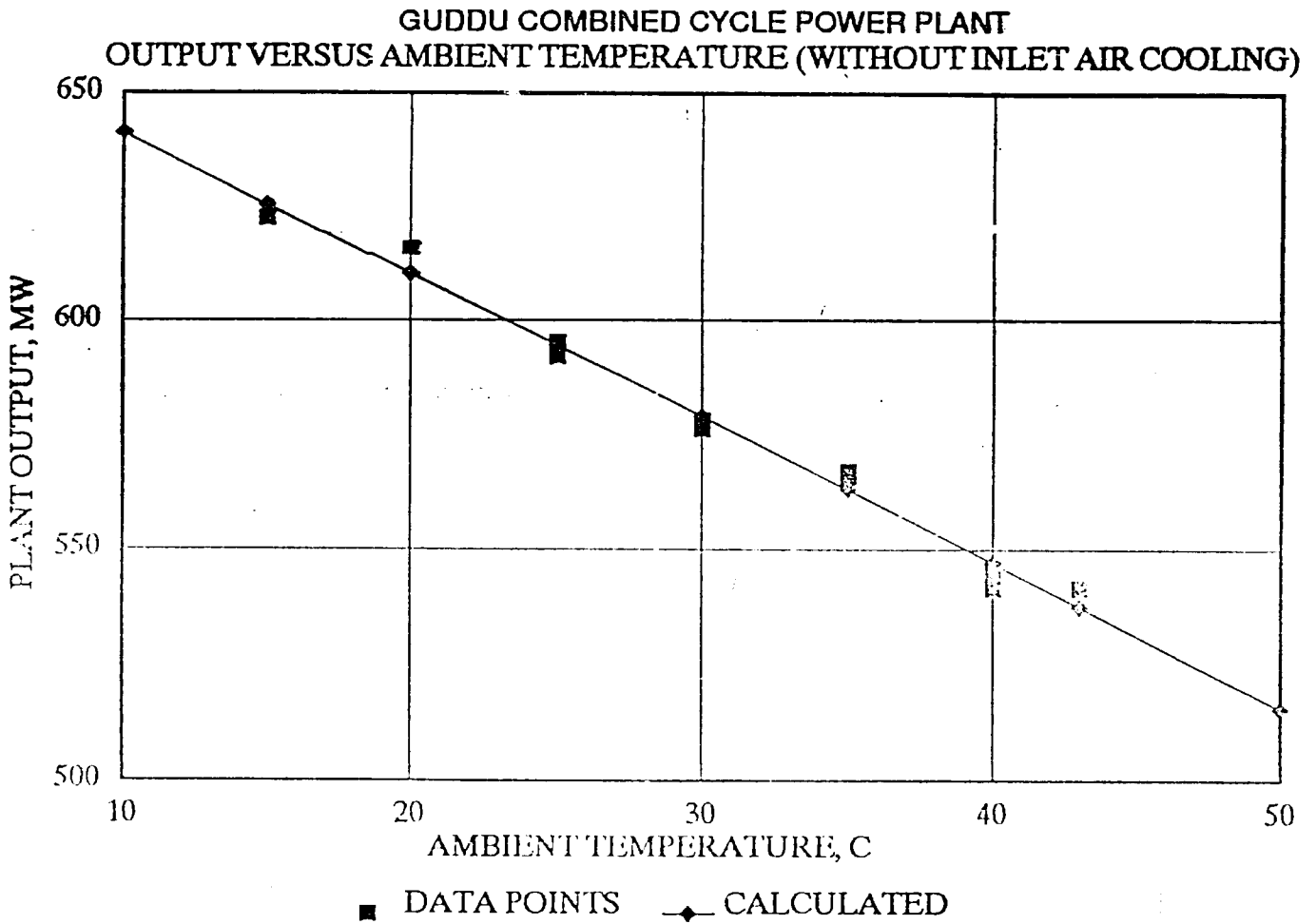


FIGURE 2

BEST AVAILABLE DOCUMENT

GUDDU COMBINED CYCLE POWER PLANT

AVERAGE INCREASE IN BASE LOAD POWER OUTPUT WITH INLET AIR COOLERS

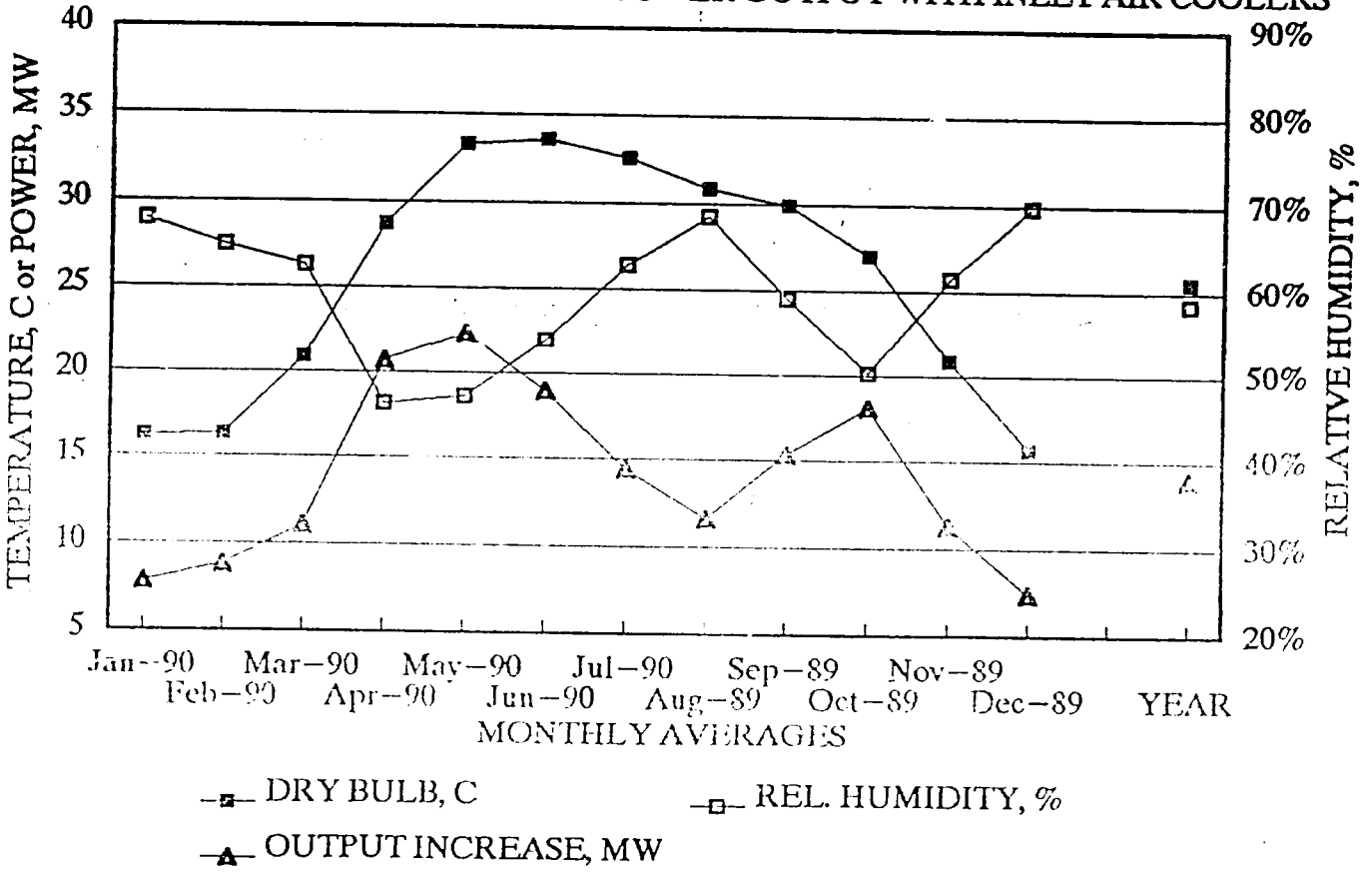


FIGURE 3

BEST AVAILABLE DOCUMENT

GUDDU COMBINED CYCLE POWER PLANT

TYPICAL DAILY POWER OUTPUT INCREASE WITH INLET AIR COOLING

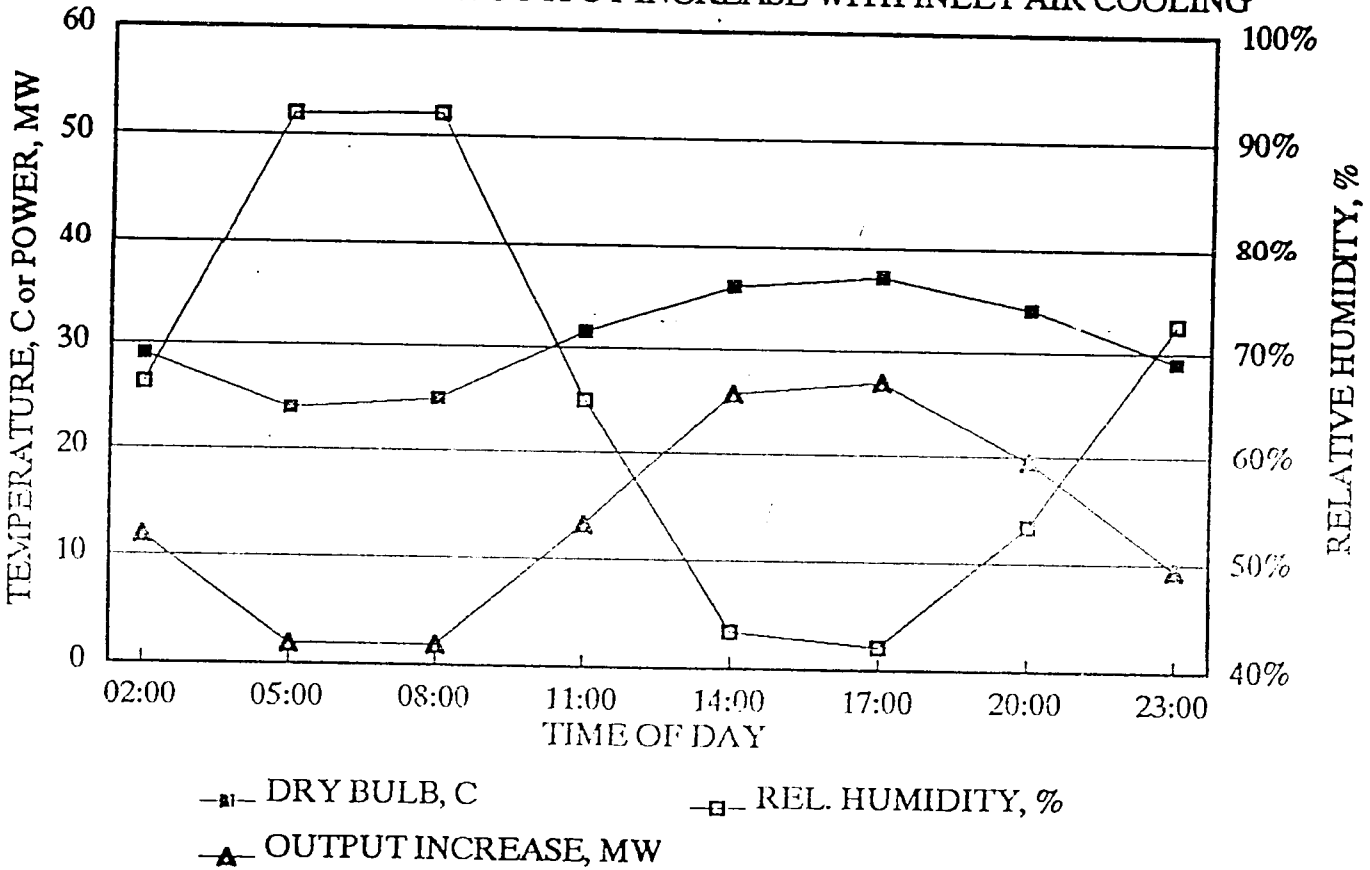


FIGURE 4

BEST AVAILABLE DOCUMENT

of 14.0 MW (for a plant which is base loaded 24 hours a day throughout the year) to 12.1 MW.

3.1.5 Economic Dispatch Loading

The power increase potential provided by the inlet air coolers is not fully utilized during those periods when plant output is reduced for economic dispatch purposes. Power reductions due to economic dispatch result in a further reduction is the calculated yearly average power increase from 12.1 MW to 10.2 MW.

3.1.6 Capital Cost of Equipment

The cost of the installation, as estimated in November 1990 is presented in reference 1 and is as follows:

Equipment delivered CIF Karachi	$3,934,000
Supervision of installation	$90,000
Inland transportation, local supply and erection	Rs. 26,820,000

On the basis of data for similar imported equipment it is assumed that WAPDA will be required to pay import duties at 17 percent of the CIF cost. Using an exchange rate of 22.0 Pakistan rupees per U.S. dollar the estimated total capital cost, including import duties, is Rs. 130,061,000.

3.1.7 Loss of Revenue During Construction

It was assumed that the retrofit work will be timed to coincide with the gas turbine shutdowns for annual maintenance. There will therefore be no loss of revenue attributable to the evaporative cooler retrofit activities.

3.1.8 Operating and Maintenance Costs

The annual cost of replacement evaporative media is $44,000 (reference 1). This figure is increased by 17 percent to account for import duties and taxes. The annual rupee cost of replacement media is therefore Rs. 1,130,000.

The power required to pump the evaporative media water is about 60 kW. Per WAPDA advice parasitic electricity costs Rs. 0.35/KWhr. The annual pumping cost is therefore Rs. 190,000.

It is assumed that the existing plant maintenance staff need not be expanded on account of the cooler installation and therefore plant staffing costs are not increased.

The annual operations and maintenance cost is therefore estimated to be Rs. 1,320,000.

BEST AVAILABLE DOCUMENT

3.1.9 Interest Rate

The interest rate on borrowed funds was assumed to be 11 percent. This is the rate on loans made to WAPDA by the Government of Pakistan. It was assumed that no interest payments on principal are due until commercial operation of the evaporative coolers, after which the loan would be repaid over 20 years. No grace period was assumed.

3.1.10 Discount Rate on Future Savings

The discount rate on future savings was taken as 10 percent. This figure was provided by WAPDA.

3.1.11 Value of Additional Electrical Output to WAPDA

A value of 9 Rs/kWh of additional output has been assigned. This value was furnished by WAPDA and is a constant, i.e. it does not vary on a seasonal, daily or hourly basis. It is an extremely high value because it includes the value of the social benefits to the country and people of Pakistan as well as the value of the additional revenue to WAPDA. For EIRR analysis purposes the value was divided into two components, 8 Rs/kWh for social benefit value and 1 Rs/kWh for revenue value. The revenue component was escalated as discussed in the following sub-section.

No value was attributed to the additional capacity available from the use of inlet air coolers because of the already very high rupee value of additional output.

3.1.12 Escalation

It was assumed that the November 1990 capital cost estimate presented in sub-section 3.1.6 and the O&M cost presented in sub-section 3.1.8 would escalate by 5 percent prior to execution of a contract for the turnkey supply of the installation. 6 percent per annum escalation in the value of additional revenue to WAPDA and in operations and maintenance costs and fuel costs was assumed over the useful life of the cooler facility.

3.1.13 Useful Life of Installation

A 20 year cooler installation life cycle was assumed, i.e. the loan term and the equipment life are the same. Compared with straight line depreciation this results in slightly lower depreciation for the first ten years and correspondingly higher depreciation in later years. This follows from the fact that for constant annual payment terms, as was assumed here, amortization in the early years of the loan is at a lower rate than for straight line depreciation.

3.1.14 Power Losses

Power losses were not considered in the analysis since the majority of these occur in the transmission and distribution system and not in generation.

BEST AVAILABLE DOCUMENT

4.0 Results and Conclusions

4.1 The analysis results are presented in Table 4-1. Both the EIRR and the number of years required to achieve payback are extremely favorable. This is because the cost of fuel and the capital investment required for the evaporative cooler installation are both relatively low.

Using the 9 Rs/KWh value attributed by WAPDA to additional electrical output the internal rate of return is 568 percent and the payback period is only a few months. If the social benefit component of the value of additional revenue is excluded and a value of 1 Rs/KWh is used, the IRR is 51 percent and the payback period is less than three years. This is considered to be a more realistic economic case since it is based on the economic benefits to WAPDA.

The two variables with significant impact upon IRR are revenue and fuel cost. The cost of the gas used at Guddu is extremely low when compared with the cost of gas in the United States. A fuel cost of 0.119 Rs/KWh was used for analysis. This is about five times less than gas fired combined cycle power plant fuel costs in the U.S. and about five times less than the fuel cost for WAPDA's conventional steam plants when fired with furnace oil. If the assumed gas cost of 0.119 Rs/KWh is increased by five times, the IRR remains at an acceptable level of 21 percent on the conservative bases of no increase in revenue to WAPDA to compensate for the increased cost of fuel and the exclusion of the social benefit value from revenue. The payback period for this case is six years.

It is concluded that the installation of inlet air evaporative coolers on the Guddu combined cycle plant gas turbines is an attractive economic proposition for WAPDA.

BEST AVAILABLE DOCUMENT

TABLE 4–1
EIRR ANALYSIS RESULTS

	0	1	2	3	4	5	6	7	8	9	10
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CAPITAL INVESTMENT, Rs	136,564,000	0	0	0	0	0	0	0	0	0	0
DEBT SERVICE (11% INT.) Rs		17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000
INCREMENTAL FUEL COST Rs		10,627,000	11,264,000	11,940,000	12,657,000	13,416,000	14,221,000	15,074,000	15,979,000	16,938,000	17,954,000
INCREMENTAL O & M Rs		1,282,000	1,465,000	1,553,000	1,646,000	1,745,000	1,850,000	1,961,000	2,079,000	2,203,000	2,335,000
TOTAL Rs		29,158,000	29,878,000	30,643,000	31,452,000	32,311,000	33,220,000	34,184,000	35,207,000	36,290,000	37,438,000
INCREMENTAL REVENUES											
– POWER BENEFIT Rs	(136,564,000)	89,301,000	94,660,000	100,339,000	106,359,000	112,741,000	119,505,000	126,675,000	134,275,000	142,330,000	150,873,000
– SOCIAL BENEFIT Rs		714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000
TOTAL REVENUES Rs		803,713,000	809,071,000	814,751,000	820,771,000	827,153,000	833,917,000	841,088,000	848,688,000	856,745,000	865,285,000
NET REVENUES Rs	(136,564,000)	774,555,000	779,192,000	784,108,000	789,319,000	794,842,000	800,697,000	806,900,000	813,482,000	820,455,000	827,846,000
NET REVENUES Rs (excluding value of social benefit)	(136,564,000)	60,143,000	64,781,000	69,696,000	74,907,000	80,431,000	86,285,000	92,491,000	99,070,000	106,043,000	113,434,000
INTERNAL RATE OF RETURN (including value of social benefit)	56%										
NET PRESENT VALUE Rs (including value of social benefit)		6,947,326,000									
PAYBACK (YEARS)	LESS THAN 1 YEAR										
INTERNAL RATE OF RETURN (excluding value of social benefit)	51%										
NET PRESENT VALUE Rs (excluding value of social benefit)		865,136,000									
PAYBACK (YEARS)	LESS THAN 3 YEARS										

	11	12	13	14	15	16	17	18	19	20
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
CAPITAL INVESTMENT, Rs	0	0	0	0	0	0	0	0	0	0
DEBT SERVICE (11% INT.) Rs	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000	17,149,000
INCREMENTAL FUEL COST Rs	19,031,000	20,173,000	21,383,000	22,666,000	24,026,000	25,468,000	26,996,000	28,616,000	30,333,000	32,153,000
INCREMENTAL O & M Rs	2,478,000	2,624,000	2,782,000	2,948,000	3,125,000	3,313,000	3,512,000	3,722,000	3,946,000	4,182,000
TOTAL Rs	38,658,000	39,946,000	41,314,000	42,764,000	44,301,000	45,930,000	47,657,000	49,487,000	51,428,000	53,484,000
INCREMENTAL REVENUES										
– POWER BENEFIT Rs	159,925,000	169,521,000	179,692,000	190,474,000	201,902,000	214,016,000	226,857,000	243,469,000	254,867,000	270,160,000
– SOCIAL BENEFIT Rs	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000	714,412,000
TOTAL REVENUES Rs	874,337,000	883,933,000	894,104,000	904,886,000	916,314,000	928,428,000	941,269,000	954,880,000	969,308,000	984,602,000
NET REVENUES Rs	835,681,000	843,988,000	852,790,000	862,121,000	872,013,000	882,498,000	893,612,000	905,393,000	917,881,000	931,118,000
NET REVENUES Rs (excluding value of social benefit)	121,269,000	129,575,000	138,378,000	147,710,000	157,601,000	168,086,000	179,200,000	190,981,000	203,469,000	216,706,000

BEST AVAILABLE DOCUMENT

References

1. G&H report, "Guddu 600 MW Combined Cycle Power Plant Project, Gas Turbine Power Augmentation Using Evaporative Coolers. Assessment and Cost Estimate" November 1990 issued under cover og G&H letter 3572-NB-152 dated November 12, 1990.

2. Asian Development Bank, "Project Completion Report of the Guddu Combined Cycle Project" January 1990

3. General Electric Company letter dated January 21, 1991, Guddu 600 MW Combined Cycle Power Plant, Installation of Evaporative Coolers.

BEST AVAILABLE DOCUMENT

PLANT POWER AUGMENTATION USING INLET AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

APPENDIX A

METEOROLOGICAL DATA

BEST AVAILABLE DOCUMENT

APPENDIX A

METEOROLOGICAL DATA

Detailed meteorological data are not available for the Guddu site. However extensive data for the Pakistan Government Meteorological Station at Rohri were obtained by Gibbs & Hill personnel based in Pakistan. Rohri is situated on the River Indus opposite the city of Sukkur and is about 150 km south of Guddu. The Rohri climate is very similar to that of Guddu and the Rohri data were therefore used for analysis.

The base data consist of dry bulb and wet bulb temperatures recorded every three hours over the twelve month period from August 2, 1989 to July 31, 1990. The data were inputted to a spreadsheet progrem to facilitate analysis. A print-out of the base data (5,840 individual readings) is presented in Table A-1.

A two step data reduction program was implemented to simplify analysis. The first step consisted of the formulation of average dry bulb and wet bulb temperatures for each month of the year, at the same three hour intervals for which the data were recorded (i.e, 2:00 a.m., 5:00 a.m., 8:00 a.m., 11:00 a.m., 2:00 p.m., 5:00 p.m., 8:00 p.m., and 11:00 p.m.). This was performed by averaging the individual data points for each day of the month at each of the eight times at which the data were recorded during the day for both dry and wet bulb temperatures. This information is presented in Table A-2.

The second step in the data reduction process was the development of monthly average dry bulb and wet bulb temperature profiles. All of the temperature readings obtained for a particular month were averaged (i.e., the eight readings taken every three hours for each day of the month). Yearly averages were also calculated. Relative and specific humidities were then computed for these averages. Table A-3 presents this information in a tabular form. Figure A-1 presents this information in a graphical format.

Additional temperature data from the Pakistan Government Meteorological Station at Rohri were processed to provide confidence that the meteorological data obtained for the twelve month period from August 1, 1989 through July 31, 1990, were truly representative of the region and not aberrations of normal weather patterns. This was done by transcribing dry bulb and wet bulb temperature records for every three hours (the same hours used for the base data discussed above) for the first, seventh, fifteenth, and twenty fifth day of each month from January 1, 1984 through August 25, 1988. These data are presented in Table A-4. A three step data reduction process, similar to that described above, was employed to facilitate the analysis of the data and to allow for ready comparison with the data records for the full twelve months. The first step in this process was to compute average dry bulb and wet bulb temperatures for each of the four days in each month at each of the three hour intervals as shown in Table A-5. These data were then condensed to formulate monthly averages for both dry bulb and wet bulb temperatures at each of the three hour intervals. The

BEST AVAILABLE DOCUMENT

10

results of this operation are presented in Table A-6. Monthly average temperature profiles were then developed. All of the readings taken for a particular month were averaged and the monthly averages were themselves also averaged to determine a yearly average. Relative humidities and specific humidities were calculated for these averages. This information is presented in Table A-7 and Figure A-2.

The two sets of data, i.e., the daily data from twelve months of records and the less extensive data from four and one-half years of records for four days of each month, were then compared. This comparison indicates that while, with minor variations, the monthly temperatures for the period from August 1, 1989 through July 31, 1990 approximate those from January 1, 1984 through August 25, 1988, there are variations in relative humidity. The reference period from August 1, 1989 through July 31, 1990 was generally more humid than the period from January 1, 1984 through August 25, 1988. Comparisons of dry bulb and wet bulb temperatures and relative humidity are presented in Figures A-3 through A-5. As discussed Appendix B the use of meteorological data for a period which exhibits above average relative humidity results in an underestimation of the probable power increases which can be obtained with inlet air evaporative coolers. The use of meteorological data for the period from August 1989 to July 1990 was therefore a conservative approach.

BEST AVAILABLE DOCUMENT

11

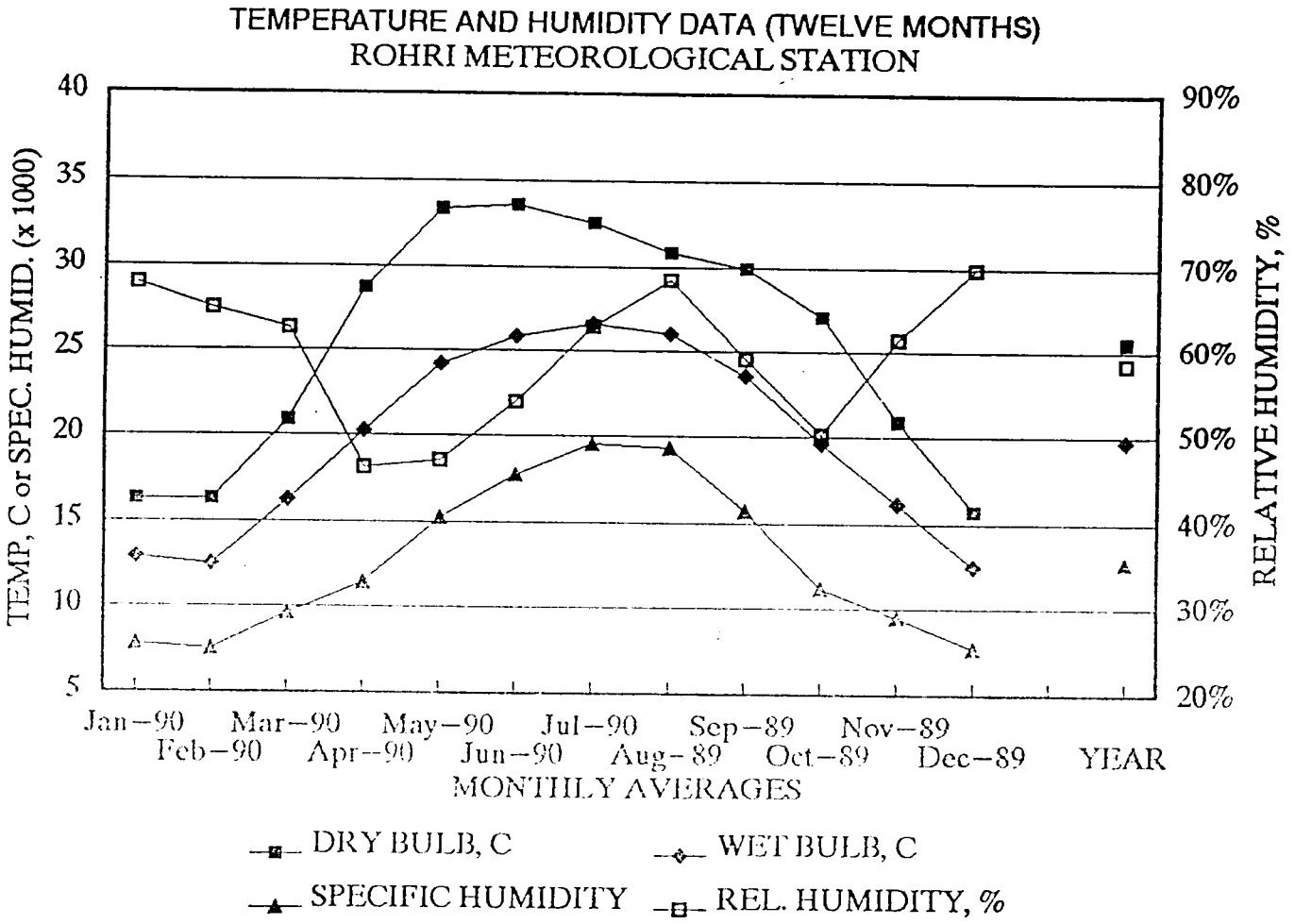


FIGURE A-1

BEST AVAILABLE DOCUMENT

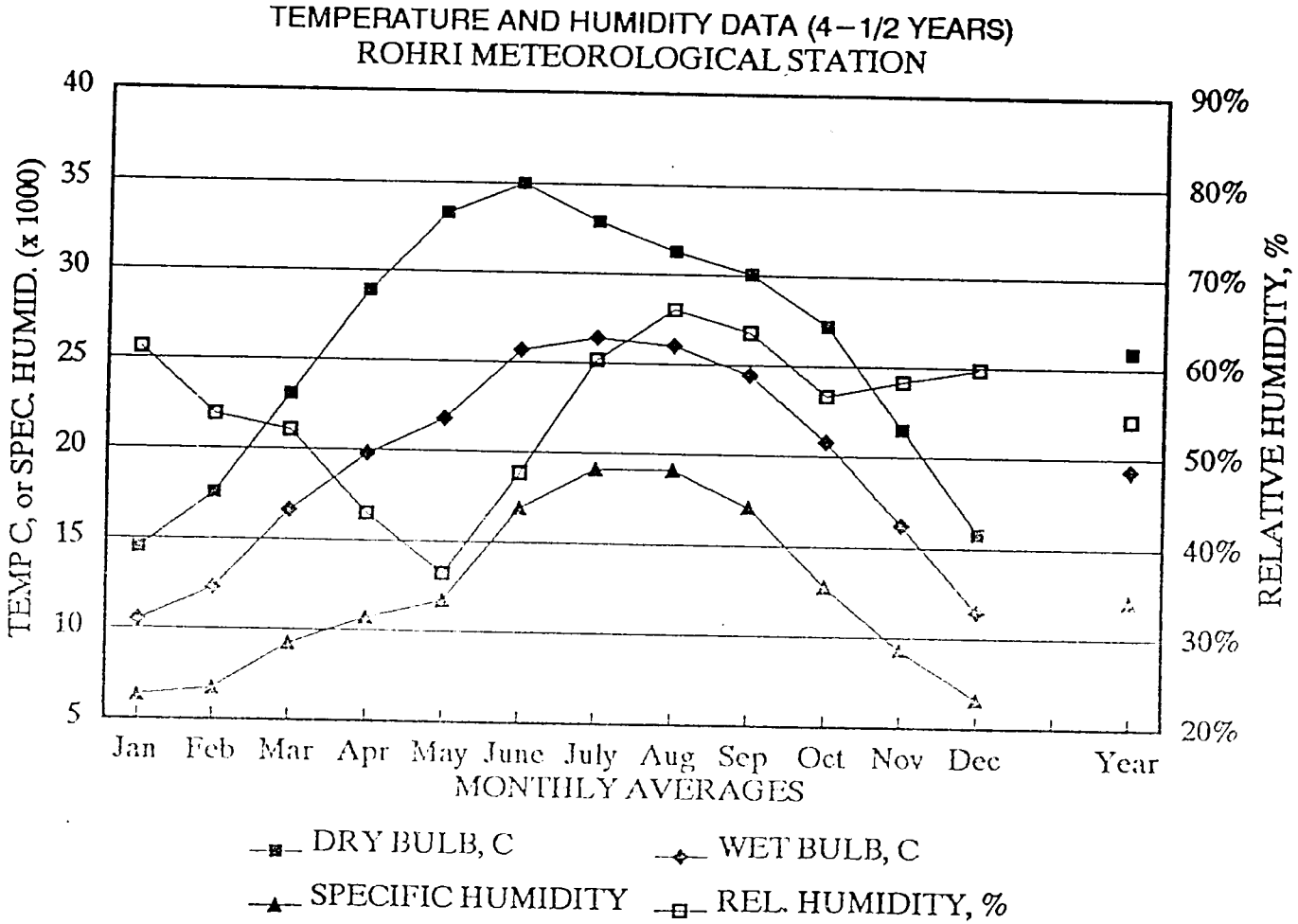


FIGURE A-2

BEST AVAILABLE DOCUMENT

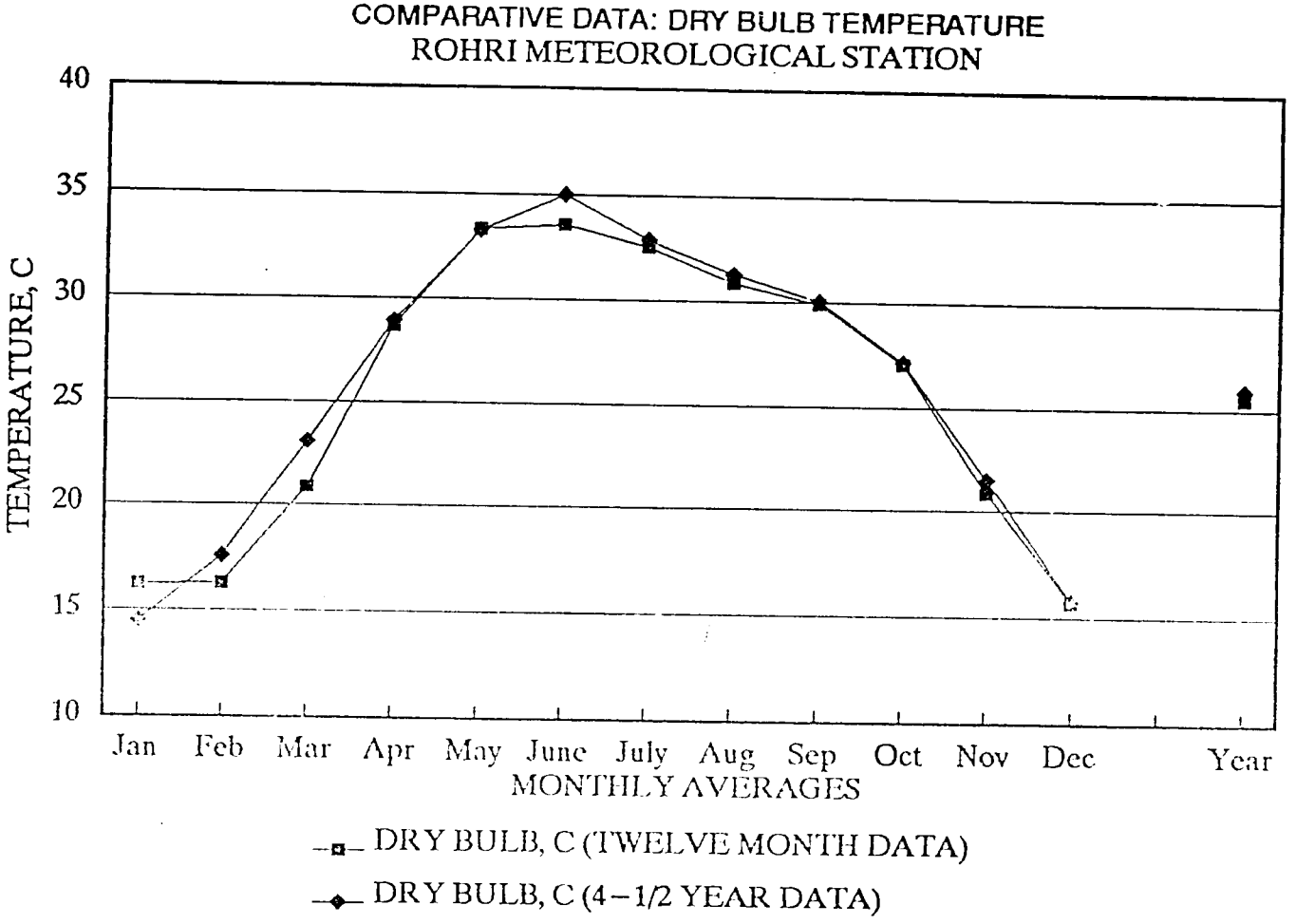


FIGURE A-3

BEST AVAILABLE DOCUMENT

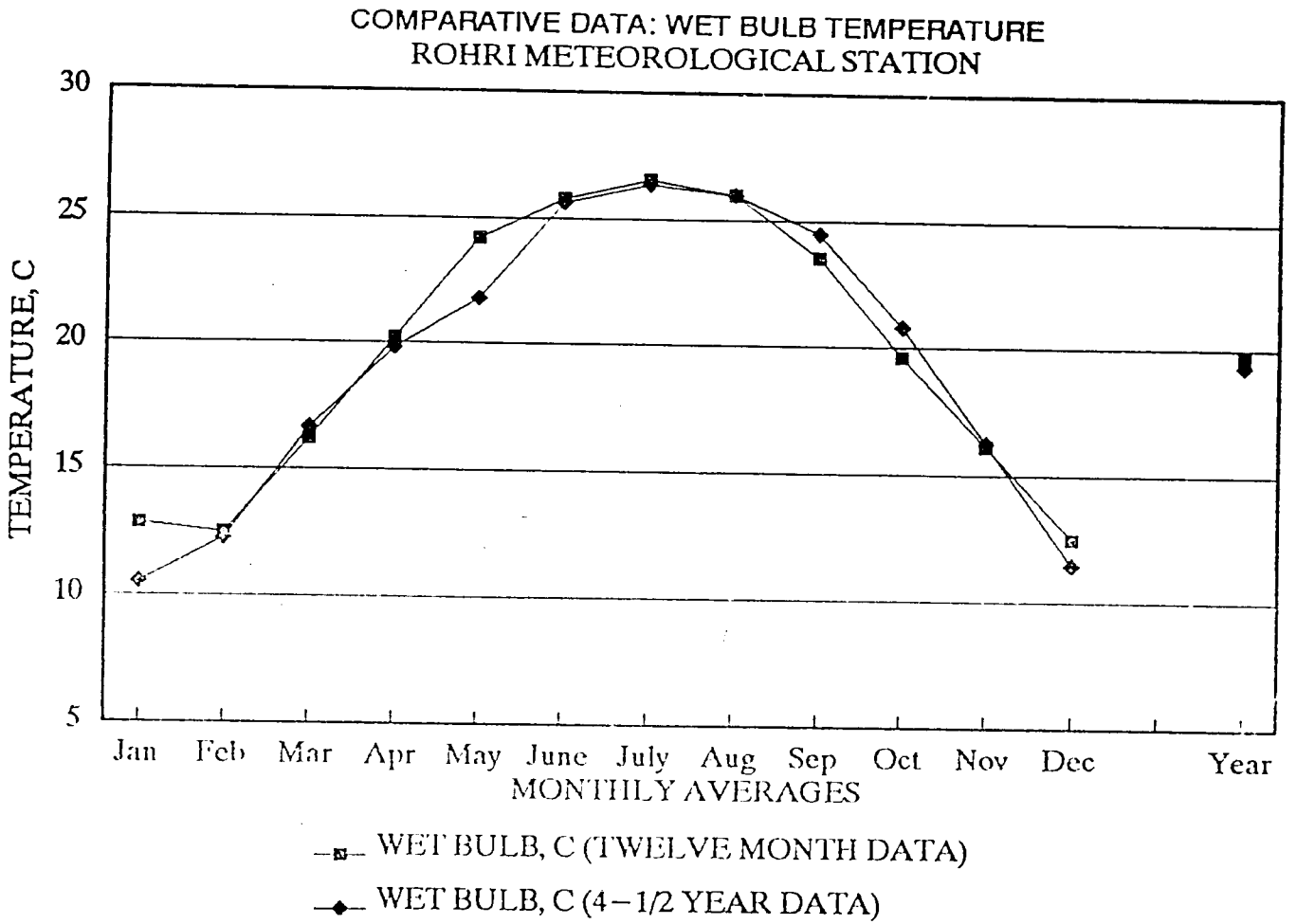


FIGURE A-4

BEST AVAILABLE DOCUMENT

15

COMPARATIVE DATA: RELATIVE HUMIDITY

ROHRI METEOROLOGICAL STATION

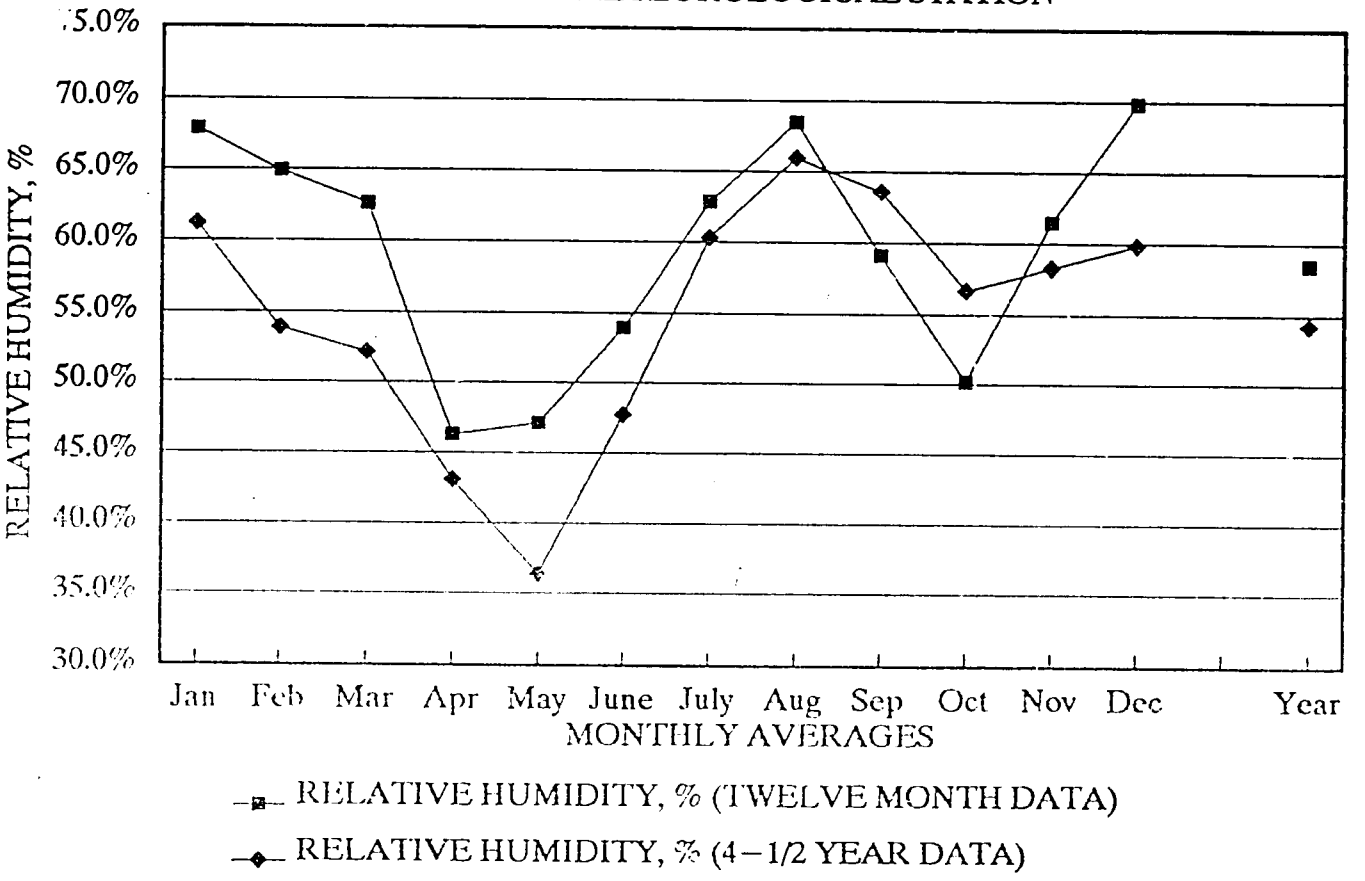


FIGURE A-5

BEST AVAILABLE DOCUMENT

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Aug-89	25.5	26.5	32	36	37	33	30	26	23.5	24.5	27	27.5	27	26	25	24
02-Aug-89	24.5	26	31.5	33	33.5	31	30	28	23	24.5	26.5	27	27	26	26	26
03-Aug-89	26	27	32	34	37	33	30	29	25	25	27	28	27	26	25	25
04-Aug-89	26	27	32.5	35.5	36.5	34	32	27	24	25	26	26.5	26	25	24	23
05-Aug-89	24	25	30.5	32	32.5	30.5	27	26	23	24	25.5	26	26	25.5	24	23
06-Aug-89	25	28	31	34	36	32	31	28	23.5	24	26.5	27	26	25	24.5	24
07-Aug-89	27	28	32	34	36	33	31	29	25.5	26	27	27.5	28	27	26	25
08-Aug-89	28	30	35	36	38	34	32	30	24	25	26	27	28	27	26	25
09-Aug-89	24.5	26	31	33	37	33	30	28	23	24	26	27	27.5	26	25.5	25
10-Aug-89	25	28	29	35	36	33	31	27	24.5	25	26	29	26	26	25.5	24
11-Aug-89	25	25.5	28	35.5	34.5	32	31	28	23	24	25	28	27.5	27	26	24
12-Aug-89	25	26	28	33.5	34.5	31	29	27	23	24	25.5	27.5	27.5	27	26	25
13-Aug-89	26	27	30.5	32	35.5	32	30	28	24.5	25	26.5	27	27.5	26	25	25
14-Aug-89	27	28	31	33	35.5	33	31	30	24.5	25	26	27	27.5	27	26	25
15-Aug-89	28	28	34	36	38	33	32	30	24.5	25	26	26.5	27.5	27	27	26
16-Aug-89	28	29	34.5	36	38	36	33	31	25	26	27	27.5	28	27	26	25.5
17-Aug-89	28.5	30	32	35	38.5	33	31	30	27	27	28	28	28.5	27	26.5	25.5
18-Aug-89	28	30	33	35	38	36	33	30	25	26	27	28	27.5	27	26	25.5
19-Aug-89	28	30	34.5	37	38	36	33	30	25	26	28	28	29	28	27	26
20-Aug-89	27	28	35	36	37	33	31	28	25	26	26.5	27	28	27	26	25
21-Aug-89	25	27	33	37	36.5	34	28	27	24	25	26	28	28	27	26	25
22-Aug-89	26	28.5	34	37	36.5	34	28	27	24	26.5	28	28	29	27	26	25
23-Aug-89	26.5	27.5	32	36	37	32	29	28	25	25.5	26	26.5	27	27	26	26
24-Aug-89	27.5	28	33.5	34	35	33	29	27	26.5	26.5	27	28	28.5	27.5	26	25
25-Aug-89	26.5	28.5	34	36.5	37	32.5	31	29	24	26.5	27	28	28.5	28.5	26	25
26-Aug-89	28	30.5	34	35	36	30	28	27	25.5	27.5	28	28.5	28	27	25.5	25
27-Aug-89	26	28	34	35	36	30	28	27	24	26	27	27.5	28	27	26	25
28-Aug-89	22	24.5	27.5	29	32.5	30	28	27	19	21.5	23	25	27	26	25.5	25
29-Aug-89	26	28	30	31.5	34	31	28	27	24.5	26	26	27	28	26	25.5	25
30-Aug-89	26	28	31	32	33	30	28	27	24	25.5	26.5	27	26	25.5	25	25
31-Aug-89	26	27.5	30.5	32	34	31	29	28	25	26.5	27	27.5	26.5	26	25	24

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Sep-89	24.5	26.5	30	32	28.5	27	26	25	23	25	26	25	24	24	23	23
02-Sep-89	24.5	26	32	34	34	34	30.5	26	23	24	22	25	27.5	25.5	25	24.5
03-Sep-89	25	28	33	34	36	33	29	27	24	25	25	26	28	27	25	24
04-Sep-89	24	26	33	36	36	34.5	34.5	29.5	23	22	25	26	26	25.5	25	24
05-Sep-89	27	29	31	36.5	37	34	31	29	23	24	27	26.5	27	25	24.5	24
06-Sep-89	24	25	31.5	36	37	34	29	27	23	24	26	25.5	26	26	25	25
07-Sep-89	24	25	31	34	34	34	29.5	27	23	24	26	27	27.5	26	25.5	25
08-Sep-89	25	27	33	34.5	36	34	32	28	24	25	27	26.5	28	27	26	25
09-Sep-89	25	26	31	33	35	33	30	26	23	23	[illegible]	25.5	26	25	24	23
10-Sep-89	25	26	30	33	36	34	30	26	22	23	24	24.5	25	24	23	23
11-Sep-89	24	25	32	35	36	34	30	28	22	23	24.5	25	26	25	24	23
12-Sep-89	26	28	31	35	37	34	31	28	22	23	25	26	25	24	23	22
13-Sep-89	24	26	29	34	35	33	30	28	21	22	25	26	25.5	25	24	23
14-Sep-89	26	27	30	34	34.5	34	26	25	22	24	23	23	23.5	23	23	22
15-Sep-89	24	25.5	33	35	36	30	27	25	21	22.5	23	24.5	24	23	23	22
16-Sep-89	24	26	34	36	35	30	28	26	19	21	23	23	24	24	25	24
17-Sep-89	23	28	32	35	35	33	29	27	22	23	23.5	25	26	26.5	25	24
18-Sep-89	24.5	27.5	32	37	37	33	31	28	23	24	26	26	26	25	24	23
19-Sep-89	24	26	28	33	36	32	28	26	22	23	24	25	26.5	25	24	23
20-Sep-89	25	27	29	32	34	31	28	26	22	23	24	25.5	26	25	24	23
21-Sep-89	25	27	30	32.5	36.5	31	29	27	22	23	24	25	25.5	25	24	23
22-Sep-89	26	30	33	35	36.5	32	30	28	22	23	24	25.5	24.5	25	24	23
23-Sep-89	26	29	33	35	36	31	28	27	22	24	26	26	25	23.5	23	21
24-Sep-89	26	28	31.5	33	34	32	28	26	17	18	19	23	18	19	23	22.5
25-Sep-89	23.5	25	30	32	32	30	28	25	22	23	24	23	24	23	22	21
26-Sep-89	21	25	29	35	34	31	29	26	20.5	21	22	22	23	22	22.5	21
27-Sep-89	21	24	33	35	34	29	24	22	19	21	21.5	22.5	23.5	21	20.5	20
28-Sep-89	21	26	35	35.5	36.5	34	28	25	19	20	22.5	22.5	22	21	19	18
29-Sep-89	22	24	34	36.5	37.5	29	27	25	17	19	22	23	25.5	22	21	20
30-Sep-89	21	24	32	35.5	37.5	30	28	23	19.5	21	23	23	21	20.5	19.5	18.5

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Oct-89	21	23	34	37	36	32	30	28	18	19	21	21	20.5	19	18	17
02-Oct-89	21	23.5	32	34.5	35	29	25	23	17	20	22	22.5	23	22	21	20
03-Oct-89	22.5	24	33	35.5	36	31.5	27	24	20	21	24	25	25	22.5	22.5	22
04-Oct-89	23	25.5	32	36	37	29	27	25	22	23	24	24	25	23	21.5	21
05-Oct-89	24	28	29	34	34.5	28.5	27.5	25.5	22.5	23	24	25	25	25	24	23.5
06-Oct-89	23	24	25	33	36	30	27.5	25	22	23	24	25	26	25	24	22
07-Oct-89	21	25	32	36	37	33	26	23.5	20	22	24	25	26	25	22	20.5
08-Oct-89	21	25	33	35	36.5	33	30	27	19	20	23	25	25.5	25	24	22
09-Oct-89	21	23	34	37	36	33	31	27	20	21	23	22	21	20	19	18
10-Oct-89	20.5	22	35	36	35	32	25	23	18	21.5	22	23	22	21	19.5	19
11-Oct-89	20	23	32	35	36.5	33	25	23	18.5	20.5	22	21	20	19.5	19	18
12-Oct-89	21	23.5	28	32	33	28	26	24	18.5	21.5	24	22	21	20	19	19
13-Oct-89	21.5	23	29	32	33	30	26	20	18	20	21	20.5	20	19.5	18.5	17.5
14-Oct-89	19	22	28	32	36.5	27	22	20	17	20.5	22	23	20	19.5	19	17
15-Oct-89	19	19.5	31	32	34	30	25.5	23	16	18	20	21	22	20	18.5	17
16-Oct-89	17.5	22	30	32	33	28	25	21	15.5	18	20	21	20	19.5	18	17
17-Oct-89	19	23	30	33	35	32	26	22	16	18	19	20	21	20	19	17
18-Oct-89	19	22	30	33	35	32	28.5	26	16	17	20	19	18	17.5	17	16
19-Oct-89	17.5	20	29	32	33	30	23	18	15	17	20	20	19	18	17	15.5
20-Oct-89	16	18	28	31	32	29	27.5	29	14	15.5	18	20	21	20	18	17
21-Oct-89	20	22	30	32	33	25.5	22	20	16	18	20	20	20	21	19	18.5
22-Oct-89	19	20	30	32	33	30	23	20	18	19	20	20	19	18	17	16
23-Oct-89	18	20	31	34	35	33	30	20	15	17	20	21	20	20	19	18
24-Oct-89	18.5	21.5	31.5	33	34	24	21	19	16	18	20.5	20	20	19	18	16
25-Oct-89	17.5	20	30	33	33	30	25	22	15.5	18	19	20	20	19	18	17
26-Oct-89	17.5	21	30	32	33	30	25	23	15.5	18	20	20	20	19	18	17
27-Oct-89	17	19.5	30	32	33	28	23	20	15.5	16.5	19	20	20	18	17	16
28-Oct-89	17.5	17	37	30	31.5	23	20	18	15.5	15	18	19	19.5	18	16	15.5
29-Oct-89	16	20	28	31	30.5	23	20	18	15	15.5	18.5	17.5	18.5	17.5	16.5	16
30-Oct-89	16	19	30	32	32	24	20	18	15	15.5	18	19	18.5	17.5	16	15
31-Oct-89	16.5	20	30	30.5	31	28	25	20	15.5	17.5	18	19	18	17	16	15.5

BEST AVAILABLE DOC

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Nov-89	16.5	21.5	30	32	33	22	20	18	15	16	18.5	19	18	17	16	15.5
02-Nov-89	17	19	27	29	31	23	20	19	14.5	14.5	18.5	18	20	19	18	16.5
03-Nov-89	18	20	28	30	29	24	22	20	15.5	16	17	18	21	19	18	17
04-Nov-89	18	20	28	29	29	22.5	20	18	16	17	19	18	17.5	17.5	18	15
05-Nov-89	17	17	23.5	27	28	23	18	16	14.5	15	18	17	17	16.5	16	14
06-Nov-89	14	15	23	26	26	20.5	18	16	12	13	17	17	16.5	16.5	16	14
07-Nov-89	15	16	24	26	27	21	19	15	13	14	17	16	16.5	16	15	13
08-Nov-89	13	16	25.5	27	28.5	20.5	18	16	12.5	13	18	17	17.5	16.5	16	13
09-Nov-89	14	16	24	27	29.5	23	18	16	12.5	13.5	13	14	18	16	15	14
10-Nov-89	15	16.5	25.5	30	30.5	25.5	20.5	18	13	13	17.5	18	18.5	17	15.5	14
11-Nov-89	15.5	16	25	28	28.5	23	21	17	13	14	18	19	18.5	17	15.5	14
12-Nov-89	15	17	25	28	28	23	20	16	13	15	19	20	18	17	16	13
13-Nov-89	14	18	24.5	28	27.5	22.5	19	15	12	15	18.5	18.5	18.5	16.5	14	12
14-Nov-89	17	19	25.5	23.5	28	20	18	17	15	16	18.5	18	18.5	17	16	15
15-Nov-89	15	17	27.5	30	30	22	18	17	13	14	19.5	19.5	20	18.5	16	15.5
16-Nov-89	16.5	18.5	27	29	28	25	19	18	15	15.5	19	19	18.5	17	15	14.5
17-Nov-89	15	16	28	29	28	23	19	18	13	14	19	18	19	19	17	16
18-Nov-89	17	19	26.5	28.5	30	22	20	18	15	16	19	20.5	23	19	16.5	16
19-Nov-89	17	20	24.5	26.5	27	21	19	16.5	15	17	18	19	19.5	17.5	16	14
20-Nov-89	15	19	25	28	26.5	22.5	18	16	13	15	16	17	19.5	18	16	14
21-Nov-89	15	17	24	28	27.5	22	20	18	13	15	19	20	19.5	19	18	16
22-Nov-99	16	18	23	26.5	26	22	20	18	14	15	18.5	20	19	18	17	16.5
23-Nov-89	16	18	21	22.5	21	16.5	15	14.5	14	15	16.5	17.5	17	15.5	14.5	13
24-Nov-89	14	15	18	19	18	16	15	14.5	12	13	15	16	15	14.5	14	13.5
25-Nov-89	14	15	21	23.5	22.5	20	18	16	13	14	18	18	18	17	16	14
26-Nov-89	15	16	20.5	23	23	19	17	15	14	15	17.5	17.5	18	17	14	13
27-Nov-89	12	15	22	25	25.5	18	16	14	11	13	17.5	18.5	18.5	15	13.5	12.5
28-Nov-89	13	15	22	23	26	18	15	14	12	13	18	18	18	16	14	13
29-Nov-89	13	15	21	24.5	24	18	15	14	12	13	16.5	17	16	15	14	13
30-Nov-89	13	15	22	25	26	23	15	13	12	13	16	17	16	15.5	14	12

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Dec-89	12	13	20	23	23	20	16	14	11	11.5	15	15	15	14	14	13
02-Dec-89	12.5	13	20	22	22	17.5	16	14	11	11.5	14	15	15	14	13	12
03-Dec-89	12	13	20	23	23.5	21	16	13	11	11.5	14	15	15	14	13	11
04-Dec-89	11	12	22	24	25	22	14	13	10	11.5	15	16	16	15	12.5	11
05-Dec-89	12	13.5	22	27	27	25	19	16	11	12	14	16	16	14	13	13
06-Dec-89	12	14	23	26	27	18	17	14	11	12	14	15	16	13.5	12	6.5
07-Dec-89	12.5	13	17	23	24	19	17	14	11	11	14	15	15	13.5	12	11
08-Dec-89	12.5	14.5	17	25	26	19.5	17	14	11	12	14	16	17	15	13.5	12
09-Dec-89	13	13.5	18	21.5	22	17	14	13	12.5	12.5	14	16	16	14	13.5	12
10-Dec-89	13	14	19	21	21	16	15	14	11	12	16	17	18	15	13	12
11-Dec-89	12	13	18	21.5	22	16.5	15	14	10	11	15	17.5	17.5	15.5	14	12
12-Dec-89	12	13.5	18	22	22	17.5	16	15	11	12.5	15.5	17.5	17.5	15	14	13
13-Dec-89	12.5	13	19	23	22	16.5	15	13	11.5	12	16	16	16	15	13	12.5
14-Dec-89	12	12	18	21	22	17	15	13.5	11	11	13	15	15	14.5	13	11.5
15-Dec-89	12	13	18.5	21	22	16.5	14	13.5	11	11.5	14.5	15	15.5	13.5	12	11.5
16-Dec-89	13	13	15	21	22	17	14.4	13	11	11.5	13	15	15.5	14.5	13	12
17-Dec-89	12	13	17.5	21	22.5	17	15.5	14	11	11.5	14	14	15	14.5	13	12
18-Dec-89	14	15	18	21	21	18	15.5	14	12	12.5	14	15	14	15	11	12
19-Dec-89	11	12	13.5	13.5	14	12.5	12	11	10	11	13	13	13	11	11	10
20-Dec-89	9	9	12	14	17	15	13	11	8	8	11	12	15	14	12	10
21-Dec-89	10	11	14	17	16	14	13	12	9	10	13	14	14	13	12	11
22-Dec-89	11	12	16	18	18.5	15	14	13	10	11	12	14	15	14	13	12
23-Dec-89	12	13	18	19	19	15	14	12	11	12	14	14.5	15	13	13	10
24-Dec-89	10	11	16.5	18.5	19	15	14	12	9	10	12.5	13	15	13	12	11
25-Dec-89	10	11	16	19	19	15	14	13	9	10	13	13	12	11	11	10
26-Dec-89	8	7	11	17	19	16	14	12	7	6	9	11	12	11	10	9
27-Dec-89	10	9	16	18	19	12.5	12	11	8	7	12	12	12	11	11	10
28-Dec-89	7	7	15.5	18	19	14	11.5	10	6	6	11.5	11.5	13	11	10	9
29-Dec-89	8	9	16.5	17.5	18.5	14	11	10	7.5	7.5	12	12	12.5	12	10	9
30-Dec-89	9	10	15	18	19	12.5	11	10	8	9	12	12.5	13	11	10	9
31-Dec-89	8	7	16	19	17.5	13.5	10	9	7	6	12	14	14	12	9	8

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	3 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Jan-90	8	9	17	21	19	14	11	10	7	8	12	14.5	14	12	10	9
02-Jan-90	9.8	10	16.5	18	21	18	15	11	9	9	11	12	13	12	11	10
03-Jan-90	9.5	10	15.5	17	18	14	12	11	9	9	12	13	14	12	10	9
04-Jan-90	9	10	14	16	17.5	14	12	11	8	9	12	13	13	12	10	9
05-Jan-90	9	10	15	18	19	15	14	12	8	9	11	12	13	12	11.5	11
06-Jan-90	11	11	13.5	17	18	15	13	12	10.5	10.5	12.5	14	14	13	11	11
07-Jan-90	11	11	15	18.5	19	15	12	11	10	9	13.5	14.4	14	13	11.5	10
08-Jan-90	8	9	15.5	19	19	15	14	13	8.5	8.5	12.5	15	14.5	14	13	11
09-Jan-90	10	11	17	20.5	20.5	16	15	13	9	10	15	15.5	16	14	13	11
10-Jan-90	10	11	18	20	21	15	12.5	11	9	10	15	16	16.5	14	11	10
11-Jan-90	10	10	19	22.5	24	21	18	15	9.5	9	16	16.5	18	15	14	12
12-Jan-90	10	12	20	22.5	24.5	19	15.5	15	8	10	16	18	18.5	16	14	12
13-Jan-90	14	15	20	23	25	18	14	12	12.5	13	17	18	18	15	13	11
14-Jan-90	9	10	15	24	23	16.5	14.5	11	8	9	12	15	14	13.5	13	10
15-Jan-90	11	12	20	24	25	19	17	14	10	10	13	15	16	16	14	13
16-Jan-90	13	15	20	24	26	20	17	15	10	11	13	15	16	16	14	13
17-Jan-90	14	15	19	24	23	18	15.5	13	12.5	13	14.5	15	16	14	13	12
18-Jan-90	12.5	13	18	19	21	15.5	14	13	11	11.5	14	15	16	14	13.5	12
19-Jan-90	12	13	17.5	21.5	22	17.5	16.5	14	11.5	12	14	16.5	16.5	15.5	15	13
20-Jan-90	13	13	22	24	24.5	20	18	16.5	12	12	16	17	18	12	16	15
21-Jan-90	15	16	23	24.5	24	20	17	15	14	15	17	17	16	15	14.5	14.5
22-Jan-90	15	16	20	23.5	23.5	19	16	15	14.5	15	16	17	17	16	15	14
23-Jan-90	15	16	20	24.5	26	22	18	16	14	15	16	17	17	17	15	14
24-Jan-90	13	14	23	26	26.5	20	16	14	11	12	17	18	18.5	16	15	13
25-Jan-90	13	13.5	22.5	25	26	20	16	15	11	12	17.5	18	18	17	15	13
26-Jan-90	14	15	20.5	23	28	25	20.5	18	12	13	16	17	20.5	18	15	15
27-Jan-90	14	15	17.5	20.5	20	15	13	12	12	13	13	14	12.5	11	10	10
28-Jan-90	11	12	14	19	18	14	12	10	9	9	10	10	11	10	10	8.5
29-Jan-90	8	9	14	19.5	20	16	13	11	7	7.5	8.5	11	12	11	10	9
30-Jan-90	10	11	18	19	20	17	15	12	8	8	11	13	12	11	10	9
31-Jan-90	10	11	19	21	20.5	15	13.5	11	8	8	12	11	12	15	13.5	10

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Feb-90	9	10	18.5	20	21.5	15	11	9	6	6.5	11.5	12	6.5	11	9	8
02-Feb-90	8	11.5	18	20.5	21.5	18	15	11	7	8.5	12	13.5	8.5	12	11	10
03-Feb-90	10	10	20	24	24.5	18	15	12	9	9	12	14	9	12	11	10
04-Feb-90	10	10.5	19	24.5	25	19	15	12	9	9.5	13.5	14	9.5	12	11	10
05-Feb-90	10	13	20.5	24.5	25	20	16	15	9	10	14.5	16	10	15	13	13
06-Feb-90	15	15.5	20	20.5	21	19	17.3	16.5	12.5	13	14.5	15.5	13	16	15	14
07-Feb-90	14	14.5	19	21	23	19	17	16	12	12.5	14.5	15	12.5	16	15	13.5
08-Feb-90	12	13.5	18	21.5	23	18	17	16	11	13.5	15.5	17	12	16	15.5	14.5
09-Feb-90	13	15	19.5	22	23	18.5	16.5	15	12	12	16	17	13.5	16.5	14.5	13
10-Feb-90	13	15.5	19.5	22	23	18	16.5	15.5	12	13	15.5	17.5	13	16	15.5	13.5
11-Feb-90	13	14.5	16.5	17	16.5	15	14	13	12	13.5	10.5	14.5	13.5	14.5	13	12.5
12-Feb-90	12.5	13.5	11.5	12	12	12	12	11	12	13.5	11	11	13	11	10.5	10
13-Feb-90	10	10.5	12	15	18	15	12	11	9	9	10	13	9	12	11	10
14-Feb-90	10	11	15	20	21	15	13	11	9	10	13	15	10	14	12	10.5
15-Feb-90	10	12	15	20.5	21	16	14	12	9	11	12	14	11	13	12	11
16-Feb-90	10	12	16	18	23	20	15	13	9	10	12	13	10	12	12	10.5
17-Feb-90	11	12	15	12.5	16	13	11	10.5	10	10	13	14	10	12	10	9.5
18-Feb-90	10	11	16	20	20.5	16	14	13	9	10	13	14	10	13	12	11.5
19-Feb-90	12	13	16	20	22	18	15	13	11	12	13	14	12	14	13	11
20-Feb-90	11	12	18	23	24	20	16	14	10	11	13	15	11	15	14	12
21-Feb-90	12	15	21.5	22	25	21	18	17	11	13	16	17	13.5	16	15	14
22-Feb-90	15	16	20	23	26	21	18	15	13	13	15	17	13	18	16	14
23-Feb-90	14	15	20	24	27	22	18	13	12	13	15	16	13	16	15	12
24-Feb-90	13	14	17.5	21.5	23	20	18	13	12	12.5	15	18	12.5	17	16	12
25-Feb-90	13	14	18	20	21	18	16	14	12	12.5	14	16	12.5	16	15	12.5
26-Feb-90	13.5	13.5	18	20	21	18	15	13	11	12	14	16	12	16	14	12
27-Feb-90	11	11.5	17	21	23	20	16	13	10	10	14	14.5	7.9	15	14	12
28-Feb-90	10.5	11	15	18	19	16	13	11	9.5	10	12	14	9	13	11	10.5

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Mar-90	10	11	18.5	21	21	17	13.5	12	9	10	13	14	13	14	13	11.5
02-Mar-90	9.5	11	20	23	24	17.5	15	13	9	10	13	15	15	15	14	13
03-Mar-90	12	13	20	24	25	19	16	14	10	11	15	16	15	16	14	13
04-Mar-90	12	13	21	24	25	21.5	16.5	14	11	12	16	16	15	16	15	13
05-Mar-90	12.5	14	21	24.5	25	20.5	16	14	11.5	12	15	15.5	16	15.5	15.5	13.5
06-Mar-90	12	16	25	27	28	22	16	14	11	13	16	14.5	15	14.5	15	14
07-Mar-90	11	13.5	26	28.5	28.5	22	17.5	14	10	12	15.5	16.5	16.5	16.5	16	14.5
08-Mar-90	13	17.5	26	30.5	30	22.5	19	17	11	13	17	18	17.5	18	18	16
09-Mar-90	16	18	27.5	32	31	24	20	18	13	14	19.5	20	19	20	18	16.5
10-Mar-90	16.5	19	24.5	31	31	25.5	21	18	15	16	18	17	16.5	17	16	15
11-Mar-90	16	16	20.5	25	26	21	19	17.5	14	14	15.5	18	17	18	16.5	15.5
12-Mar-90	15	17	23.5	26	27	22	19	17	13	13	16.5	16	17	16	16	15
13-Mar-90	14	16	26	29	30.5	25	20	20	13	14	17	17.5	20	17.5	19	18
14-Mar-90	16	18	26	29	33	28	25	23	15	16	17	18	20	18	19	18.5
15-Mar-90	19	20	28	32	34	30	28	23	17	18	20	22	24	22	22	21
16-Mar-90	20	21	25	28	31	25	20	18	18	19	20	21	22	21	20	17
17-Mar-90	17	19	26.5	29	32	27	23	20	14	15	20	21	22	21	21	19
18-Mar-90	17	19	24	28	30	25	22	20	14	16	18	19	20	19	20	19
19-Mar-90	19	20	25	29	31	26	25	22	17	18	21	23	24	23	20	18
20-Mar-90	20	21	25	28	28	23.5	22	21	16	17	18.5	21	20	21	21.5	20
21-Mar-90	20	21	25.5	28.5	28.5	20.5	18.5	16	18	18	20.5	21.5	20.5	21.5	15.5	12
22-Mar-90	15	16	20	25	23	20	17	14	10	10	13	15	13	15	12	10
23-Mar-90	12	13	21	25	25	23	18	15	8	9	12	14	14	14	13	11
24-Mar-90	11	13	24.5	28	28.5	21	19	15	10	11	15.5	17	18	17	16	14
25-Mar-90	11	13	24	27	28	20.5	19	14	9	10	16	17.5	18.5	17.5	16	14
26-Mar-90	17	17	20.5	23	23	19.5	18	16	14	14	16	16.5	17	16.5	15.5	15
27-Mar-90	15	16	23	25	25.5	21	19	15	14	15	17	17.5	18	17	17.5	15
28-Mar-90	14	15	22.5	26.5	26	21	17	15	13	14	18.5	16	19	18.5	16	16
29-Mar-90	14	15	21	25.5	24.5	20.5	18	15	13	14	18.5	19	19	18.5	19	17
30-Mar-90	14	15.5	23.5	25.5	26	23	18	16	13	14	20	19	20	20	19	17
31-Mar-90	15	16.5	23	26.5	21	22	17	15	13	15	20	19	19.5	20	19	16

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Apr-90	13	15.5	24	27.5	28	24	21	20	12	13	18.5	20	19.5	19	18	17
02-Apr-90	20.5	21	27.5	30	30	25	21	18	17.5	18	19	20	20	19	18	16
03-Apr-90	16.5	19	29	32.5	33	27	22	20	15	17	21	22	20.5	19	18	16
04-Apr-90	17	21.5	31	33	35	30	25	20	15	17	20	21	22	20	18	16
05-Apr-90	17	18	30	36	38	31	20	19.5	15	16	24	25	26	23	18	17
06-Apr-90	19	20	30	35	38	31	28	25	16	17	20	22	24	22	19	17
07-Apr-90	18	20	25	27	29	26	23	21	16	17	20	21	22	21.5	18.5	17.5
08-Apr-90	20	21	27.5	30	33	30	25	23	17	18	21.5	23	25	24	22	20
09-Apr-90	21	22	32	35	37	28	25.5	24	18	20	22	23	24	20	18.5	19.5
10-Apr-90	21.5	22	31	35.5	37.5	33	29	25	17.5	18	20.5	20.5	21	20.5	20	18
11-Apr-90	20	22	26.5	31	33	29	25	23	16	17	19	19.5	20	19.5	19	18
12-Apr-90	21	23	29	31	32.5	29	26	21	17	18	21	21.5	21	20	18	17
13-Apr-90	18	21.5	29	31	33	30	24	20	15	17.5	19	20	23	22	21	18
14-Apr-90	19	21	33.5	34.5	35	30	25	22	15	17	19.5	20.5	19	18	17	16
15-Apr-90	20.5	22.5	30	32	34	32	28	26.5	15.5	16.5	18	20	21	20	18	17.5
16-Apr-90	25.5	26	33	35	35	32	28	23	16.5	20	22	24	22.5	21.5	20	19
17-Apr-90	21	23	29.5	31.5	33	30	26	25	18	19	21	23	21	20	19	18.5
18-Apr-90	23	25	34	36	38.5	33	30	25	18	20	24	24	24	23	22	21
19-Apr-90	23	25	35	38	40	36	31	28	20	21	23	24	22	21	20	19
20-Apr-90	25	26	33	38	39	37	30	28	18	19	21	23	23.5	22	21	20
21-Apr-90	25	28	33	38	38	32	29	25	18	20	22	24	23	22	20	18
22-Apr-90	22.5	25.5	31	36	37	30	27	25	17	18	22	24	23	22	21	20
23-Apr-90	24	28	35	38	39	31	28	26	18.5	22	24	25	26	23	22	20
24-Apr-90	23	25.5	35.5	40	41	32	28.5	26.5	18	21.5	25.5	25	29	24.5	22.5	20.5
25-Apr-90	25	32	36	40	42	33	30	28	20	21.5	27	26	26	24.5	22.5	20.5
26-Apr-90	27	28	34	38	40	31	30	29	22	23	23	22	22	20	18	18
27-Apr-90	25	27.5	34	38.5	39	31	29	27	20	21	21	20	20	18	17.5	17
28-Apr-90	22	23	36	39	41	31.5	29.5	27.5	17	17.5	21	21	22	21	20	19.5
29-Apr-90	26	31	39	40	40	32.5	30	26	19.5	20	22	22	22	22	21	20
30-Apr-90	24	29	35.5	40	41	37	33	30	19	23	22.5	24	26	25	23	22

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-May-90	27	28	33	36	38	32	30.5	27	21.5	23	25	27	28	26	25.5	24.5
02-May-90	24.5	26	32	34.5	35.5	34	30	26	21	22	23	24	24.5	23	22	21
03-May-90	24	26	35	37	38	32	29	26	20	21	25	26	26	24	22	21
04-May-90	24	28	36	39.5	40.5	34.5	30.5	27	20	21	24.5	27.5	26	26.5	25	24
05-May-90	26	28	35	38	39	35	30.5	28	23	25	26	28	27	24	23	23
06-May-90	27.5	28	34	36.5	37	35	31	29	23.5	24.5	24	26.5	27	26	25	23.5
07-May-90	27	28	33.5	37.5	38.5	33.5	31	28	22	23.5	26	27	28	25.5	25	24
08-May-90	26	29	34.5	38	39	34	30	29	23	24	25.5	26	26	24	24	23
09-May-90	27	30	36	40.5	42	34.5	31	29	22	23	24	24.5	25	24.5	23.5	22.5
10-May-90	27	29	38	42	44	37.5	35	31	22	23	24	25	26	24	23	22.5
11-May-90	29	32	38	42	43	33.5	32	31	22	23	25.5	26.5	26.5	24.5	23.5	22.5
12-May-90	30	31	38	42	42.5	36	33	30	22	23	25	25	25	24	23.5	23
13-May-90	28	30	40	43	44	41	38	32	22.5	25	25.5	26	26	25	24	23.5
14-May-90	30	31	38.5	42	44	35.5	33	31	23	24	27	28	28	24.5	24	23.5
15-May-90	30	31	34	38	41	38.5	34	31	23	24	25	26	27	26	25	24
16-May-90	27	28.5	38	44	44	36	34	32.5	23	25.5	23	23	23	21	20.5	20
17-May-90	28.5	30	36	39	41	37	34	32	25	25	24	24	23	22	21.5	21
18-May-90	26	28	36	39	40	36	31	28	22.5	23.5	23	23	23	22.5	21.5	20.5
19-May-90	26	29	37.5	41	42	35	33	29	20	21	22	22	22	22	22	21.5
20-May-90	27	27.5	35	38	41	35	32	27	20	22	24	24	24	23	24	24
21-May-90	25	26.5	34	40	41	34.5	33.5	29	24	25	25	26	26	24	24	23
22-May-90	25	27	36	41	42	36	33.5	28	22.5	23	25	26	26	25	23.5	23
23-May-90	26	28	38	43	43	34.5	31.5	28	22	23	24	23	23	24.5	23.5	23
24-May-90	26	28	36	42	43	34	32.5	28.5	22	23	24	23	23	25	24.5	21.5
25-May-90	25.5	27.5	35	40	42	33	32	28	24	25	24	25	25	26.5	26	24
26-May-90	26	27.5	35	40	42	30	28.5	25	24.5	25	25	26	27	27.5	27	24
27-May-90	27	28	36	41	43	36	34	31	25.5	26.5	21.5	20.7	27	24.9	24.1	23.9
28-May-90	27	28.5	36	41	42	33	32.5	28.5	25	25.5	28	27	28	28	27.5	24
29-May-90	27	28.5	34	39	41	35	33	31	25.5	26	25	26	27	27.5	27	26
30-May-90	27.5	29	35.5	38	39.5	25	26	24	25.5	24	27	27.5	30	22.5	23	21
31-May-90	29	26	30	34	35	32	31	29	23	24	27	22	28	24.5	23	21

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Jun-90	27.5	28	32.5	35	37	32.5	28.5	28	25	23.5	27.5	28	29	23	23	23
02-Jun-90	27.5	29	35	38.5	40.5	33	30	28	23	24	26	27.5	28	23	21.5	21
03-Jun-90	26.5	28	38	40	41	33	30.5	28.5	21	22	23.5	24	21	22	21.5	21.5
04-Jun-90	26.5	27	40	41	42	36	32.5	30	20	21	22	21	21.5	20	18	17
05-Jun-90	27.5	29	35.5	41	42	35	33	28	25	25	26	27.5	27.5	25	24	24
06-Jun-90	26	28	34	40	41.5	35.5	32	27	24	25	26	27	27.5	25.5	24	24
07-Jun-90	26.5	27.5	31	39	40.5	37.5	34	28	24	25	26	27	27.5	25.5	24	24
08-Jun-90	26.5	29.5	35.5	39	41	37	34	30	25	26	27.5	28	28.5	25.5	25.5	25
09-Jun-90	27	29.5	38	40	41	37	34.5	31	25	26	28	28	27	25.5	23.5	22.5
10-Jun-90	27	30	39	40	41	34.5	32.5	30	24	25	25.5	26	26.5	26	26	25
11-Jun-90	26	28.5	33.5	36	38	35	33	30	24	25.5	27	27	28	26	24	25
12-Jun-90	28	30	33	36	38	36	33	26	24	25	28	27	28	27	26	23
13-Jun-90	23	23	27.5	31	32.5	30	28	27	20	20	24	25	24.5	25	24	23.5
14-Jun-90	26	29.5	32	36	38	34	30	29	23	25.5	27	27	27	26	24	23.5
15-Jun-90	28	30	36	38	39.5	37	33	30	23	24	26	27	27	25	25	24.5
16-Jun-90	29	32	38	42.5	43	36	32	29	24	25	27	25	25	25.5	24.5	23.5
17-Jun-90	28	30	37	42.5	43.5	40	36	30	24	25	27.5	27	27	26.5	26	25.5
18-Jun-90	27	28	35.5	40	42	38	34	30	25	25.5	28	29	30	28	26	25
19-Jun-90	27	28	34	38	40	35	32	30	24	25	27.5	28.5	29.5	28	27	26
20-Jun-90	28	29	34	37	39	36	34	31	25	26	28	29	29.5	27	26	26
21-Jun-90	28	30	36	39.5	41	38.5	34	31	26	26	27.5	28.5	28	27	26	26
22-Jun-90	27.5	29.5	35	40	45	37.5	33.5	30	26.5	26.5	28	29	29	27.5	26	26
23-Jun-90	26	28	34.5	40	41	38	32.5	30	24	25	27.5	28.5	31.5	30.5	28	26.5
24-Jun-90	27.5	29	34	40	40.5	35	30	29	26	26	27	28.5	28.5	27.5	26.5	26
25-Jun-90	27	29	34.5	39.5	40	35	31	29	26	26.5	28	29.5	29.5	28	27.5	27
26-Jun-90	28	29	38	38.5	39	36	33	31	26.5	28.5	28	30	27	26	25	24.5
27-Jun-90	29	31.5	37	38	40	37	34.5	31	23	26.5	28	29	30	27	26.5	25
28-Jun-90	30	32	37	38	41	38	35	32	25	26	28	29	28	27	26	25.5
29-Jun-90	28.5	29.5	37	39.5	42	36	34	30	25.5	27	28.5	29	30	28	27	26
30-Jun-90	28	29	37	41	40	39	35	31	25.5	26	27	28	28	27	26	25

BEST AVAILABLE DOCUMENT

TABLE A-1

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01-Jul-90	26	29	35.5	38	40	37	31	29	24	26	27.5	28	29	28	27	26
02-Jul-90	27.5	29	33.5	37	39	36	32	31	21	26.5	28	28	28	27	26	26
03-Jul-90	30	31.5	36	37	39	37	33	30	27	27.5	28	27	27.5	26.5	26	26
04-Jul-90	29	30	33	34.5	35.5	39	31	29	27	27.5	28	27	27.5	27	27	26
05-Jul-90	28	29	33	36	35.5	34	32	30	25	26	27	29	28.5	28	27	26
06-Jul-90	28	30	38	39	38	32	30	28	25	26	27	29	28	27	26	26
07-Jul-90	28.5	29	36	38	39	36	32	30	27	27	28	28	29	28	27	26.5
08-Jul-90	28	29	34	39	40	37	33	29	26	27.5	28	28	29	27	26	26
09-Jul-90	27	29	35.5	39.5	41	38	32	29	25.5	26	27.5	28.5	29	27.5	26	25.5
10-Jul-90	27	29	35	39	38	32	30	29	25	26.5	28.5	29	28	27	26	25.5
11-Jul-90	27.5	28.5	32	34	35	33.5	32	29	26.5	26.5	27.5	28.5	29.5	27	26	25.5
12-Jul-90	27	28	35	39	40	35	31	27	25.5	26	27	27.5	27	26	25	24
13-Jul-90	25.5	27	33.5	39	40	36.5	32	28	23.5	24.5	26	28	27	27	25	25
14-Jul-90	26	28	33	38.5	41	36	31.5	28	24	25	26	27.5	26.5	25.5	24	24
15-Jul-90	25.5	27.5	33.5	37	39	34.5	31	28	24.5	25	27	27	27	26.5	26	25.5
16-Jul-90	25.5	27	31.5	35	39	35	32	29	24.5	25	26.5	27	27.5	27	26.5	26
17-Jul-90	26.5	28	33.5	36.5	38	35	32	28	25	26	26	28	27.5	27.5	27	25
18-Jul-90	25	28.5	34.5	38	40	36	33	28	24	25.5	27.5	29	28	27.5	27	26
19-Jul-90	26	28	33.5	36	38	34	30.5	28	25	25.5	27	28.5	28.5	27	26	25
20-Jul-90	26.5	28	34	36	37.5	33	30	27	24	25	27	28	28	26.5	26	25
21-Jul-90	25.5	27	33.5	37	38.5	33	30	28	24.5	25.5	26.5	27	27	27	26	26
22-Jul-90	27	28	33	38	38.5	34	31.5	28	26	25	27	27.5	27.5	27	26.5	26
23-Jul-90	26	28.5	33.5	37	38	37	33	29	25	25.5	27	28.5	29	27	26	25.5
24-Jul-90	26	30	35	37	38	35	31	30	25	26	27.5	29.5	29	28	27	26.5
25-Jul-90	29	29.5	35.5	38	40	37	32	30	26.5	27	28.5	29	29	27	26	25.5
26-Jul-90	29	30	33	37.5	40	35	31	27.5	25	25.5	26.5	27.5	27	26	25	25
27-Jul-90	25	27	32.5	38	40.5	32.5	27	26	24.5	25	26.5	28	27.5	27	25	24
28-Jul-90	25	27	32.5	36	37.5	33	31	28	23	25	27	28	28.5	27	26	25
29-Jul-90	25.5	26.5	33	37	39	37	34	29	24.5	25.5	27	28	29	28	27	26
30-Jul-90	27.5	28	32.5	37.5	39	36	32	28	25	26	26.5	27.5	28	27	26	25
31-Jul-90	25	27	34	37	39	35.5	31	29	24	24.5	26	27	28	27	26	25

BEST AVAILABLE DOCUMENT

TABLE A-2

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

AVERAGES BY MONTH EVERY THREE HOURS

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
Aug-89	26.2	27.7	32.0	34.4	36.0	32.5	30.1	28.1	24.2	25.3	26.5	27.4	27.5	26.6	25.7	24.9
Sep-89	24.2	26.4	31.5	34.5	35.3	31.8	29.0	26.4	21.6	22.7	24.1	24.7	25.0	24.1	23.5	22.6
Oct-89	19.4	21.9	30.7	33.2	34.2	29.3	25.3	22.4	17.3	19.0	20.9	21.3	21.1	20.2	19.0	18.0
Nov-89	15.2	17.2	24.4	26.7	27.1	21.4	18.4	16.4	13.4	14.5	17.7	18.0	18.3	17.0	15.7	14.2
Dec-89	11.2	11.8	17.3	20.4	21.0	16.6	14.4	12.7	10.0	10.5	13.4	14.4	14.9	13.4	12.2	10.9
Jan-90	11.3	12.2	18.0	21.3	22.0	17.4	14.9	13.0	10.1	10.6	13.7	14.9	15.3	13.9	12.7	11.4
Feb-90	11.6	12.9	17.5	20.3	21.8	17.8	15.2	13.2	10.4	11.2	13.4	14.9	11.1	14.3	13.1	11.7
Mar-90	14.7	16.3	23.5	26.9	27.5	22.5	19.1	16.6	12.8	13.8	17.0	17.8	18.1	17.9	17.0	15.4
Apr-90	21.4	23.8	31.6	34.9	36.3	30.8	26.9	24.2	17.2	18.8	21.5	22.3	22.7	21.2	19.7	18.5
May-90	26.9	28.5	35.6	39.6	40.9	34.5	32.0	28.8	22.7	23.7	24.7	25.2	25.8	24.6	23.9	22.8
Jun-90	27.3	29.0	35.3	38.8	40.4	35.9	32.6	29.5	24.2	25.1	26.9	27.5	27.6	26.0	24.9	24.3
Jul-90	26.8	28.4	33.9	37.3	38.7	35.2	31.4	28.6	24.9	25.8	27.1	28.0	28.0	27.0	26.1	25.5
YEAR	19.7	21.4	27.7	30.7	31.8	27.2	24.1	21.7	17.4	18.5	20.6	21.4	21.3	20.6	19.5	18.4

TABLE A-3

TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

MONTHLY AVERAGES

	DRY BULB TEMPERATURE C	WET BULB TEMPERATURE C	RELATIVE HUMIDITY %	SPECIFIC HUMIDITY LB WATER/LB DRY AIR
Aug-89	30.9	26.0	68.4%	0.0193
Sep-89	29.9	23.5	59.1%	0.0157
Oct-89	27.0	19.6	50.2%	0.0112
Nov-89	20.8	16.1	61.5%	0.0095
Dec-89	15.7	12.5	69.8%	0.0077
Jan-90	16.3	12.9	67.9%	0.0078
Feb-90	16.3	12.5	64.9%	0.0075
Mar-90	20.9	16.2	62.6%	0.0096
Apr-90	28.7	20.2	46.3%	0.0114
May-90	33.3	24.2	47.1%	0.0152
Jun-90	33.6	25.8	53.9%	0.0177
Jul-90	32.6	26.6	62.8%	0.0195
YEAR	25.5	19.7	58.5%	0.0120

DOCUMENT

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
01/01/84	11	12.8	17.2	20.6	18.9	15.6	13.3	11.7	7.8	8.3	10.6	12.2	12.2	10.6	9.4	8.9
01/07/84	8.9	7.8	12.8	18.3	19.4	13.9	11.7	10	6.2	6.1	8.3	11.1	11.1	10	8.9	8.3
01/15/84	8.9	7.8	18.9	21.7	22	15.6	11.7	10	7.2	7.2	10.6	12.2	12.8	10.6	9.4	8.9
01/25/84	8.9	9.4	16.1	21	22	14.6	12.8	11.7	7.2	7.8	12.8	13.3	13.3	11.1	10	8.3
02/01/84	12.2	11.1	17.8	22.8	22.8	18.5	15.6	14.4	7.8	7.8	12.6	12.9	13.3	10.9	9.9	9.4
02/07/84	10.6	8.3	17.8	21.7	22.2	15.6	13.3	11.7	6.7	6.1	10	11.7	13.9	10	8.9	6.7
02/15/84	12.2	12.8	21.7	27.2	27.8	21.1	18.9	16.1	10	10	12.8	15	15.6	13.9	13.3	11.7
02/25/84	7.8	7.2	18.3	21.2	21.7	15.6	10.6	10	5.6	5.6	10.6	11.2	11.7	10.6	8.8	8.3
03/01/84	15.6	14.4	25	28.3	28.9	22.8	19.4	17.8	12.8	12.2	14.4	16.7	16.7	16.1	13.9	12.8
03/07/84	16.7	16.1	30	33.3	33.3	25.6	24.4	21.7	13.3	12.2	17.2	18.3	18.9	16.1	16.1	14.4
03/15/84	20.6	19.4	26.1	27.8	29.4	25	22.8	21.1	17.2	17.2	19.4	20	19.4	18.9	18.3	17.8
03/25/84	22.8	23.3	26.7	29.4	29.4	26.1	24.4	23.7	17.8	17.8	18.8	20.6	20.6	20	19.4	18.9
04/01/84	24.4	23.9	28.9	32.8	33.3	30.8	26.7	23.9	20	19.4	21.1	22.2	22.8	21.7	21.1	22
04/07/84	22.2	22.2	28.9	33.3	35	28.3	27.8	25.6	18.3	17.8	21.3	22.2	21.7	21.4	21	18.2
04/15/84	27.2	30.6	36	40.6	41	36.7	33.9	30.6	21.1	23.9	25	25	25	23.3	22.2	22.2
04/25/84	25.6	26.1	37.8	41.7	42.2	36.1	33.9	31.1	18.9	18.9	27.7	22.2	22.8	22.2	22.2	21.7
05/01/84	25.6	26.1	36.7	41.7	42.2	35	32.2	29.9	19.4	20	19.4	21	22.2	18.9	17.2	16.7
05/07/84	28.9	28.9	37.2	42.8	43.3	37.8	33.3	32.2	22.8	23.9	24.4	25	25	23.3	21.1	20.6
05/15/84	30.6	31.1	38.9	41.1	42.2	35.6	32.2	30.6	17.2	17.2	18.9	21.1	21.7	20	19.4	18.8
05/25/84	32.2	31.1	39.4	45	46.1	40.6	36.7	33.9	24.4	25.6	26.7	26.7	26.1	25	24.5	23.9
06/01/84	28.3	28.9	36.1	42.2	44.4	37.8	36.7	32.2	22.8	25	26.7	27.2	27.2	26.7	26.7	25.6
06/07/84	27.8	28.9	35.6	40.6	42.2	37.8	35.6	31.7	23.3	25	26.7	26.7	27.2	26.7	26.7	25
06/15/84	32.8	35.6	40	43.3	45	41.1	38.9	35.6	25.6	27.2	27.8	28.3	28.3	27.8	26.7	26.7
06/25/84	28.9	32.2	36.1	42.8	44.4	38.9	32.8	29.4	23.9	24.4	25	26.1	26.1	26.1	24.1	23.9
07/01/84	29.4	31.7	36.7	40	41.1	34.7	31.7	31.1	25	26.1	27.2	27.8	27.8	26.1	25	25
07/07/84	30.6	32.2	37.8	40.6	41.1	37.2	34.4	32.2	26.1	26.7	26.7	27.2	27.2	26.7	26.1	26.1
07/15/84	27.7	28.9	34.4	40.6	41.7	36.7	31.7	31.1	23.3	24.4	26.1	26.2	27.2	26.7	25.6	24.1
07/25/84	27.8	28.9	35	38.9	41.1	36.7	33.3	30.6	24.4	25	26.7	27.8	27.8	27.8	26.1	24.4

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
08/01/84	27.3	27.8	33.9	37.2	38.9	36.1	34.4	30	22.8	24.4	26.7	26.7	27.2	27.2	26.7	25.6
08/07/84	26.1	27.2	29.4	30.6	32.8	31.1	29.9	27.8	24.4	22.8	25	26.1	25.6	25.6	26.6	25
08/15/84	28.9	29.4	32.8	36.1	37.2	33.9	30.6	28.3	26.1	26.7	26.7	27.2	28	27.8	26.6	26.1
08/25/84	27.8	28.3	32.8	37.7	37.2	34.4	30.6	29.3	25	25.6	26.7	27.8	28.3	27.2	26.7	25.6
09/01/84	25.6	26.7	30.6	35	35.6	32.8	32.2	30	23.3	23.9	25.6	26.7	27.8	28.3	28.3	26.7
09/07/84	26.6	26.7	32.8	33.9	33.9	32.2	30	27.8	22.8	23.9	25.6	25.6	23.3	26.1	25.6	24.4
09/15/84	27.8	28.9	30.6	32.8	32.8	29.9	28.3	27.8	24.4	25	24.4	25.6	27.2	25	23.3	23.3
09/25/84	24.4	26.7	32.2	35	34.4	29.4	26.7	25	21.1	21.7	23.9	24.4	25	24.4	24.4	23.9
10/01/84	23.9	25	32.2	35	29.4	29.7	26.7	25	19.4	20	23.3	23.9	23.9	20	18.3	18.9
10/07/84	19.4	21.1	33.3	35.6	35	27.8	22.8	21.1	17.2	17.2	19.4	19.4	20	19.4	18.9	17.2
10/15/84	22.2	22.8	31.1	33.3	31.7	28.3	24.4	23.3	18.9	18.9	19.4	20.6	21.1	20.6	19.4	18.9
10/25/84	20.6	19.4	28.9	30	30.6	26.1	24.4	23.3	15.2	15	19.4	20.6	19.4	19.4	18.3	17.9
11/01/84	15.6	16.1	27.2	30	28.9	23.3	18.3	16.7	13.3	13.7	17.2	16.1	17.8	15.6	14.4	13.9
11/07/84	17.2	17.8	23.9	28.9	26.7	22.2	19.6	18.3	13.9	13.3	16.6	17.8	18.3	16.9	16.1	15.6
11/15/84	17.8	18.3	23.9	28.3	27.8	22.2	19.4	18.9	15.6	15.6	18.3	19.4	19.4	18.9	18.3	16.7
11/25/84	13.9	14.4	22.2	25.6	26	18.9	15.6	14.4	12.8	12.8	16.1	16.1	17.2	15	13.9	13.3
12/01/84	15	14.4	21.7	25	24.4	20.6	18.3	17.2	12.8	12.2	15.6	16.7	17.2	15.6	15	14.4
12/07/84	12.8	15	23.3	26.7	26.1	20	17.2	16.1	11.1	11.7	15.6	16.7	16.7	16.1	14.4	13.9
12/15/84	12.8	13.9	18.9	22.2	22.2	18.9	15.6	14.4	10	10	12.2	13.9	14.4	13.3	11.7	11.1
12/25/84	8.3	8.3	13.9	19.4	19.4	15.6	11.1	9.4	3.3	3.3	8.3	10.6	10	8.9	7.8	7.2
01/01/85	6.7	8.3	16.1	18.3	18.3	12	10	8.9	5	5.6	9.4	10	11.1	8.3	7.8	7.2
01/07/85	11.1	11.1	13.3	17.8	17.8	13.9	11.7	10	9.4	10	10.6	12.2	12.2	11.7	10	9.9
01/15/85	12.2	14.4	21.1	25	24.4	18.3	15	13.3	10.6	11.7	15	15	16.1	14.4	11.7	10.6
01/25/85	11.7	12.2	21.1	25.6	25	21.7	17.8	16.1	10	10.8	15.6	15.6	15	14.4	13.3	12.2
02/01/85	12.2	11.7	22.8	26.1	26.1	23.9	15.6	14.4	10.6	10	15	15.6	16.7	15	12.8	12.2
02/07/85	18.3	18.3	21.7	25.6	24.4	21.7	18.3	15	13.3	11.7	15	15.6	13.3	12.2	10.6	10
02/15/85	11.7	13.9	22.2	26.7	28.3	21.1	17.2	15	8.3	9.4	14.4	14.4	15	12.8	12.2	11
02/25/85	13.9	16.7	25	29.4	30	22.8	17.8	15	10.6	11.7	16.1	16.1	16.7	15.6	12.8	11.7

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
03/01/85	14.4	15.6	28.3	32.2	32.8	26.7	22.2	17.8	11.1	11.7	18.3	18.3	18.9	17.2	15.6	13.3
03/07/85	16.7	19.4	26.7	31.1	32.8	30	24.4	22.2	14.4	15.6	18.9	20	20	18.9	18.3	18.3
03/15/85	15.6	22.2	28.3	33.3	34.4	27.8	25	21	11.7	13.3	16.7	18.3	18.3	19.4	16.7	14.4
03/25/85	22.2	22.8	31.7	35.6	37.2	30.6	29.9	25.6	16.7	16.7	20.6	22.2	21.7	21.7	20.6	20
04/01/85	22.2	21.7	25	23.3	23.3	20	20.6	19.4	18.3	18.3	19.4	18.3	18.3	18.3	17.8	17.8
04/07/85	22.2	22.8	29.4	32.8	34.4	31.1	28.3	25.6	18.3	18.9	21.7	22.8	18.3	22.8	22.2	21.1
04/15/85	22.8	25	33.9	37.8	39.4	32.2	27.8	25	15	16.1	19.4	19.4	19.4	18.9	17.2	17.2
04/25/85	24.4	25.6	37.8	41.1	41.7	35	33.9	28.3	17.2	17.2	21.7	22.8	23.3	23.3	20	18.9
05/01/85	21.6	30	37.2	37.8	38.9	32.2	27.2	26.7	17.2	18.3	18.9	19.4	19.4	17.8	16.7	16.7
05/07/85	28.3	29.4	28.3	42.8	48.8	36.7	33.9	31.1	20	21.1	21.7	23.3	23.3	22.8	21.1	20
05/15/85	27.8	28.3	41.1	41.7	41.7	32.2	29.4	28.3	15.8	17.2	20.6	19.4	20	19.4	19.4	19.4
05/25/85	31	33	35	41	42	36	31	30	18	20	21.1	22.1	23.1	23.1	21.1	20.1
06/01/85	29	31	35	38	39	36.5	32.5	30.5	27.1	28.1	29	29.1	28.6	27.6	28.1	27.6
06/07/85	27	30	35.5	40.5	43	37.5	31.5	29.5	25.1	26.5	27.1	27.1	25.1	27.1	26.6	25.6
06/15/85	29	31	37	43	45	40	34.5	32.5	25	26.5	26	26	23.6	22.6	21.6	21.1
06/25/85	29	30	36	39	41	38	35	32	26.1	26.6	28	28	28	27.1	27.1	27.1
07/01/85	27	27.5	32.5	37	37	32	29	28	25	25.6	26.1	27.6	27.6	24.1	23.8	22.6
07/07/85	27	28	32	36	37	35	33.5	31	25.1	26.1	27.1	28.1	27.6	27.1	27.1	26.6
07/15/85	26	27	29	34	36	34	32.5	30.5	25	25	26	27.1	27.1	27.1	26.6	26.6
07/25/85	25.5	27	31	35	35	33.5	29	28	24.1	25	26.6	27.6	28.1	28.1	26	25.1
08/01/85	28	29	33.5	35	35.5	33	32	30.5	26.1	27.1	27.6	28.1	28.5	28.1	28.5	27.6
08/07/85	24	25	30	34	34.5	32.5	30.5	28.5	23.6	24.1	25.1	27.1	27.6	25.1	26.1	25.1
08/15/85	26	27	32	35	36	33	30	28.5	24.6	25.1	26.1	27.1	28.1	27.1	26.1	25.6
08/25/85	23.5	25.5	30.5	35	36.5	33	29.5	26	22.6	23.1	25.1	26.1	26.6	26.1	24.1	23.1
09/01/85	26	27	30.5	33.5	33.5	31.5	28	27	25.1	26.1	25.5	25.5	25	25.5	25	24.5
09/07/85	22	24	31	33	35	29	28.5	26.5	21.1	23.1	25	26	26	25	24.5	23.5
09/15/85	22.5	25	30	35	36	30	28	26	22.1	23.1	24	25	25.1	24	23	22
09/25/85	24.5	27	32	35.5	33	30	28.5	26.5	22.6	24.6	26	25	25.5	25.5	25	23.5

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
10/01/85	23	25	33	37	36.5	29.5	26.5	25	19.1	21.1	22	22.5	23	23	21	20
10/07/85	23.5	25	30	31.5	31	28	25	24	23.1	23.5	24.5	25	25.1	24	22.5	22
10/15/85	19	24	30	31	31	26	19	19	14.5	18.1	22	22.5	22	19	16.5	16.5
10/25/85	18.5	22	28.5	31.5	30	25	22	20	17.5	20.1	22	22	20.1	20	20	19
11/01/85	18.5	22	28	32	31	27	21	19	15	17	18	20	21	19	18.5	17
11/07/85	17	18	25	28	30	24	21	19	15.5	16	20	20	19	20	17	16
11/15/85	15	17	25	28	27	23	19	18	14	14.5	18	20	20	18.5	17.5	16.5
11/25/85	13	15	21	25	26	19	14	14	11	12	16	16	16	15	12	12
12/01/85	12	14			23.5				11	12			16			
12/07/85	14	14.5			19				13	13.1			11			
12/15/85	10	11			21				9	10			13			
12/25/85	11.5	13			20.5				10	11			17			
01/01/86	8	9	17	20	19	13	9	6	6	6	10	11.5	11	9	7	4
01/07/86	7	8.5	17	20	19	14	12	10	6	7	11	12	11.5	10	9	8
01/15/86	7.5	8	16	21.5	20.5	13.5	12	10	7	7.5	12	13	13.5	11	10	8
01/25/86	8	9	17	20	19	14	9	7	6	6.9	10	10	10	8	7	6
02/01/86	7	8	19	22	22.5	16	14	12	6.5	7	12	12.5	13	11.5	9.9	9
02/07/86	8	10	19	22	21.5	15	13.5	13	6	7.5	13	12.5	12	10	10	9
02/15/86	12	13	18	21	22	17	15	14	10	11	13	15	16	15	14	13
02/25/86	10	12.5	22.5	25	26	20	16	14	9	10	15	14.5	15.5	14	12.5	12
03/01/86	14.5	15.5	23	29	28	23	18	16	12	12.5	16	17	17	16	15	14
03/07/86	17	18	24	30	30	26.5	24	22	15	16	18	20	20.5	19.5	19	18
03/15/86	14	15	24	25.5	26	22	18	16	10	10	13.5	13.5	14	13	12	10
03/25/86	16	18	24.5	30	30	24	20	18	12	13	15	18	17.5	17	15	14
04/01/86	19	20	27.5	29.5	30	24	20	18	11	12	15.5	15.5	16.5	16	15	14
04/07/86	21	22	32	35.5	36	30	26	24	17	17.5	21.5	23	23	22	20	19
04/15/86	22	24	33	36	36	30	28	26	19	20	23	22	23	22.5	22	21
04/25/86	24	25	29.5	33.5	35	30	28	26	19	20	20.5	21	21.5	21.5	21	18

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
05/01/86	26	26.5	32	34	37	32	29	27	21	21	22	23	23	22.5	21	20
05/07/86	22.5	27	37	42	42.5	35.5	32	30	21	22	25	24	24	23	21	22
05/15/86	29	29.5	39	43	45	38	34	32	21	22	25	25	26	25	25	24
05/25/86	25	26	35	41	43	36	33	30	20.5	21.5	22	22	23	23	22	22
06/01/86	23	24	30	33	32	31	27	25	20	20.5	24	24	25	24	22	21
06/07/86	29	30	37	41	40.5	35	34	31	20	21	23	25	23	22.5	22	21
06/15/86	28	29.5	38	43	44	39	36	32	24	25	26	26	26	26	26	25
06/25/86	29	30	38	42	42	35	33	31	25	27	28.5	31	30	27.5	27	26
07/01/86	29	29.5	34	34	31	27	25	24	24	25	26	27	24.5	24	23	22.5
07/07/86	28	29.5	36	41	42	38	35	32	25	26	28	28	28	27	26	25
07/15/86	28.5	29	35	39	41	37	34	31	24.5	25	26	27	27	27	25	25
07/25/86	27	28	30	33	37	33.5	31.5	29	25	28	26	26.5	27	26.5	26	25
08/01/86	25	26	30	33	35	32	29	27	25	26	26	27	27	26	25	24
08/07/86	29	29	33	35	30	27.5	27	27	26.5	26.5	27	27.5	25	24.5	24	25
08/15/86	27	27	30.5	33	34	32	30	28	25	25.5	26.5	27	27	26.5	26	26
08/25/86	24	25	30.5	35	36	32	27.5	25	22	23	25	25	25	25	24	23
09/01/86	23.5	24.5	29.5	34.5	35	31	28	26	23	24	24.5	25	26	24.9	24	24
09/07/86	24.5	25	31	35	35	31.5	30	28	22	23	25	25.5	26.5	26	25.5	24
09/15/86	24	26	30	32	33	30.5	28	26.5	22	23	24	25	26	25	24.5	23
09/25/86	24	25	31	34.5	33.5	30	26	25	22.5	23	25	26	25	25	23	22.5
10/01/86	24	25	30.5	36	33.5	28.5	27	28	22	22.5	25	25	25.5	25	24.5	23.5
10/07/86	23	26	31	35	34.5	29	26	25	22	23.5	24.5	25	25	25	24	23
10/15/86	25	26	32	35	35	30.5	25.5	23.5	20	19	21	23	22.5	22	22.5	22
10/25/86	18	20	26	30	25	23	21.5	20	16	16.5	19	20	20	18.5	18	17
11/01/86	16	19	30	31	29.5	23	19	17	15	16	20.5	19	19.5	18	17	16.5
11/07/86	16	15.5	26	29.5	29	24	22	20	15	14	18.5	18	19	16.5	16	15
11/15/86	18	18.5	25	28	27.5	21	20	16	14.6	14.6	17	17	16.5	15.5	13	11.5
11/25/86	17	14	20	23	21	18	17	15.5	14	13	15.5	16	15.6	15	14.5	14

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
12/01/86	12	11	17	21	21	17	14	13	12	10	15	15	15	13.6	12	11
12/07/86	14	13.5	20	23	22.5	20	15	13	13	13.1	16	17	17.6	17	14	12
12/15/86	4	3	15	18	16.5	10	5	5	2.5	2	9	10	9	8	4.6	4
12/25/86	5	7	17.5	20	17	15	9	8	4.5	6	11.5	13	11.5	10	9	8
01/01/87	8	10	15	19.5	18.5	13.5	12.5	11	8	8	10	13	12.5	11	10	9
01/07/87	9	9	17	20	19	13.5	11.5	10.5	8.5	8.5	13	13	13.5	11	10	9
01/15/87	9.5	9.5	16.5	20.5	21.5	13.5	12	11	8	8	13.5	14.5	14	13	10	10
01/25/87	8	8	20.5	23.5	24	16	13	10	7	7.5	14.5	15.5	15	13	12	11
02/01/87	10	10.5	19	24	23	19	13	12	9	9	15.5	18	16.5	15	12	11
02/07/87	11	12	19.5	26	26	18	16	15	10	10.5	13.5	16.5	17	14.5	13	12
02/15/87	13	14	22	24	25	18.5	14	13	12	13	14	16	15	14	12	11
02/25/87	11	12	18	21	21	17.5	15	13	10	10	15	15.5	15	14	12	11
03/01/87	13	13.5	27	27.5	28	22.5	18.5	16	12	12	18	18	18	17	16	14
03/07/87	16	19	25	27	28.5	23	21	19	14	16	18	19	20	19	18	17
03/15/87	17	17.5	22	25	26	23	22	20	16	16	19	20	20.5	20	20	19
03/25/87	16.5	17	22.5	25.5	26	22	19	17	15.5	16	18	18	18	17.5	17.5	16
04/01/87	20.5	20.5	28.5	31.5	30	28	25	23	19.5	19.5	21.5	21	21.5	20.5	20	19
04/07/87	19	24.5	33	35	34.5	31	29	26	17	21.5	22	22	22	22	21	20
04/15/87	19	21	31.5	35	38	29	27	22	17	19	21	21	21.5	21	19	17
04/25/87	18.5	20	33.5	38	37.5	29	25	21	17.5	19	18.5	19	19.5	19	17.5	16.5
05/01/87	26.5	28	35	40	40.5	32	25	22	18	19	20	20	20.5	19	19	18
05/07/87	22	23	25	32	33	30	27	25	19	19.5	20	22	23	21	22	22
05/15/87	23	25.5	29	31	33	30	29.5	25	19.5	21	21.5	22	23	23	21.5	20
05/25/87	25	27	34	39	40.5	34	32	30	24	25	24	24	24	24	22	22
06/01/87	28	32	36.5	39	40	35	33	31	27	27.5	26.5	27	27.5	26	25	24.5
06/07/87	29	31	40	43	43.5	36.5	35	32	23	25	25.5	26.5	27	25.5	25	25
06/15/87	28	32	36	41	42	36	34	30	27	29	27	25.5	25.5	24	24	23
06/25/87	29	29.5	36	40.5	42	35	33.5	32.5	27.5	29	26.5	24.5	26.5	25	25	25

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
07/01/87	27.5	29	36	41	42.5	38	34.5	33.5	26.5	27	27	27	27	26.5	27.5	25
07/07/87	28	30	35	40.5	42.5	38	35.5	33	26.5	27.5	28	29.5	27.5	27	27.5	27
07/15/87	27	29.5	35	38.5	38	35	32.5	30	26	26.5	27	27.5	27.5	24	27	26
07/25/87	27	27.5	35	38	41	36.5	31	30	26	26	27	27.5	27.5	27.5	26	25
08/01/87	28.5	30	36	42	42	37	34	32	24	25.5	27	25	25	25.5	26	25.5
08/07/87	29	30	37	38	39	35	32.5	29	26	26	27	27	27.5	27	26	25.5
08/15/87	25.5	28	32	35	34.5	32	29.5	26	24.5	25	26.6	26.6	27	26	25.5	25
08/25/87	26.5	27.5	32.5	36	37	34.5	32.5	29	25	25.5	27	27.5	28	28.5	27.5	27
09/01/87	27.5	29	32	37	40	35	31	28.5	24	25	26	27	28	27.5	25.5	25
09/07/87	25.5	27	31.5	36	37	32.5	28	26	23	24	25.5	26	27	26	24	23.5
09/15/87	24	25.5	31	33	34	30	27.5	26	23	23.5	25	25	23.5	24.5	23.5	23
09/25/87	26	27	33.5	38	70	31	28.5	25.5	19.5	20	23	24	25	24	22.5	20
10/01/87	25	26	35	38	37.5	31	28	26.5	24	25	24	24	24.5	23.5	23.5	23
10/07/87	23	25	35	37	38	30	27.5	25.5	21.5	22	21.5	22	22.5	24.5	23	22
10/15/87	18	20	27	30	31	25	21	19	16.5	17	18	18	18	17.5	17	16.5
10/25/87	20.5	21	29	32	32	26.5	24	21	18	18	20	21	21	21	20	20
11/01/87	18	19	27	30	29	25	20	18	16.5	16.5	19	19	20	18	17	16
11/07/87	15	16	29.5	33	32.5	22	20	19.5	13	14	18	19	19	17.5	16	16
11/15/87	15	16	27.5	30.5	30	20	18	16	14	14.5	20	19	19	17.5	16.5	15
11/25/87	11	12	20.5	24	24.5	21	18	13	10	10.5	15	16	16.5	15	13	11
12/01/87	12	14	19	21	20	14	13	9	8	9	10	10	10	8	6	5
12/07/87	5.5	6	17	23	22	15	10	18	5	4.5	11	13	13	12	9	6
12/15/87	12	11	20	25	25	17	15	13	10.5	9	14	17	18	15	13	12
12/25/87	10	11.5	17	22	23	17	14	12	9	10	13	14	15	15	11	10
01/01/88	12	14	15	19	18.5	16.5	15	13	10	10.5	11.5	14	13	12.5	12	11
01/07/88	9	10	18.5	23	22.5	16	14	12	8	9	13.5	15.5	15	13	12	11.5
01/15/88	10.5	12	18	21	21.5	17	16	14	9	10.5	14	15	14.5	13	12	11.5
01/25/88	7.5	8	16.5	21	22.5	14.5	9.5	9	6.5	6.5	12	12	12.5	11	8.5	8

BEST AVAILABLE COPY

TABLE A-4

4-1/2 YEAR TEMPERATURE DATA (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
02/01/88	10.5	12	20	20.5	22	19	15	13	9.5	10	15	16	15	14.5	14	11
02/07/88	12	14	20	24	23	19	15	13	11	12	15	14	13.5	12	9	11
02/15/88	10.5	11	19	21	20.5	18	15	13	10	10	14	14	14	12	11	10
02/25/88	13	15	26	29	30.5	23	19	18	10	11	16	17	18	17	16	15
03/01/88	11	13	22	26	27	20.5	16	14	10	11	16	16	17	14	13	12
03/07/88	19	20	23	27	28	24	22	20	18	17	18	20	21	20	19	18
03/15/88	17	18.5	24.5	30	31	25	23.5	19	16	17	19	20	21	21.5	19	17
03/25/88	20	19	26	28	29	22	19	17	14	13.5	15	15	16	15	12	11
04/01/88	18	18.5	30	32.5	34.5	24	24	22	13	14.5	18.5	18.5	18	17	16	15
04/07/88	19	20	29.5	33	37	30	24	22	13	14	17.5	17.5	20	18	16	15
04/15/88	23	25	39	43	43	35	34	29	17	18	22	23	22	22	20	19
04/25/88	26	28	34	38	39	34	30	29	20	21	23	25	25	22	23	22
05/01/88	23	25	32	35	36	32	31	30	20	18.8	22	23	23	22	22	22
05/07/88	28	30	40	43	44	35	33	32	20	21	21	23	23	24	25	25
05/15/88	24.5	27	35	40	41	36	33	32	23	24.5	25	25	24	23	23.5	23
05/25/88	27	28	37	42	44	39	35	31	24	24	25	25	25	26	25.5	25
06/01/88	30	31	37	46	47	40	35.5	33	26	26.5	26	24	23	22	22.5	22
06/07/88	30	30	36	40	42	36	34	33	23	25	25	26	27	26	25	25
06/15/88	26	28	30	41	42	37	36	35	25	26	23.5	26.5	26	26.5	26	25
06/25/88	28	28.5	34	39	39	34	33	32	26	26	26	27	28	27	27	26
07/01/88	27	29	31	30	31	30	29	28	25.5	26	27	25	25	25	26	26
07/07/88	28	29	33	35	37	36.5	36	34.5	26	26.5	28	28	28	27.5	27	27
07/15/88	28	29	31	35	36	34	32	31	27	26	27	27.5	28	27	27.5	27
07/25/88	28	29	35	36	35	33	31	30	27	27.5	28	28.5	30	28	27	26.5
08/01/88	25.5	26.5	32	36	37	33	30	26	23.5	24.5	27	27.5	27	26	25	24
08/07/88	27	28	32	34	36	33	31	29	25.5	26	27	27.5	28	27	26	25
08/15/88	25.5	28	34	36	38	33	32	30	24.5	25	26	26.5	27.5	27	27	26
08/25/88	26.5	28.5	34	36.5	37	32.5	31	29	24	26.5	27	28	28.5	28.5	26	25

TABLE A-5

BEST AVAILABLE COPY

4-1/2 YEAR TEMPERATURE DATA - DAILY AVERAGES EVERY THREE HOURS (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
[illegible]	9.14	10.82	16.06	19.48	18.64	14.12	11.96	10.12	7.36	7.68	10.30	12.14	11.96	10.28	9.24	8.02
07-[illegible]	9.00	9.28	15.72	19.82	19.54	14.26	12.18	10.50	7.62	8.12	11.28	12.76	12.66	11.14	9.98	9.14
15-Jan	[illegible]	10.34	18.10	21.94	21.98	15.58	13.34	11.66	8.36	8.98	13.02	13.94	14.18	12.40	10.62	9.80
25-Jan	8.82	[illegible]	18.24	22.22	22.50	16.16	12.42	10.76	7.34	7.90	12.98	13.28	13.16	11.50	10.16	9.10
01-Feb	10.38	[illegible]	[illegible]	23.08	23.28	19.28	14.64	13.16	8.68	8.76	14.02	15.00	14.90	13.38	11.72	10.52
07-Feb	11.98	12.52	[illegible]	[illegible]	23.42	17.86	15.22	13.54	9.40	9.56	13.30	14.06	13.94	11.74	10.30	9.74
15-Feb	11.88	12.94	20.58	[illegible]	24.72	19.14	16.02	14.22	10.06	10.68	13.64	14.88	15.12	13.54	12.50	11.34
25-Feb	11.14	12.68	21.96	25.12	[illegible]	19.78	15.68	14.00	9.04	9.66	14.54	14.86	15.38	14.24	12.42	11.60
01-Mar	13.70	14.40	25.06	28.60	[illegible]	[illegible]	18.82	16.32	11.58	11.88	16.54	17.20	17.52	16.06	14.70	13.22
07-Mar	17.08	18.50	25.74	29.68	30.52	[illegible]	[illegible]	20.98	14.94	15.36	18.02	19.46	20.08	18.70	18.08	17.14
15-Mar	16.84	18.52	24.98	28.32	29.36	24.56	[illegible]	[illegible]	14.18	14.70	17.52	18.36	18.64	18.56	17.20	15.64
25-Mar	19.50	20.02	26.28	29.70	30.32	24.94	22.46	[illegible]	[illegible]	15.40	17.48	18.76	18.76	18.24	16.90	15.98
01-Apr	20.82	20.92	27.98	29.92	30.22	25.36	23.26	21.26	[illegible]	[illegible]	19.20	19.10	19.42	18.70	17.98	17.56
07-Apr	20.68	22.30	30.56	33.92	35.38	30.08	27.02	24.64	16.72	[illegible]	[illegible]	21.50	21.00	21.24	20.04	18.66
15-Apr	22.80	25.12	34.68	38.48	39.48	32.58	30.14	26.52	17.82	19.40	[illegible]	[illegible]	22.18	21.54	20.08	19.28
25-Apr	23.70	24.94	34.52	38.46	39.08	32.82	30.16	27.08	18.52	19.22	22.28	[illegible]	[illegible]	21.60	20.74	19.42
01-May	24.54	27.12	34.58	37.70	38.92	32.64	28.88	27.12	19.12	19.42	20.46	21.28	[illegible]	[illegible]	19.18	18.68
07-May	25.94	27.66	33.50	40.52	42.32	35.00	31.84	30.06	20.56	21.50	22.42	23.46	23.86	[illegible]	22.04	21.92
15-May	26.98	28.28	36.60	39.36	40.58	34.36	31.62	29.58	19.30	20.38	22.20	22.50	22.94	22.08	[illegible]	21.04
25-May	28.04	29.02	36.08	41.60	43.12	37.12	33.54	30.98	22.18	23.22	23.76	23.96	24.24	24.22	23.02	[illegible]
01-Jun	27.66	29.38	34.92	39.64	40.48	36.06	32.94	30.34	24.58	25.52	26.44	26.26	26.26	25.26	24.86	24.14
07-Jun	28.56	29.98	36.82	41.02	42.24	36.56	34.02	31.44	22.88	24.50	25.46	26.26	25.86	25.56	25.06	24.32
15-Jun	28.76	31.22	36.20	42.26	43.60	38.62	35.88	33.02	[illegible]	26.74	26.06	26.46	25.88	25.38	24.86	24.16
25-Jun	28.78	30.04	36.02	40.66	41.68	36.18	33.46	31.38	25.70	26.60	26.80	27.32	27.72	26.54	26.04	25.60
01-Jul	27.98	29.34	34.04	36.40	36.52	32.34	29.84	28.92	25.20	25.94	26.66	26.88	26.38	25.14	25.06	24.22
07-Jul	28.32	29.74	34.76	38.62	39.92	36.94	34.88	32.54	25.74	26.56	27.56	28.16	27.66	27.06	26.74	26.34
15-Jul	27.44	28.68	32.88	37.42	38.54	35.34	32.54	30.72	25.16	25.38	[illegible]	27.06	27.36	26.36	26.34	25.74
25-Jul	27.06	28.08	33.20	36.18	37.82	34.64	31.16	29.52	25.30	26.30	26.86	27.58	28.08	27.58	26.22	25.20
01-Aug	26.86	27.86	33.08	36.64	37.68	34.22	31.88	29.10	24.28	25.50	26.86	26.86	26.94	26.56	26.24	25.34
07-Aug	27.02	27.84	32.29	34.32	34.46	31.82	30.18	28.25	25.20	25.08	26.22	27.04	26.74	25.84	25.74	25.12

TABLE A-5

4-1/2 YEAR TEMPERATURE DATA - DAILY AVERAGES EVERY THREE HOURS (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
15-Aug	26.58	27.88	32.26	35.02	35.94	32.78	30.42	28.16	24.94	25.46	26.38	26.88	27.52	26.88	26.24	25.74
25-Aug	25.66	26.96	32.06	36.04	36.74	33.28	30.22	27.66	23.72	24.74	26.16	26.88	27.28	27.06	25.66	24.74
01-Sep	25.65	26.80	30.65	35.00	36.03	32.58	29.80	27.88	23.85	24.75	25.40	26.05	26.95	26.55	25.70	25.05
07-Sep	24.65	25.68	31.58	34.48	35.23	31.30	29.13	27.08	22.23	23.50	25.28	25.78	25.70	25.78	24.90	23.85
15-Sep	24.58	26.35	30.40	33.20	33.95	30.10	27.95	26.58	22.88	23.65	24.35	25.15	25.45	24.63	23.58	22.83
25-Sep	24.73	26.43	32.18	35.75	42.73	30.10	27.43	25.50	21.43	22.33	24.48	24.85	25.13	24.73	23.73	22.48
01-Oct	23.98	25.25	32.68	36.50	34.23	29.68	27.05	26.13	21.13	22.15	23.58	23.85	24.23	22.88	21.83	21.35
07-Oct	22.23	24.28	32.33	34.78	34.63	28.70	25.33	23.90	20.95	21.55	22.48	22.85	23.15	23.23	22.10	21.05
15-Oct	21.05	23.20	30.03	32.33	32.18	27.45	22.48	21.20	17.48	18.25	20.10	21.03	20.90	19.78	18.85	18.48
25-Oct	19.40	20.60	28.10	30.88	29.40	25.15	22.98	21.08	16.68	17.40	20.10	20.90	20.13	19.73	19.08	18.48
01-Nov	17.03	19.03	28.05	30.75	29.60	24.58	19.58	17.68	14.95	15.80	18.68	18.53	19.58	17.65	16.73	15.85
07-Nov	16.30	16.83	26.10	29.85	29.55	23.05	20.65	19.20	14.35	14.33	18.28	18.70	18.83	17.73	16.28	15.65
15-Nov	16.45	17.45	25.35	28.70	28.08	21.55	19.10	17.23	14.55	14.80	18.33	18.85	18.73	17.60	16.33	14.93
25-Nov	13.73	13.85	20.93	24.40	24.38	19.23	16.15	14.23	11.95	12.08	15.65	16.03	16.33	15.00	13.35	12.58
01-Dec	12.75	13.35	19.23	22.33	22.23	17.20	15.10	13.07	10.95	10.80	13.53	13.90	14.55	12.40	11.00	10.13
07-Dec	11.58	12.25	20.10	24.23	22.40	18.33	14.07	15.70	10.53	10.60	14.20	15.57	14.58	15.03	12.47	10.63
15-Dec	9.70	9.73	17.97	21.73	21.18	15.30	11.87	10.80	8.00	7.75	11.73	13.63	13.60	12.10	9.77	9.03
25-Dec	8.70	9.95	16.13	20.47	19.98	15.87	11.37	9.80	6.70	7.58	10.93	12.53	13.38	11.30	9.27	8.40

TABLE A-6

4-1/2 YEAR TEMPERATURE DATA - MONTHLY AVERAGES EVERY THREE HOURS (ROHRI METEOROLOGICAL STATION)

DATE	DRY BULB TEMPERATURE, C								WET BULB TEMPERATURE, C							
	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)	5 AM (0500)	8 AM (0800)	11 AM (1100)	2 PM (1400)	5 PM (1700)	8 PM (2000)	11 PM (2300)	2 AM (0200)
January	9.17	9.94	17.03	20.87	20.67	15.03	12.48	10.76	7.67	8.17	11.90	13.03	12.99	11.33	10.00	9.02
February	11.35	12.20	20.47	24.01	24.32	19.02	15.39	13.73	9.30	9.67	13.88	14.70	14.83	13.23	11.74	10.80
March	16.78	17.86	25.52	29.08	29.79	24.61	21.68	19.25	13.98	14.33	17.39	18.45	18.75	17.89	16.72	15.50
April	22.00	23.32	31.94	35.20	36.04	30.21	27.65	24.88	17.36	18.33	21.09	21.17	21.26	20.77	19.71	18.73
May	26.38	28.02	35.19	39.80	41.24	34.78	31.47	29.44	20.29	21.13	22.21	22.80	23.12	22.29	21.50	21.06
June	28.44	30.16	35.99	40.90	42.00	36.86	34.08	31.55	24.62	25.84	26.19	26.58	26.43	25.69	25.21	24.56
July	27.70	28.96	33.72	37.16	38.20	34.82	32.11	30.43	25.35	26.05	26.88	27.42	27.37	26.54	26.09	25.38
August	26.53	27.64	32.42	35.51	36.21	33.03	30.68	28.30	24.54	25.20	26.41	26.92	27.12	26.59	25.97	25.24
September	24.90	26.31	31.20	34.61	36.98	31.02	28.58	26.76	22.59	23.56	24.88	25.46	25.81	25.42	24.48	23.55
October	21.66	23.33	30.78	33.62	32.61	27.74	24.46	23.08	19.06	19.84	21.56	22.16	22.10	21.40	20.46	19.84
November	15.88	16.79	25.11	28.43	27.90	22.10	18.87	17.08	13.95	14.25	17.73	18.03	18.36	16.99	15.67	14.75
December	10.68	11.32	18.36	22.19	21.44	16.68	13.10	12.34	9.04	9.18	12.60	13.91	14.03	12.71	10.63	9.55

TABLE A–7
4–1/2 YEAR TEMPERATURE DATA – MONTHLY AVERAGES
(ROHRI METEOROLOGICAL STATION)

MONTH	DRY BULB C	WET BULB C	RELATIVE HUMIDITY %	SPECIFIC HUMIDITY LB WATER/ LB DRY AIR
Jan	14.5	10.5	61.2%	0.0063
Feb	17.6	12.3	53.8%	0.0067
Mar	23.1	16.6	52.1%	0.0092
Apr	28.9	19.8	43.0%	0.0107
May	33.3	21.8	36.4%	0.0117
June	35.0	25.6	47.7%	0.0169
July	32.9	26.4	60.3%	0.0191
Aug	31.3	26.0	66.0%	0.0191
Sep	30.0	24.5	63.6%	0.0171
Oct	27.2	20.8	56.7%	0.0128
Nov	21.5	16.2	58.3%	0.0093
Dec	15.8	11.5	59.8%	0.0066
Year	25.9	19.3	54.2%	0.0113

BEST AVAILABLE DOCUMENT

PLANT POWER AUGMENTATION USING INLET AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

APPENDIX B

POWER INCREASES ATTRIBUTABLE TO INLET AIR EVAPORATIVE COOLING

BEST AVAILABLE COPY

APPENDIX B

POWER INCREASES ATTRIBUTABLE TO INLET AIR EVAPORATIVE COOLING

A methodology was developed to calculate the power increases attributable to inlet air evaporative cooling. A necessary step in performing this analysis was to obtain the appropriate temperature profiles (dry bulb and wet bulb) and corresponding relative humidities upon which to base the power increase calculations. The treatment of the meteorological data is described in Appendix A.

The "cooled air temperature" was first determined for each point of interest. The cooled air temperature is the temperature to which the compressor inlet air temperature can be reduced with the evaporative cooler. For the purpose of this study an assumption was made that the evaporative coolers would operate at an average efficiency of 80 percent. This is thought to be more realistic, and more conservative over the long term, than the 90 percent recommended by the media supplier and used in the reference 1 report. This figure adequately accounts for degradation of the cooler media over time until its periodic replacement. The procedure for calculating the cooled air temperature presupposes that both the dry bulb and wet bulb temperatures are known. The cooled air temperature is then the temperature obtained by subtracting 80 percent of the difference between the dry bulb and wet bulb temperature from the dry bulb temperature. For example, with a dry bulb temperature of 34 degrees C and a wet bulb temperature of 24 degrees C, the cooled air temperature would be 26 degrees C. The psychometrics of the cooling process are discussed in more detail in reference 1.

Independent of the calculation of the cooled air temperature, it was necessary to develop an equation to represent the Guddu combined cycle power plant base load output (without evaporative cooling) as a function of ambient dry bulb temperature. Data provided by the General Electric Company (reference 3) shows that the relationship is that of a straight line. Fifteen data points were extracted from the Guddu plant operation logs at ambient temperatures from 15 degrees C to 40 degrees C. A regression analysis was performed to find the equation of the straight line most closely representing the data. Figure B-1 presents the individual points used in the regression analysis as well as the plot of the straight line calculated in the analysis. As can be seen from the figure, the curve fits the data extremely well and confirms the straight line relationship. The regression analysis resulted in a standard error of the coefficient of approximately 3.5 percent, and a standard error of the y-intercept of approximately 0.5 percent.

The computer model constructed by Gibbs & Hill also accounts for the slight penalty (loss in efficiency) resulting from the increase in inlet air pressure drop caused by the use of evaporative media. Data provided by the gas turbine manufacturer, General Electric, indicates that an increase in the inlet pressure drop of 4 inches of water results in a one and one-half percent reduction in gas turbine output. The addition of evaporative coolers results in an increase in the pressure drop through the inlet air system of about 0.3 inches water gauge. This results in a reduction of approximately 0.1 percent in output.

BEST AVAILABLE COPY

With the above methodology in place, the Guddu combined cycle power plant output was calculated both without and with evaporative cooling. This was done using the equation and correction factor described above. For the plant without evaporative cooling, the ambient (dry bulb) air temperature was used as the input variable in the equation. For the plant with evaporative cooling, the cooled air temperature was selected as the inut variable. This calculation was performed for each of the 2,920 data points (365 days x 8 sets of dry and wet bulb temperature per day) of the year for which complete meteorological data was obtained, i.e., August 1, 1989 through July 31, 1990. The increases in base load power output for each month of the year were also calculated using the average monthly temperatures determined as discussed in Appendix A. The average monthly power increases are presented in Table B-1. Figure B-2 shows this information in a graphical format. A tabulation of the calculated power increases for each of the 2,920 data points would be too voluminous for this report. However, Gibbs & Hill has prepared Figures B-3 through B-5 which show daily power increase curves. Figure B-3 presents the daily curve for January 3, 1990, which is representative of a probable minimum daily increase. Figure B-4 presents similar information for May 23, 1990, and represents a probable maximum daily increase. A typical daily power increase curve is shown in Figure B-5 and is based on the weather data for September 6, 1989.

The calculated plant power increase attributable to evaporative cooling, averaged for an entire year, without consideration of unit outages or power reductions resulting from economic dispatch loading, is 14.0 MW. The maximum calculated power increase was 9.75 percent. This is within the capability of the generator which, as discussed in reference 1, limits the power increase to about 11 percent at 0.90 power factor.

Gibbs & Hill also undertook a review of the methodology described above to determine how closely power increases predicted by its use compare with data provided by the General Electric Company. The curve supplied by General Electric for the Guddu combined cycle power plant via reference 3 was entered into a personal computer based program. An equation of this curve was developed by means of a regression analysis as described earlier. Figure B-6 shows the close comparison of the values calculated by the Gibbs & Hill procedure with the data points extracted from the General Electric curve for the base loaded plant without evaporative cooling. For the three curves presented by General Electric for the plant output with evaporative cooling, data points were selected (ambient dry bulb temperature and specific humidity), and corresponding wet bulb temperatures were calculated. This information was then inputted to the equations developed by Gibbs & Hill. Figure B-7 presents the results of this comparison for three sets of specific humidity lines, i.e., specific humidity of 0.002 lb water/lb dry air, 0.010 lb water/lb dry air, and 0.020 lb water/lb dry air. As seen in the figure the results compare very well with a maximum difference of only approximately one percent at the higher ambient temperatures. This difference decreases and essentially vanishes entirely as ambient temperature decreases. This confirms the validity of the methodology developed by Gibbs & Hill to calculate the power increases which can be achieved with an inlet air evaporative cooler.

BEST AVAILABLE COPY

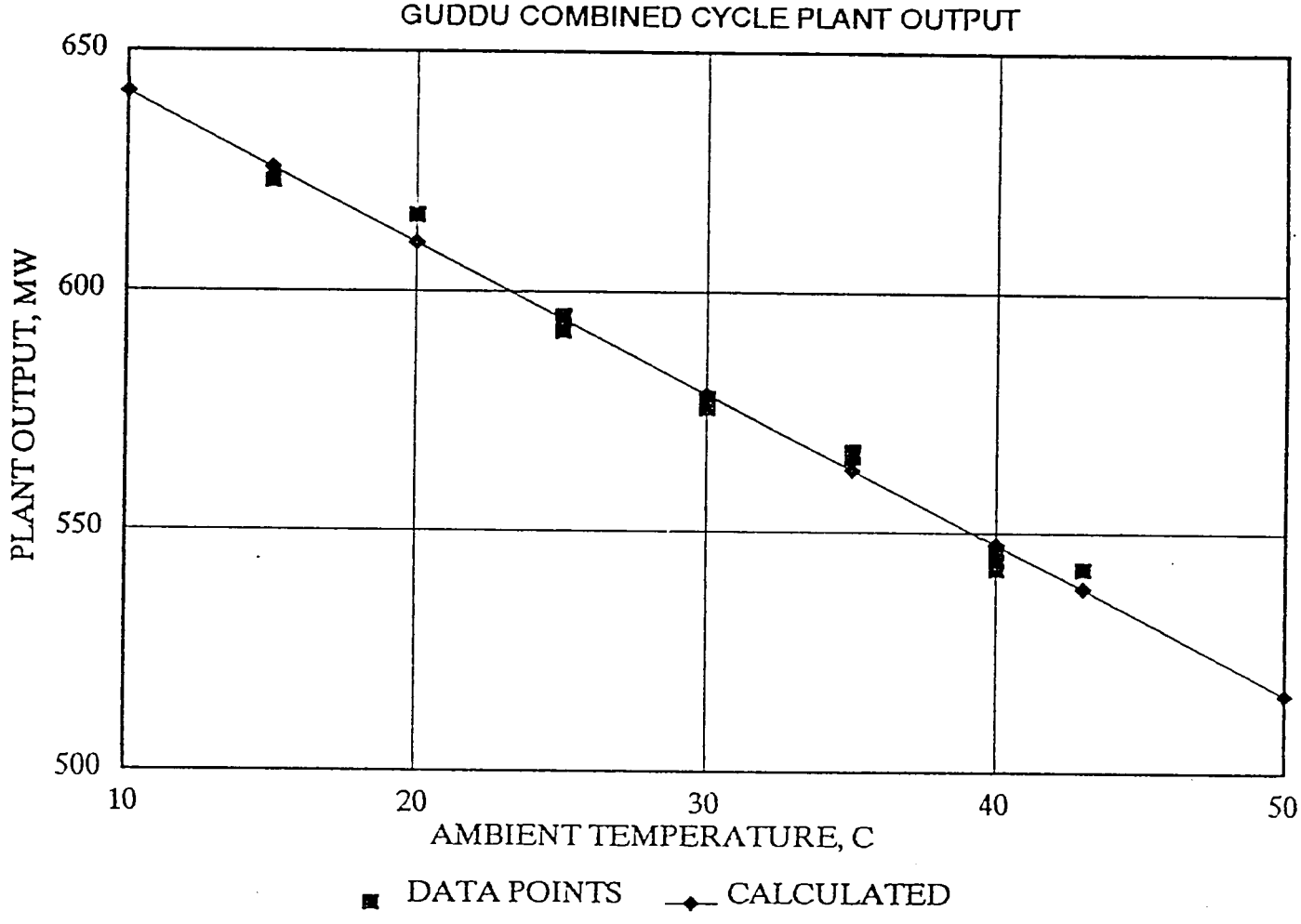


FIGURE B-1

BEST AVAILABLE COPY

GUDDU EVAPORATIVE COOLER STUDY

AVERAGE OUTPUT INCREASE

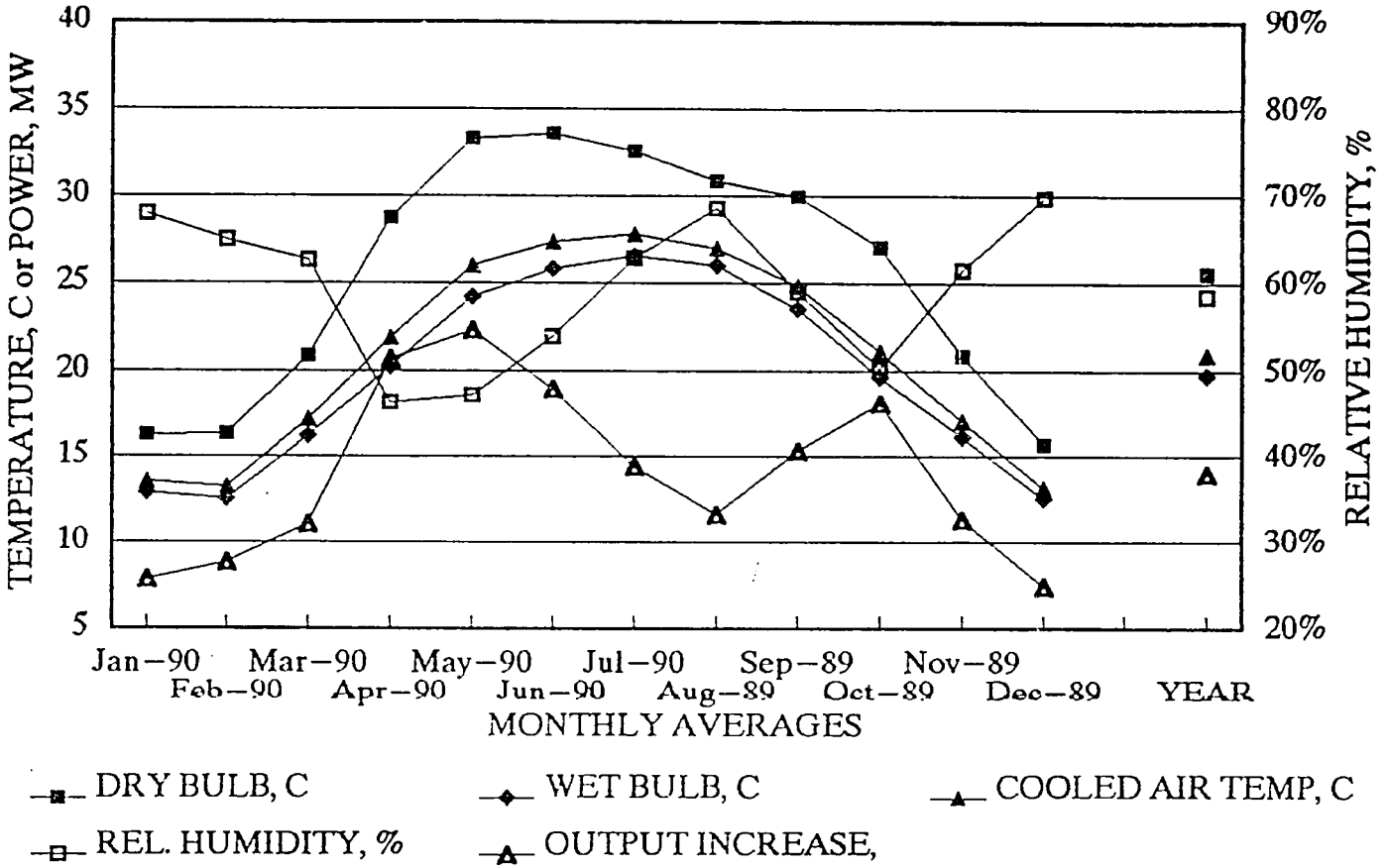


FIGURE B-2

BEST AVAILABLE COPY

GUDDU EVAPORATIVE COOLER STUDY

TYPICAL MINIMUM OUTPUT INCREASE (03–Jan–90)

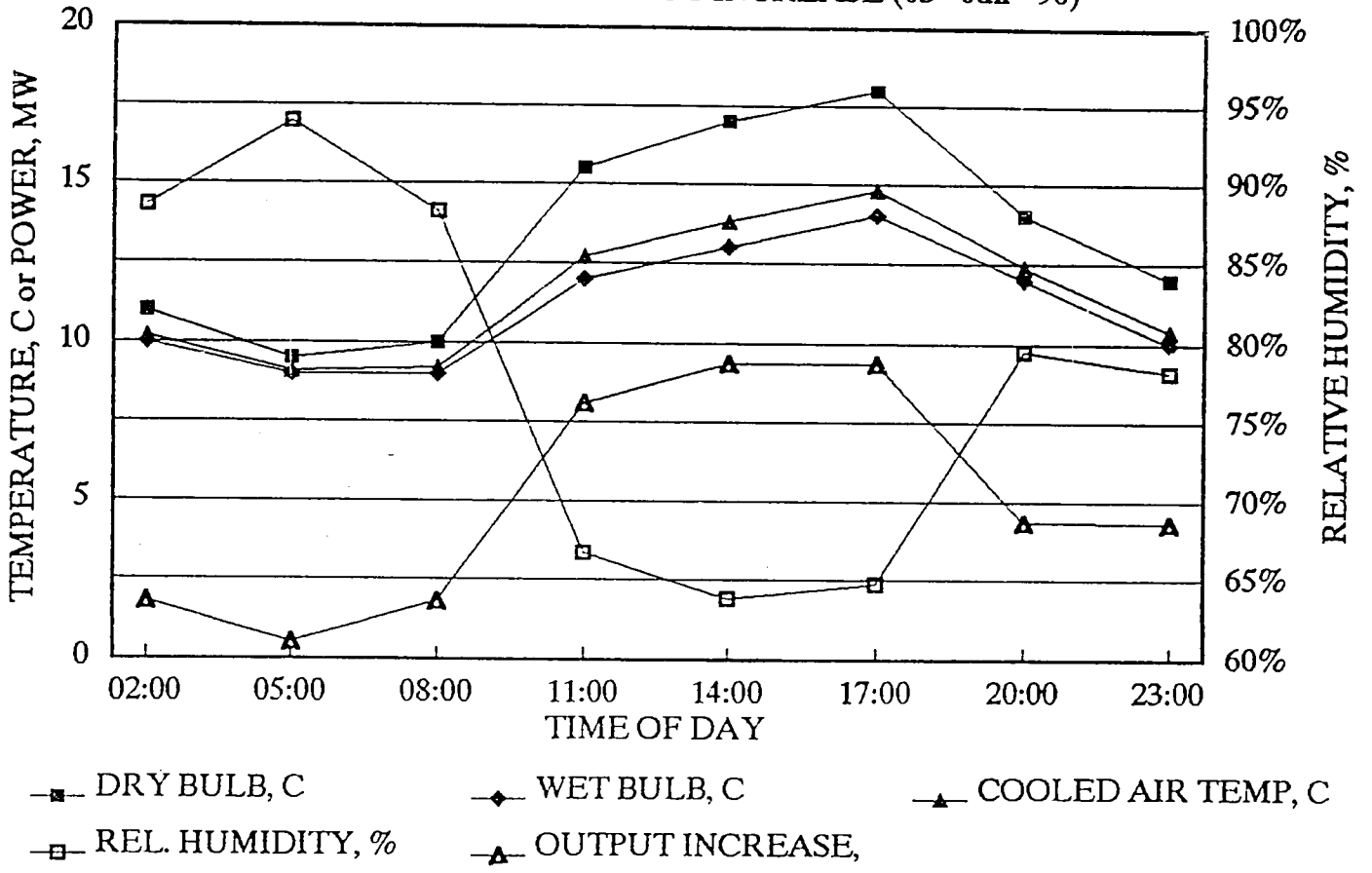


FIGURE B-3

BEST AVAILABLE COPY

GUDDU EVAPORATIVE COOLER STUDY

TYPICAL MAXIMUM OUTPUT INCREASE (23–May–90)

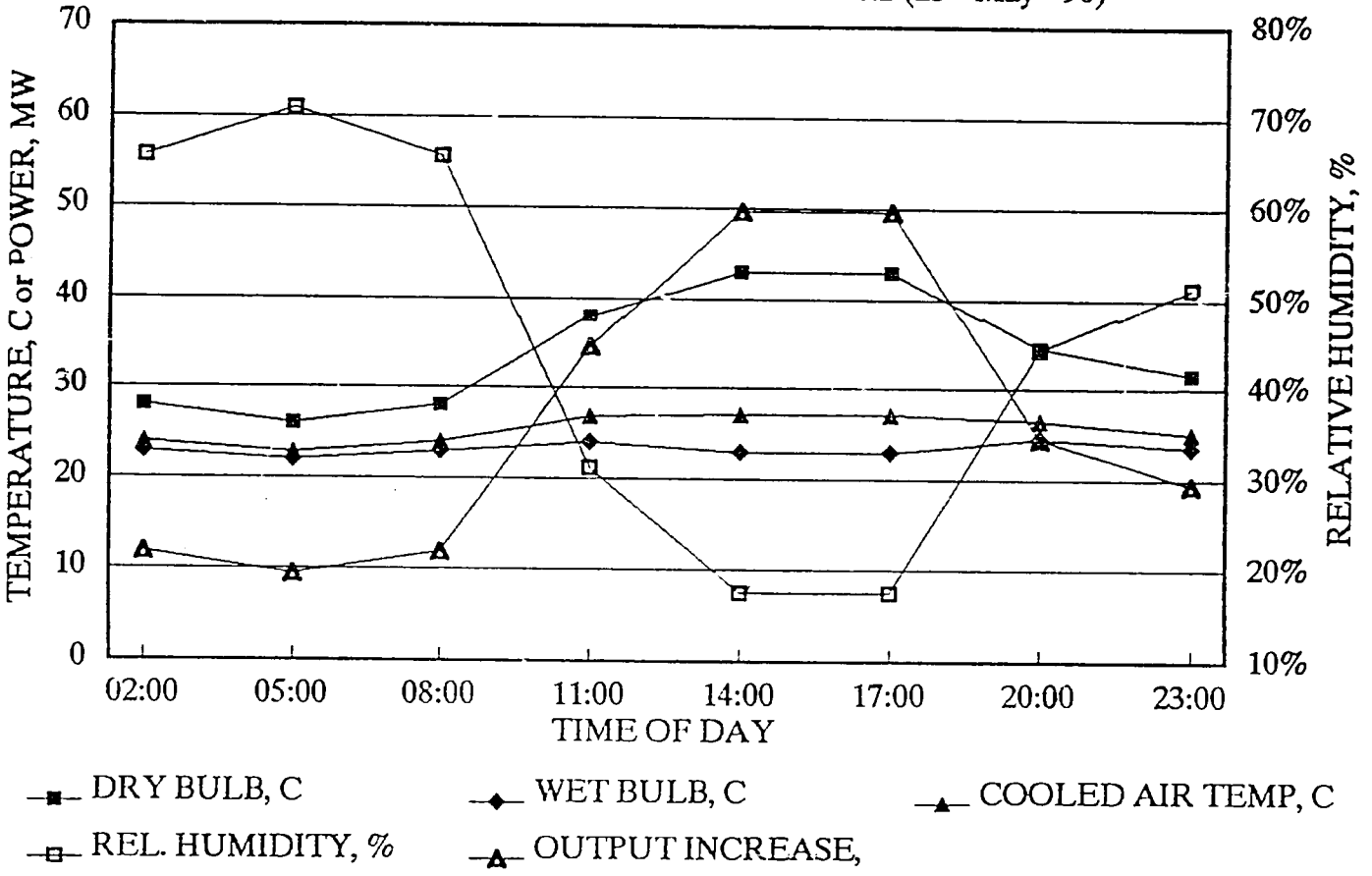
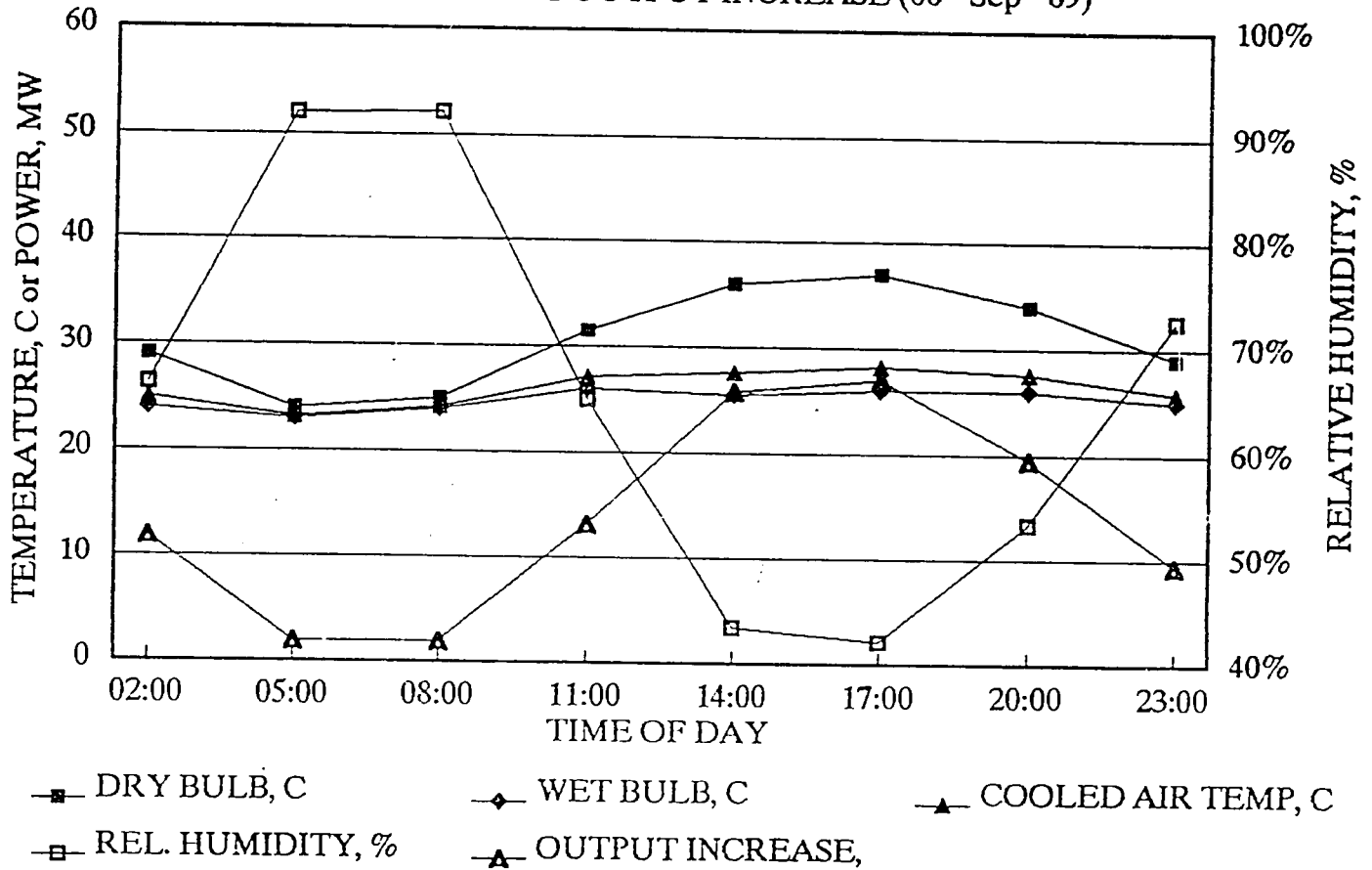


FIGURE B-4

BEST AVAILABLE COPY

GUDDU EVAPORATIVE COOLER STUDY

TYPICAL AVERAGE OUTPUT INCREASE (06–Sep–89)



BEST AVAILABLE COPY FIGURE B-5

50

GUDDU COMBINED CYCLE PLANT PERFORMANCE
COMPARISON OF G&H AND GE DATA WITHOUT INLET AIR COOLING

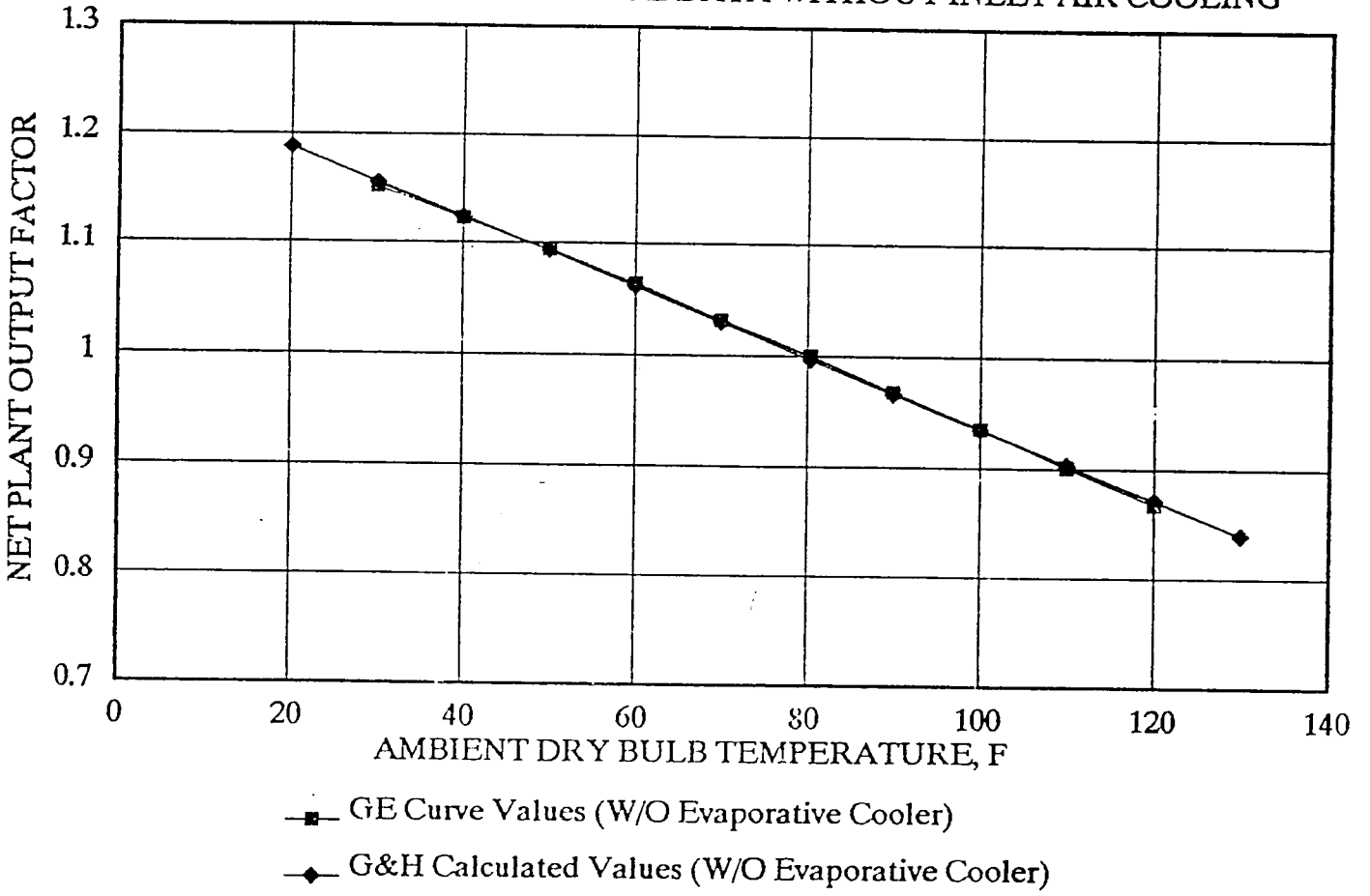


FIGURE B-6

BEST AVAILABLE COPY

GUDDU COMBINED CYCLE PLANT PERFORMANCE
COMPARISON OF G&H AND GE DATA WITH INLET AIR COOLING

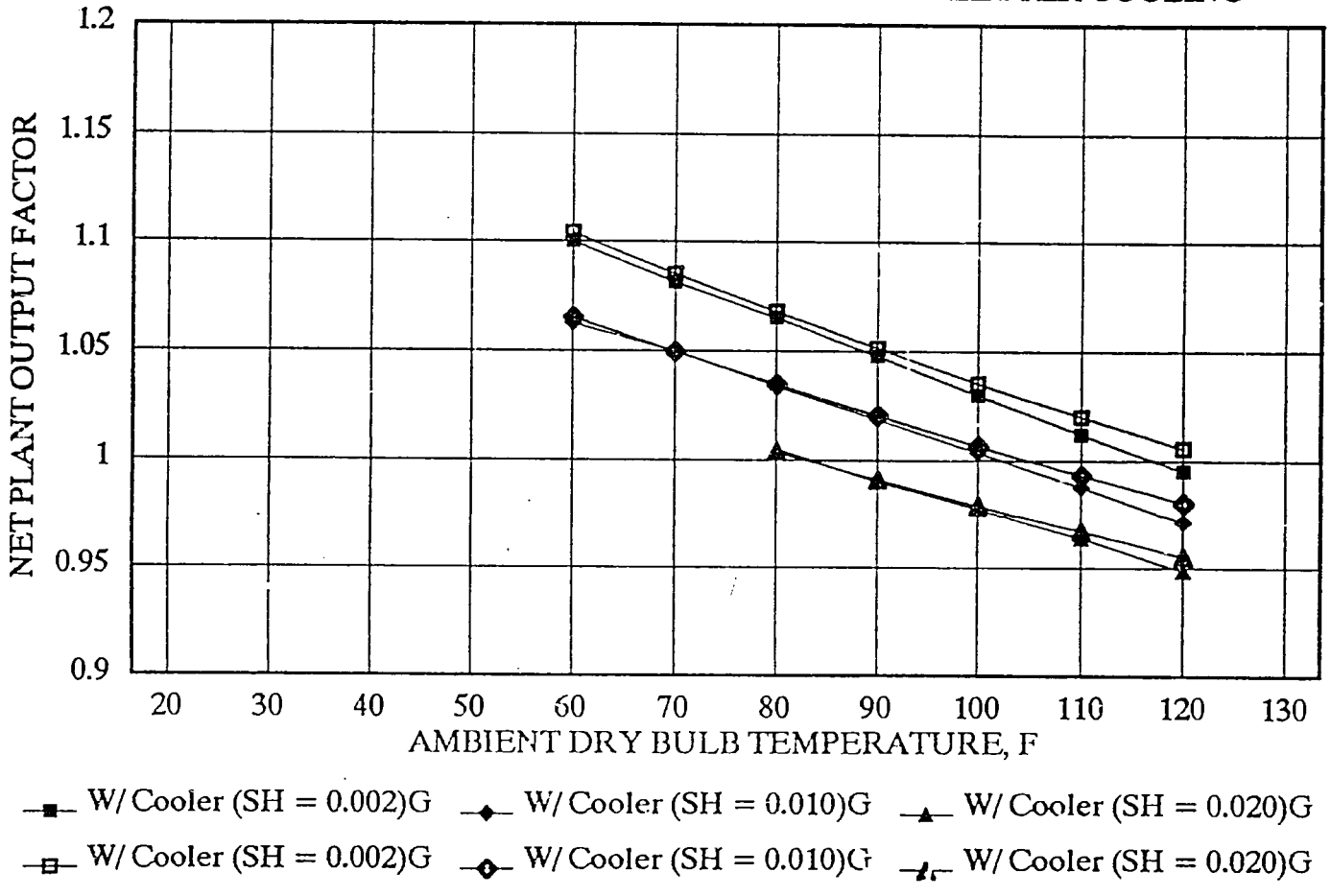


FIGURE B-7

BEST AVAILABLE COPY

TABLE B–1
GUDDU COMBINED CYCLE POWER PLANT
AVERAGE MONTHLY POWER OUTPUTS
WITH AND WITHOUT EVAPORATIVE COOLING

MONTH	DRY BULB C	WET BULB C	COOLED AIR TEMP DB, C	RELATIVE HUMIDITY %	SPECIFIC HUMIDITY LB WATER/ LB DRY AIR	BASE LOAD PLANT OUTPUT W/O COOLING	WITH COOLING	OUTPUT INCREASE
an–90	16.3	12.9	13.5	67.9%	0.0078	621.9	629.7	7.8
eb–90	16.3	12.5	13.3	64.9%	0.0075	621.8	630.6	8.8
ar–90	20.9	16.2	17.1	62.6%	0.0096	607.4	618.4	11.0
pr–90	28.7	20.2	21.9	46.3%	0.0114	582.9	603.5	20.6
ay–90	33.3	24.2	26.0	47.1%	0.0152	568.2	590.5	22.3
un–90	33.6	25.8	27.4	53.9%	0.0177	567.4	586.3	18.9
ul–90	32.6	26.6	27.8	62.8%	0.0195	570.6	585.0	14.4
ug–89	30.9	26.0	27.0	68.4%	0.0193	576.0	587.5	11.5
ep–89	29.9	23.5	24.8	59.1%	0.0157	579.0	594.3	15.3
ct–89	27.1	19.6	21.1	50.2%	0.0112	587.9	606.0	18.1
ov–89	20.9	16.1	17.1	61.5%	0.0095	607.4	618.7	11.2
ec–89	15.7	12.5	13.1	69.8%	0.0077	623.7	631.0	7.4
YEAR	25.5	19.7	20.9	58.5%	0.0120	592.7	606.7	14.0

BEST AVAILABLE COPY

PLANT POWER AUGMENTATION USING INLET AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

APPENDIX C

PLANT OUTAGES

BEST AVAILABLE COPY

APPENDIX C

PLANT OUTAGES

Forced and scheduled outage data obtained from the plant operational logs for the period July 1989 to June 1990 are shown in Table C-1. Separate data for the four gas turbines (units G-5 through G-8) and the two steam turbines (units G-9 and G-10) are shown.

Outages for inspection and overhaul are scheduled for the period from August to mid-December whenever possible because the availability of hydro power is much greater during these months than during the first part of the year. There are inevitably some scheduled outages during the low hydro months and there are, of course, forced outages throughout the year.

The data presented in Table C-1 were used in the economic analysis. No distinction was made between scheduled and forced outages since both have the same effect on the availability of generating capacity. The average outage rate was 10.9 percent over the period under consideration.

Account was taken of the fact that a gas turbine outage reduces the output of the associated combined cycle steam turbine by 50 percent. This was done by attributing half of the gas turbine outage hours to steam turbine outage hours and applying a coincidence factor of 33 percent (i.e. the probability of unrelated outages of gas turbines and their associated steam turbine occuring at the same time is 33 percent). Application of this factor on a monthly basis has the impact of increasing plant unavailability from a yearly average of 10.9 percent to 12.9 percent. The base loaded 14.0 MW average increase in output discussed in Appendix B is therefore effectively reduced to 12.1 MW.

BEST AVAILABLE COPY

55

TABLE C-1

GUDDU 600 MW COMBINED CYCLE POWER PLANT
FORCED AND SCHEDULED OUTAGES (HOURS)

	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90	Feb-90	Mar-90	Apr-90	May-90	June-90	Total Hours	Percent of Available hours
UNIT G-5														
FORCED	0	152	0	3	428	10	10	5	13	8	11	105	745	8.5%
SCHEDULED	0	396	720	723	0	47	0	0	40	9	21	0	1,956	22.3%
COMBINED	0	548	720	726	428	57	10	5	53	17	32	105	2,701	30.8%
UNIT G-6														
FORCED	11	36	8	21	9	31	12	7	10	7	12	6	170	1.9%
SCHEDULED	0	4	2	99	687	14	0	0	55	9	20	0	890	10.2%
COMBINED	11	40	10	120	696	45	12	7	65	16	32	6	1,060	12.1%
UNIT G-7														
FORCED	0	1	0	5	15	0	3	0	34	4	7	0	69	0.8%
SCHEDULED	43	0	51	39	218	0	0	86	0	0	0	70	517	5.9%
COMBINED	43	1	61	44	233	0	3	86	34	4	7	70	586	6.7%
UNIT G-8														
FORCED	29	1	1	0	10	2	1	0	8	0	3	0	55	0.6%
SCHEDULED	26	19	0	0	38	0	0	31	21	26	66	100	327	3.7%
COMBINED	55	20	1	0	48	2	1	31	29	26	69	100	382	4.4%
UNIT G-9														
FORCED	1	0	0	0	0	13	1	0	1	0	0	12	28	0.3%
SCHEDULED	0	0	0	137	33	0	16	0	0	0	0	74	260	3.0%
COMBINED	1	0	0	137	33	13	17	0	1	0	0	86	288	3.3%
UNIT G-10														
FORCED	187	1	1	2	247	31	4	16	0	0	7	1	497	5.7%
SCHEDULED	0	0	21	8	14	99	5	11	27	0	0	8	193	2.2%
COMBINED	187	1	22	10	261	130	9	27	27	0	7	9	690	7.9%

BEST AVAILABLE COPY

TABLE C-1 (CONT'D)

GUDDU 600 MW COMBINED CYCLE POWER PLANT
FORCED AND SCHEDULED OUTAGES (HOURS)

	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90	Feb-90	Mar-90	Apr-90	May-90	June-90	Total Hours	Percent of Available hours
TOTAL														
FORCED	228	191	10	31	709	87	31	28	66	19	40	124	1.564	3.0%
SCHEDULED	69	419	304	1.006	990	160	21	128	143	44	107	252	4.143	7.9%
COMBINED	297	610	314	1.037	1,699	247	52	156	209	63	147	376	5.707	10.9%
PERCENT OF AVAILABLE HOURS														
FORCED	5.1%	4.3%	0.2%	0.7%	16.4%	1.9%	0.7%	0.7%	1.5%	0.4%	0.9%	2.9%	3.0%	
SCHEDULED	1.5%	9.4%	18.6%	22.5%	22.9%	3.6%	0.5%	3.2%	3.2%	1.0%	2.4%	5.8%	7.9%	
COMBINED	6.7%	13.7%	18.8%	23.2%	39.3%	5.5%	1.2%	3.9%	4.7%	1.5%	3.3%	8.7%	10.9%	

BEST AVAILABLE COPY

PLANT POWER AUGMENTATION USING FILL AIR EVAPORATIVE COOLERS

ANALYSIS OF ECONOMIC INTERNAL RATE OF RETURN

APPENDIX D

ECONOMIC DISPATCH LOADING

BEST AVAILABLE COPY

APPENDIX D

ECONOMIC DISPATCH LOADING

Several statistical data sets prepared by WAPDA were analyzed to obtain plant performance data and economic dispatch loading. Generation statistics, sampled for 55 days during 1989 and 1990, provided daily load and plant factor percentages, outage data in hours per unit, daily generation, fuel data, temperature data and number of starts. Selected data are presented in Table D-1 on a monthly basis and were used to estimate a generation reduction factor resulting from load dispatch. This reduction factor was applied to the calculated power increases attributable to inlet air evaporative cooling.

WAPDA's economic dispatch loading recognizes three distinct time periods:

i) Mid-December through April, during which period the units are base loaded.

ii) May through July, during which period the units are base loaded during the daytime and loaded at about 50 percent between 10:00 pm and 5:00 am.

iii) August through mid-December, during which period hydro power is relatively plentiful and the Guddu units operate at an approximate 20 percent reduction in output relative to base load.

On the basis of the above the reduction in output per annum due to economic dispatch is about 15.5 percent. As would be anticipated from the loading pattern given above this is a low number. This is not unexpected since the Guddu Combined Cycle Units are the most efficient thermal units on the WAPDA system and there are generation shortfalls in Pakistan for significant periods during the year.

The 15.5 percent reduction in output due to economic dispatch has the effect of reducing the 12.1 MW average power increase in output discussed in Appendix C to 10.2 MW.

BEST AVAILABLE COPY

TABLE D-1

GUDDU 600 MW COMBINED CYCLE POWER PLANT HISTORICAL GENERATION PATTERNS

MONTH	OUTPUT MWh	KEY DISPTACH LOGIC USED	LOAD FACTOR %	REDUCTION IN MAX. LOAD FACTOR %
Jul-89	384,927	Base load, day 50% 10pm-5am	90.7%	9.3%
Aug-89	349,463	Hydro preferred	81.5%	18.5%
Sep-89	325,500	Hydro preferred	78.1%	21.9%
Oct-89	319,517	Hydro preferred	73.0%	27.0%
Nov-89	273,840	Hydro preferred	62.6%	37.4%
Dec-89	368,187	Mid-Dec, base load	79.4%	20.6%
Jan-90	429,257	Base load	92.8%	7.2%
Feb-90	389,844	Base load	93.3%	6.7%
Mar-90	431,799	Base load	95.5%	4.5%
Apr-90	401,520	Base load	95.7%	4.3%
May-90	405,294	Base load, day 50% 10pm-5am	95.9%	4.1%
Jun-90	310,050	Base load, day 50% 10pm-5am	75.9%	24.1%
Total	4,389,198	**Average**	84.5%	15.5%

BEST AVAILABLE COPY