ADVERSE CLIMATIC CONDITIONS AND IMPACT ON CONSTRUCTION SCHEDULING AND COST

BY
ROBERT J. SACHUK

N00228-85-G-3323

A REPORT PRESENTED TO THE GRADUATE COMMITTEE OF THE DEPARTMENT OF CIVIL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

Summer 1988

TABLE OF CONTENTS

LIST OF TABLES

Table	Page

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABS MAX MAX TEMP ......Absolute maximum maximum temperature

ABS MIN MIN TEMP ......Absolute minimum minimum temperature

AVG .... Average

BTU ....British thermal unit

CD .... Calendar day

CPM .... Critical path method

CU FT .... Cubic feet

D .... Duration

DCAA .... Defense Contract Audit Agency

EF .... Early finish

EIFS .... Exterior Insulation Finish System

ES .... Early start

°F .... Degrees Farenheit

LF .... Late finish

LS .... Late start

MEAN MAX TEMP .... Mean maximum temperature

MEAN MIN TEMP .... Mean minimum temperature

MWTC .... Mountain Warfare Training Center

NCDC .... National Climatic Data Center

RH .... Relative humidity

SAM .... Simple average method

TEMP .... Temperature

WD .... Work day

CHAPTER I

INTRODUCTION

The success of a construction project from the point of view of the contractor can be defined in different terms. However, of all possible definitions the most important may be the profit generated by a single project. In cases where the project management concept is used, the construction manager is tasked with the overall management of design, procurement, construction operations. In these types of projects, the construction manager also has the greatest amount of influence in controlling costs and generating profit. However, in the case of competitively advertised, fixed-price government construction contracts, the extent of contractor influence is normally limited to the procurement/construction portion of the project's life cycle. Therefore, the contractor's degree of success is highly dependent on two different operations that occur during procurement and construction phases of the project. The first operation, project planning, involves estimating the labor, materials, equipment, and preliminary schedule needed to execute a project as established by the owner's design. The second operation, the implementation phase, is for the most part dependent on the prior planning. In the case of a fixed-price contract, the project cost as presented in the base bid also becomes the control amount upon which the contractor's control budget is based. Therefore, what estimating and planning is done in the preparation of the base bid can be considered essential to the success of the construction project.

However, there is a certain amount of uncertainty in the bidding process. Material quotes may be based on materials that do not conform to the specifications. The material take-off may contain errors that result in quantities different than what is required. Equipment costs are based on what the estimator considers to be the most efficient piece of equipment for the job while not knowing what will be available at the time the equipment is needed.

Overall, the items noted above can be considered to be controllable and therefore not subject to creating substantial additive costs. In comparison, however, estimating labor productivity is the most complicated part of the estimating process. Many of the factors influencing labor productivity are highly qualitative in nature, and a great deal of experience and judgement is needed to develop the type of qualitative information that is required. However, the productivity component also offers the contractor by far the greatest opportunity to control his labor costs, assuming that the contractor also has some basic understanding of the factors that influence the variable in this equation.

Preliminary estimates of productivity are normally based on either average or historical productivity rates. However, average productivity rates normally do not consider climatic effects. Historical productivity rates consider climatic effects only if prior construction projects have been executed in similar conditions. Therefore, for the estimator that is basing productivity solely on average productivity or dissimilar historical rates, there is a high probability that adverse climatic conditions will result in unforeseen additive costs that only serve to deduct from the desired profit.

The ability to anticipate adverse climatic conditions also has legal implications. As noted above, a schedule that does not address or take into account climatic conditions will more than likely be subject to delay. However, precedence has been set that daily variations in weather patterns should be expected. Precedence goes on to state that climatic conditions are only to be considered adverse when a condition arises and that condition is considered to be occurring at an unusual time of the year. Therefore if the climatic condition is not unusual for the particular time and place, or if a contractor should have reasonably anticipated it, the contractor would not be entitled to relief [1].

Therefore, the question that arises is how does a contractor estimate productivity for a project subjected to adverse climatic conditions and how do these efficiencies impact on schedule and cost estimates. Additionally, what alternatives are available to the contractor in completing a project subject to adverse climatic conditions.

It is therefore the intent of this report to demonstrate one method of estimating productivity efficiencies and to demonstrate their impact on construction scheduling and cost. Additionally, it is intended to investigate alternatives available to the contractor.

In order to demonstrate the impact of adverse climatic conditions on project schedule and cost, an actual construction contract was selected as the basis for comparison. The project selected is a two story building of approximately 4800 square feet for fire station use including an apparatus room, a dormitory area, a living/dining area, alarm room, reception room, and administrative spaces. This facility is located at the Marine Corps Mountain Warfare Training Center (MWTC), Bridgeport, California. Construction was started in September 1984 and was completed in December 1985. Further information concerning the project and details concerning the construction execution are found in Appendix A (Page 37).

CHAPTER II

CALCULATION OF PRODUCTIVITY EFFICIENCIES FOR THE EXAMPLE PROJECT SITE

All types of productivity are influenced by air temperature, wind velocity, relative humidity, precipitation, and light. Therefore, it is universally accepted that operations in adverse climatic conditions suffer from a loss of productivity - the extent of which depends upon, in part, the type of activity and the degree of protection.

Adverse conditions, here limited to both warm and cold conditions, create varying degrees of problems. In general, the effect of adverse climatic conditions on construction projects plays a major part on the success of the project. Adverse conditions have been shown to require considerable planning due to the impact on [2]:

1) Arrival of personnel
2) Transportation of equipment
3) Delivery of materials
4) Construction of temporary shelters
5) Environmental protection

However, not only does severe conditions effect different facets of a construction project, but it also can have a severe impact on individuals. In extreme conditions, studies have indicated that workers would more likely be subject to the following factors [3,4]:

1) Errors in judgement
2) Carelessness
3) Complaints
4) General lethargy
5) Irritability and poor mental attitudes
6) Decrease in quality of workmanship
7) General slowdown of work pace
8) Unscheduled stoppage of work

In warm climates, injuries take the form of sunburn, cramps, heat exhaustion and heat stroke. These types of injuries can be prevented by utilizing preventive measures such as ensuring adequate salt and water intake, proper work/rest cycles and adequate acclimatization. These preventive measures, however, generally result in an overall slowdown and, therefore, reduced productivity.

In comparison, cold weather brings about a wider range and a more severe degree of injury. Wind chill guidelines indicate that in an equivalent temperature of -25°F (which can occur with an actual thermometer temperature of 10°F combined with a 20 mile per hour wind) exposed dry skin may freeze within one minute. It has also been shown that frostbite can occur in relatively warm temperatures (30°F) if the skin is wet and the wind speed is 15 miles per hour.

Prevention of cold weather injuries is complicated in a construction environment. Normally, proper clothing is required for exposed workers with the materials being lightweight and designed with a great degree of mobility. However, protective clothing creates the problem of maintaining a worker's skin dry. This results in a decrease in the body's pain threshold of approximately 5°F and the risk of frostbite is greatly increased.

In order to reduce the effect of cold weather, temporary shelters are often built [5]. However, these temporary shelters result in increased field overhead costs attributable to the cost of the shelter itself, the cost of heating the shelter, and the cost of maintaining the shelter.

Therefore, it can be inferred that a cold weather environment will have a greater impact on productivity, schedule, and costs. The problem, therefore is to estimate productivity rates, establish a construction schedule, and determine costs based on anticipated climatic conditions. In order to do this, the contractor must do the following:

1) Estimate efficiencies that are based on climatic conditions.
2) Establish a construction schedule based on average production rates.
3) Apply calculated efficiencies to the average construction schedule and calculate a new schedule based on climatic conditions.

4) Reevaluate field overhead requirements based on a new schedule (i.e., determine requirements for temporary shelters and heating equipment in cold weather)

The first step involves the contractor utilizing the basic methodology in creating a construction schedule. As seen in the third step, the efficiencies are then applied to the average productivity rates, thereby modifying the individual activity durations and the overall schedule. The difficulty, however, is utilizing a valid and repeatable method to calculate efficiencies in a cold weather climate.

As illustrated in Appendix D (Page 65), E. Koehn and G. Brown provide one method to calculate productivity efficiencies whereby they derived two non-linear relationships for both cold and warm weather climates [6]. For the purpose of this paper, these relationships will be utilized to determine the impact of adverse climatic conditions on project schedule and cost. The expected productivity efficiency values as determined by these authors follows as Table 2-1. These productivity values are also graphically illustrated in Figure 2-1. It should be noted that these values represent efficiencies for a broad range of temperatures and humidities. For the example project, productivity efficiency values were calculated for specific site conditions. These values are shown in Table 2-3.

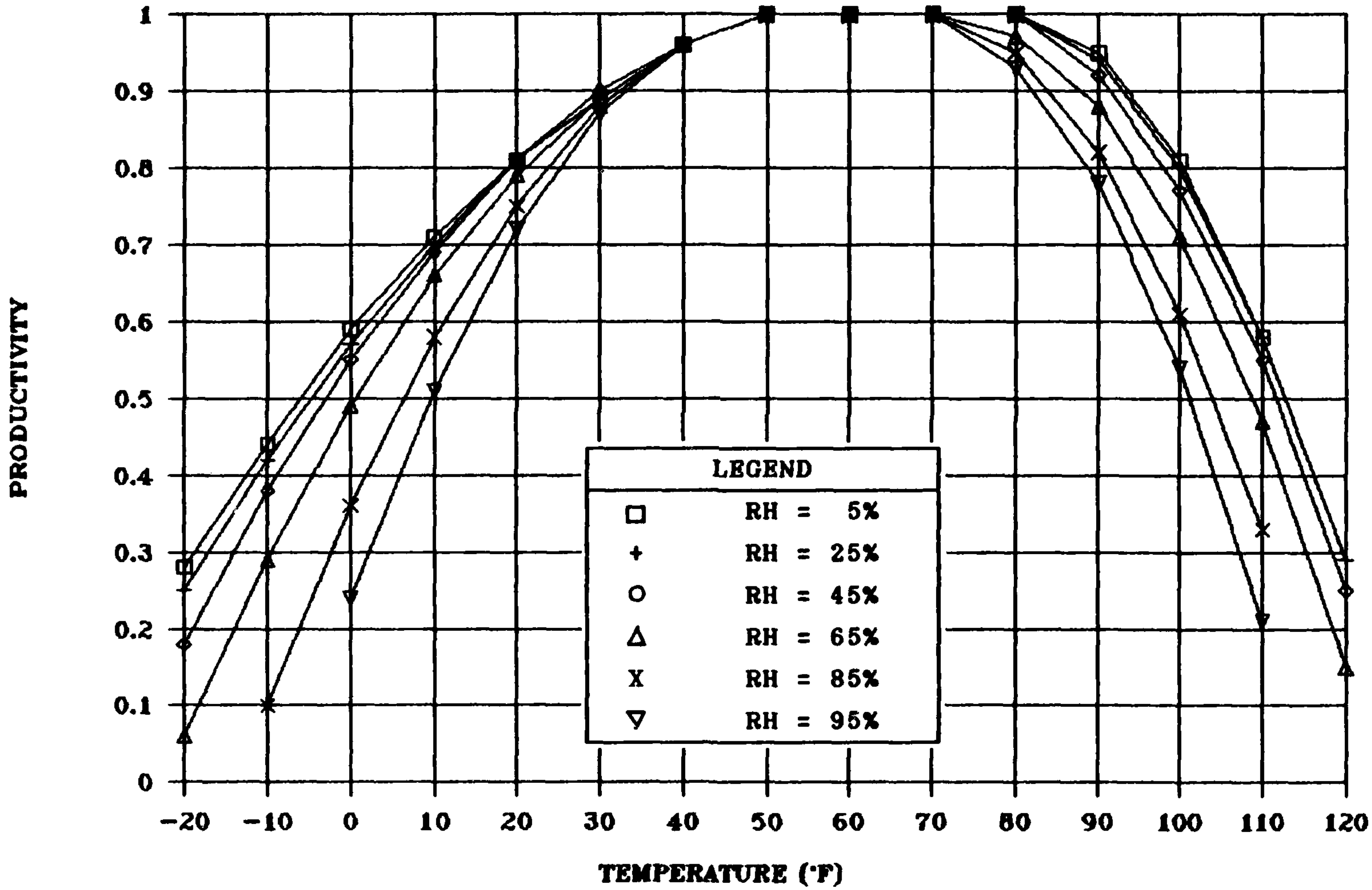
TABLE 2-1. CONSTRUCTION PRODUCTIVITY EFFICIENCIES AS A FUNCTION OF TEMPERATURE AND RELATIVE HUMIDITY

Temperature (°F)	Relative Humidity (%)					
	5	25	45	65	85	95
-20	0.28	0.25	0.18	0.06	—	—
-10	0.44	0.42	0.38	0.29	0.10	—
0	0.59	0.57	0.55	0.49	0.36	0.24
10	0.71	0.70	0.69	0.66	0.58	0.51
20	0.81	0.81	0.81	0.79	0.75	0.72
30	0.89	0.90	0.90	0.89	0.88	0.87
40	0.96	0.96	0.96	0.96	0.96	0.96
50	1.00	1.00	1.00	1.00	1.00	1.00
60	1.00	1.00	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	0.97	0.95	0.93
90	0.95	0.94	0.92	0.88	0.82	0.78
100	0.81	0.80	0.77	0.71	0.61	0.54
110	0.58	0.58	0.55	0.47	0.33	0.21
120	—	0.29	0.25	0.15	—	—

Source: Enno Koehn and Gerald Brown, "Climatic Effects on Construction," Journal of Construction Engineering and Management, ASCE, Vol. 111, No. 2, June 1985, 129-137.

FIGURE 2-1. CONSTRUCTION PRODUCTIVITY

AS A FUNCTION OF TEMP AND RH



As noted above, the first step is to estimate efficiencies based on historical weather data. In doing so, one must decide what data will be used and how to use it. Generally, average temperature and humidity data is easily obtainable from various sources. However, as in the case of weather data obtained from the National Oceanic and Atmospheric Administration, National Climatic Data Center (NCDC) for the example project, weather data may not be representative of the project location. For the purpose of data collection, the NCDC utilizes only specific population centers, usually supported by an airport. In the case of the example project and as indicated in Appendix A (Page 37), major population areas were twenty-five miles to the south (Bridgeport, California) and seventy miles to the north (South Lake Tahoe, California) of the site. Therefore, it may be necessary to calculate the average monthly temperature and relative humidity prior to calculating efficiencies.

For the purpose of this report, it is assumed that available average temperature and humidity data is not available for the example project site. Therefore, procedures used to calculate the required data are presented. For the purpose of these calculations, available temperature data was taken from Bridgeport, California as weather systems affect both the example project site and the town simultaneously. Humidity data was taken from South Lake

Tahoe records. Elevations of both data sources are within 1000 feet of the example project site.

In order to firmly establish seasonal trends, temperature and humidity data for a twenty year period was obtained. This provided five hundred sixty (560) to six hundred twenty (620) daily mean temperature data points for any given month from which a statistical analysis could be made.

Prior to utilizing the productivity relationships established by Koehn and Brown, a determination had to be made as to what was to be considered a proper average or typical temperature. Ultimately, it was the goal of this analysis to establish an average monthly temperature for each respective month from which productivity estimates could be made. However, with daily minimum, mean, and maximum temperatures available, a determination had to be made as to whether forecasts were based on absolute, mean, or statistically derived temperatures.

Invariably, the data can first be considered a seasonal variation in that there is a more or less regular movement within the year which occurs year after year. Therefore, in a time series with seasonal variation each month has a typical or average value position in relation to the year as a whole. The problem of seasonal variation therefore is to determine this typical or average position of each month.

Of the various methods used for measuring the seasonal variation occurring within a time series, the Simple Average Method (SAM) was selected to analyze the available temperature data [7]. Typically, SAM analyzes monthly values to establish a typical value for each of the twelve months. However, with approximately 22,000 minimum and maximum daily temperatures, the method was modified to first establish a typical value for each day of the month. The typical daily values were then used to establish a typical value for each of the twelve months. The resulting monthly values are shown in Table 2-2 below. A detailed description of the procedures used involving SAM and the analysis of the available temperature data is provided as Appendix E (Page 67).

TABLE 2-2. CALCULATED AVERAGE MONTHLY TEMPERATURES FOR MWTC BRIDGEPORT USING THE SIMPLE AVERAGE METHOD

MONTH	AVERAGE MONTHLY TEMPERATURE (°F)
JANUARY	24.95 ± 2.59
FEBRUARY	27.94 ± 1.47
MARCH	33.28 ± 1.41
APRIL	38.47 ± 1.29
MAY	47.40 ± 0.91
JUNE	55.18 ± 0.71
JULY	60.99 ± 0.67
AUGUST	59.57 ± 0.66
SEPTEMBER	52.90 ± 0.98
OCTOBER	43.43 ± 1.18
NOVEMBER	34.85 ± 1.43
DECEMBER	27.20 ± 1.30

With average monthly temperature data calculated, average productivity efficiencies for each month could be calculated using the Koehn/Brown relationships. Results of these calculations are shown in Table 2-3 below.

TABLE 2-3. CALCULATED PRODUCTIVITY EFFICIENCIES FOR MWTC BRIDGEPORT USING KOEHN/BROWN RELATIONSHIPS

MONTH	AVG MEAN TEMPERATURE (°F)	RELATIVE HUMIDITY (%)	CALCULATED PRODUCTIVITY EFFICIENCY
JANUARY	25	74	0.84
FEBRUARY	28	76	0.87
MARCH	33	64	0.92
APRIL	38	59	0.95
MAY	47	57	0.99
JUNE	55	51	1.00
JULY	61	41	1.00
AUGUST	59	37	1.00
SEPTEMBER	52	43	1.00
OCTOBER	43	55	0.98
NOVEMBER	34	59	0.93
DECEMBER	26	67	0.85

CHAPTER III

ESTIMATING PROJECT SCHEDULE AND COST BASED ON CLIMATIC CONDITIONS

In order to evaluate the impact of climatic conditions on a construction project's schedule and cost, it was decided to establish five scenarios in which both schedule and cost could be traced. Prior to developing these scenarios, it was necessary to duplicate the contractor's CPM schedule in a form that could be easily cost loaded and modified. In order to accomplish this, the CPM network was duplicated on a Lotus 1-2-3 spreadsheet. Use of Lotus 1-2-3 in the construction of this CPM network and a listing of all cell formula is included as Appendix B (Page 44).

Two separate formats were used to provide for scheduling and cost loading. The first format, as seen in Appendix C (Page 53), Tables C-1 through C-5, utilizes a precedence network format to calculate early start, late start, early finish, late finish, float, and determine whether the activity is on the critical path. The second format, not shown in this report, utilized early start-early finish information to construct a Gantt chart upon which daily cost information for each activity was loaded. This cost loading information was then used to construct cost forecasts.

Scenario A was based on the actual CPM schedule used by the contractor. For this scenario, a total of 466 calendar days was used to accomplish the project. From the contractor's schedule of prices, the cost of the project to the government was $663,810. Of the total project cost, total direct labor and material costs equalled $520,406, including $2,125 for maintenance during winter shutdown. Field overhead costs equalled $117,384 or $253.53 per calendar day. These field overhead costs included superintendent and quality control personnel wages, job trailer costs, utilities, laboratory services, etc. The remaining amount, $26,020 is attributed to a profit of approximately 5%. The productivity efficiencies in this actual case are assumed to be at 100% and therefore not affected by climatic conditions.

Scenario B (Table C-2, Page 57), is based on the ideal case of the actual CPM without any time taken for winter shutdown. Without this time period, total project time is reduced to 289 calendar days. In comparison, total direct costs were calculated at $518,281 and total field overhead at $73,017. Based on the actual cost to the government (the base bid), this would have left a total of $72,512 or 12.26% attributable to profit. It should be noted however that it is considered unreasonable to assume that construction execution will reach ideal conditions. Therefore, Scenario B shall only be used as the basic schedule from which Scenarios C,D, & E are constructed. Scenario B, therefore, shall not be considered in any further comparative analyses.

As it is being hypothesized that temperatures affect the productivity and therefore scheduling and cost, the ideal case was then used as the basis for calculating the contract duration after applying the calculated productivity efficiencies. In order to allow for a comparison between different climate scenarios, it was decided to first use the mean temperature data to modify the project schedule. It was then decided to create worst and best case scenarios by arbitrarily subtracting from and adding to the monthly mean temperatures.

Scenario C, the precedence network based on mean climatic conditions, was created by using the calculated productivity efficiencies indicated in Table 2-3 (Page 14) to modify the ideal case in Scenario B.

For Scenario D, the average monthly temperature minus ten degrees was used. For Scenario E, the average monthly temperature plus ten degrees was used. In both scenarios, the resulting efficiencies were then factored into the resulting CPM schedule.

Table 3-1 (Page 20) shows the monthly temperatures and efficiencies used for Scenarios C, D, and E.

Once productivity efficiencies were established for the MWTC construction site, they were then factored into the cost loaded Gantt chart. Simply, the procedure utilized was to take the monthly efficiency corresponding with the starting date of the activity and dividing the activity duration by the efficiency. This would result in a modified, usually longer, activity duration. For those activities that extended over multiple months, the efficiency used corresponded with the longest partial duration. Going through each activity of the network resulted in a listing of modified activity durations. This was then used to calculate total direct cost per activity day. These direct costs were then inserted into the cost loaded Gantt chart. The cost loaded Gantt chart was then set up to calculate total direct costs per day and cumulative direct cost per day.

The modified activity durations were then inserted into the precedence network spreadsheet to determine float and critical activities. This also served the purpose of verifying the early starts and finishes of each activity and the overall project duration.

As seen in Table C-3 (Page 59), Scenario C, based on mean climatic conditions, resulted in a total project duration of 306 calendar days. Total direct costs again were calculated at $518,281. Field overhead was calculated at $77,327. Based on the actual cost to the government ($663,810), a total of $68,202 is left for potential profit.

As seen in Table C-4 (Page 61), Scenario D, based on temperatures ten degrees below the calculated monthly mean temperatures, resulted in a total project duration of 327 calendar days. Total direct costs were verified at $518,281. Field overhead costs were calculated at $82,651. Based on the actual cost to the government, a total of $62,878 is left for potential profit.

As seen in Table C-5 (Page 63), Scenario E, based on temperatures ten degrees above the calculated monthly mean temperatures, resulted in a total project duration of 296 calendar days. Total direct costs were verified at $518,281. Field overhead costs were calculated at $74,284. Based on the actual cost to the government, a total of $71,245 is left for potential profit.

The costs noted above for Scenarios C through E, however, are misleading. In the actual execution of the example project, the contractor shut down the job from the beginning of October through to the beginning of April. A review of the activities surrounding this shutdown also indicates that the work done immediately before and after the shutdown did not require any extraordinary measures to protect work or construction personnel. In the actual schedule, the first activity that occurred that would require monitoring of weather conditions (concrete placement) didn't occur until June. In addition, the exterior finishes that were also temperature dependent (the exterior insulation finish system (EIFS) and the roof membrane) were completed prior to the onset of winter. Therefore, all

TABLE 3-1. MONTHLY TEMPERATURES AND CALCULATED EFFICIENCIES FOR SCENARIOS C, D, & E

Month	Temperature (Efficiency)		
	Scenario C (Mean Temp)	Scenario D (Mean Temp - 10 °F)	Scenario E (Mean Temp + 10 °F)
January	25 (0.84)	15 (0.71)	35 (0.93)
February	28 (0.87)	18 (0.75)	38 (0.95)
March	33 (0.92)	23 (0.83)	43 (0.98)
April	38 (0.95)	28 (0.88)	48 (0.99)
May	47 (0.99)	37 (0.95)	57 (1.00)
June	55 (1.00)	45 (0.98)	65 (1.00)
July	61 (1.00)	51 (1.00)	71 (1.00)
August	59 (1.00)	49 (1.00)	69 (1.00)
September	52 (1.00)	42 (0.97)	62 (1.00)
October	43 (0.98)	33 (0.92)	53 (1.00)
November	34 (0.93)	24 (0.84)	44 (0.98)
December	26 (0.85)	16 (0.74)	36 (0.94)

work that was temperature dependent was done at a time where little or no protection was required.

Scenarios C, D, & E, however, force temperature dependent activities into the winter thereby requiring some level of protection. The cost of this protection, then, will offset the potential profit.

For the purpose of this report, arbitrary decisions are made concerning weather protection. A review of contract specifications indicates the following areas as temperature dependent:

1) Section 03301, Cast-in-place Concrete
2) Section 04230, Reinforced Masonry
3) Section 07111, Elastomeric Waterproofing, Sheet Applied
4) Section 07240, Exterior Insulation Finish System
5) Section 07920, Sealants and Caulking
6) Section 09310, Ceramic Tile
7) Section 09650, Resilient Tile
8) Section 09910, Painting of Buildings

Scenarios C, D, and E were then evaluated to establish weather protection requirements.

It was first assumed that the target period for weather protection would be from the beginning of October through to the beginning of April, matching the winter shutdown period in the actual contract. From within that period, each scenario was reviewed to identify where in the schedule the first temperature dependent activity occurred.

Then, each scenario was reviewed to establish the end of the last temperature dependent activity within the protection period. This period was then noted as the duration in which some sort of weather protection and supplemental heating would be required.

After initial review of the three scenarios, it was decided that it would be assumed that one enclosure could be constructed to protect the construction area. It was therefore assumed that the enclosure would allow for ten feet of clear space around the building and for a fifteen foot clearance above the structures highest elevation. This then required an enclosure of 77 feet wide by 87 feet long by 52 feet high for a total of 348,348 cubic feet of enclosed and heated space. For the purpose of this report, it was assumed that the enclosure would be constructed of heavy duty steel tubular scaffolding along the perimeter covered with a reinforced, oil resistant, fire retardant, polyethylene tarpaulin. It was also assumed that both the scaffolding and the tarpaulin were rented. Due to the nature of the enclosure, it was also assumed that fourteen calendar days would be required to both set up and remove the enclosure. From current pricing data, it was estimated that both set up and removal would cost a total of $5,000 each time and that rental would cost $6,020 per month.

Taking set up, protection and removal periods into consideration, Table 3-2 (Page 23) indicates the time periods for weather protection for the three scenarios. Calcu

TABLE 3-2. CRITICAL DATES FOR TEMPORARY SHELTERS FOR SCENARIOS C, D, & E

Activity Description	Scenario		
	C	D	E
Start construction of shelter	14 NOV 84	20 NOV 84	30 NOV 84
Complete construction of shelter, start heating	28 NOV 84	4 DEC 84	14 DEC 84
Complete heating, start demolition of shelter	15 MAR 85	3 APR 85	2 APR 85
Complete demolition of shelter	29 MAR 85	17 APR 85	15 APR 85

lations for estimated fuel costs and heater rental also are to be included in the estimates for winter protection. These costs are summarized below. Assumptions and calculations concerning these costs are found in Appendix F (Page 108).

Based on these heating scenarios, potential profit for Scenario C is affected as follows:

Set up of shelter:	$5,000
Shelter rental:	$21,177
Shelter removal:	$5,000
Heater rental:	$5,113
Heater fuel:	$12,060
Total Cost for Protection:	$48,350
Potential Profit:	$68,202
Anticipated Profit after subtracting protection costs	$19,852

Based on these heating scenarios, potential profit for Scenario D is affected as follows:

Set up of shelter:	$5,000
Shelter rental:	$23,750
Shelter removal:	$5,000
Heater rental:	$5,728
Heater fuel:	$14,236
Total Cost for Protection:	$53,714
Potential Profit:	$62,878
Anticipated Profit after subtracting protection costs	$9,164

Based on these heating scenarios, potential profit for Scenario E is affected as follows:

Set up of shelter:	$5,000
Shelter rental:	$21,573
Shelter removal:	$5,000
Heater rental:	$5,160
Heater fuel:	$11,449

Total Cost for Protection:	$48,182
Potential Profit:	$71,245
Anticipated Profit after subtracting protection costs	$23,063

The impact of the winter protection costs on the overall cumulative costs is graphically shown on the cost forecasts in Figure 3-1.

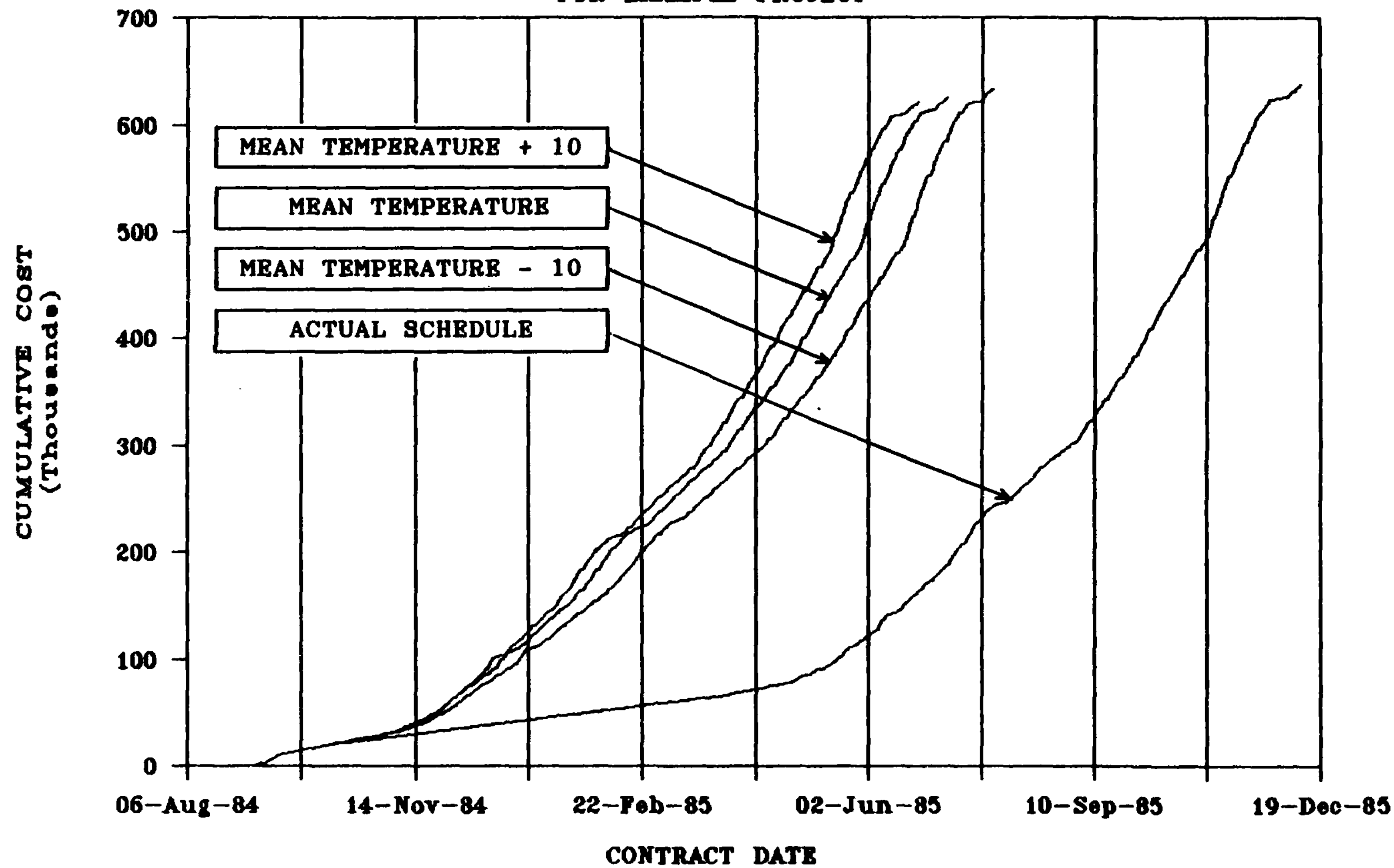
The following is a summary of all factors used to compare Scenario A, the actual project, to Scenarios C, D, and E.

In terms of critical activities, Table C-1 (Page 55) identifies a total of twenty five activities deemed critical. Review of Scenarios C, D, and E and the application of the productivity efficiencies to the 69 activities indicate that the activities originally deemed critical remain critical after the application of the efficiencies. This then serves to validate the method in which the efficiencies were factored.

In addition, the application of productivity efficiencies had little impact on the available float. Overall, the efficiencies applied had little effect on the duration of the individual activities. Scenario C, with a mean efficiency of 0.94, only resulted in a seventeen (17) calendar day increase in the overall schedule. This would leave little time available to add to the float of all the non-critical activities. Even in the worst case, Scenario D where temperatures ten degrees below the mean were consid

FIGURE 3-1. COMPARATIVE COST FORECAST

FOR EXAMPLE PROJECT



ered, the mean efficiency stands at 0.88. This results in increases in float above 30% in only three of the 44 non-critical activities. All remaining non-critical activities gain one or two days in float.

In the case of overall project duration, there is a definite advantage to working during periods of adverse climatic conditions. Scenarios A, C, D, and E have overall project durations of 466, 306, 327, and 296 calendar days, respectively. The first advantage is that the contractor can reduce direct costs by eliminating a caretaker force during the winter shutdown period. Though, for the example project, this equates to only less than one percent of the direct costs, this could increase substantially for other projects depending on the severity of the weather and on the amount of the work in place that must be maintained.

The primary advantage to a shorter project duration is the reduction in field overhead costs. As indicated previously, the example project was estimated to incur field overhead costs of $117,384. Field overhead costs for Scenarios C, D, and E, in comparison ranged from $74,284 to $82,651. This alone represents a 29-36 percent decrease in costs. For a fixed-price construction project, this savings becomes potential profit.

However, as indicated previously, working through adverse climatic conditions does come without additive costs. In Scenario A, the actual construction project, the contractor's period of winter shutdown resulted in minimal costs ($2,125) due to caretaker maintenance. In Scenarios C, D, and E, the cost for a temporary shelter and supplemental heating would have cost the contractor an average of $50,082. This cost would then have an impact on the potential profit.

In terms of the potential profit, Scenario A estimates a profit of $26,020, or 5.0% of the direct costs. In comparison, Scenario C estimates an anticipated profit of $19,852 after deducting the cost of weather protection. This anticipated profit represents only 3.8% of the direct costs, a decrease from the actual 5%. Scenario D estimates an anticipated profit of $9,164, only 1.7% of the estimated direct costs. Lastly, Scenario E estimates an anticipated profit of $23,063, or 4.4% of the estimated direct costs. It should be noted, however, that for the purposes of estimating project costs, only those values generated by Scenario C would be considered. A review of the estimated temperatures for the three scenarios indicates that the temperatures used in Scenarios D and E are well outside of the range of values generated for Scenario C. A cursory review of this data would indicate that there is little probability that the daily mean temperatures would continuously be outside of the range of the calculated mean value. If mean temperature values were to continuously remain outside of the expected range, the contractor would then have reason to claim unusual adverse conditions thereby setting the stage for damages.

In order to test the validity of the procedures, a sensitivity analysis was conducted by, first, varying the expected mean temperature during the winter protection period and evaluating the resulting anticipated profit, and secondly, by varying the length of the winter protection period and evaluating the resulting profit. In both cases, Scenario C, the mean temperature case was used.

In the case of varying the expected mean temperature during the winter protection period, it was anticipated an increase in the mean temperature would reduce the requirement for heating and therefore reduce winter protection costs and increase profit. Temperatures for the months November through March were increased incrementally using the average standard error for the months in question. The resulting winter protection costs, profit, and mean temperature for the winter protection period were then calculated. Results are shown below in Table 3-3.

TABLE 3-3. EXPECTED WINTER PROTECTION COSTS AND PROFIT AS A FUNCTION OF MEAN DAILY TEMPERATURE.

AMOUNT OF INCREASE (°F)	EXPECTED PROTECTION COSTS	EXPECTED PROFIT	RESULTANT MEAN TEMPERATURE (°F)
0.00	$48,344	$19,858	29
1.64	$48,227	$19,974	31
3.28	$48,111	$20,091	33
4.92	$47,994	$20,207	34
6.56	$47,878	$20,324	36
9.84	$47,644	$20,557	39
10.50	$47,598	$20,604	40

The significance of Table 3-3 above is that as hypothesized, an increase in the average mean temperature during the winter protection period will decrease the winter protection costs and therefore increase the profit. However, of particular note is that once the average mean temperature is above 40°F, there is no longer a requirement for winter protection. Therefore, winter protection costs would equal zero. However, once the mean temperature for the winter protection period goes below 40°F, the contractor can plan on spending a minimum of $47,598. This cost would include set up, rental of both shelter and heaters, dismantling the shelter and minimal fuel costs. At no time is this analysis, does the expected profit match or exceed that of the actual case. Of major significance is that a major increase in average mean temperature will produce little in the way of savings.

Of equal significance is the probability of the average mean temperature increase to a degree in which winter protection costs can be disregarded. It should be pointed out that an increase in mean daily temperatures for the entire winter protection period are unrealistic just by the nature of the available temperature data.

Sensitivity analysis was also conducted on the length of the winter protection period. In doing this analysis, it is anticipated that a decrease in the length of the winter protection period will also decrease the overall winter protection costs and increase expected profit. In

Scenario C, heating and a temporary shelter was provided from 28 November to 15 March, a total of 107 calendar days. Two additional data points were then calculated for winter protection periods ending 28 February and 31 March. Results of this analysis are found below in Table 3-4.

TABLE 3-4. EXPECTED WINTER PROTECTION COSTS AND PROFIT AS A FUNCTION OF DURATION OF WINTER PROTECTION

LENGTH OF WINTER PROTECTION (CD)	EXPECTED PROTECTION COSTS	EXPECTED PROFIT
93	$43,381	$24,821
107	$48,350	$19,852
124	$54,383	$13,819

As hypothesized, the shorter the winter protection period, the lower the winter protection costs. Of significance is that the decrease in the winter protection duration brings about a greater degree in reduced costs than increased mean daily temperatures. However, as indicated in the previous sensitivity analysis, one reason for decreasing the winter protection period may be the arrival of warmer weather. This would mean that the mean daily temperatures would require to be above 40°F for a period of over 30 days before anticipated increase in order to match the anticipated profit identified in Scenario A. Basing increased savings solely on anticipated temperatures decreasing the length of the winter protection period may be totally unreasonable and expose the contractor to undue risks.

Alternatively, the contractor may consider decreasing the winter protection period by compressing the activities that fall in that protection period. Two things must then be considered. The first is that if the contractor compresses the activities planned to occur during the winter protection period, will the activities filling the available float also require protection. Overall, this may result in completion of the entire schedule in a shorter time period but not reduce the required shelter time. What would be expected, however, is that the decrease in the overall schedule would result in a decrease in overhead expenses that occur over the entire project duration. The second consideration must be given to whether compression of the schedule will result in additive direct labor and material costs. These compression costs would then only serve to decrease anticipated profit.

CHAPTER IV

CONCLUSION

As can be seen in the previous discussions, there are distinct advantages in working during anticipated adverse conditions. However, there are numerous distinct disadvantages that have not been discussed.

In estimating productivity during periods of adverse climatic conditions, one can only predict the outcome based on occurrences to date. In the previous discussions, it is assumed that a contractor would be able to work continuously through periods of adverse climatic conditions based solely on temperature predictions. Realistically, however, one can expect that the contractor will experience occurrences of work stoppages and delays in delivery of materials during this same time due to not only unusual temperatures but also due to oncoming weather systems (i.e., snow, ice, high winds).

For the example project site, the primary difference between the actual project schedule (Scenario A) and the schedule based on mean temperature data (Scenario C) represents an decrease in profit of $6,168, or a difference of 1.19% of the actual direct costs. However, even this decrease indicates that it probably will be economically non-advantageous to conduct construction operations twelve months of the year for this specific project at this specific site.

Other factors must be considered in working during adverse conditions which would also reduce a contractor's anticipated profit. For example, in the case of winter accident costs, it has been clearly shown that the frequency as well as the severity of accidents is substantially higher in the winter, and therefore the additional cost of winter accidents must be considered in the overall cost considerations [8]. Additionally, one must concern themselves with the loss of personnel during periods of adverse weather conditions. On one hand, if the contractor continues work through periods of adverse weather, he or she must also anticipate loss of experienced personnel as a result of accidents or the employees desire to work under better conditions. On the other hand, if the contractor shuts down during long periods of adverse weather, he or she can also anticipate loss of personnel prior to start-up due to the desire to remain employed during that period.

The construction project is essentially an investment for the contractor from which a certain amount of return or profit is generated. Therefore, as a prudent investor, a contractor would tend to limit bids to low risk projects. In the case of adverse weather conditions, the probability for unforeseen conditions is high. Unless the contractor anticipates these unforeseen conditions and plans and documents accordingly, there is little chance for the contractor to recover from damages [9].

In the case of the example project, only proper planning and documentation during the construction project would result in a successful execution of the project. This prior planning would require estimations of weather conditions similar to what has been done in this report. Then the contractor would be required to document the actual occurrences and note the differences. Without this information, the contractor would have no basis to recover damages.

Without proper planning and documentation, the contractor is only subjecting himself to high risks if pursuing work during periods of adverse weather conditions. If this were determined to be the case with the actual execution of the example project, it is only logical that the contractor would choose to utilize a winter shutdown period.

In conclusion, this report presents one procedure for estimating productivity based on temperature and humidity and traces the impact that these conditions have on scheduling and cost. In addition, this report provides some of the analysis required in making a decision as to whether or not a contractor should work during periods of adverse climatic conditions. While these analyses may be preliminary in nature, it is suggested that they may be sufficient enough to evaluate risks when initially bidding on projects. With this in mind, if the alternative of working through adverse weather conditions is selected, further refinement of these estimates, together with constant monitoring and adjustment, will be necessary to ensure successful execution of the project and attainment of one's profit objectives.

APPENDIX A

DESCRIPTION OF THE EXAMPLE PROJECT

The Marine Corps Mountain Warfare Training Center (MWTC), Pickel Meadows, is located on a portion of the Toiyabe National Forest in a region defined by the Sierra Nevada Mountains to the west, the Sweetwater Mountains to the northeast, Mono Lake to the southeast, and Lake Tahoe to the north. It is in northwestern Mono County, California, approximately 20 miles northwest of Bridgeport, the county seat, and 17 miles southwest of Walker. Both towns are located on the major north-south access through the region, Interstate 395. Between Walker and Bridgeport, California, Highway 108 intersects with Interstate 395, and the Center is four miles west along the east-west route to the Sonora Pass, one of the few passes through the mountains.

The climate of the region varies considerably with elevation, which ranges from 4,400 feet to 12,512 feet above sea level. The yearly average temperature in the Bridgeport area is 25°F minimum and 61°F maximum, with the lowest temperature recorded approximately -31°F in January and the highest temperature recorded approximately 96°F in August. The Pickel Meadows base camp represents subalpine conditions with an average annual precipitation of 20 to 40 inches occurring from midwinter through late spring. Snow can remain on the ground from December until May.

The 45,635 acres of land that compromise the Center are rugged and and contain steep slopes ranging between 15 to 50 percent. The topography generally slopes from west to east with the highest peaks forming the western boundary of the training area and the lowest elevations along State Highway 108 and the West Walker River. The base camp has a total of 420 acres and has an elevation of 6,760 feet overlooking the West Walker River floodplain.

The Fire Station project was one of a nine-project, $20 million military construction program started in 1983. This program replaced all "temporary" structures constructed in 1952. Construction of the fire station commenced in September 1984 and was completed in December 1985 [10].

The project itself was to construct a two story building of approximately 4,800 square feet for fire station type use. The facility included an apparatus room, a dormitory, a living/dining area, an alarm/reception area, and administrative areas. Foundations were constructed using spread footings and columns with concrete block foundation walls. Interior and exterior walls were mostly concrete block with gypsum board on metal studs being used in limited areas. Interior supports were steel beams and purlins. The lower level floor consisted of a 6 inch concrete slab reinforced with wire mesh on a 4 inch base. The upper level floor consisted of a 3-1/4 inch concrete slab reinforced with wire mesh on a 3 inch steel deck. Roofing consisted of a standing seam metal roof on a structural steel deck. Doors consisted of hollow metal and wood in hollow metal frames. Windows consisted of steel frames with tinted insulated glass. Interior finishes consisted of a combination of exposed concrete floors, painted walls, exposed ceilings, vinyl asbestos tile floor coverings, and acoustical tile ceilings. The mechanical system consisted of a forced area heating system and the building was fully fire sprinkled.

As seen in Table A-1 (Page 40), List of Activities, the contractor utilized a total of 69 activities. Table A-2 (Page 41), Example Project CPM Network Based on Contractor's Actual Schedule (Listed by Activity Number, Ascending Order), indicates that the actual contract was performed over a period of 463 calendar days. Of particular note in this network is Activity 4, Winter Shutdown, where the contractor terminated all construction operations (other than caretaker maintenance) for a period of 177 calendar days. Of additional note are the temperatures that could have been expected. As indicated in Appendix E (Page 67), mean minimum monthly temperatures for this period ranged from 8-21 °F. Mean maximum monthly temperatures ranged from 42-66 °F. Mean mean monthly temperatures ranged from 25-43 °F.

TABLE A-1. LIST OF ACTIVITIES FOR EXAMPLE PROJECT

ACT NO	ACTIVITY DESCRIPTION	DURATION (WD)	PRECEDING ACTIVITIES	ACT NO	ACTIVITY DESCRIPTION	DURATION (WD)	PRECEDING ACTIVITIES
1	SURVEY	5	-	37	ROUGH-IN ELEC	40	31
2	DEMOLITION	5	1	38	ROUGH-IN MECH	40	31
3	EXCAVATE & FILL	18	2	39	FOUNDATION DRAINS	20	31
4	WINTER SHUTDOWN	177	3	40	BCKFL MASONRY WALL	30	31
5	STRT UNDERSLAB ELEC	15	4	41	MASONRY INSULATION	20	31
6	STRT UNDERSLAB PLMB	15	4	42	STRT METL STUD FRAMI	8	32,33
7	STRT FOOTING EXCAV	10	5	43	INST ROOF SHEATH	15	32,33
8	FNSH UNDERSLAB ELEC	18	6,7	44	INST EIFS HARDCOAT	22	34
9	FNSH UNDERSLAB PLMB	18	6,7	45	INST EXT WNDW FRAMES	20	34
10	STRT FOOTING FORMS	8	7	46	FNSH EIFS	12	34
11	FNSH FOOTING EXCAV	12	7	47	INST EXT WNDW GLAZIN	12	44,45,46
12	STRT FOOTING REBAR	8	10	48	INST ROOF MEMBRANE	10	43
13	FNSH FOOTING FORMS	12	10	49	INST METAL ROOFING	16	48
14	POUR FOOTINGS	12	8,9,11,12	50	STRT GYPSUM BOARD	8	42
15	FNSH FOOTING REBAR	8	8,9,11,12	51	INST BATT INSUL	30	42
16	STRT FOOTING MASONRY	12	13,14,15	52	FNSH MTL STUD FRAMIN	20	42
17	SLAB PREPARATION	5	13,14,15	53	INST OVRHD DOORS	20	42
18	ERCT W10x45 COLUMNS	12	13,14,15	54	STRT PAINTING	12	50
19	POUR SLAB-ON-GRADE	3	17	55	FNSH GYPSUM BOARD	15	50
20	STRT 1ST FL MASONRY	18	16	56	STRT SUS CEILING	8	35,36,37,38,48,54
21	ERCT W8x31 COLUMNS	8	16	57	INST CHAIN HOIST	18	35,36,37,38,48,54
22	INST METL DR FRAMES	30	16	58	FNSH PAINTING	23	35,36,37,38,48,54
23	ERCT 2ND FL BEAMS	12	18,19,20	59	PNT FIRE SYS PIPING	18	35,36,37,38,48,54
24	REINFRC MASONRY SO W	20	18,19,20	60	FNSH ELEC	23	52,55,56
25	INST STL STR SUPPORT	5	18,19,20	61	INST VINYL TILE	18	52,55,56
26	INST 2ND FL DECKING	12	21,23	62	FNSH MECH	20	52,55,56
27	ERCT STL STAIRS	12	25	63	FNSH PLMB	20	52,55,56
28	POUR 2ND FL CONCRETE	2	26,27	64	INST CERAMIC TILE	18	52,55,56
29	STRT 2ND FL MASONRY	12	28	65	HANG DOORS	18	52,55,56
30	CIP CONC LENTELS	12	28	66	FNSH SUS CEILING	20	52,55,56
31	ERCT STL ROOF BEAMS	12	22,24,29,30	67	INST KITCHEN EQUIP	20	52,55,56
32	ROOF BLOCKOUTS	18	22,24,29,30	68	TEST & BALANCE	5	39,40,41,47,49,51
33	INST ROOF DECKING	15	31				52,53,57,58,59,60
34	STRT EIFS INSULATION	20	31				61,62,63,64,65,66
35	ROUGH-IN FIRE MAINS	40	31				67
36	ROUGH-IN PLMB	40	31	69	FINAL INSP & ACCPTNC	5	68

TABLE A-2. EXAMPLE PROJECT CPM NETWORK BASED ON CONTRACTOR'S ACTUAL SCHEDULE

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
1	SURVEY	6	-	04-Sep-84	04-Sep-84	10-Sep-84	10-Sep-84		-- C --
2	DEMOLITION	5	1	10-Sep-84	10-Sep-84	15-Sep-84	15-Sep-84		-- C --
3	EXCAVATE & FILL	21	2	15-Sep-84	15-Sep-84	06-Oct-84	06-Oct-84		-- C --
4	WINTER SHUTDOWN	177	3	06-Oct-84	06-Oct-84	01-Apr-85	01-Apr-85		-- C --
5	STRT UNDERSLAB ELEC	16	4	01-Apr-85	01-Apr-85	17-Apr-85	17-Apr-85		-- C --
6	STRT UNDERSLAB PLMB	16	4	01-Apr-85	13-Apr-85	17-Apr-85	29-Apr-85	12	
7	STRT FOOTING EXCAV	12	5	17-Apr-85	17-Apr-85	29-Apr-85	29-Apr-85		-- C --
8	FNSH UNDERSLAB ELEC	21	6,7	29-Apr-85	29-Apr-85	20-May-85	20-May-85		-- C --
9	FNSH UNDERSLAB PLMB	21	6,7	29-Apr-85	29-Apr-85	20-May-85	20-May-85		-- C --
10	STRT FOOTING FORMS	9	7	29-Apr-85	02-May-85	08-May-85	11-May-85	3	
11	FNSH FOOTING EXCAV	14	7	29-Apr-85	06-May-85	13-May-85	20-May-85	7	
12	STRT FOOTING REBAR	9	10	08-May-85	11-May-85	17-May-85	20-May-85	3	
13	FNSH FOOTING FORMS	14	10	08-May-85	20-May-85	22-May-85	03-Jun-85	12	
14	POUR FOOTINGS	14	8,9,11,12	20-May-85	20-May-85	03-Jun-85	03-Jun-85		-- C --
15	FNSH FOOTING REBAR	10	8,9,11,12	20-May-85	24-May-85	30-May-85	03-Jun-85	4	
16	STRT FOOTING MASONRY	14	13,14,15	03-Jun-85	03-Jun-85	17-Jun-85	17-Jun-85		-- C --
17	SLAB PREPARATION	6	13,14,15	03-Jun-85	28-Jun-85	09-Jun-85	04-Jul-85	25	
18	ERCT W10x45 COLUMNS	14	13,14,15	03-Jun-85	24-Jun-85	17-Jun-85	08-Jul-85	21	
19	POUR SLAB-ON-GRADE	4	17	09-Jun-85	04-Jul-85	13-Jun-85	08-Jul-85	25	
20	STRT 1ST FL MASONRY	21	16	17-Jun-85	17-Jun-85	08-Jul-85	08-Jul-85		-- C --
21	ERCT W8x31 COLUMNS	10	16	17-Jun-85	12-Jul-85	27-Jun-85	22-Jul-85	25	
22	INST METL DR FRAMES	35	16	17-Jun-85	18-Jul-85	22-Jul-85	22-Aug-85	31	
23	ERCT 2ND FL BEAMS	14	18,19,20	08-Jul-85	08-Jul-85	22-Jul-85	22-Jul-85		-- C --
24	REINFRC MASONRY SO W	24	18,19,20	08-Jul-85	29-Jul-85	01-Aug-85	22-Aug-85	21	
25	INST STL STR SUPPORT	6	18,19,20	08-Jul-85	16-Jul-85	14-Jul-85	22-Jul-85	8	
26	INST 2ND FL DECKING	14	21,23	22-Jul-85	22-Jul-85	05-Aug-85	05-Aug-85		-- C --
27	ERCT STL STAIRS	14	25	14-Jul-85	22-Jul-85	28-Jul-85	05-Aug-85	8	
28	POUR 2ND FL CONCRETE	3	26,27	05-Aug-85	05-Aug-85	08-Aug-85	08-Aug-85		-- C --
29	STRT 2ND FL MASONRY	14	28	08-Aug-85	08-Aug-85	22-Aug-85	22-Aug-85		-- C --
30	CIP CONC LENTELS	14	28	08-Aug-85	08-Aug-85	22-Aug-85	22-Aug-85		-- C --
31	ERCT STL ROOF BEAMS	14	22,24,29,30	22-Aug-85	22-Aug-85	05-Sep-85	05-Sep-85		-- C --
32	ROOF BLOCKOUTS	21	22,24,29,30	22-Aug-85	01-Sep-85	12-Sep-85	22-Sep-85	10	
33	INST ROOF DECKING	17	31	05-Sep-85	05-Sep-85	22-Sep-85	22-Sep-85		-- C --
34	STRT EIFS INSULATION	23	31	05-Sep-85	28-Sep-85	28-Sep-85	21-Oct-85	23	
35	ROUGH-IN FIRE MAINS	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	
36	ROUGH-IN PLMB	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	

TABLE A-2. EXAMPLE PROJECT CPM NETWORK BASED ON CONTRACTOR'S ACTUAL SCHEDULE

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
37	ROUGH-IN ELEC	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	
38	ROUGH-IN MECH	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	
39	FOUNDATION DRAINS	23	31	05-Sep-85	07-Nov-85	28-Sep-85	30-Nov-85	63	
40	BCKFL MASONRY WALL	35	31	05-Sep-85	26-Oct-85	10-Oct-85	30-Nov-85	51	
41	MASONRY INSULATION	23	31	05-Sep-85	07-Nov-85	28-Sep-85	30-Nov-85	63	
42	STRT METL STUD FRAMI	9	32,33	22-Sep-85	22-Sep-85	01-Oct-85	01-Oct-85		-- C --
43	INST ROOF SHEATH	18	32,33	22-Sep-85	13-Oct-85	10-Oct-85	31-Oct-85	21	
44	INST EIFS HARDCOAT	26	34	28-Sep-85	21-Oct-85	24-Oct-85	16-Nov-85	23	
45	INST EXT WNDW FRAMES	23	34	28-Sep-85	24-Oct-85	21-Oct-85	16-Nov-85	26	
46	FNSH EIFS	14	34	28-Sep-85	02-Nov-85	12-Oct-85	16-Nov-85	35	
47	INST EXT WNDW GLAZIN	14	44,45,46	24-Oct-85	16-Nov-85	07-Nov-85	30-Nov-85	23	
48	INST ROOF MEMBRANE	11	43	10-Oct-85	31-Oct-85	21-Oct-85	11-Nov-85	21	
49	INST METAL ROOFING	19	48	21-Oct-85	11-Nov-85	09-Nov-85	30-Nov-85	21	
50	STRT GYPSUM BOARD	10	42	01-Oct-85	01-Oct-85	11-Oct-85	11-Oct-85		-- C --
51	INST BATT INSUL	35	42	01-Oct-85	26-Oct-85	05-Nov-85	30-Nov-85	25	
52	FNSH MTL STUD FRAMIN	24	42	01-Oct-85	06-Nov-85	25-Oct-85	30-Nov-85	36	
53	INST OVRHD DOORS	24	42	01-Oct-85	06-Nov-85	25-Oct-85	30-Nov-85	36	
54	STRT PAINTING	14	50	11-Oct-85	11-Oct-85	25-Oct-85	25-Oct-85		-- C --
55	FNSH GYPSUM BOARD	17	50	11-Oct-85	17-Oct-85	28-Oct-85	03-Nov-85	6	
56	STRT SUS CEILING	9	35,36,37,38,48,54	25-Oct-85	25-Oct-85	03-Nov-85	03-Nov-85		-- C --
57	INST CHAIN HOIST	21	35,36,37,38,48,54	25-Oct-85	09-Nov-85	15-Nov-85	30-Nov-85	15	
58	FNSH PAINTING	25	35,36,37,38,48,54	25-Oct-85	05-Nov-85	19-Nov-85	30-Nov-85	11	
59	PNT FIRE SYS PIPING	21	35,36,37,38,48,54	25-Oct-85	09-Nov-85	15-Nov-85	30-Nov-85	15	
60	FNSH ELEC	27	52,55,56	03-Nov-85	03-Nov-85	30-Nov-85	30-Nov-85		-- C --
61	INST VINYL TILE	21	52,55,56	03-Nov-85	09-Nov-85	24-Nov-85	30-Nov-85	6	
62	FNSH MECH	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
63	FNSH PLMB	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
64	INST CERAMIC TILE	21	52,55,56	03-Nov-85	09-Nov-85	24-Nov-85	30-Nov-85	6	
65	HANG DOORS	21	52,55,56	03-Nov-85	09-Nov-85	24-Nov-85	30-Nov-85	6	
66	FNSH SUS CEILING	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
67	INST KITCHEN EQUIP	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
68	TEST & BALANCE	8	39,40,41,47,49,51 52,53,57,58,59,60 61,62,63,64,65,66 67	30-Nov-85	30-Nov-85	08-Dec-85	08-Dec-85		-- C --
69	FINAL INSP & ACCPTNC	6	68	08-Dec-85	08-Dec-85	14-Dec-85	14-Dec-85		-- C --

PROJECT DURATION (CD): 466

Based on the contractor's Schedule of Prices, pricing data obtained from Defense Contract Audit Agency (DCAA) audits,and a base bid of $721,055, direct costs (labor and material) equalled $520,406, field overhead costs totaled $117,384, home office overhead costs totaled $57,245, and leaving $26,020 attributable to profit. It is noted that as determined by the DCAA audits, home office overhead was estimated based on an estimated eleven percent of direct costs. Therefore, in the analyses done in this report, it is assumed that direct costs remain constant throughout the comparisons. Only the duration over which the expenditures are incurred change. Therefore, all costs comparisons are performed with no consideration given to home overhead costs only for the purpose of simplifying the comparisons.

APPENDIX B

USE OF LOTUS 1-2-3 FOR CPM NETWORK CALCULATIONS

As indicated previously in Chapter III, the contractor's actual schedule was duplicated on a Lotus 1-2-3 spreadsheet in order that impact on activity duration and slippage of activities could be evaluated instantaneously.

The spreadsheet critical path network utilizes basic formulas found in any network analysis.[11] These basic formulas are as follows:

Early Start = ES = the earliest time that an activity can start

Early Finish = EF = ES + Duration = ES + D

Late Finish = LF = the latest time that an activity can finish

Late Start = LS = LF - D

Float = LS - ES

In addition, basic calculations indicate that when Float = 0, then the activity is considered critical.

Information on the spreadsheet used for the CPM network occupied the following ranges of columns and rows:

1) Duration for Activities 1-36 - Columns C, Rows 6-41

2) Duration for Activities 37-69 - Columns C, Rows 48-83

3) Early Start Dates for Activities 1-36 - Columns G, Rows 6-41

4) Early Start Dates for Activities 37-69 - Columns G, Rows 48-83

5) Late Start Dates for Activities 1-36 - Column H, Rows 6-41

6) Late Start Dates for Activities 37-69 - Column H, Rows 48-83

7) Early Finish Dates for Activities 1-36 - Column I, Rows 6-41

8) Early Finish Dates for Activities 37-69 - Column I, Rows 48-83

9) Late Finish Dates for Activities 1-36 - Column J, Rows 6-41

10) Late Finish Dates for Activities 37-69 - Column J, Rows 48-83

11) Float for Activities 1-36 - Column K, Rows 6-41

12) Float for Activities 37-69 - Column K, Rows 48-83

13) Critical Activity Flag for Activities 1-36 - Column L, Rows 6-41

14) Critical Activity Flag for Activities 37-69 - Column L, Rows 48-83

Therefore, combining basic network calculations and the column/row notation used in Lotus 1-2-3, network calculations for the example project as they would be found on the spreadsheet are as follows:

1) Early Start/Early Finish Cell Formula

Act No.	Early Start Cell Descrptn	Early Start Formula/Value Used in Cell	Early Finish Cell Descrptn	Early Finish Formula/Value Used in Cell
1	G6	@DATE(84,9,4)	I6	+G6+E6
2	G7	+I6	I7	+G7+E7
3	G8	+I7	I8	+G8+E8
4	G9	+I8	I9	+G9+E9
5	G10	+I9	I10	+G10+E10
6	G11	+I10	I11	+G11+E11
7	G12	+I10	I12	+G12+E12
8	G13	@MAX(I11,I12)	I13	+G13+E13
9	G14	@MAX(I11,I12)	I14	+G14+E14
10	G15	+I12	I15	+G15+E15
11	G16	+I12	I16	+G16+E16
12	G17	+I15	I17	+G17+E17
13	G18	+I15	I18	+G18+E18
14	G19	@MAX(I13,I14, I16,I17)	I19	+G19+E19
15	G20	@MAX(I13,I14, I16,I17)	I20	+G20+E20
16	G21	@MAX(I18,I19,I20)	I21	+G21+E21
17	G22	@MAX(I18,I19,I20)	I22	+G22+E22
18	G23	@MAX(I18,I19,I20)	I23	+G23+E23
19	G24	+I22	I24	+G24+E24
20	G25	+I21	I25	+G25+E25
21	G26	+I21	I26	+G26+E26
22	G27	+I21	I27	+G27+E27
23	G28	@MAX(I23,I24,I25)	I28	+G28+E28
24	G29	@MAX(I23,I24,I25)	I29	+G29+E29
25	G30	@MAX(I23,I24,I25)	I30	+G30+E30
26	G31	@MAX(I26,I28)	I31	+G31+E31
27	G32	+I30	I32	+G32+E32
28	G33	@MAX(I31,I32)	I33	+G33+E33
29	G34	+I33	I34	+G34+E34
30	G35	+I33	I35	+G35+E35
31	G36	@MAX(I27,I29, I34,I35)	I36	+G36+E36
32	G37	@MAX(I27,I29, I34,I35)	I37	+G37+E37
33	G38	+I36	I38	+G38+E38
34	G39	+I36	I39	+G39+E39
35	G40	+I36	I40	+G40+E40
36	G41	+I36	I41	+G41+E41
37	G48	+I36	I48	+G48+E48
38	G49	+I36	I49	+G49+E49
39	G50	+I36	I50	+G50+E50
40	G51	+I36	I51	+G51+E51
41	G52	+I36	I52	+G52+E52
42	G53	@MAX(I37,I38)	I53	+G53+E53
43	G54	@MAX(I37,I38)	I54	+G54+E54

Act No.	Early Start Cell Descrptn	Early Start Formula/Value Used in Cell	Early Finish Cell Descrptn	Early Finish Formula/Value Used in Cell
44	G55	+I39	I55	+G55+E55
45	G56	+I39	I56	+G56+E56
46	G57	+I39	I57	+G57+E57
47	G58	@MAX((I55,I56,I57)	I58	+G58+E58
48	G59	+I54	I59	+G59+E59
49	G60	+I59	I60	+G60+E60
50	G61	+I53	I61	+G61+E61
51	G62	+I53	I62	+G62+E62
52	G63	+I53	I63	+G63+E63
53	G64	+I53	I64	+G64+E64
54	G65	+I61	I65	+G65+E65
55	G66	+I61	I66	+G66+E66
56	G67	@MAX(I40,I41,I48 I49,I65)	I67	+G67+E67
57	G68	@MAX((I40...I49, I65)	I68	+G68+E68
58	G69	@MAX((I40...I49, I65)	I69	+G69+E69
59	G70	@MAX((I40...I49, I65)	I70	+G70+E70
60	G71	@MAX(I63,I66,I67)	I71	+G71+E71
61	G72	@MAX(I63,I66,I67)	I72	+G72+E72
62	G73	@MAX(I63,I66,I67)	I73	+G73+E73
63	G74	@MAX(I63,I66,I67)	I74	+G74+E74
64	G75	@MAX(I63,I66,I67)	I75	+G75+E75
65	G76	@MAX(I63,I66,I67)	I76	+G76+E76
66	G77	@MAX(I63,I66,I67)	I77	+G77+E77
67	G78	@MAX(I63,I66,I67)	I78	+G78+E78
68	G79	@MAX(I50..I52,I58, I60,I62..I64, I68..I78)	I79	+G79+E79
69	G83	+I79	I83	+G83+E83

2) Late Start/Late Finish Cell Formula

Act No.	Late Start Cell Descrptn	Late Start Formula/Value Used in Cell	Late Finish Cell Descrptn	Late Finish Formula/Value Used in Cell
1	H6	+J6-E6	J6	+H7
2	H7	+J7-E7	J7	+H8
3	H8	+J8-E8	J8	+H9
4	H9	+J9-E9	J9	@MIN(H10..H11)
5	H10	+J10-E10	J10	+H12
6	H11	+J11-E11	J11	@MIN(H13..H14)
7	H12	+J12-E12	J12	@MIN(H13..H16)
8	H13	+J13-E13	J13	@MIN(H19..H20)
9	H14	+J14-E14	J14	@MIN(H19..H20)

Act No.	Late Start Cell Descrptn	Late Start Formula/Value Used in Cell	Late Finish Cell Descrptn	Late Finish Formula/Value Used in Cell
10	H15	+J15-E15	J15	@MIN(H17..H18)
11	H16	+J16-E16	J16	@MIN(H19..H20)
12	H17	+J17-E17	J17	@MIN(H19..H20)
13	H18	+J18-E18	J18	@MIN(H21..H23)
14	H19	+J19-E19	J19	@MIN(H21..H23)
15	H20	+J20-E20	J20	@MIN(H21..H23)
16	H21	+J21-E21	J21	@MIN(H25..H27)
17	H22	+J22-E22	J22	+H24
18	H23	+J23-E23	J23	@MIN(H28..H30)
19	H24	+J24-E24	J24	@MIN(H28..H30)
20	H25	+J25-E25	J25	@MIN(H28..H30)
21	H26	+J26-E26	J26	+H31
22	H27	+J27-E27	J27	@MIN(H36..H37)
23	H28	+J28-E28	J28	+H31
24	H29	+J29-E29	J29	@MIN(H36..H37)
25	H30	+J30-E30	J30	+H32
26	H31	+J31-E31	J31	+H33
27	H32	+J32-E32	J32	+H33
28	H33	+J33-E33	J33	@MIN(H34..H35)
29	H34	+J34-E34	J34	@MIN(H36..H37)
30	H35	+J35-E35	J35	@MIN(H36..H37)
31	H36	+J36-E36	J36	@MIN(H38..H41, H48..H52)
32	H37	+J37-E37	J37	@MIN(H53..H54)
33	H38	+J38-E38	J38	@MIN(H53..H54)
34	H39	+J39-E39	J39	@MIN(H55..H57)
35	H40	+J40-E40	J40	@MIN(H67..H70)
36	H41	+J41-E41	J41	@MIN(H67..H70)
37	H48	+J48-E48	J48	@MIN(H67..H70)
38	H49	+J49-E49	J49	@MIN(H67..H70)
39	H50	+J50-E50	J50	+H79
40	H51	+J51-E51	J51	+H79
41	H52	+J52-E52	J52	+H79
42	H53	+J53-E53	J53	@MIN(H61..H64)
43	H54	+J54-E54	J54	+H59
44	H55	+J55-E55	J55	+H58
45	H56	+J56-E56	J56	+H58
46	H57	+J57-E57	J57	+H58
47	H58	+J58-E58	J58	+H79
48	H59	+J59-E59	J59	+H60
49	H60	+J60-E60	J60	+H79
50	H61	+J61-E61	J61	@MIN(H65..H66)
51	H62	+J62-E62	J62	+H79
52	H63	+J63-E63	J63	+H79
53	H64	+J64-E64	J64	+H79
54	H65	+J65-E65	J65	@MIN(H67..H70)
55	H66	+J66-E66	J66	@MIN(H71..H78)
56	H67	+J67-E67	J67	@MIN(H71..H78)
57	H68	+J68-E68	J68	+H79

Act No.	Late Start Cell Descrptn	Late Start Formula/Value Used in Cell	Late Finish Cell Descrptn	Late Finish Formula/Value Used in Cell
58	H69	+J69-E69	J69	+H79
59	H70	+J70-E70	J70	+H79
60	H71	+J71-E71	J71	+H79
61	H72	+J72-E72	J72	+H79
62	H73	+J73-E73	J73	+H79
63	H74	+J74-E74	J74	+H79
64	H75	+J75-E75	J75	+H79
65	H76	+J76-E76	J76	+H79
66	H77	+J77-E77	J77	+H79
67	H78	+J78-E78	J78	+H79
68	H79	+J79-E79	J79	+H83
69	H83	+J83-E83	J83	+I83

3)Float Cell Formula

Act No.	Float Cell Descrptn	Float Formula Used in Cell
1	K6	@IF(H6-G6=0," ",H6-G6)
2	K7	@IF(H7-G6=0," ",H6-G6)
3	K8	@IF(H8-G6=0," ",H6-G6)
4	K9	@IF(H9-G6=0," ",H6-G6)
5	K10	@IF(H10-G10=0," ",H10-G10)
6	K11	@IF(H11-G11=0," ",H11-G11)
7	K12	@IF(H12-G12=0," ",H12-G12)
8	K13	@IF(H13-G13=0," ",H13-G13)
9	K14	@IF(H14-G14=0," ",H14-G14)
10	K15	@IF(H15-G15=0," ",H15-G15)
11	K16	@IF(H16-G16=0," ",H16-G16)
12	K17	@IF(H17-G17=0," ",H17-G17)
13	K18	@IF(H18-G18=0," ",H18-G18)
14	K19	@IF(H19-G19=0," ",H19-G19)
15	K20	@IF(H20-G20=0," ",H20-G20)
16	K21	@IF(H21-G21=0," ",H21-G21)
17	K22	@IF(H22-G22=0," ",H22-G22)
18	K23	@IF(H23-G23=0," ",H23-G23)
19	K24	@IF(H24-G24=0," ",H24-G24)
20	K25	@IF(H25-G25=0," ",H25-G25)
21	K26	@IF(H26-G26=0," ",H26-G26)
22	K27	@IF(H27-G27=0," ",H27-G27)
23	K28	@IF(H28-G28=0," ",H28-G28)
24	K29	@IF(H29-G29=0," ",H29-G29)
25	K30	@IF(H30-G30=0," ",H30-G30)
26	K31	@IF(H31-G31=0," ",H31-G31)
27	K32	@IF(H32-G32=0," ",H32-G32)
28	K33	@IF(H33-G33=0," ",H33-G33)
29	K34	@IF(H34-G34=0," ",H34-G34)
30	K35	@IF(H35-G35=0," ",H35-G35)

Act No.	Float Cell Descrptn	Float Formula Used in Cell
31	K36	@IF(H36-G36=0," ",H36-G36)
32	K37	@IF(H37-G37=0," ",H37-G37)
33	K38	@IF(H38-G38=0," ",H38-G38)
34	K39	@IF(H39-G39=0," ",H39-G39)
35	K40	@IF(H40-G40=0," ",H40-G40)
36	K41	@IF(H41-G41=0," ",H41-G41)
37	K48	@IF(H48-G48=0," ",H48-G48)
38	K49	@IF(H49-G49=0," ",H49-G49)
39	K50	@IF(H50-G50=0," ",H50-G50)
40	K51	@IF(H51-G51=0," ",H51-G51)
41	K52	@IF(H52-G52=0," ",H52-G52)
42	K53	@IF(H53-G53=0," ",H53-G53)
43	K54	@IF(H54-G54=0," ",H54-G54)
44	K55	@IF(H55-G55=0," ",H55-G55)
45	K56	@IF(H56-G56=0," ",H56-G56)
46	K57	@IF(H57-G57=0," ",H57-G57)
47	K58	@IF(H58-G58=0," ",H58-G58)
48	K59	@IF(H59-G59=0," ",H59-G59)
49	K60	@IF(H60-G60=0," ",H60-G60)
50	K61	@IF(H61-G61=0," ",H61-G61)
51	K62	@IF(H62-G62=0," ",H62-G62)
52	K63	@IF(H63-G63=0," ",H63-G63)
53	K64	@IF(H64-G64=0," ",H64-G64)
54	K65	@IF(H65-G65=0," ",H65-G65)
55	K66	@IF(H66-G66=0," ",H66-G66)
56	K67	@IF(H67-G67=0," ",H67-G67)
57	K68	@IF(H68-G68=0," ",H68-G68)
58	K69	@IF(H69-G69=0," ",H69-G69)
59	K70	@IF(H70-G70=0," ",H70-G70)
60	K71	@IF(H71-G71=0," ",H71-G71)
61	K72	@IF(H72-G72=0," ",H72-G72)
62	K73	@IF(H73-G73=0," ",H73-G73)
63	K74	@IF(H74-G74=0," ",H74-G74)
64	K75	@IF(H75-G75=0," ",H75-G75)
65	K76	@IF(H76-G76=0," ",H76-G76)
66	K77	@IF(H77-G77=0," ",H77-G77)
67	K78	@IF(H78-G78=0," ",H78-G78)
68	K79	@IF(H79-G79=0," ",H79-G79)
69	K83	@IF(H83-G83=0," ",H83-G83)

4) Critical Activity Flag Cell Formula

Act No.	Crit Flg Cell Descrptn	Critical Activity Flag Formula Used in Cell
1	L6	@IF(H6-G6=0," -- C --"," ")
2	L7	@IF(H7-G6=0," -- C --"," ")
3	L8	@IF(H8-G6=0," -- C --"," ")
4	L9	@IF(H9-G6=0," -- C --"," ")

Act No.	Crit Flg Cell Descrptn	Critical Activity Flag Formula Used in Cell
5	L10	@IF(H10-G10=0," -- C --"," ")
6	L11	@IF(H11-G11=0," -- C --"," ")
7	L12	@IF(H12-G12=0," -- C --"," ")
8	L13	@IF(H13-G13=0," -- C --"," ")
9	L14	@IF(H14-G14=0," -- C --"," ")
10	L15	@IF(H15-G15=0," -- C --"," ")
11	L16	@IF(H16-G16=0," -- C --"," ")
12	L17	@IF(H17-G17=0," -- C --"," ")
13	L18	@IF(H18-G18=0," -- C --"," ")
14	L19	@IF(H19-G19=0," -- C --"," ")
15	L20	@IF(H20-G20=0," -- C --"," ")
16	L21	@IF(H21-G21=0," -- C --"," ")
17	L22	@IF(H22-G22=0," -- C --"," ")
18	L23	@IF(H23-G23=0," -- C --"," ")
19	L24	@IF(H24-G24=0," -- C --"," ")
20	L25	@IF(H25-G25=0," -- C --"," ")
21	L26	@IF(H26-G26=0," -- C --"," ")
22	L27	@IF(H27-G27=0," -- C --"," ")
23	L28	@IF(H28-G28=0," -- C --"," ")
24	L29	@IF(H29-G29=0," -- C --"," ")
25	L30	@IF(H30-G30=0," -- C --"," ")
26	L31	@IF(H31-G31=0," -- C --"," ")
27	L32	@IF(H32-G32=0," -- C --"," ")
28	L33	@IF(H33-G33=0," -- C --"," ")
29	L34	@IF(H34-G34=0," -- C --"," ")
30	L35	@IF(H35-G35=0," -- C --"," ")
31	L36	@IF(H36-G36=0," -- C --"," ")
32	L37	@IF(H37-G37=0," -- C --"," ")
33	L38	@IF(H38-G38=0," -- C --"," ")
34	L39	@IF(H39-G39=0," -- C --"," ")
35	L40	@IF(H40-G40=0," -- C --"," ")
36	L41	@IF(H41-G41=0," -- C --"," ")
37	L48	@IF(H48-G48=0," -- C --"," ")
38	L49	@IF(H49-G49=0," -- C --"," ")
39	L50	@IF(H50-G50=0," -- C --"," ")
40	L51	@IF(H51-G51=0," -- C --"," ")
41	L52	@IF(H52-G52=0," -- C --"," ")
42	L53	@IF(H53-G53=0," -- C --"," ")
43	L54	@IF(H54-G54=0," -- C --"," ")
44	L55	@IF(H55-G55=0," -- C --"," ")
45	L56	@IF(H56-G56=0," -- C --"," ")
46	L57	@IF(H57-G57=0," -- C --"," ")
47	L58	@IF(H58-G58=0," -- C --"," ")
48	L59	@IF(H59-G59=0," -- C --"," ")
49	L60	@IF(H60-G60=0," -- C --"," ")
50	L61	@IF(H61-G61=0," -- C --"," ")
51	L62	@IF(H62-G62=0," -- C --"," ")
52	L63	@IF(H63-G63=0," -- C --"," ")
53	L64	@IF(H64-G64=0," -- C --"," ")
54	L65	@IF(H65-G65=0," -- C --"," ")

Act No.	Crt Flg Cell Descrptn	Critical Activity Flag Formula Used in Cell
55	L66	@IF(H66-G66=0," -- C --"," ")
56	L67	@IF(H67-G67=0," -- C --"," ")
57	L68	@IF(H68-G68=0," -- C --"," ")
58	L69	@IF(H69-G69=0," -- C --"," ")
59	L70	@IF(H70-G70=0," -- C --"," ")
60	L71	@IF(H71-G71=0," -- C --"," ")
61	L72	@IF(H72-G72=0," -- C --"," ")
62	L73	@IF(H73-G73=0," -- C --"," ")
63	L74	@IF(H74-G74=0," -- C --"," ")
64	L75	@IF(H75-G75=0," -- C --"," ")
65	L76	@IF(H76-G76=0," -- C --"," ")
66	L77	@IF(H77-G77=0," -- C --"," ")
67	L78	@IF(H78-G78=0," -- C --"," ")
68	L79	@IF(H79-G79=0," -- C --"," ")
69	L83	@IF(H83-G83=0," -- C --"," ")

APPENDIX C

DEVELOPMENT OF SCENARIOS C, D, & E

As indicated in Appendix B (Page 44), the contractor's actual schedule was simulated on a Lotus 1-2-3 spreadsheet in order that different scenarios involving activity duration changes could be instantaneously monitored during the process. For the sake of continuity within this Appendix, Table C-1 shows the contractors actual schedule in the Lotus format.

With the basic (actual) schedule in place, it was then decided to develop the ideal case. This case, Scenario B, assumed that all durations indicated on the actual schedule were at an ideal productivity efficiency of 100 per cent. In addition, it was assumed that winter shutdown would be of no consequence in the ideal case resulting in the respective activity duration to be reduced to zero. As indicated in Chapter 3, total project time is reduced to 289 calendar days. The CPM network for Scenario B follows as Table C-2 (Page 57).

With an ideal schedule assumed to be independent of temperature influences, it was then decided to create an expected mean, worst, and best case scenario to identify trends and impact. Scenario C, based on mean climatic conditions, was created by using the calculated productivity efficiencies indicated in Table 2-3 (Page 14) to modify the ideal case in Scenario B. This resulted in a total project duration of 306 calendar days. The CPM network for Scenario C follows as Table C-3 (Page 59).

As seen in Table C-4 (Page 61), Scenario D, based on temperatures ten (10) degrees below the calculated monthly mean temperatures, total project duration was calculated as 327 calendar days.

Lastly, as seen in Table C-5 (Page 63), Scenario E, based on temperatures ten (10) degrees above the calculated monthly mean temperatures, total project duration was calculated as 296 calendar days.

TABLE C-1. CPM NETWORK FOR SCENARIO A

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
1	SURVEY	6	-	04-Sep-84	04-Sep-84	10-Sep-84	10-Sep-84		-- C --
2	DEMOLITION	5	1	10-Sep-84	10-Sep-84	15-Sep-84	15-Sep-84		-- C --
3	EXCAVATE & FILL	21	2	15-Sep-84	15-Sep-84	06-Oct-84	06-Oct-84		-- C --
4	WINTER SHUTDOWN	177	3	06-Oct-84	06-Oct-84	01-Apr-85	01-Apr-85		-- C --
5	STRT UNDERSLAB ELEC	16	4	01-Apr-85	01-Apr-85	17-Apr-85	17-Apr-85		-- C --
6	STRT UNDERSLAB PLMB	16	4	01-Apr-85	13-Apr-85	17-Apr-85	29-Apr-85	12	
7	STRT FOOTING EXCAV	12	5	17-Apr-85	17-Apr-85	29-Apr-85	29-Apr-85		-- C --
8	FNSH UNDERSLAB ELEC	21	6,7	29-Apr-85	29-Apr-85	20-May-85	20-May-85		-- C --
9	FNSH UNDERSLAB PLMB	21	6,7	29-Apr-85	29-Apr-85	20-May-85	20-May-85		-- C --
10	STRT FOOTING FORMS	9	7	29-Apr-85	02-May-85	08-May-85	11-May-85	3	
11	FNSH FOOTING EXCAV	14	7	29-Apr-85	06-May-85	13-May-85	20-May-85	7	
12	STRT FOOTING REBAR	9	10	08-May-85	11-May-85	17-May-85	20-May-85	3	
13	FNSH FOOTING FORMS	14	10	08-May-85	20-May-85	22-May-85	03-Jun-85	12	
14	POUR FOOTINGS	14	8,9,11,12	20-May-85	20-May-85	03-Jun-85	03-Jun-85		-- C --
15	FNSH FOOTING REBAR	10	8,9,11,12	20-May-85	24-May-85	30-May-85	03-Jun-85	4	
16	STRT FOOTING MASONRY	14	13,14,15	03-Jun-85	03-Jun-85	17-Jun-85	17-Jun-85		-- C --
17	SLAB PREPARATION	6	13,14,15	03-Jun-85	28-Jun-85	09-Jun-85	04-Jul-85	25	
18	ERCT W10x45 COLUMNS	14	13,14,15	03-Jun-85	24-Jun-85	17-Jun-85	08-Jul-85	21	
19	POUR SLAB-ON-GRADE	4	17	09-Jun-85	04-Jul-85	13-Jun-85	08-Jul-85	25	
20	STRT 1ST FL MASONRY	21	16	17-Jun-85	17-Jun-85	08-Jul-85	08-Jul-85		-- C --
21	ERCT W8x31 COLUMNS	10	16	17-Jun-85	12-Jul-85	27-Jun-85	22-Jul-85	25	
22	INST METL DR FRAMES	35	16	17-Jun-85	18-Jul-85	22-Jul-85	22-Aug-85	31	
23	ERCT 2ND FL BEAMS	14	18,19,20	08-Jul-85	08-Jul-85	22-Jul-85	22-Jul-85		-- C --
24	REINFRC MASONRY SO W	24	18,19,20	08-Jul-85	29-Jul-85	01-Aug-85	22-Aug-85	21	
25	INST STL STR SUPPORT	6	18,19,20	08-Jul-85	16-Jul-85	14-Jul-85	22-Jul-85	8	
26	INST 2ND FL DECKING	14	21,23	22-Jul-85	22-Jul-85	05-Aug-85	05-Aug-85		-- C --
27	ERCT STL STAIRS	14	25	14-Jul-85	22-Jul-85	28-Jul-85	05-Aug-85	8	
28	POUR 2ND FL CONCRETE	3	26,27	05-Aug-85	05-Aug-85	08-Aug-85	08-Aug-85		-- C --
29	STRT 2ND FL MASONRY	14	28	08-Aug-85	08-Aug-85	22-Aug-85	22-Aug-85		-- C --
30	CIP CONC LENTELS	14	28	08-Aug-85	08-Aug-85	22-Aug-85	22-Aug-85		-- C --
31	ERCT STL ROOF BEAMS	14	22,24,29,30	22-Aug-85	22-Aug-85	05-Sep-85	05-Sep-85		-- C --
32	ROOF BLOCKOUTS	21	22,24,29,30	22-Aug-85	01-Sep-85	12-Sep-85	22-Sep-85	10	
33	INST ROOF DECKING	17	31	05-Sep-85	05-Sep-85	22-Sep-85	22-Sep-85		-- C --
34	STRT EIFS INSULATION	23	31	05-Sep-85	28-Sep-85	28-Sep-85	21-Oct-85	23	
35	ROUGH-IN FIRE MAINS	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	
36	ROUGH-IN PLMB	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	

TABLE C-1. CPM NETWORK FOR SCENARIO A.

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
37	ROUGH-IN ELEC	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	
38	ROUGH-IN MECH	46	31	05-Sep-85	09-Sep-85	21-Oct-85	25-Oct-85	4	
39	FOUNDATION DRAINS	23	31	05-Sep-85	07-Nov-85	28-Sep-85	30-Nov-85	63	
40	BCKFL MASONRY WALL	35	31	05-Sep-85	26-Oct-85	10-Oct-85	30-Nov-85	51	
41	MASONRY INSULATION	23	31	05-Sep-85	07-Nov-85	28-Sep-85	30-Nov-85	63	
42	STRT METL STUD FRAMI	9	32,33	22-Sep-85	22-Sep-85	01-Oct-85	01-Oct-85		-- C --
43	INST ROOF SHEATH	18	32,33	22-Sep-85	13-Oct-85	10-Oct-85	31-Oct-85	21	
44	INST EIFS HARDCOAT	26	34	28-Sep-85	21-Oct-85	24-Oct-85	16-Nov-85	23	
45	INST EXT WNDW FRAMES	23	34	28-Sep-85	24-Oct-85	21-Oct-85	16-Nov-85	26	
46	FNSH EIFS	14	34	28-Sep-85	02-Nov-85	12-Oct-85	16-Nov-85	35	
47	INST EXT WNDW GLAZIN	14	44,45,46	24-Oct-85	16-Nov-85	07-Nov-85	30-Nov-85	23	
48	INST ROOF MEMBRANE	11	43	10-Oct-85	31-Oct-85	21-Oct-85	11-Nov-85	21	
49	INST METAL ROOFING	19	48	21-Oct-85	11-Nov-85	09-Nov-85	30-Nov-85	21	
50	STRT GYPSUM BOARD	10	42	01-Oct-85	01-Oct-85	11-Oct-85	11-Oct-85		-- C --
51	INST BATT INSUL	35	42	01-Oct-85	26-Oct-85	05-Nov-85	30-Nov-85	25	
52	FNSH MTL STUD FRAMIN	24	42	01-Oct-85	06-Nov-85	25-Oct-85	30-Nov-85	36	
53	INST OVRHD DOORS	24	42	01-Oct-85	06-Nov-85	25-Oct-85	30-Nov-85	36	
54	STRT PAINTING	14	50	11-Oct-85	11-Oct-85	25-Oct-85	25-Oct-85		-- C --
55	FNSH GYPSUM BOARD	17	50	11-Oct-85	17-Oct-85	28-Oct-85	03-Nov-85	6	
56	STRT SUS CEILING	9	35,36,37,38,48,54	25-Oct-85	25-Oct-85	03-Nov-85	03-Nov-85		-- C --
57	INST CHAIN HOIST	21	35,36,37,38,48,54	25-Oct-85	09-Nov-85	15-Nov-85	30-Nov-85	15	
58	FNSH PAINTING	25	35,36,37,38,48,54	25-Oct-85	05-Nov-85	19-Nov-85	30-Nov-85	11	
59	PNT FIRE SYS PIPING	21	35,36,37,38,48,54	25-Oct-85	09-Nov-85	15-Nov-85	30-Nov-85	15	
60	FNSH ELEC	27	52,55,56	03-Nov-85	03-Nov-85	30-Nov-85	30-Nov-85		-- C --
61	INST VINYL TILE	21	52,55,56	03-Nov-85	09-Nov-85	24-Nov-85	30-Nov-85	6	
62	FNSH MECH	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
63	FNSH PLMB	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
64	INST CERAMIC TILE	21	52,55,56	03-Nov-85	09-Nov-85	24-Nov-85	30-Nov-85	6	
65	HANG DOORS	21	52,55,56	03-Nov-85	09-Nov-85	24-Nov-85	30-Nov-85	6	
66	FNSH SUS CEILING	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
67	INST KITCHEN EQUIP	23	52,55,56	03-Nov-85	07-Nov-85	26-Nov-85	30-Nov-85	4	
68	TEST & BALANCE	8	39,40,41,47,49,51 52,53,57,58,59,60 61,62,63,64,65,66 67	30-Nov-85	30-Nov-85	08-Dec-85	08-Dec-85		-- C --
69	FINAL INSP & ACCPTNC	6	68	08-Dec-85	08-Dec-85	14-Dec-85	14-Dec-85		-- C --

PROJECT DURATION (CD): 466

TABLE C-2. CPM NETWORK FOR SCENARIO B.

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
1	SURVEY	6	-	04-Sep-84	04-Sep-84	10-Sep-84	10-Sep-84		-- C --
2	DEMOLITION	5	1	10-Sep-84	10-Sep-84	15-Sep-84	15-Sep-84		-- C --
3	EXCAVATE & FILL	21	2	15-Sep-84	15-Sep-84	06-Oct-84	06-Oct-84		-- C --
4	WINTER SHUTDOWN	0	3	06-Oct-84	06-Oct-84	06-Oct-84	06-Oct-84		-- C --
5	STRT UNDERSLAB ELEC	16	4	06-Oct-84	06-Oct-84	22-Oct-84	22-Oct-84		-- C --
6	STRT UNDERSLAB PLMB	16	4	06-Oct-84	18-Oct-84	22-Oct-84	03-Nov-84	12	
7	STRT FOOTING EXCAV	12	5	22-Oct-84	22-Oct-84	03-Nov-84	03-Nov-84		-- C --
8	FNSH UNDERSLAB ELEC	21	6,7	03-Nov-84	03-Nov-84	24-Nov-84	24-Nov-84		-- C --
9	FNSH UNDERSLAB PLMB	21	6,7	03-Nov-84	03-Nov-84	24-Nov-84	24-Nov-84		-- C --
10	STRT FOOTING FORMS	9	7	03-Nov-84	06-Nov-84	12-Nov-84	15-Nov-84	3	
11	FNSH FOOTING EXCAV	14	7	03-Nov-84	10-Nov-84	17-Nov-84	24-Nov-84	7	
12	STRT FOOTING REBAR	9	10	12-Nov-84	15-Nov-84	21-Nov-84	24-Nov-84	3	
13	FNSH FOOTING FORMS	14	10	12-Nov-84	24-Nov-84	26-Nov-84	08-Dec-84	12	
14	POUR FOOTINGS	14	8,9,11,12	24-Nov-84	24-Nov-84	08-Dec-84	08-Dec-84		-- C --
15	FNSH FOOTING REBAR	10	8,9,11,12	24-Nov-84	28-Nov-84	04-Dec-84	08-Dec-84	4	
16	STRT FOOTING MASONRY	14	13,14,15	08-Dec-84	08-Dec-84	22-Dec-84	22-Dec-84		-- C --
17	SLAB PREPARATION	6	13,14,15	08-Dec-84	02-Jan-85	14-Dec-84	08-Jan-85	25	
18	ERCT W10x45 COLUMNS	14	13,14,15	08-Dec-84	29-Dec-84	22-Dec-84	12-Jan-85	21	
19	POUR SLAB-ON-GRADE	4	17	14-Dec-84	08-Jan-85	18-Dec-84	12-Jan-85	25	
20	STRT 1ST FL MASONRY	21	16	22-Dec-84	22-Dec-84	12-Jan-85	12-Jan-85		-- C --
21	ERCT W8x31 COLUMNS	10	16	22-Dec-84	16-Jan-85	01-Jan-85	26-Jan-85	25	
22	INST METL DR FRAMES	35	16	22-Dec-84	22-Jan-85	26-Jan-85	26-Feb-85	31	
23	ERCT 2ND FL BEAMS	14	18,19,20	12-Jan-85	12-Jan-85	26-Jan-85	26-Jan-85		-- C --
24	REINFRC MASONRY SO W	24	18,19,20	12-Jan-85	02-Feb-85	05-Feb-85	26-Feb-85	21	
25	INST STL STR SUPPORT	6	18,19,20	12-Jan-85	20-Jan-85	18-Jan-85	26-Jan-85	8	
26	INST 2ND FL DECKING	14	21,23	26-Jan-85	26-Jan-85	09-Feb-85	09-Feb-85		-- C --
27	ERCT STL STAIRS	14	25	18-Jan-85	26-Jan-85	01-Feb-85	09-Feb-85	8	
28	POUR 2ND FL CONCRETE	3	26,27	09-Feb-85	09-Feb-85	12-Feb-85	12-Feb-85		-- C --
29	STRT 2ND FL MASONRY	14	28	12-Feb-85	12-Feb-85	26-Feb-85	26-Feb-85		-- C --
30	CIP CONC LENTELS	14	28	12-Feb-85	12-Feb-85	26-Feb-85	26-Feb-85		-- C --
31	ERCT STL ROOF BEAMS	14	22,24,29,30	26-Feb-85	26-Feb-85	12-Mar-85	12-Mar-85		-- C --
32	ROOF BLOCKOUTS	21	22,24,29,30	26-Feb-85	08-Mar-85	19-Mar-85	29-Mar-85	10	
33	INST ROOF DECKING	17	31	12-Mar-85	12-Mar-85	29-Mar-85	29-Mar-85		-- C --
34	STRT EIFS INSULATION	23	31	12-Mar-85	04-Apr-85	04-Apr-85	27-Apr-85	23	
35	ROUGH-IN FIRE MAINS	46	31	12-Mar-85	16-Mar-85	27-Apr-85	01-May-85	4	
36	ROUGH-IN PLMB	46	31	12-Mar-85	16-Mar-85	27-Apr-85	01-May-85	4	

TABLE C-2. CPM NETWORK FOR SCENARIO B.

ACT NO	ACTIVITY DESCRIPTION	NORM DUR (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
37	ROUGH-IN ELEC	46	31	12-Mar-85	16-Mar-85	27-Apr-85	01-May-85	4	
38	ROUGH-IN MECH	46	31	12-Mar-85	16-Mar-85	27-Apr-85	01-May-85	4	
39	FOUNDATION DRAINS	23	31	12-Mar-85	14-May-85	04-Apr-85	06-Jun-85	63	
40	BCKFL MASONRY WALL	35	31	12-Mar-85	02-May-85	16-Apr-85	06-Jun-85	51	
41	MASONRY INSULATION	23	31	12-Mar-85	14-May-85	04-Apr-85	06-Jun-85	63	
42	STRT METL STUD FRAMI	9	32,33	29-Mar-85	29-Mar-85	07-Apr-85	07-Apr-85		-- C --
43	INST ROOF SHEATH	18	32,33	29-Mar-85	19-Apr-85	16-Apr-85	07-May-85	21	
44	INST EIFS HARDCOAT	26	34	04-Apr-85	27-Apr-85	30-Apr-85	23-May-85	23	
45	INST EXT WNDW FRAMES	23	34	04-Apr-85	30-Apr-85	27-Apr-85	23-May-85	26	
46	FNSH EIFS	14	34	04-Apr-85	09-May-85	18-Apr-85	23-May-85	35	
47	INST EXT WNDW GLAZIN	14	44,45,46	30-Apr-85	23-May-85	14-May-85	06-Jun-85	23	
48	INST ROOF MEMBRANE	11	43	16-Apr-85	07-May-85	27-Apr-85	18-May-85	21	
49	INST METAL ROOFING	19	48	27-Apr-85	18-May-85	16-May-85	06-Jun-85	21	
50	STRT GYPSUM BOARD	10	42	07-Apr-85	07-Apr-85	17-Apr-85	17-Apr-85		-- C --
51	INST BATT INSUL	35	42	07-Apr-85	02-May-85	12-May-85	06-Jun-85	25	
52	FNSH MTL STUD FRAMIN	24	42	07-Apr-85	13-May-85	01-May-85	06-Jun-85	36	
53	INST OVRHD DOORS	24	42	07-Apr-85	13-May-85	01-May-85	06-Jun-85	36	
54	STRT PAINTING	14	50	17-Apr-85	17-Apr-85	01-May-85	01-May-85		-- C --
55	FNSH GYPSUM BOARD	17	50	17-Apr-85	23-Apr-85	04-May-85	10-May-85	6	
56	STRT SUS CEILING	9	35,36,37,38,48,54	01-May-85	01-May-85	10-May-85	10-May-85		-- C --
57	INST CHAIN HOIST	21	35,36,37,38,48,54	01-May-85	16-May-85	22-May-85	06-Jun-85	15	
58	FNSH PAINTING	25	35,36,37,38,48,54	01-May-85	12-May-85	26-May-85	06-Jun-85	11	
59	PNT FIRE SYS PIPING	21	35,36,37,38,48,54	01-May-85	16-May-85	22-May-85	06-Jun-85	15	
60	FNSH ELEC	27	52,55,56	10-May-85	10-May-85	06-Jun-85	06-Jun-85		-- C --
61	INST VINYL TILE	21	52,55,56	10-May-85	16-May-85	31-May-85	06-Jun-85	6	
62	FNSH MECH	23	52,55,56	10-May-85	14-May-85	02-Jun-85	06-Jun-85	4	
63	FNSH PLMB	23	52,55,56	10-May-85	14-May-85	02-Jun-85	06-Jun-85	4	
64	INST CERAMIC TILE	21	52,55,56	10-May-85	16-May-85	31-May-85	06-Jun-85	6	
65	HANG DOORS	21	52,55,56	10-May-85	16-May-85	31-May-85	06-Jun-85	6	
66	FNSH SUS CEILING	23	52,55,56	10-May-85	14-May-85	02-Jun-85	06-Jun-85	4	
67	INST KITCHEN EQUIP	23	52,55,56	10-May-85	14-May-85	02-Jun-85	06-Jun-85	4	
68	TEST & BALANCE	8	39,40,41,47,49,51 52,53,57,58,59,60 61,62,63,64,65,66 67	06-Jun-85	06-Jun-85	14-Jun-85	14-Jun-85		-- C --
69	FINAL INSP & ACCPTNC	6	68	14-Jun-85	14-Jun-85	20-Jun-85	20-Jun-85		-- C --

PROJECT DURATION (CD): 289

TABLE C-3. CPM NETWORK FOR SCENARIO C.

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
1	SURVEY	6	-	04-Sep-84	04-Sep-84	10-Sep-84	10-Sep-84		-- C --
2	DEMOLITION	6	1	10-Sep-84	10-Sep-84	16-Sep-84	16-Sep-84		-- C --
3	EXCAVATE & FILL	21	2	16-Sep-84	16-Sep-84	07-Oct-84	07-Oct-84		-- C --
4	WINTER SHUTDOWN	0	3	07-Oct-84	07-Oct-84	07-Oct-84	07-Oct-84		-- C --
5	STRT UNDERSLAB ELEC	17	4	07-Oct-84	07-Oct-84	24-Oct-84	24-Oct-84		-- C --
6	STRT UNDERSLAB PLMB	17	4	07-Oct-84	20-Oct-84	24-Oct-84	06-Nov-84	13	
7	STRT FOOTING EXCAV	13	5	24-Oct-84	24-Oct-84	06-Nov-84	06-Nov-84		-- C --
8	FNSH UNDERSLAB ELEC	22	6,7	06-Nov-84	06-Nov-84	28-Nov-84	28-Nov-84		-- C --
9	FNSH UNDERSLAB PLMB	22	6,7	06-Nov-84	06-Nov-84	28-Nov-84	28-Nov-84		-- C --
10	STRT FOOTING FORMS	10	7	06-Nov-84	07-Nov-84	16-Nov-84	17-Nov-84	1	
11	FNSH FOOTING EXCAV	15	7	06-Nov-84	13-Nov-84	21-Nov-84	28-Nov-84	7	
12	STRT FOOTING REBAR	11	10	16-Nov-84	17-Nov-84	27-Nov-84	28-Nov-84	1	
13	FNSH FOOTING FORMS	15	10	16-Nov-84	29-Nov-84	01-Dec-84	14-Dec-84	13	
14	POUR FOOTINGS	16	8,9,11,12	28-Nov-84	28-Nov-84	14-Dec-84	14-Dec-84		-- C --
15	FNSH FOOTING REBAR	10	8,9,11,12	28-Nov-84	04-Dec-84	08-Dec-84	14-Dec-84	6	
16	STRT FOOTING MASONRY	17	13,14,15	14-Dec-84	14-Dec-84	31-Dec-84	31-Dec-84		-- C --
17	SLAB PREPARATION	7	13,14,15	14-Dec-84	12-Jan-85	21-Dec-84	19-Jan-85	29	
18	ERCT W10x45 COLUMNS	17	13,14,15	14-Dec-84	07-Jan-85	31-Dec-84	24-Jan-85	24	
19	POUR SLAB-ON-GRADE	5	17	21-Dec-84	19-Jan-85	26-Dec-84	24-Jan-85	29	
20	STRT 1ST FL MASONRY	24	16	31-Dec-84	31-Dec-84	24-Jan-85	24-Jan-85		-- C --
21	ERCT W8x31 COLUMNS	11	16	31-Dec-84	29-Jan-85	11-Jan-85	09-Feb-85	29	
22	INST METL DR FRAMES	41	16	31-Dec-84	02-Feb-85	10-Feb-85	15-Mar-85	33	
23	ERCT 2ND FL BEAMS	16	18,19,20	24-Jan-85	24-Jan-85	09-Feb-85	09-Feb-85		-- C --
24	REINFRC MASONRY SO W	27	18,19,20	24-Jan-85	16-Feb-85	20-Feb-85	15-Mar-85	23	
25	INST STL STR SUPPORT	7	18,19,20	24-Jan-85	03-Feb-85	31-Jan-85	10-Feb-85	10	
26	INST 2ND FL DECKING	17	21,23	09-Feb-85	09-Feb-85	26-Feb-85	26-Feb-85		-- C --
27	ERCT STL STAIRS	16	25	31-Jan-85	10-Feb-85	16-Feb-85	26-Feb-85	10	
28	POUR 2ND FL CONCRETE	2	26,27	26-Feb-85	26-Feb-85	28-Feb-85	28-Feb-85		-- C --
29	STRT 2ND FL MASONRY	15	28	28-Feb-85	28-Feb-85	15-Mar-85	15-Mar-85		-- C --
30	CIP CONC LENTELS	15	28	28-Feb-85	28-Feb-85	15-Mar-85	15-Mar-85		-- C --
31	ERCT STL ROOF BEAMS	15	22,24,29,30	15-Mar-85	15-Mar-85	30-Mar-85	30-Mar-85		-- C --
32	ROOF BLOCKOUTS	23	22,24,29,30	15-Mar-85	26-Mar-85	07-Apr-85	18-Apr-85	11	
33	INST ROOF DECKING	19	31	30-Mar-85	30-Mar-85	18-Apr-85	18-Apr-85		-- C --
34	STRT EIFS INSULATION	25	31	30-Mar-85	23-Apr-85	24-Apr-85	18-May-85	24	
35	ROUGH-IN FIRE MAINS	49	31	30-Mar-85	02-Apr-85	18-May-85	21-May-85	3	
36	ROUGH-IN PLMB	49	31	30-Mar-85	02-Apr-85	18-May-85	21-May-85	3	

TABLE C-3. CPM NETWORK FOR SCENARIO C.

ACT NO	ACTIVITY DESCRIPTION	NORM DUR (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
37	ROUGH-IN ELEC	49	31	30-Mar-85	02-Apr-85	18-May-85	21-May-85	3	
38	ROUGH-IN MECH	49	31	30-Mar-85	02-Apr-85	18-May-85	21-May-85	3	
39	FOUNDATION DRAINS	25	31	30-Mar-85	01-Jun-85	24-Apr-85	26-Jun-85	63	
40	BCKFL MASONRY WALL	38	31	30-Mar-85	19-May-85	07-May-85	26-Jun-85	50	
41	MASONRY INSULATION	25	31	30-Mar-85	01-Jun-85	24-Apr-85	26-Jun-85	63	
42	STRT METL STUD FRAMI	9	32,33	18-Apr-85	18-Apr-85	27-Apr-85	27-Apr-85		-- C --
43	INST ROOF SHEATH	19	32,33	18-Apr-85	08-May-85	07-May-85	27-May-85	20	
44	INST EIFS HARDCOAT	26	34	24-Apr-85	18-May-85	20-May-85	13-Jun-85	24	
45	INST EXT WNDW FRAMES	23	34	24-Apr-85	21-May-85	17-May-85	13-Jun-85	27	
46	FNSH EIFS	14	34	24-Apr-85	30-May-85	08-May-85	13-Jun-85	36	
47	INST EXT WNDW GLAZIN	13	44,45,46	20-May-85	13-Jun-85	02-Jun-85	26-Jun-85	24	
48	INST ROOF MEMBRANE	11	43	07-May-85	27-May-85	18-May-85	07-Jun-85	20	
49	INST METAL ROOFING	19	48	18-May-85	07-Jun-85	06-Jun-85	26-Jun-85	20	
50	STRT GYPSUM BOARD	10	42	27-Apr-85	27-Apr-85	07-May-85	07-May-85		-- C --
51	INST BATT INSUL	35	42	27-Apr-85	22-May-85	01-Jun-85	26-Jun-85	25	
52	FNSH MTL STUD FRAMIN	24	42	27-Apr-85	02-Jun-85	21-May-85	26-Jun-85	36	
53	INST OVRHD DOORS	24	42	27-Apr-85	02-Jun-85	21-May-85	26-Jun-85	36	
54	STRT PAINTING	14	50	07-May-85	07-May-85	21-May-85	21-May-85		-- C --
55	FNSH GYPSUM BOARD	17	50	07-May-85	13-May-85	24-May-85	30-May-85	6	
56	STRT SUS CEILING	9	35,36,37,38,48,54	21-May-85	21-May-85	30-May-85	30-May-85		-- C --
57	INST CHAIN HOIST	21	35,36,37,38,48,54	21-May-85	05-Jun-85	11-Jun-85	26-Jun-85	15	
58	FNSH PAINTING	29	35,36,37,38,48,54	21-May-85	28-May-85	19-Jun-85	26-Jun-85	7	
59	PNT FIRE SYS PIPING	21	35,36,37,38,48,54	21-May-85	05-Jun-85	11-Jun-85	26-Jun-85	15	
60	FNSH ELEC	27	52,55,56	30-May-85	30-May-85	26-Jun-85	26-Jun-85		-- C --
61	INST VINYL TILE	21	52,55,56	30-May-85	05-Jun-85	20-Jun-85	26-Jun-85	6	
62	FNSH MECH	23	52,55,56	30-May-85	03-Jun-85	22-Jun-85	26-Jun-85	4	
63	FNSH PLMB	23	52,55,56	30-May-85	03-Jun-85	22-Jun-85	26-Jun-85	4	
64	INST CERAMIC TILE	21	52,55,56	30-May-85	05-Jun-85	20-Jun-85	26-Jun-85	6	
65	HANG DOORS	21	52,55,56	30-May-85	05-Jun-85	20-Jun-85	26-Jun-85	6	
66	FNSH SUS CEILING	23	52,55,56	30-May-85	03-Jun-85	22-Jun-85	26-Jun-85	4	
67	INST KITCHEN EQUIP	23	52,55,56	30-May-85	03-Jun-85	22-Jun-85	26-Jun-85	4	
68	TEST & BALANCE	6	39,40,41,47,49,51 52,53,57,58,59,60 61,62,63,64,65,66 67	26-Jun-85	26-Jun-85	02-Jul-85	02-Jul-85		-- C --
69	FINAL INSP & ACCPTNC	5	68	02-Jul-85	02-Jul-85	07-Jul-85	07-Jul-85		-- C --

PROJECT DURATION (CD): 306

TABLE C-4. CPM NETWORK FOR SCENARIO D.

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
1	SURVEY	6	-	04-Sep-84	04-Sep-84	10-Sep-84	10-Sep-84		-- C --
2	DEMOLITION	6	1	10-Sep-84	10-Sep-84	16-Sep-84	16-Sep-84		-- C --
3	EXCAVATE & FILL	22	2	16-Sep-84	16-Sep-84	08-Oct-84	08-Oct-84		-- C --
4	WINTER SHUTDOWN	0	3	08-Oct-84	08-Oct-84	08-Oct-84	08-Oct-84		-- C --
5	STRT UNDERSLAB ELEC	18	4	08-Oct-84	08-Oct-84	26-Oct-84	26-Oct-84		-- C --
6	STRT UNDERSLAB PLMB	18	4	08-Oct-84	22-Oct-84	26-Oct-84	09-Nov-84	14	
7	STRT FOOTING EXCAV	14	5	26-Oct-84	26-Oct-84	09-Nov-84	09-Nov-84		-- C --
8	FNSH UNDERSLAB ELEC	25	6,7	09-Nov-84	09-Nov-84	04-Dec-84	04-Dec-84		-- C --
9	FNSH UNDERSLAB PLMB	25	6,7	09-Nov-84	09-Nov-84	04-Dec-84	04-Dec-84		-- C --
10	STRT FOOTING FORMS	12	7	09-Nov-84	10-Nov-84	21-Nov-84	22-Nov-84	1	
11	FNSH FOOTING EXCAV	17	7	09-Nov-84	17-Nov-84	26-Nov-84	04-Dec-84	8	
12	STRT FOOTING REBAR	12	10	21-Nov-84	22-Nov-84	03-Dec-84	04-Dec-84	1	
13	FNSH FOOTING FORMS	16	10	21-Nov-84	06-Dec-84	07-Dec-84	22-Dec-84	15	
14	POUR FOOTINGS	18	8,9,11,12	04-Dec-84	04-Dec-84	22-Dec-84	22-Dec-84		-- C --
15	FNSH FOOTING REBAR	12	8,9,11,12	04-Dec-84	10-Dec-84	16-Dec-84	22-Dec-84	6	
16	STRT FOOTING MASONRY	19	13,14,15	22-Dec-84	22-Dec-84	10-Jan-85	10-Jan-85		-- C --
17	SLAB PREPARATION	9	13,14,15	22-Dec-84	26-Jan-85	31-Dec-84	04-Feb-85	35	
18	ERCT W10x45 COLUMNS	19	13,14,15	22-Dec-84	20-Jan-85	10-Jan-85	08-Feb-85	29	
19	POUR SLAB-ON-GRADE	4	17	31-Dec-84	04-Feb-85	04-Jan-85	08-Feb-85	35	
20	STRT 1ST FL MASONRY	29	16	10-Jan-85	10-Jan-85	08-Feb-85	08-Feb-85		-- C --
21	ERCT W8x31 COLUMNS	13	16	10-Jan-85	14-Feb-85	23-Jan-85	27-Feb-85	35	
22	INST METL DR FRAMES	49	16	10-Jan-85	13-Feb-85	28-Feb-85	03-Apr-85	34	
23	ERCT 2ND FL BEAMS	19	18,19,20	08-Feb-85	08-Feb-85	27-Feb-85	27-Feb-85		-- C --
24	REINFRC MASONRY SO W	32	18,19,20	08-Feb-85	02-Mar-85	12-Mar-85	03-Apr-85	22	
25	INST STL STR SUPPORT	8	18,19,20	08-Feb-85	16-Feb-85	16-Feb-85	24-Feb-85	8	
26	INST 2ND FL DECKING	16	21,23	27-Feb-85	27-Feb-85	15-Mar-85	15-Mar-85		-- C --
27	ERCT STL STAIRS	19	25	16-Feb-85	24-Feb-85	07-Mar-85	15-Mar-85	8	
28	POUR 2ND FL CONCRETE	3	26,27	15-Mar-85	15-Mar-85	18-Mar-85	18-Mar-85		-- C --
29	STRT 2ND FL MASONRY	16	28	18-Mar-85	18-Mar-85	03-Apr-85	03-Apr-85		-- C --
30	CIP CONC LENTELS	16	28	18-Mar-85	18-Mar-85	03-Apr-85	03-Apr-85		-- C --
31	ERCT STL ROOF BEAMS	16	22,24,29,30	03-Apr-85	03-Apr-85	19-Apr-85	19-Apr-85		-- C --
32	ROOF BLOCKOUTS	23	22,24,29,30	03-Apr-85	16-Apr-85	26-Apr-85	09-May-85	13	
33	INST ROOF DECKING	20	31	19-Apr-85	19-Apr-85	09-May-85	09-May-85		-- C --
34	STRT EIFS INSULATION	27	31	19-Apr-85	10-May-85	16-May-85	06-Jun-85	21	
35	ROUGH-IN FIRE MAINS	49	31	19-Apr-85	23-Apr-85	07-Jun-85	11-Jun-85	4	
36	ROUGH-IN PLMB	49	31	19-Apr-85	23-Apr-85	07-Jun-85	11-Jun-85	4	

TABLE C-4. CPM NETWORK FOR SCENARIO D.

ACT NO	ACTIVITY DESCRIPTION	NORM DUR (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
37	ROUGH-IN ELEC	49	31	19-Apr-85	23-Apr-85	07-Jun-85	11-Jun-85	4	
38	ROUGH-IN MECH	49	31	19-Apr-85	23-Apr-85	07-Jun-85	11-Jun-85	4	
39	FOUNDATION DRAINS	27	31	19-Apr-85	20-Jun-85	16-May-85	17-Jul-85	62	
40	BCKFL MASONRY WALL	37	31	19-Apr-85	10-Jun-85	26-May-85	17-Jul-85	52	
41	MASONRY INSULATION	27	31	19-Apr-85	20-Jun-85	16-May-85	17-Jul-85	62	
42	STRT METL STUD FRAMI	9	32,33	09-May-85	09-May-85	18-May-85	18-May-85		-- C --
43	INST ROOF SHEATH	19	32,33	09-May-85	29-May-85	28-May-85	17-Jun-85	20	
44	INST EIFS HARDCOAT	27	34	16-May-85	06-Jun-85	12-Jun-85	03-Jul-85	21	
45	INST EXT WNDW FRAMES	24	34	16-May-85	09-Jun-85	09-Jun-85	03-Jul-85	24	
46	FNSH EIFS	12	34	16-May-85	21-Jun-85	28-May-85	03-Jul-85	36	
47	INST EXT WNDW GLAZIN	14	44,45,46	12-Jun-85	03-Jul-85	26-Jun-85	17-Jul-85	21	
48	INST ROOF MEMBRANE	11	43	28-May-85	17-Jun-85	08-Jun-85	28-Jun-85	20	
49	INST METAL ROOFING	19	48	08-Jun-85	28-Jun-85	27-Jun-85	17-Jul-85	20	
50	STRT GYPSUM BOARD	10	42	18-May-85	18-May-85	28-May-85	28-May-85		-- C --
51	INST BATT INSUL	35	42	18-May-85	12-Jun-85	22-Jun-85	17-Jul-85	25	
52	FNSH MTL STUD FRAMIN	25	42	18-May-85	22-Jun-85	12-Jun-85	17-Jul-85	35	
53	INST OVRHD DOORS	25	42	18-May-85	22-Jun-85	12-Jun-85	17-Jul-85	35	
54	STRT PAINTING	14	50	28-May-85	28-May-85	11-Jun-85	11-Jun-85		-- C --
55	FNSH GYPSUM BOARD	17	50	28-May-85	03-Jun-85	14-Jun-85	20-Jun-85	6	
56	STRT SUS CEILING	9	35,36,37,38,48,54	11-Jun-85	11-Jun-85	20-Jun-85	20-Jun-85		-- C --
57	INST CHAIN HOIST	21	35,36,37,38,48,54	11-Jun-85	26-Jun-85	02-Jul-85	17-Jul-85	15	
58	FNSH PAINTING	29	35,36,37,38,48,54	11-Jun-85	18-Jun-85	10-Jul-85	17-Jul-85	7	
59	PNT FIRE SYS PIPING	21	35,36,37,38,48,54	11-Jun-85	26-Jun-85	02-Jul-85	17-Jul-85	15	
60	FNSH ELEC	27	52,55,56	20-Jun-85	20-Jun-85	17-Jul-85	17-Jul-85		-- C --
61	INST VINYL TILE	21	52,55,56	20-Jun-85	26-Jun-85	11-Jul-85	17-Jul-85	6	
62	FNSH MECH	23	52,55,56	20-Jun-85	24-Jun-85	13-Jul-85	17-Jul-85	4	
63	FNSH PLMB	23	52,55,56	20-Jun-85	24-Jun-85	13-Jul-85	17-Jul-85	4	
64	INST CERAMIC TILE	21	52,55,56	20-Jun-85	26-Jun-85	11-Jul-85	17-Jul-85	6	
65	HANG DOORS	21	52,55,56	20-Jun-85	26-Jun-85	11-Jul-85	17-Jul-85	6	
66	FNSH SUS CEILING	23	52,55,56	20-Jun-85	24-Jun-85	13-Jul-85	17-Jul-85	4	
67	INST KITCHEN EQUIP	23	52,55,56	20-Jun-85	24-Jun-85	13-Jul-85	17-Jul-85	4	
68	TEST & BALANCE	6	39,40,41,47,49,51 52,53,57,58,59,60 61,62,63,64,65,66 67	17-Jul-85	17-Jul-85	23-Jul-85	23-Jul-85		-- C --
69	FINAL INSP & ACCPTNC	5	68	23-Jul-85	23-Jul-85	28-Jul-85	28-Jul-85		-- C --

PROJECT DURATION (CD): 327

TABLE C-5. CPM NETWORK FOR SCENARIO E.

ACT NO	ACTIVITY DESCRIPTION	DURATION (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
1	SURVEY	6	-	04-Sep-84	04-Sep-84	10-Sep-84	10-Sep-84		-- C --
2	DEMOLITION	6	1	10-Sep-84	10-Sep-84	16-Sep-84	16-Sep-84		-- C --
3	EXCAVATE & FILL	21	2	16-Sep-84	16-Sep-84	07-Oct-84	07-Oct-84		-- C --
4	WINTER SHUTDOWN	0	3	07-Oct-84	07-Oct-84	07-Oct-84	07-Oct-84		-- C --
5	STRT UNDERSLAB ELEC	17	4	07-Oct-84	07-Oct-84	24-Oct-84	24-Oct-84		-- C --
6	STRT UNDERSLAB PLMB	17	4	07-Oct-84	19-Oct-84	24-Oct-84	05-Nov-84	12	
7	STRT FOOTING EXCAV	12	5	24-Oct-84	24-Oct-84	05-Nov-84	05-Nov-84		-- C --
8	FNSH UNDERSLAB ELEC	21	6,7	05-Nov-84	05-Nov-84	26-Nov-84	26-Nov-84		-- C --
9	FNSH UNDERSLAB PLMB	21	6,7	05-Nov-84	05-Nov-84	26-Nov-84	26-Nov-84		-- C --
10	STRT FOOTING FORMS	9	7	05-Nov-84	08-Nov-84	14-Nov-84	17-Nov-84	3	
11	FNSH FOOTING EXCAV	14	7	05-Nov-84	12-Nov-84	19-Nov-84	26-Nov-84	7	
12	STRT FOOTING REBAR	9	10	14-Nov-84	17-Nov-84	23-Nov-84	26-Nov-84	3	
13	FNSH FOOTING FORMS	14	10	14-Nov-84	28-Nov-84	28-Nov-84	12-Dec-84	14	
14	POUR FOOTINGS	16	8,9,11,12	26-Nov-84	26-Nov-84	12-Dec-84	12-Dec-84		-- C --
15	FNSH FOOTING REBAR	10	8,9,11,12	26-Nov-84	02-Dec-84	06-Dec-84	12-Dec-84	6	
16	STRT FOOTING MASONRY	15	13,14,15	12-Dec-84	12-Dec-84	27-Dec-84	27-Dec-84		-- C --
17	SLAB PREPARATION	5	13,14,15	12-Dec-84	09-Jan-85	17-Dec-84	14-Jan-85	28	
18	ERCT W10x45 COLUMNS	15	13,14,15	12-Dec-84	03-Jan-85	27-Dec-84	18-Jan-85	22	
19	POUR SLAB-ON-GRADE	4	17	17-Dec-84	14-Jan-85	21-Dec-84	18-Jan-85	28	
20	STRT 1ST FL MASONRY	22	16	27-Dec-84	27-Dec-84	18-Jan-85	18-Jan-85		-- C --
21	ERCT W8x31 COLUMNS	10	16	27-Dec-84	23-Jan-85	06-Jan-85	02-Feb-85	27	
22	INST METL DR FRAMES	37	16	27-Dec-84	29-Jan-85	02-Feb-85	07-Mar-85	33	
23	ERCT 2ND FL BEAMS	15	18,19,20	18-Jan-85	18-Jan-85	02-Feb-85	02-Feb-85		-- C --
24	REINFRC MASONRY SO W	25	18,19,20	18-Jan-85	10-Feb-85	12-Feb-85	07-Mar-85	23	
25	INST STL STR SUPPORT	6	18,19,20	18-Jan-85	27-Jan-85	24-Jan-85	02-Feb-85	9	
26	INST 2ND FL DECKING	15	21,23	02-Feb-85	02-Feb-85	17-Feb-85	17-Feb-85		-- C --
27	ERCT STL STAIRS	15	25	24-Jan-85	02-Feb-85	08-Feb-85	17-Feb-85	9	
28	POUR 2ND FL CONCRETE	3	26,27	17-Feb-85	17-Feb-85	20-Feb-85	20-Feb-85		-- C --
29	STRT 2ND FL MASONRY	15	28	20-Feb-85	20-Feb-85	07-Mar-85	07-Mar-85		-- C --
30	CIP CONC LENTELS	15	28	20-Feb-85	20-Feb-85	07-Mar-85	07-Mar-85		-- C --
31	ERCT STL ROOF BEAMS	14	22,24,29,30	07-Mar-85	07-Mar-85	21-Mar-85	21-Mar-85		-- C --
32	ROOF BLOCKOUTS	21	22,24,29,30	07-Mar-85	17-Mar-85	28-Mar-85	07-Apr-85	10	
33	INST ROOF DECKING	17	31	21-Mar-85	21-Mar-85	07-Apr-85	07-Apr-85		-- C --
34	STRT EIFS INSULATION	23	31	21-Mar-85	13-Apr-85	13-Apr-85	06-May-85	23	
35	ROUGH-IN FIRE MAINS	46	31	21-Mar-85	25-Mar-85	06-May-85	10-May-85	4	
36	ROUGH-IN PLMB	46	31	21-Mar-85	25-Mar-85	06-May-85	10-May-85	4	

TABLE C-5. CPM NETWORK FOR SCENARIO E.

ACT NO	ACTIVITY DESCRIPTION	NORM DUR (CD)	PRECEDING ACTIVITIES	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT	CRITICAL ACTIVITY
37	ROUGH-IN ELEC	46	31	21-Mar-85	25-Mar-85	06-May-85	10-May-85	4	
38	ROUGH-IN MECH	46	31	21-Mar-85	25-Mar-85	06-May-85	10-May-85	4	
39	FOUNDATION DRAINS	23	31	21-Mar-85	23-May-85	13-Apr-85	15-Jun-85	63	
40	BCKFL MASONRY WALL	35	31	21-Mar-85	11-May-85	25-Apr-85	15-Jun-85	51	
41	MASONRY INSULATION	23	31	21-Mar-85	23-May-85	13-Apr-85	15-Jun-85	63	
42	STRT METL STUD FRAMI	10	32,33	07-Apr-85	07-Apr-85	17-Apr-85	17-Apr-85		-- C --
43	INST ROOF SHEATH	18	32,33	07-Apr-85	28-Apr-85	25-Apr-85	16-May-85	21	
44	INST EIFS HARDCOAT	26	34	13-Apr-85	06-May-85	09-May-85	01-Jun-85	23	
45	INST EXT WNDW FRAMES	23	34	13-Apr-85	09-May-85	06-May-85	01-Jun-85	26	
46	FNSH EIFS	14	34	13-Apr-85	18-May-85	27-Apr-85	01-Jun-85	35	
47	INST EXT WNDW GLAZIN	14	44,45,46	09-May-85	01-Jun-85	23-May-85	15-Jun-85	23	
48	INST ROOF MEMBRANE	11	43	25-Apr-85	16-May-85	06-May-85	27-May-85	21	
49	INST METAL ROOFING	19	48	06-May-85	27-May-85	25-May-85	15-Jun-85	21	
50	STRT GYPSUM BOARD	9	42	17-Apr-85	17-Apr-85	26-Apr-85	26-Apr-85		-- C --
51	INST BATT INSUL	34	42	17-Apr-85	12-May-85	21-May-85	15-Jun-85	25	
52	FNSH MTL STUD FRAMIN	23	42	17-Apr-85	23-May-85	10-May-85	15-Jun-85	36	
53	INST OVRHD DOORS	23	42	17-Apr-85	23-May-85	10-May-85	15-Jun-85	36	
54	STRT PAINTING	14	50	26-Apr-85	26-Apr-85	10-May-85	10-May-85		-- C --
55	FNSH GYPSUM BOARD	17	50	26-Apr-85	02-May-85	13-May-85	19-May-85	6	
56	STRT SUS CEILING	9	35,36,37,38,48,54	10-May-85	10-May-85	19-May-85	19-May-85		-- C --
57	INST CHAIN HOIST	21	35,36,37,38,48,54	10-May-85	25-May-85	31-May-85	15-Jun-85	15	
58	FNSH PAINTING	29	35,36,37,38,48,54	10-May-85	17-May-85	08-Jun-85	15-Jun-85	7	
59	PNT FIRE SYS PIPING	21	35,36,37,38,48,54	10-May-85	25-May-85	31-May-85	15-Jun-85	15	
60	FNSH ELEC	27	52,55,56	19-May-85	19-May-85	15-Jun-85	15-Jun-85		-- C --
61	INST VINYL TILE	21	52,55,56	19-May-85	25-May-85	09-Jun-85	15-Jun-85	6	
62	FNSH MECH	23	52,55,56	19-May-85	23-May-85	11-Jun-85	15-Jun-85	4	
63	FNSH PLMB	23	52,55,56	19-May-85	23-May-85	11-Jun-85	15-Jun-85	4	
64	INST CERAMIC TILE	21	52,55,56	19-May-85	25-May-85	09-Jun-85	15-Jun-85	6	
65	HANG DOORS	21	52,55,56	19-May-85	25-May-85	09-Jun-85	15-Jun-85	6	
66	FNSH SUS CEILING	23	52,55,56	19-May-85	23-May-85	11-Jun-85	15-Jun-85	4	
67	INST KITCHEN EQUIP	23	52,55,56	19-May-85	23-May-85	11-Jun-85	15-Jun-85	4	
68	TEST & BALANCE	6	39,40,41,47,49,51 52,53,57,58,59,60 61,62,63,64,65,66 67	15-Jun-85	15-Jun-85	21-Jun-85	21-Jun-85		-- C --
69	FINAL INSP & ACCPTNC	6	68	21-Jun-85	21-Jun-85	27-Jun-85	27-Jun-85		-- C --

PROJECT DURATION (CD): 296

APPENDIX D

METHOD FOR DERIVING PRODUCTIVITY AS A FUNCTION OF TEMPERATURE AND RELATIVE HUMIDITY

For the purpose of this report, efficiencies in productivity were solely based on the non-linear equations derived by E. Koehn and G. Brown [12]. In deriving these productivity efficiencies, the authors employed historical data for various activities and crafts encompassing a total of 172 data points. From this data, two nonlinear relationships, shown below as Eqs. 1 and 2, were derived relating productivity with temperature and relative humidity - one for cold or cool weather, and another for warm or hot weather. Eq. 1 is applicable from -20°F to 50°F and Eq. 2 from 70°F to 120°F.

$$P_c = 0.0144T - 0.00313H - 0.000107T^2 - 0.000029H^2 - 0.0000357TH + 0.647 \quad (1)$$

$$P_w = 0.0517T + 0.0173H - 0.00032T^2 - 0.0000985H^2 - 0.0000911TH - 1.459 \quad (2)$$

where

P_c = productivity factor for cool or cold weather;

P_w = productivity factor for warm or hot weather;

T = temperature in degrees Fahrenheit;

and H = relative humidity as a percent.

In order to represent the productivity as a percent of standard efficient operations, Eqs. 1 and 2 were then normalized as a function of their respective maximum values. Also, to obtain a smooth transition between the two curves, productivity at 60°F and 70°F was arbitrarily taken as unity. Applying the aforementioned expressions, the authors developed Table 2-1 which illustrates the resulting relationships between productivity and temperature for various relative humidities. These relationships are graphically illustrated by way of Figure 2-1 found in the text.

For the example project, each month was individually calculated to derive the productivity efficiency for the specific month and site. Again, calculations were made using a Lotus 1-2-3 spreadsheet.

For each month, values of P_c were calculated for each temperature between absolute minimum temperature and 50°F. These values were then normalized by dividing each efficiency value by the maximum value in the series. The appropriate efficiency value was then selected based on the calculated mean monthly temperature.

Procedures for calculating values of P_w are the same with the exception that values were calculated for each temperature between 70°F and the absolute maximum maximum temperature.

APPENDIX E

CALCULATION OF AVERAGE MONTHLY TEMPERATURES USING THE SIMPLE AVERAGE METHOD

For the purpose of this report, the Simple Average Method was used to estimate average monthly temperatures based on the available data over a twenty year period. Procedures used were as follows:

1) Calculate the mean (using the arithmetic mean) daily mean temperature for each day of the month in question.

2) Assuming a straight line trend, calculate the linear trend occurring for each month. The least squares line for a given series is obtained by using a set of normal equations. These equations are derived mathematically [13] but for working purposes they may be obtained by multiplying the type equation through by the coefficients of each unknown (a and b). In this case, the type equation, which is for a straight line, is

$$Y = a + bX$$

where

a = the Y-intercept

b = slope of the given line

X = X coordinate

Y = corresponding Y coordinate

The coefficient of the first unknown (a) is 1. Therefore, multiplying the type equation through by 1 we have

$$Y = a + bX$$

The formula must be summed up for all points. The summation results in

$$\Sigma(Y) = \Sigma a + b\Sigma(X)$$

But, the sum of a equals the number of items times the constant

$$\Sigma a = Na$$

Therefore

$$\text{(I)} \quad \Sigma(Y) = Na + b\,\Sigma(X)$$

The coefficient of the second unknown (b) is X. Multiplying the type equation through by X we obtain

$$XY = aX + bX^2$$

This sums up to

$$\text{(II)} \quad \Sigma(XY) = a\Sigma(X) + b\Sigma(X^2)$$

By the use of these two equations the values of the two unknowns can be determined and the trend fitted.

As an example of the above equations, information for the Table E-4 (Page 74) will be used to demonstrate trend calculations. From Table E-4, the following information is obtained:

$\Sigma X = 406$

$\Sigma Y = 814.4$

$\Sigma XY = 12013.75$

$\Sigma X^2 = 7714$

Combining with equations I and II above the following is obtained:

$$\text{(I)} \quad 814.40 = 29a + 406b$$

$$\text{(II)} \quad 12013.75 = 406a + 7714b$$

$$\text{(II)} \quad 12013.73 = 406a + 7714b$$

$$\text{(III)} \quad \underline{11402.38 = 406a + 5684b} \quad (\text{I} \times 14)$$

$$\text{(IV)} \quad 611.35 = 2030b \quad (\text{II} - \text{III})$$

$$b = 0.30116$$

3) Adjust the mean daily mean temperatures for trend. Each of the averages just computed would then be distorted by the secular trend of the data. If the trend is upward, the adjusted mean daily mean temperature at the end of the month would be higher than it should be in relation to the rest of the days since it occurs later along the trend line.

The increase per month due to trend was determined by fitting a least squares line to the monthly figures and dividing the b value (slope) by the number of days in the month. The resulting value represented the amount each daily average is distorted by the trend as compared to the previous day. This trend adjustment was completed for each month resulting in the listing of average temperatures for the month as seen at the end of this section.

4) With these monthly values established, it was then decided that the temperatures would also require adjustment as the monthly average would also be distorted by the trend

as compared to the previous month. Therefore Steps 1 and 2 were repeated using the monthly values. The results of these calculations follows.

With a line of regression used to estimate a theoretical value of Y for a given value of X, if the relationship is not perfect the actual values will not usually coincide with the theoretical values because of scatter. If the scatter is definitely measured the variation may then be allowed for. For this purpose the standard error of estimate was used to measure the variation or scatter about the line of regression. This standard error of estimate is used similarly to the standard deviation.

Tables E-1 through E-37 utilize the above noted procedures and provide data for the months of January throuh December. This data provides the basis for the productivity efficiency estimates listed in Table 2-3 (Page 14).

TABLE E-1. JANUARY TEMPERATURE STATISTICS

X	Y	X*Y	X^2	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	18	0.00	0	23	0.0000	18
1	19	18.63	1	23	-0.0044	19
2	21	41.60	4	23	-0.0088	21
3	21	62.55	9	23	-0.0132	21
4	23	92.20	16	24	-0.0176	23
5	22	110.13	25	24	-0.0220	22
6	23	137.55	36	24	-0.0264	23
7	25	177.10	49	24	-0.0308	25
8	26	204.00	64	24	-0.0352	25
9	24	217.35	81	24	-0.0396	24
10	26	257.75	100	24	-0.0440	26
11	28	303.05	121	24	-0.0484	28
12	27	328.50	144	25	-0.0528	27
13	28	363.03	169	25	-0.0572	28
14	28	394.45	196	25	-0.0616	28
15	29	439.13	225	25	-0.0660	29
16	27	433.20	256	25	-0.0704	27
17	28	471.75	289	25	-0.0748	28
18	28	508.95	324	25	-0.0792	28
19	27	514.43	361	26	-0.0836	27
20	28	558.50	400	26	-0.0880	28
21	26	549.68	441	26	-0.0924	26
22	25	548.35	484	26	-0.0968	25
23	26	604.33	529	26	-0.1012	26
24	26	620.40	576	26	-0.1056	26
25	28	704.90	625	26	-0.1100	28
26	26	670.15	676	27	-0.1144	26
27	24	645.30	729	27	-0.1188	24
28	24	661.50	784	27	-0.1232	24
29	23	664.83	841	27	-0.1276	23
30	22	666.00	900	27	-0.1320	22
465	775.4	11969.25	9455			

TRENDLINE SLOPE (b) = 0.1363

MON AVG TEMP: 25.02

MON AVG TEMP: (CORRECTED) 24.95

STANDARD ERROR: 2.59

ABSOLUTE MIN MIN TEMPERATURE: -31
MEAN MIN TEMPERATURE: 8

MEAN MAX TEMPERATURE: 42
ABSOLUTE MAX MAX TEMPERATURE: 68

TABLE E-2. MINIMUM DAILY TEMPERATURES FOR JANUARY

RH=74		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
JAN 1	:	-22	10	3	-3	6	0	-18	3	13	-20	6	-4	-5	-16	16	8	14	-4	25	-6	0
JAN 2	:	-23	4	10	5	6	9	-15	2	-19	-17	-10	21	16	-5	3	10	8	-4	15	0	1
JAN 3	:	8	6	-4	5	-6	-24	-4	19	-15	-7	8	11	15	18	6	26	-7	1	17	0	4
JAN 4	:	21	9	-6	4	11	-20	-29	11	-7	14	1	-8	13	8	10	19	10	14	19	-2	5
JAN 5	:	31	22	-6	0	1	-16	-16	-5	-8	6	22	-8	14	20	6	18	13	6	19	8	6
JAN 6	:	13	-3	-7	-4	-1	-12	-10	4	19	36	0	-19	12	14	23	8	-5	8	18	17	6
JAN 7	:	1	1	-5	1	20	1	-8	-10	21	34	5	-18	-11	8	15	9	-31	7	18	21	4
JAN 8	:		3	1	10	28	18	-3	11	21	23	9	-21	2	8	23	8	-22	8	17	8	8
JAN 9	:	-1	3	24	-5	32	14	-13	17	-12	13	28	-11	28	10	27	9	-13	10	15	9	9
JAN 10	:	5	10	27	-1	28	13	-10	-1	-21	18	2	-14	5	-4	24	8	-13	8	16	21	6
JAN 11	:	14	21	-14	8	23	24	-10	11	-8	10	11	-12	-1	36	23	8	-10	4	18	-2	8
JAN 12	:	-3	17	-3	36	15	14	8	32	32	9	9	0	2	22	37	8	-2	3	15	0	13
JAN 13	:	3	13	8	31	22	18	5	27	26	8	7	-11	19	12	35	12	-8	4	15	-7	12
JAN 14	:	5	10	8	26	27	17	-8	19	12	7	8	-10	29	28	32	12	-9	6	5	-2	11
JAN 15	:	11	8	32	18	10	14	-8	11	38	10	6	-12	14	26	19	16	-10	10	4	-3	11
JAN 16	:	9	7	28	16	27	33	-12	27	38	11	6	-13	26	10	30	21	-9	24	4	3	14
JAN 17	:	-8	0	11	5	27	23	-10	19	33	12	9	-13	21	12	27	11	-7	8	0	3	9
JAN 18	:	-11	2	8	11	15	17	8	4	25	11	4	-1	5	10	23	21	19	11	5	6	10
JAN 19	:	-2	10	14	30	14	11	23	7	31	10	4	6	18	-5	17	22	8	11	4	14	12
JAN 20	:	-7	31	12	32	16	21	13	-8	29	13	-6	12	13	-4	10	11	7	-9	4	11	10
JAN 21	:	-11	30	15	26	29	10	26	4	18	12	-6	30	0	12	10	25	1	-14	19	10	12
JAN 22	:	5	22	15	16	39	2	29	-1	-4	10	-4	24	5	1	8	27	-15	5	2	7	10
JAN 23	:	-7	10	12	-4	30	2	22	-10	8	14	4	25	6	-1	7	26	-5	-7	13	17	8
JAN 24	:	5	11	11	15	28	3	-8	-1	10	17	11	18	-16	13	10	15	-2	12	24	1	9
JAN 25	:	-6	2	14	17	12	7	24	14	14	11	-6	5	-7	12	11	5	-1	-1	17	12	8
JAN 26	:	14	4	21	24	21	6	12	3	23		2	10	3	-8	16	10	18	6	20	20	12
JAN 27	:	2	13	13	18	28	3	3	-7	9	14	5	3	-1	-12	28	29	3	30	12	13	10
JAN 28	:	-7	18	-1	6	9	0	20	2	16	-6	5	2	5	-2	21	26	12	-9	10	-4	6
JAN 29	:	11	25	11	-18	7	0	1	4	14	5	5	0	-2	-17	18	22	9	19	10	-5	6
JAN 30	:	20	26	23	1	24	0	-18	0	16	0	8	-2	-2	2	15	0	-11	-1	10	11	6
JAN 31	:	-2	19	5	-27	8	2	-18	13	22	1	8	12	-1	-3	12	7	-10	-15	21	-4	3

TABLE E-3. MAXIMUM DAILY TEMPERATURES FOR JANUARY

RH=74	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
JAN 1	21	49	44	42	38	41	21	37	30	28	28	43	28	25	40	56	38	29	53	33	36	18
JAN 2	33	44	38	41	30	28	21	43	14	31	40	46	45	28	41	60	33	26	49	38	36	19
JAN 3	39	49	34	43	45	14	25	35	26	38	40	35	35	45	40	53	33	34	57	39	38	21
JAN 4	41	53	39	36	39	15	10	26	22	42	48	32	37	40	39	52	35	39	58	39	37	21
JAN 5	48	44	42	42	33	20	23	40	30	50	48	21	39	32	50	54	43	40	58	38	40	23
JAN 6	39	41	39	40	36	20	25	30	29	48	46	22	40	35	49	58	34	43	60	36	39	22
JAN 7	40	38	42	58	45	35	49	37	30	51	55	30	27	34	50	55	20	42	63	37	42	23
JAN 8	55	43	37	50	41	42	35	41	36	42	54	28	40	38	48	51	19	53	60	39	43	25
JAN 9	46	49	47	41	40	51	23	42	24	36	45	40	40	36	47	53	25	51	59	41	42	26
JAN 10	51	54	42	44	48	44	34	34	25	44	45	39	32	49	40	55	25	40	60	40	42	24
JAN 11	44	60	33	47	40	38	38	50	43	45	54	33	45	48	42	50	29	40	60	38	44	26
JAN 12	34	52	42	51	45	29	32	52	48	49	50	40	34	38	48	52	39	42	42	32	43	28
JAN 13	35	53	43	48	44	27	38	53	53	58	52	39	45	34	40	58	28	40	33	35	43	27
JAN 14	44	55	43	47	42	44	30	55	49	51	60	36	45	37	42	60	31	42	40	42	45	28
JAN 15	39	63	50	48	32	54	29	51	56	53	62	35	39	41	46	58	29	40	42	46	46	28
JAN 16	34	56	44	46	42	56	29	47	52	59	62	38	34	33	50	50	33	39	36	45	44	29
JAN 17	28	47	42	46	49	47	33	41	51	61	64	41	44	37	42	51	50	41	39	46	45	27
JAN 18	28	46	50	44	43	48	47	39	57	58	56	43	35	34	35	58	45	46	48	57	46	28
JAN 19	28	54	53	41	46	46	47	29	50	62	47	46	36	35	30	58	30	39	52	55	44	28
JAN 20	24	47	55	42	41	58	48	26	42	63	58	42	38	34	40	58	27	32	48	59	44	27
JAN 21	24	42	53	39	53	45	52	33	33	52	62	40	32	35	49	58	34	29	47	59	44	28
JAN 22	36	38	48	33	53	38	54	25	39	61	58	40	41	37	47	55	23	37	48	43	43	26
JAN 23	28	26	53	27	50	42	41	31	42	64	55	42	36	40	48	52	37	36	49	36	42	25
JAN 24	37	33	57	39	43	45	40	45	48	63	48	44	20	39	54	46	40	41	54	38	44	26
JAN 25	36	28	50	40	47	48	35	38	49	63	49	43	33	31	55	46	55	36	61	35	44	26
JAN 26	38	46	44	38	55	46	28	32	43	58	58	46	42	30	50	48	54	52	48	35	45	28
JAN 27	35	44	31	34	45	45	25	32	50	41	60	47	33	30	54	44	40	48	54	33	41	26
JAN 28	41	52	34	23	36	44	35	44	52	38	63	52	39	21	43	39	42	36	62	37	42	24
JAN 29	45	45	38	28	50	47	27	38	53	30	68	51	34	27	35	36	41	38	58	37	41	24
JAN 30	43	41	32	33	38	46	23	40	53	30	55	61	33	26	46	33	33	34	63	32	40	23
JAN 31	38	47	40	17	48	45	46	41	54	37	58	57	42	31	48	33	37	28	63	28	42	22

TABLE E-4. FEBRUARY TEMPERATURE STATISTICS

X	Y	X*Y	X^2	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	23	0.00	0	24	0.0000	23
1	22	21.98	1	24	-0.0104	22
2	24	47.20	4	24	-0.0208	24
3	26	78.00	9	25	-0.0312	26
4	27	106.70	16	25	-0.0415	27
5	27	134.63	25	25	-0.0519	27
6	24	146.55	36	26	-0.0623	24
7	27	186.20	49	26	-0.0727	27
8	28	227.00	64	26	-0.0831	28
9	27	246.60	81	27	-0.0935	27
10	25	250.25	100	27	-0.1038	25
11	29	315.98	121	27	-0.1142	29
12	28	339.30	144	27	-0.1246	28
13	28	364.00	169	28	-0.1350	28
14	30	413.74	196	28	-0.1454	29
15	27	412.13	225	28	-0.1558	27
16	27	430.40	256	29	-0.1662	27
17	29	500.65	289	29	-0.1765	29
18	32	568.35	324	29	-0.1869	31
19	28	522.98	361	30	-0.1973	27
20	27	539.00	400	30	-0.2077	27
21	30	620.55	441	30	-0.2181	29
22	30	649.00	484	30	-0.2285	29
23	31	702.08	529	31	-0.2389	30
24	30	730.80	576	31	-0.2492	30
25	31	767.50	625	31	-0.2596	30
26	32	821.60	676	32	-0.2700	31
27	33	885.00	729	32	-0.2804	32
28	35	985.60	784	32	-0.2908	35
406	814.4	12013.73	7714			

TRENDLINE SLOPE (b) = 0.3011

MON AVG TEMP: 28.08

MON AVG TEMP: (CORRECTED) 27.94

STANDARD ERROR: 1.47

ABSOLUTE MIN MIN TEMPERATURE: -29
MEAN MIN TEMPERATURE: 10

MEAN MAX TEMPERATURE: 46
ABSOLUTE MAX MAX TEMPERATURE: 71

TABLE E-5. MINIMUM DAILY TEMPERATURES FOR FEBRUARY

RH=76		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
FEB 1	:	13	2	-15	-7	20	4	17	5	31	21	8	9	-6	13	14	-15	-5	-19	15	-7	5
FEB 2	:	-9	-3	11	-11	9	8	-17	12	9	24	1	0	5	7	22	0	-5	-13	14	2	3
FEB 3	:	8	2	19	-20	16	-1	-9	8	9	11	1	1	6	-11	15	-15	0	14	10	9	4
FEB 4	:	22	-2	15	-10	25	8	6	23	11	18	18	3	16	-12	19	-14	-4	-11	11	7	7
FEB 5	:	10	0	20	16	21	19	13	5	18	12	8	6	25	-6	21	-9	5	4	11	-3	10
FEB 6	:	22	-2	20	18	17	20	3	26	10	14	9	10	28	2	24	0	-17	2	13	-3	11
FEB 7	:	0	-1	21	-28	15	6	-8	21	7	23	4	10	23	10	18	-5	-12	11	14	14	7
FEB 8	:	3	-1	20	-16	13	6	-2	18	6	16	6	32	7	1	15	5	5	31	15	15	10
FEB 9	:	-1	6	25	18	22	6	0	2	6	27	30	15	29	5	6	17	1	18	14	4	13
FEB 10	:	16	11	21	6	31	12	-8	20	6	21	8	10	25	5	11	-1	-10	25	12	-25	10
FEB 11	:	-14	8	20	10	32	16	-8	19	7	-16	-15	6	3	4	12	14	-14	29	10	-7	6
FEB 12	:	0	16	19	12	13	16	-1	18	24	11	-6	10	-14	19	18	14	-10	15	11	-2	9
FEB 13	:	-15	21	24	-11	15	17	-6	15	-1	34	1	9	8	31	11	18	16	31	10	0	11
FEB 14	:	-12	20	18	9	8	19	-1	-2	15	1	5	10	-18	24	28	34	34	22	-1	-1	11
FEB 15	:	-4	2	12	20	15	33	10	18	13	0	17	8	-2	5	19		36	7	28	1	13
FEB 16	:	-8	6	17	-17	15	15	0	10	16	4	6	10	0	14	23	11	33	12	20	12	10
FEB 17	:	-7	9	22	-29	15	6	-2	-8	5	0	24	15	-11	10	33	11	25	14	6	18	8
FEB 18	:	5	11	21	15	0	-1	12	-8	15	-8	22	8	8	11	33	21	18	8	2	17	11
FEB 19	:	21	13	28	15	0	15	20	-15	28	15	24	8	-2	22	32	27	16	33	2	17	16
FEB 20	:	-2	0	31	0	5	12	20	-15	6	26	-4	8	-4	11	14	22	24	19	2	21	10
FEB 21	:	0	0	31	-11	18	0	20	-12	11	-1	2	30	-8	26	17	14	26	-3	14	13	9
FEB 22	:	21	7	32	-6	23	12	28	-10	29	-8	15	22	-2	8	19	10	31	-5	10	19	13
FEB 23	:	30	10	32	9	14	20	25	-9	4	2	10	22	-5	14	3	19	15	4	9	17	12
FEB 24	:	27	14	18	16	15	6	25	21	7	5	12	12	-5	-1	10	5	15	4	10	21	12
FEB 25	:	-1	24	17	9	14	22	29	-1	11	13	24	5	-1	8	8	10	17	15	8	19	13
FEB 26	:	16	20	17	-6	15	-1	24	-2	20	8	24	10	10	22	14	15	6	24	9	18	13
FEB 27	:	2	12	16	-17	19	-1	18	15	30	28	12	8	10	3	21	13	24	12	8	17	13
FEB 28	:	2	26	12	12	14	12	28	12	32	19	26	16	15	13	23	16		17	22		18
FEB 29	:			12				28				31				8				21		20

TABLE E-6. MAXIMUM DAILY TEMPERATURES FOR FEBRUARY

RH=76	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
FEB 1	37	37	40	39	45	45	33	34	43	32	62	43	40	33	58	28	40	23	63	36	41	23
FEB 2	34	35	52	29	51	46	22	37	50	36	68	49	35	27	59	30	40	23	57	33	41	22
FEB 3	44	37	52	25	60	41	34	36	58	43	63	53	42	27	62	30	38	36	57	33	44	24
FEB 4	45	38	52	40	57	47	44	43	57	36	48	52	48	42	54	35	36	28	60	29	45	26
FEB 5	43	46	40	36	57	48	36	41	48	37	22	58	42	37	68	42	37	34	61	38	44	27
FEB 6	41	37	40	36	58	44	33	41	40	45	27	54	32	51	55	42	35	42	63	45	43	27
FEB 7	32	41	46	22	59	47	33	41	44	45	22	58	40	55	40	35	29	41	60	44	42	24
FEB 8	29	41	48	33	57	45	32	39	50	48	40	50	40	56	43	35	38	46	61	38	43	27
FEB 9	37	45	38	44	49	44	38	40	53	44	43	51	36	49	55	41	42	46	54	36	44	28
FEB 10	36	53	39	40	44	52	33	40	54	42	42	55	38	51	57	53	41	51	45	34	45	27
FEB 11	29	45	44	47	57	55	35	39	53	33	40	60	32	53	50	48	41	47	40	37	44	25
FEB 12	42	45	48	50	46	57	39	41	46	51	49	66	38	56	54	48	45	47	54	44	48	29
FEB 13	28	49	43	30	37	55	45	43	43	46	48	63	37	48	47	49	54	44	52	42	45	28
FEB 14	42	47	45	41	48	57	44	40	47	44	45	58	25	40	43	51	52	42	52	45	45	28
FEB 15	33	37	45	35	60	47	45	40	58	35	43	70	40	43	44		54	54	47	50	47	30
FEB 16	39	42	42	28	58	46	42	40	50	35	49	71	32	42	35	55	52	51	38	53	45	27
FEB 17	38	45	55	35	42	40	42	36	41	33	57	67	35	50	47	56	53	55	36	57	46	27
FEB 18	47	49	58	35	37	45	52	40	49	35	53	69	40	47	46	62	56	50	43	55	48	29
FEB 19	44	46	57	35	42	39	53	38	50	51	42	69	35	43	38	62	59	40	47	54	47	32
FEB 20	39	36	56	36	42	36	48	38	42	41	43	64	35	41	45	54	65	45	58	41	45	28
FEB 21	39	45	53	30	43	40	50	37	48	30	48	53	36	38	42	53	64	39	57	46	45	27
FEB 22	45	45	59	31	49	35	41	38	47	39	50	40	40	39	45	64	60	47	58	55	46	30
FEB 23	44	47	61	29	55	39	42	40	44	43	52	43	38	42	43	64	58	53	43	55	47	30
FEB 24	40	51	62	29	55	52	44	42	56	43	51	40	48	45	43	55	60	51	55	62	49	31
FEB 25	36	42	63	40	57	42	48	49	57	49	53	42	43	46	46	42	57	46	50	60	48	30
FEB 26	38	46	65	32	58	29	57	45	52	50	57	47	48	43	49	46	55	44	44	60	48	31
FEB 27	42	51	57	36	56	30	61	43	54	56	57	55	43	50	57	49	60	43	55	59	51	32
FEB 28	46	60	57	36	44	36	57	42	48	55	56	51	38	44	47	45		43	58		48	33
FEB 29			57				47				43				46				59		50	35

TABLE E-7. MARCH TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTED DAILY MEAN
0	32	0.00	0	31	0.0000	32
1	29	29.18	1	31	-0.0049	29
2	29	57.47	4	31	-0.0097	29
3	29	86.61	9	32	-0.0146	29
4	30	121.47	16	32	-0.0195	30
5	32	161.84	25	32	-0.0244	32
6	33	200.53	36	32	-0.0292	33
7	33	231.55	49	32	-0.0341	33
8	33	266.95	64	32	-0.0390	33
9	34	306.95	81	32	-0.0438	34
10	33	328.68	100	33	-0.0487	33
11	34	375.16	121	33	-0.0536	34
12	34	408.63	144	33	-0.0585	34
13	32	413.26	169	33	-0.0633	32
14	32	445.05	196	33	-0.0682	32
15	35	519.47	225	33	-0.0731	35
16	34	548.21	256	34	-0.0780	34
17	35	594.55	289	34	-0.0828	35
18	34	608.21	324	34	-0.0877	34
19	34	649.50	361	34	-0.0926	34
20	36	727.37	400	34	-0.0974	36
21	35	741.63	441	34	-0.1023	35
22	36	798.72	484	34	-0.1072	36
23	34	782.61	529	35	-0.1121	34
24	34	816.67	576	35	-0.1169	34
25	33	812.50	625	35	-0.1218	32
26	35	904.53	676	35	-0.1267	35
27	33	898.82	729	35	-0.1315	33
28	34	950.53	784	35	-0.1364	34
29	36	1047.82	841	35	-0.1413	36
30	35	1049.17	900	36	-0.1462	35
465	1033.	15883.63	9455			

TRENDLINE SLOPE (b): 0.1510

MON AVG TEMP: 33.35

MON AVG TEMP: (CORRECTED) 33.28

STANDARD ERROR: 1.41

ABSOLUTE MIN MIN TEMPERATURE: -26
MEAN MIN TEMPERATURE: 16

MEAN MAX TEMPERATURE: 50
ABSOLUTE MAX MAX TEMPERATURE: 77

TABLE E-8. MINIMUM DAILY TEMPERATURES FOR MARCH

RH=64	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
MAR 1 :	21	23	12	5	32	4	16	3	30	21	18	2	31	19	14	26		30	19	17	18
MAR 2 :	11	29	15	-20	-6	-2	37	6	22	35	-10	6	29	5	25	22		30	12	12	14
MAR 3 :	-2	22	13	-1	5	4	40	-10	19	14	-1	12	22	21	11	14		28	11	9	12
MAR 4 :	-4	17	12	19	3	10	31	3	-8	21	-10	18	33	21	17	10		11	12	14	12
MAR 5 :	21	0	13	-17	22	6	18	3	8	30	-10	4	30	21	28	25		12	12	18	13
MAR 6 :	28	10	11	15	11	8	19	10	25	21	-9	10	15	21	20	29		12	16	12	15
MAR 7 :	33	15	23	2	14	10	20	11	30	25	-3	12	11	21	8	20		31	15	18	17
MAR 8 :	33	16	18	-26	28	17	20	6	26	21	8	16	29	21	5	26		26	16	-5	16
MAR 9 :	32	23	19	-13	8	15	20	2	26	18	12	26	31	20	6	19		16	15	11	16
MAR 10 :	32	33	12	9	12	18	30	6	12	21	14	4	25	19	8	19		19	27	27	18
MAR 11 :	23	27	8	-22	1	30	26	12	18	24	26	4	20	20	19	6		19	25	28	17
MAR 12 :	29	24	30	-8	21	30	24	17	25	3	10	19	20	19	9	18		26	22	15	19
MAR 13 :	39	20	23	5	21	6	24	11	25	21	11	9	10	21	18	20		32	24	14	19
MAR 14 :	23	10	16	-19	7	-1	18	13	25	20	17	0	8	19	24	20		21	24	17	14
MAR 15 :	27	3	17	-21	14	25	17	-7	22	10	14	8	2	25	28	19		12	23	18	13
MAR 16 :	30	33	25	-10	14	15	18	4	30	13	22	21	6	25	12	26		16	18	19	18
MAR 17 :	15	33	10	15	21	24	19	25	21	7	20	12	11	15	13	12		13	17	22	17
MAR 18 :	19	23	19	12	6	11	29	15	13	35	32	4	20	18	24	14		22	16	29	19
MAR 19 :	20	17	15	-6	8	14	18	7	14	30	23	10	22	22	15	18		18	21	18	16
MAR 20 :	12	29	5	-1	7	16	18	25	14	33	8	11	16	25	10	17		10	22	29	16
MAR 21 :	21	19	8	23	12	17	31	16	11	27	11	11	30	24	17	19		10	31	16	19
MAR 22 :	21	20	19	3	11	24	34	19	14	10	19	12	22	15	23	18		13	17	18	17
MAR 23 :	14	35	20	3	13	31	11	21	15	2	32	26	17	22	14			14	15	34	19
MAR 24 :	15	22	21	-1	13	11	16	6	11	29	22	19	11	17	7	16		12	14	32	15
MAR 25 :	15	13	19	-9	17	34	37	12	25	25	19	22	12	16	8			17	15	13	17
MAR 26 :	18	30	10	-5	9	30	20	29	31	11	10	8	18	19	8	19		11	14	10	16
MAR 27 :	17	28	14	-1	18	25	18	26	34	9	22	15	22	30	12	16		25	30	24	20
MAR 28 :	17	26	14	6	11	17	8	21	33	4	12	4	19	28	11	20		26	20	12	16
MAR 29 :	17	7	16	9	10	17	23	2	34	7	10	1	26	20	10	23		27	25	14	16
MAR 30 :	18	10	18	14	22	26	7	11	33	15	9	20	36	17	17	19		34	26	7	19
MAR 31 :	18	13	15	28	19	12	10	19	10	21	19	4	33	14	8			30	26	16	18

TABLE E-9. MAXIMUM DAILY TEMPERATURES FOR MARCH

RH=64	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
MAR 1	41	59	60	43	42	36	55	50	45	52	33	33	49	40	44	41		41	64	57	47	32
MAR 2	28	56	59	36	53	39	60	42	40	55	28	35	45	45	43	35		42	61	49	45	29
MAR 3	29	46	58	36	56	46	58	41	31	57	29	39	49	52	49	45		44	60	36	45	29
MAR 4	37	29	60	36	40	52	65	39	36	57	32	43	45	52	50	51		46	59	38	46	29
MAR 5	49	41	50	39	44	48	72	37	47	50	38	58	45	58	42	43		51	60	38	48	30
MAR 6	54	51	48	36	63	49	69	43	51	46	41	57	45	59	38	53		46	64	33	50	32
MAR 7	49	51	47	33	62	50	67	44	45	38	48	59	48	67	40	56		51	63	36	50	33
MAR 8	57	57	44	26	49	54	71	37	35	47	48	62	46	62	42	56		56	61	46	50	33
MAR 9	54	51	41	30	52	53	69	42	50	43	50	53	43	62	46	55		51	64	53	51	33
MAR 10	55	45	43	36	41	51	67	52	52	39	56	35	44	64	48	59		53	56	53	50	34
MAR 11	61	37	59	25	50	52	64	37	54	37	48	56	42	62	43	53		52	56	47	49	33
MAR 12	60	35	56	29	59	48	59	38	53	47	47	52	37	60	50	52		54	57	50	50	34
MAR 13	59	36	44	35	63	38	62	31	60	46	60	36	50	60	55	52		48	55	50	49	34
MAR 14	60	43	45	31	59	48	60	33	62	42	59	39	42	60	53	54		47	55	54	50	32
MAR 15	57	53	45	33	59	48	62	40	65	49	61	41	42	50	43	55		44	50	55	50	32
MAR 16	44	49	44	48	61	56	68	51	62	41	68	41	51	42	46	54		45	53	55	52	35
MAR 17	52	56	39	44	59	45	69	44	61	50	63	39	50	45	56	58		44	50	53	51	34
MAR 18	60	49	37	48	49	48	63	42	58	55	49	47	53	43	43	57		45	67	55	51	35
MAR 19	52	52	42	39	44	60	66	47	54	56	45	56	50	38	53	48		49	69	60	52	34
MAR 20	52	54	52	42	60	63	68	36	56	50	56	54	47	40	52	41		45	70	55	52	34
MAR 21	54	59	62	39	60	63	63	37	56	50	63	66	47	47	39	53		48	67	55	54	36
MAR 22	48	62	60	42	63	65	52	39	56	34	59	67	48	49	39	55		44	69	59	53	35
MAR 23	59	52	56	50	62	56	53	40	61	49	58	54	47	50	54			45	68	54	54	36
MAR 24	60	47	54	42	63	59	61	42	56	56	60	45	50	57	37	61		40	64	46	53	34
MAR 25	61	54	54	39	56	58	53	44	55	48	46	43	56	58	36			48	65	41	51	34
MAR 26	62	48	61	40	53	47	42	43	54	29	57	53	54	55	39	50		46	61	41	49	33
MAR 27	66	58	66	42	50	55	38	43	53	27	45	60	54	43	49	49		51	54	35	49	35
MAR 28	67	50	69	44	57	62	38	38	53	30	49	51	54	45	48	58		46	60	37	50	33
MAR 29	69	32	70	46	53	70	44	35	61	41	52	42	58	50	57	57		59	58	38	52	34
MAR 30	73	42	65	50	42	62	57	48	50	61	67	35	56	48	45	54		55	54	50	53	36
MAR 31	77	35	66	58	36	49	59	46	50	56	57	42	48	50	50			55	53	57	52	35

TABLE E-10. APRIL TEMPERATURE STATISTICS

X	Y	X*Y	X^2	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	36	0.00	0	37	0.0000	36
1	35	34.95	1	37	-0.0041	35
2	35	69.75	4	37	-0.0083	35
3	37	110.55	9	37	-0.0124	37
4	39	155.90	16	37	-0.0165	39
5	38	191.75	25	37	-0.0207	38
6	36	218.10	36	37	-0.0248	36
7	39	273.55	49	38	-0.0290	39
8	40	316.20	64	38	-0.0331	39
9	40	355.73	81	38	-0.0372	39
10	39	390.25	100	38	-0.0414	39
11	39	432.30	121	38	-0.0455	39
12	39	462.00	144	38	-0.0496	38
13	40	514.80	169	38	-0.0538	40
14	39	550.55	196	38	-0.0579	39
15	39	579.38	225	39	-0.0620	39
16	38	612.00	256	39	-0.0662	38
17	38	639.20	289	39	-0.0703	38
18	36	653.85	324	39	-0.0744	36
19	38	720.10	361	39	-0.0786	38
20	38	750.00	400	39	-0.0827	37
21	40	830.03	441	39	-0.0869	39
22	41	892.10	484	39	-0.0910	40
23	41	931.50	529	40	-0.0951	40
24	39	928.20	576	40	-0.0993	39
25	39	973.75	625	40	-0.1034	39
26	38	999.70	676	40	-0.1075	38
27	40	1090.13	729	40	-0.1117	40
28	41	1155.70	784	40	-0.1158	41
29	42	1207.85	841	40	-0.1199	42
435	1156	17039.85	8555			

TRENDLINE SLOPE (b): 0.1240

MON AVG TEMP: 38.53

MON AVG TEMP: (CORRECTED) 38.47

STANDARD ERROR: 1.29

ABSOLUTE MIN MIN TEMPERATURE: -2
MEAN MIN TEMPERATURE: 20

MEAN MAX TEMPERATURE: 57
ABSOLUTE MAX MAX TEMPERATURE: 84

TABLE E-11. MINIMUM DAILY TEMPERATURES FOR APRIL

RH=59	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
APR 1 :	20	15	32	16	4	9	27	11	35	-2	21	30	29	12	21	26	18	19	20	22	19
APR 2 :	18	22	24	9	9	12	17	9	18	10	9	19	30	19	22	22	13	14	19	24	17
APR 3 :	17	13	13	14	10	14	18	-1	11	30	9	12	24	17	11	24	21	12	17	26	16
APR 4 :	20	23	15	9	8	12	32	15	12	21	17	15	30	17	8	16	6	16	17	25	17
APR 5 :	19	25	28	35	10	15	35	13	23	22	23	18	17	19	30	17	17	12	17	24	21
APR 6 :	23	18	19	15	13	26	24	18	29	3	24	18	30	34	31	24	13	11	31	26	22
APR 7 :	24	24	12	4	14	22	22	11	10	-2	19	15	24	29	10	18	5	11	21	26	16
APR 8 :	23	25	12	7	22	16	22	15	21	12	33	46	24	17	16		9	17	21	29	20
APR 9 :	25	18	12	11	14	18	29	21	20	12	6	23	32	36	28	19	20	15	13	26	20
APR 10 :	33	28	15	12	21	39	36	33	16	16	12	20	20	26	13	20	31	14	13	25	22
APR 11 :	24	20	22	12	19	18	30	22	15	30	29	13	22	41	20	22	25	13	28	28	23
APR 12 :	30	24	22	17	11	18	30	19	19	17	21	13	24	34	10	16	29	12	22	25	21
APR 13 :	14	17	11	16	20	26	17	30	9	16	26	20	35	27	14	17	20	12	19	26	20
APR 14 :	15	32	12	16	16	26	6	23	10	28	28	20	30	15	38	19	21	15	23	28	21
APR 15 :	18	25	32	17	8	20	17	23	19	21	17	15	30	18	15	21	22	20	25	33	21
APR 16 :	20	10	26	18	25	19	21	19	16	15	16	19	14	20	13	23	20	20	24	32	20
APR 17 :	25	24	17	16	24	21	16	29	16	15	4	26	13	20	26	23	21	21	28	30	21
APR 18 :	26	24	10	28	13	21	21	5	28	28	32	17	16	8	28	32	22	20	32	29	22
APR 19 :	15	17	14	19	19	20	12	10	29	21	11	8	25	12	18	32	21	21	25	29	19
APR 20 :	9	16	22	25	8	25	8	16	34	30	18	10	35	15	33	24	20	18	22	25	21
APR 21 :	15	22	4	26	17	15	16	24	16	22	16	17	18	21	28	26	20	19	14	24	19
APR 22 :	17	20	5	27	8	9	20	16	17	30	18	25	14	31	26	25	18	22	21	27	20
APR 23 :	16	18	8	29	8	25	23	27	26	25	14	16	20	21	23	30	19	23	21	22	21
APR 24 :	19	19	15	22	11	22	34	21	21	21	21	20	31	26	25	38	26	24	24	22	23
APR 25 :	26	14	11	15	22	16	9	16	8	19	21	33	31	19	22	39	26	26	19	24	21
APR 26 :	40	13	14	19	28	13	12	20	28	11	21	21	24	30	23	39	24	19	14	14	21
APR 27 :	12	29	16	14	0	21	14	26	9	21	7	26	21	24	28	25	24	18	14	19	18
APR 28 :	16	18	9	18	12	25	31	28	23	15	11	22	22	17	35	25	25	18	11	24	20
APR 29 :	17	16	12	24	28	18	32	12	18	12	12	22	25	17	25	29	21	27	23	30	21
APR 30 :	17	15	21	19	30	19	10	22	17	19	18	29	31	25	26	37	22	22	32	7	22

TABLE E-12. MAXIMUM DAILY TEMPERATURES FOR APRIL

RH=59	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
APR 1	80	39	49	48	57	61	57	38	51	37	57	45	50	45	41	58	43	65	51	65	52	36
APR 2	69	34	46	51	57	58	67	38	42	57	65	39	47	51	48	54	42	64	58	72	53	35
APR 3	64	49	52	44	53	59	65	46	52	45	61	53	52	57	49	54	43	49	67	69	54	35
APR 4	68	46	60	52	61	66	58	51	65	46	53	67	44	64	55	62	48	40	66	68	57	37
APR 5	70	44	50	46	66	68	55	58	60	39	58	68	58	69	47	68	51	40	53	72	57	39
APR 6	70	46	53	39	63	65	51	62	57	36	58	72	48	54	50	62	45	46	53	74	55	38
APR 7	71	39	55	41	59	63	58	55	66	38	65	73	36	56	54	60	55	52	66	73	57	36
APR 8	69	51	59	45	55	59	60	59	65	38	54	66	41	66	61		53	59	66	72	58	39
APR 9	61	54	66	45	68	59	61	64	58	47	60	55	55	53	62	68	60	55	60	72	59	40
APR 10	50	51	69	49	66	58	51	55	52	48	58	55	70	46	55	66	61	50	59	69	57	40
APR 11	52	36	66	51	56	63	46	62	58	43	54	58	68	54	55	57	50	45	63	71	55	39
APR 12	56	48	60	54	57	68	47	60	55	48	46	67	66	63	68	66	55	37	64	74	58	39
APR 13	63	56	57	52	45	63	37	50	58	58	45	59	55	66	70	66	57	42	71	78	57	39
APR 14	69	47	64	49	40	54	57	48	63	51	48	60	55	70	64	69	56	49	73	77	58	40
APR 15	74	38	58	49	48	65	57	50	63	42	42	69	45	66	68	69	56	55	71	72	58	39
APR 16	74	50	50	51	42	62	59	62	66	39	32	71	38	62	71	68	60	59	69	70	58	39
APR 17	65	50	35	58	47	57	54	52	67	42	53	61	53	42	71	72	64	56	64	52	56	38
APR 18	50	37	47	52	53	40	45	47	59	48	55	55	59	46	72	63	65	55	52	64	53	38
APR 19	42	35	55	66	47	59	44	43	51	52	65	57	58	58	74	50	60	62	43	54	54	36
APR 20	55	41	50	70	47	53	59	42	50	57	66	65	51	62	64	61	59	57	46	48	55	38
APR 21	55	33	43	70	37	45	61	51	68	60	65	67	47	64	50	66	65	58	60	55	56	38
APR 22	53	39	52	66	42	53	64	63	67	55	64	69	58	58	44	74	70	60	70	64	59	40
APR 23	63	44	63	54	52	52	66	63	55	53	69	76	65	50	47	75	70	56	70	65	60	41
APR 24	70	43	55	43	62	41	53	63	45	51	68	72	59	56	61	70	66	53	65	62	58	41
APR 25	70	46	64	41	52	43	57	69	46	42	55	67	51	57	68	67	70	54	57	55	57	39
APR 26	67	55	64	53	45	53	62	70	48	40	48	66	53	65	68	59	70	51	41	53	57	39
APR 27	60	49	60	61	35	53	64	67	55	47	53	71	62	64	68	65	71	54	44	67	59	38
APR 28	63	36	72	65	38	60	66	63	54	58	61	70	59	65	67	77	73	54	40	69	61	40
APR 29	65	39	72	63	47	64	57	53	65	56	69	69	56	69	64	84	67	57	44	71	62	41
APR 30	70	45	68	63	53	67	62	53	72	53	73	66	53	65	64	82	68	55	46	50	61	42

TABLE E-13. MAY TEMPERATURE STATISTICS

X	Y	X*Y	X^2	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	44	0.00	0	43	0.0000	44
1	45	45.05	1	43	-0.0100	45
2	45	89.70	4	44	-0.0200	45
3	44	131.55	9	44	-0.0300	44
4	44	175.47	16	44	-0.0401	44
5	43	217.25	25	44	-0.0501	43
6	43	257.05	36	45	-0.0601	43
7	44	310.21	49	45	-0.0701	44
8	45	362.11	64	45	-0.0801	45
9	45	401.85	81	46	-0.0901	45
10	44	443.50	100	46	-0.1001	44
11	46	504.26	121	46	-0.1102	46
12	47	565.20	144	47	-0.1202	47
13	48	622.05	169	47	-0.1302	48
14	47	661.50	196	47	-0.1402	47
15	48	712.50	225	48	-0.1502	47
16	47	753.60	256	48	-0.1602	47
17	48	813.45	289	48	-0.1702	48
18	50	891.00	324	48	-0.1803	49
19	49	938.50	361	49	-0.1903	49
20	50	998.95	400	49	-0.2003	50
21	51	1060.50	441	49	-0.2103	50
22	50	1104.40	484	50	-0.2203	50
23	49	1129.30	529	50	-0.2303	49
24	51	1215.00	576	50	-0.2403	50
25	51	1286.18	625	51	-0.2504	51
26	52	1349.40	676	51	-0.2604	52
27	51	1382.68	729	51	-0.2704	51
28	52	1458.10	784	52	-0.2804	52
29	51	1478.28	841	52	-0.2904	51
30	51	1523.25	900	52	-0.3004	50
465	1474	22881.85	9455			

TRENDLINE SLOPE (b): 0.3104

MON AVG TEMP: 47.55

MON AVG TEMP: (CORRECTED) 47.40

STANDARD ERROR: 0.91

ABSOLUTE MIN MIN TEMPERATURE: 6
MEAN MIN TEMPERATURE: 28

MEAN MAX TEMPERATURE: 67
ABSOLUTE MAX MAX TEMPERATURE: 87

TABLE E-14. MINIMUM DAILY TEMPERATURES FOR MAY

RH=57	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
MAY 1 :	16	12	20	27	13	21	14	15	20	27	22	32	35	29	23	31	23	18	31	28	23
MAY 2 :	22	25	19	18	12	25	18	18	28	18	28	16	22	35	25	35	24	18	31	40	24
MAY 3 :	26	16	20	28	11	32	21	6	26	26	21	25	23	26	31	20	23	24	46	33	24
MAY 4 :	29	32	19	27	26	28	23	14	28	12	19	12	24	26	28	22	33	22	38	22	24
MAY 5 :	33	27	19	31	23	30	25	16	21	19	38	32	32	44	30	32		24	20	26	27
MAY 6 :	43	30	23	22	35	33	19	16	24	20	27	8	18	40	28	21	23	23	18	27	25
MAY 7 :	28	23	13	27	15	34	17	26	26	21	31	8	18	30	23	16		19	18	28	22
MAY 8 :	31	30	24	24	18	22	32	24	28	14	26	28	22	28	34	18		24	19	29	25
MAY 9 :	43	41	20	28	22	33	26	18	26	16	32	29	27	19	25	27		25	18	28	26
MAY 10 :	40	28	16	28	38	30	17	26	28	20	25	30	27	21	23	30	21	24	33	26	27
MAY 11 :	29	22	16	28	11	30	16	26	21	31	29	21	33	19	27	29	23	23	44	25	25
MAY 12 :	19	13	30	32	34	37	18	19	31	21	20	31	27	21	36	31		19	38	24	26
MAY 13 :	24	16	29	28	25	37	22	32	34	20	25	31	27	22	28	31	19	23	33	24	27
MAY 14 :	29	16	12	25	21	27	24	34	26	28	35	21	40	26	35	36	35	20	33	37	28
MAY 15 :	22	23	15	20	18	29	25	32	41	23	20	21	37	29	31	29	38	27	34	24	27
MAY 16 :	27	26	19	24	20	37	32	31	33	28	24	24	32	34	28	29	29	22	27	23	27
MAY 17 :	24	29	19	26	27	21	37	36	26	28	31	19	22	34	30	22	31	22	24	28	27
MAY 18 :	25	26	26	26	32	13	23	36	23	28	22	16	22	36	27	42	37	20	42	33	28
MAY 19 :	28	24	31	19	45	23	29	34	23	34	35	32	28	31	32	39		36	37	34	31
MAY 20 :	31	31	46	22	24	27	23	46	16	22	31	21	28	28	34		34	29	36	25	29
MAY 21 :	39	33	40	26	22	27	29	30	21	22	37	21	30	32	40		35	27	34	29	30
MAY 22 :	45	36	20	31	24	34	23	24	29	24	22	32	34	35	31	26	40	25	36	32	30
MAY 23 :	25	34	16	28	36	25	24	28	27	26	26	38	36	41	29	40	35	27	35	35	31
MAY 24 :	28	34	17	29	22	32	29	30	28	25	23	34	22	32	28	42	40	24	35	36	30
MAY 25 :	33	31	33	27	28	28	24	38	31	26	25	21	14	34	16	50	35	36	45	33	30
MAY 26 :	35	36	25	35	28	41	31	24	31	24	23	26	26	36	22	45		33	33	30	31
MAY 27 :	34	39	29	38	34	27	31	19	37	26	35	24	31	38	27	32	30	37	33	29	32
MAY 28 :	38	32	31	25	20	23	30	33	41	27	35	18	34	31	33		25	37	37	33	31
MAY 29 :	42	30	29	29	26	23	36	36	33	28	17	21	34	32	37	35	30	33	41	37	31
MAY 30 :	30	26	31	30	29	23	36	45	26	25	27	23	34	29	29	36	29	32	42	22	30
MAY 31	24	34	27	29	24	19	34	40	30	32	46	29	24	25	24	35	27	29	38	39	30

TABLE E-15. MAXIMUM DAILY TEMPERATURES FOR MAY

RH=57	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
MAY 1	75	50	71	67	64	67	70	60	64	57	71	54	53	61	66	80	72	55	53	77	64	44
MAY 2	74	54	71	60	70	62	72	65	70	62	67	62	62	62	68	75	73	59	65	72	66	45
MAY 3	74	57	66	60	71	53	73	63	64	55	71	57	67	71	70	65	72	67	65	69	66	45
MAY 4	71	54	67	50	71	57	68	58	63	45	69	62	65	70	71	67	69	66	63	64	64	44
MAY 5	70	51	59	62	67	52	68	47	69	46	64	56	60	66	68	65		46	59	70	60	44
MAY 6	77	61	60	68	58	58	68	66	76	53	55	44	51	52	66	60	74	61	62	70	62	43
MAY 7	77	68	63	71	57	59	68	65	77	62	61	40	60	46	64	66		63	76	64	64	43
MAY 8	71	70	68	76	59	53	60	70	77	62	66	40	68	40	55	69		64	77	64	64	44
MAY 9	65	64	61	70	61	58	58	73	73	63	66	50	66	46	60	73		72	76	62	64	45
MAY 10	66	48	65	72	52	64	65	73	71	69	71	49	62	59	55	73	54	57	79	51	63	45
MAY 11	65	45	60	72	51	61	68	76	77	69	71	49	62	68	49	75	56	58	75	64	64	44
MAY 12	65	49	55	71	50	66	72	76	72	68	77	43	75	73	51	74		61	80	63	65	46
MAY 13	70	54	53	69	65	64	74	74	67	75	80	54	74	72	55	76	69	62	76	71	68	47
MAY 14	65	68	54	63	66	69	75	67	68	73	71	63	70	74	55	72	66	68	76	71	68	48
MAY 15	70	73	63	69	78	70	73	72	66	70	77	58	62	74	64	51	69	66	58	69	68	47
MAY 16	71	76	65	74	80	65	67	76	57	70	77	52	51	74	68	51	73	65	67	72	68	48
MAY 17	72	74	68	74	76	53	62	77	46	70	72	47	64	77	69	68	70	69	64	76	67	47
MAY 18	74	73	74	66	72	62	62	75	43	74	72	54	65	75	72	64	64	71	72	75	68	48
MAY 19	79	78	73	68	65	61	61	63	43	66	70	58	68	75	77	57		72	82	71	68	50
MAY 20	77	80	67	71	73	63	47	67	58	59	68	68	71	78	76		74	76	79	71	70	49
MAY 21	72	82	61	74	70	57	56	70	68	47	68	68	70	80	76		75	82	74	74	70	50
MAY 22	74	82	54	73	73	55	64	70	69	61	70	65	68	77	71	71	81	80	82	77	71	51
MAY 23	73	81	56	74	72	67	67	70	67	68	70	58	62	72	55	73	75	79	82	76	70	50
MAY 24	79	75	62	74	68	61	64	70	75	73	68	56	51	70	42	72	81	83	74	76	69	49
MAY 25	81	75	70	71	73	68	75	62	79	66	70	58	59	78	50	69	81	84	76	72	71	51
MAY 26	79	74	75	70	73	62	82	65	82	70	76	58	64	79	56	68		82	83	73	72	51
MAY 27	76	71	80	71	70	50	80	73	73	68	73	65	68	74	58	78	80	85	84	69	72	52
MAY 28	76	63	79	76	71	54	78	79	74	63	68	68	78	74	52		70	86	87	67	72	51
MAY 29	72	61	74	79	73	62	80	81	70	70	76	78	75	66	62	79	67	82	87	60	73	52
MAY 30	65	62	73	79	73	58	79	77	69	77	68	80	70	66	58	76	73	80	82	70	72	51
	61	57	77	78	75	49	78	68	75	81	68	83	70	70	60	79	73	78	73	69	71	51

TABLE E-16. JUNE TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	51	0.00	0	51	0.0000	51
1	51	51.10	1	52	-0.0088	51
2	52	103.79	4	52	-0.0175	52
3	53	157.74	9	52	-0.0263	53
4	54	214.74	16	53	-0.0351	54
5	55	273.68	25	53	-0.0438	55
6	54	321.47	36	53	-0.0526	54
7	53	368.97	49	53	-0.0614	53
8	53	423.16	64	54	-0.0701	53
9	53	479.03	81	54	-0.0789	53
10	53	531.25	100	54	-0.0877	53
11	54	594.00	121	54	-0.0964	54
12	54	650.70	144	55	-0.1052	54
13	55	708.83	169	55	-0.1140	54
14	55	766.85	196	55	-0.1228	55
15	56	839.25	225	55	-0.1315	56
16	57	908.00	256	56	-0.1403	57
17	56	949.88	289	56	-0.1491	56
18	56	1011.60	324	56	-0.1578	56
19	57	1085.38	361	56	-0.1666	57
20	58	1156.50	400	57	-0.1754	58
21	57	1203.83	441	57	-0.1841	57
22	58	1268.85	484	57	-0.1929	57
23	57	1320.78	529	58	-0.2017	57
24	57	1378.20	576	58	-0.2104	57
25	58	1450.63	625	58	-0.2192	58
26	59	1535.30	676	58	-0.2280	59
27	59	1586.25	729	59	-0.2367	59
28	58	1629.60	784	59	-0.2455	58
29	58	1681.28	841	59	-0.2543	58
435	1659	24650.60	8555			

TRENDLINE SLOPE (b): 0.2630

MON AVG TEMP: 55.31

MON AVG TEMP: (CORRECTED) 55.18

STANDARD ERROR: 0.71

ABSOLUTE MIN MIN TEMPERATURE: 17
MEAN MIN TEMPERATURE: 35

MEAN MAX TEMPERATURE: 76
ABSOLUTE MAX MAX TEMPERATURE: 94

TABLE E-17. MINIMUM DAILY TEMPERATURES FOR JUNE

RH=51	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
JUN 1 :	32	23	32	31	28	20	36	42	31	43	27	41	29	29	27	37	27	27	30	29	31
JUN 2 :	27	29	37	34	31	25	37	25	34	32	24	30	30	29	38	49	30	28	31	29	31
JUN 3 :	23	26	41	35	33	27	34	29	30	30	42	28	32	31		35	17	39	29	36	31
JUN 4 :	30	28	34	35	33	29	35	29	32	27	19	31	35	37		37	33	39	29	34	32
JUN 5 :	24	39	37	34	30	29	37	32	37	33	17	36	36	36		42	25	31	42	34	33
JUN 6 :	43	30	30	35	32	31	46	32	34	37	26	42	34	36		43	25	30	48	41	36
JUN 7 :	37	34	28	34	30	33	46	31	33	33	34	40	36	34		51	21	31	34	39	35
JUN 8 :	47	35	32	41	40	34	40	36	22	32	25	36	33	18		50	29	28	28	37	34
JUN 9 :	35	29	25	35	35	33	42	33	27	29	33	43	42	23		51	30	34	27	41	34
JUN 10 :	32	29	30	39	39	33	37	37	35	27	36	36	45	31	26	48	33	34	32	38	35
JUN 11 :	24	32	30	28	20	31	29	44	38	37	22	29	29	31	39	43	39	36	31	39	33
JUN 12 :	30	33	30	40	32	33	30	36	35	38	22	35	35	31	44	48	35	30	35	43	35
JUN 13 :	32	39	31	33	28	37	34	42	36	34	28	41	44	44	29	24	32	31	35	46	35
JUN 14 :	37	29	31	34	27	30	36	34	38	38	18	34	40	48	37	30	34	31	38	42	34
JUN 15 :	36	29	32	37	25	35	35	22	37	35	29	35	27	22	39	26	37	32	35	45	33
JUN 16 :	43	33	32	39	34	34	35	28	36	39	42	37	24	27	36	34	37	36	37	47	36
JUN 17 :	34	32	34	42	32	29	35	23	34	44	39	46	27	37	38	35	38	39	39	45	36
JUN 18 :	35	39	36	41	31	29	37	27	30	28	32	52	42	24	37	37	36	35	36	46	36
JUN 19 :	36	35	34	36	35	36	38	29	36	29	36	40	26	27	38	40	38	30	41	45	35
JUN 20 :	41	38	33	34	36	33	40	33	31	41	39	35	31	32	38	47	37	39	33	51	37
JUN 21 :	35	40	28	41	40	39	34	42	37	32	40	48	28	35	33	40	35	29	32	60	37
JUN 22 :	34	30	38	39	36	33	37	40	40	37	31	36	28	33	38	41	39	28	35	44	36
JUN 23 :	37	32	36	38	37	33	36	42	33	42	27	38	41	32	39	42	41	37	35	47	37
JUN 24 :	27	34	34	43	37	33	30	47	30	39	25	42	47	36	35	43	38	35	35	46	37
JUN 25 :	28	38	31	41	40	35	32	36	42	18	30	48	28	32	44	43	34	32	45	38	36
JUN 26 :	32	40	33	36	32	36	34	46	30	27	25	40	30	35	45	44	41	35	43	31	36
JUN 27 :	36	39	40	32	40	41	38	49	34	28	27	41	40	34	33	46	41	34	43	36	38
JUN 28 :	40	39	38	20	33	33	40	36	34	26	33	46	37	36	43	45	45	36	47	37	37
JUN 29 :	42	40	27	27	29	31	42	44	38	27	48	44	35	41	39	47	40	33	54	35	38
JUN 30 :	33	43	21	29	26	32	42	32	36	28	39	51	35	39	48	48	34	35	41	38	37

TABLE E-18. MAXIMUM DAILY TEMPERATURES FOR JUNE

RH=51	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
JUN 1	64	51	80	78	82	52	78	64	78	78	71	76	69	72	64	78	71	64	76	59	70	51
JUN 2	61	59	83	78	82	61	72	69	77	74	72	80	70	78	60	73	70	63	73	60	71	51
JUN 3	66	68	75	81	83	61	73	67	77	70	68	81	73	80		79	66	68	72	67	72	52
JUN 4	66	68	70	78	79	65	70	73	75	75	71	86	71	80		87	63	69	74	72	73	53
JUN 5	70	61	67	78	80	68	68	77	75	80	72	87	72	81		86	63	75	74	75	74	54
JUN 6	69	67	61	74	78	74	67	80	77	77	73	81	80	78		82	63	77	64	83	74	55
JUN 7	66	66	50	74	73	75	66	83	74	77	70	78	79	73		78	68	76	67	84	72	54
JUN 8	66	68	62	67	64	73	67	84	74	70	67	72	83	68		76	73	76	66	84	72	53
JUN 9	67	66	65	57	63	68	65	81	80	73	64	67	79	80		80	77	78	69	84	72	53
JUN 10	74	66	72	63	59	71	62	76	85	76	58	67	68	82	74	79	79	76	62	83	72	53
JUN 11	77	67	72	65	65	72	71	77	85	77	66	72	74	82	72	76	79	70	68	87	74	53
JUN 12	78	63	72	68	59	75	78	76	86	76	71	73	73	80	67	75	72	69	67	87	73	54
JUN 13	83	57	74	72	58	72	79	70	85	83	68	72	72	76	64	69	69	87	73	86	73	54
JUN 14	86	67	79	74	60	78	78	62	84	84	70	75	70	73	71	66	79	80	72	87	75	55
JUN 15	83	73	81	67	67	82	79	65	80	84	80	77	67	72	81	79	80	82	71	91	77	55
JUN 16	78	73	83	58	70	79	77	64	74	76	78	81	70	68	81	81	82	84	79	92	76	56
JUN 17	84	78	84	59	76	76	79	70	71	74	80	72	75	62	86	84	84	83	80	91	77	57
JUN 18	85	77	86	59	81	71	81	70	72	57	80	72	71	64	81	85	75	86	78	94	76	56
JUN 19	84	69	83	71	84	76	82	80	68	60	83	68	77	72	82	89	73	78	75	89	77	56
JUN 20	75	78	81	71	86	83	79	81	77	59	77	69	75	75	82	87	75	76	73	84	77	57
JUN 21	73	77	83	71	85	80	81	78	82	72	68	75	75	75	78	93	77	80	75	87	78	58
JUN 22	68	74	88	69	85	83	74	76	82	75	70	83	75	80	73	92	80	79	81	89	79	57
JUN 23	68	79	84	68	81	77	69	74	83	70	73	86	73	84	73	92	82	75	86	85	78	58
JUN 24	74	81	81	68	82	78	70	82	80	61	78	87	68	83	76	91	78	80	86	77	78	57
JUN 25	80	83	82	68	80	77	77	87	75	72	79	84	72	84	76	91	79	81	84	71	79	57
JUN 26	84	82	88	67	81	74	78	90	79	75	83	82	67	85	76	90	83	79	84	79	80	58
JUN 27	87	80	84	68	82	67	83	82	84	72	85	86	59	84	86	90	79	81	89	82	81	59
JUN 28	85	83	78	68	79	67	86	81	89	72	84	82	68	85	86	88	76	82	86	81	80	59
JUN 29	80	87	72	73	65	75	89	80	86	72	78	79	73	80	81	88	59	80	86	82	78	58
JUN 30	82	90	77	79	76	79	89	76	88	70	76	84	75	79	79	82	61	78	86	83	79	58

TABLE E-19. JULY TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	58	0.00	0	59	0.0000	58
1	58	58.08	1	59	-0.0052	58
2	59	117.00	4	59	-0.0104	58
3	60	179.48	9	59	-0.0156	60
4	60	241.30	16	59	-0.0208	60
5	59	295.79	25	59	-0.0259	59
6	58	350.70	36	60	-0.0311	58
7	60	417.38	49	60	-0.0363	60
8	60	476.42	64	60	-0.0415	60
9	60	536.63	81	60	-0.0467	60
10	60	596.00	100	60	-0.0519	60
11	61	668.80	121	60	-0.0571	61
12	62	741.30	144	61	-0.0623	62
13	62	803.73	169	61	-0.0674	62
14	62	868.35	196	61	-0.0726	62
15	62	922.50	225	61	-0.0778	61
16	62	985.60	256	61	-0.0830	62
17	61	1043.38	289	61	-0.0882	61
18	62	1107.45	324	62	-0.0934	61
19	61	1166.60	361	62	-0.0986	61
20	62	1236.00	400	62	-0.1038	62
21	62	1306.20	441	62	-0.1089	62
22	63	1382.53	484	62	-0.1141	63
23	62	1433.26	529	62	-0.1193	62
24	63	1511.40	576	63	-0.1245	63
25	63	1575.00	625	63	-0.1297	63
26	63	1645.15	676	63	-0.1349	63
27	63	1701.68	729	63	-0.1401	63
28	63	1751.47	784	63	-0.1453	62
29	63	1818.30	841	63	-0.1504	63
30	62	1856.25	900	63	-0.1556	62
465	1893	28793.69	9455			

TRENDLINE SLOPE (b): 0.1608

MON AVG TEMP: 61.06

MON AVG TEMP: (CORRECTED) 60.99

STANDARD ERROR: 0.67

ABSOLUTE MIN MIN TEMPERATURE; 21
MEAN MIN TEMPERATURE: 39

MEAN MAX TEMPERATURE: 83
ABSOLUTE MAX MAX TEMPERATURE: 96

TABLE E-20. MINIMUM DAILY TEMPERATURES FOR JULY

RH=41	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
JUL 1 :	32	46	29	29	31	35	37	30	45	28	21	46	35	31	49	48	29	38	41	38	36
JUL 2 :	43	44	33	29	35	37	38	32	33	26	21	48	30	29	46	46	36	35	46	38	36
JUL 3 :	23	43	33	26	39	34	40	32	34	27	39	38	28	39	38	45	34	32	48	45	36
JUL 4 :	30	42	33	29	49	36	39	36	39	32	31	45	31	34	34	43	37	34	47	45	37
JUL 5 :	32	49	36	28	52	37	39	39	38	41	31	25	36	36	38	50	34	47	46	43	39
JUL 6 :	32		36	40	38	30	36	36	34	37	33	30	37	34	37	54	35	42	45	48	38
JUL 7 :	40	38	42	30	36	32	33	35	37	37	26	32	39	28	32	47	40	33	45	44	36
JUL 8 :	44	35	46	36	39	32	39	39	51	37	28	29	35	26	38	45	46	31	49	46	39
JUL 9 :	43		41	35	48	27	41	35	49	42	32	32	40	49	36	47	37	31	45	45	40
JUL 10 :	32	32	34	36	48	33	37	44	49	58	34	26	36	39	35	42	40	30	40	55	39
JUL 11 :	26	39	36	46	36	30	38	44	25	42	37	31	34	33	31	34	41	32	40	46	36
JUL 12 :	30	43	40	39	41	36	39	36	32	44	34	36	28	37	37	36	42	38	42	45	38
JUL 13 :	28	48	35	49	42	38	40	43	36	38	33	31	39	37	41	30	39	41	44	47	39
JUL 14 :	26	50	35	40	46	40	39	38	39	39	32	32	39	43	37	24	42	45	44	46	39
JUL 15 :	27	48	39	41	51	42	40	37	51	36	35	35	40	42	42	34	40	38	44	45	40
JUL 16 :	27	53	39	36	37	47	41	39	39	42	46	35	33	41	41	45	39	32	46	45	40
JUL 17 :	26	45	33	39	36	45	38	37	35	39	43	47	35	42	44	42	34	40	54	43	40
JUL 18 :	31	41	36	42	46	50	40	37	37	38	33	42	37	36	39	35	39	28	54	43	39
JUL 19 :	35	35	38	45	46	46	35	32	36	40	36	42	33	36	36	33	40	33	50	45	39
JUL 20 :	39	31	34	46	46	45	44	36	38	43	32	34	31	46	42	37	42	26	48	52	40
JUL 21 :	40	32	41	45	44	45	26	31	41	39	31	37	39	52	44	39	42	32	52	54	40
JUL 22 :	39	40	41	45	36	44	29	31	41	42	35	42	39	46	48	34	43	36	49	41	40
JUL 23 :	41	38	36	57	35	42	34	31	41	40	52	33	41	39	46	42	42	32		41	40
JUL 24 :	41	42	36	46	37	44	29	29	41	40	51	28	39	44	45	37	44	32		44	39
JUL 25 :	41	43	36	42	38	45	28	34	51	41	42	26	47	43	44	35	42	36	44	45	40
JUL 26 :	38	39	39	42	38	42	32	35	46	41	46	26	58	37	47	35	45	36	46	44	41
JUL 27 :	40	41	41	46	39	45	32	35	45	41	45	30	53	35	47	37	47	36	46	40	41
JUL 28 :	38	45	47	39	33	44	32	33	45	48	51	30	40	34	47	40	47	37	44	43	41
JUL 29 :	40	45	51	45	39	44	42	33	52	41	40	28	39	35	52	36	43	40		39	41
JUL 30 :	60	44	57	45	33	46	55	34	48	35	43	30	42	37	46	32	44	31	46	38	42
JUL 31 :	52	44	54	35	33	44	42	40	45	26	51	32	40	38	52	33	42	51	44	36	42

TABLE E-21. MAXIMUM DAILY TEMPERATURES FOR JULY

RH=41	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
JUL 1	77	91	82	80	80	81	88	79	82	73	77	79	73	78	76	84	69	77	87	84	80	58
JUL 2	72	88	80	80	85	77	87	82	81	76	80	75	68	78	74	85	76	77	89	88	80	58
JUL 3	81	83	82	78	84	78	86	85	84	76	84	74	65	79	77	86	70	85	94	92	81	59
JUL 4	82	82	85	78	86	71	86	90	86	80	84	72	74	77	77	94	73	88	94	88	82	60
JUL 5	87	80	86	78	80	78	80	89	80	82	87	76	78	76	76	86	76	86	89	86	82	60
JUL 6	81		85	75	82	78	79	86	76	83	84	81	81	77	75	82	77	83	84	85	81	59
JUL 7	76	78	84	74	83	77	77	85	75	85	87	82	78	79	81	83	76	84	84	84	81	58
JUL 8	71	78	83	76	83	77	80	85	65	89	88	79	80	79	78	86	84	83	83	87	81	60
JUL 9	72		77	78	72	76	76	88	63	86	88	78	81	79	76	84	80	83	82	89	79	60
JUL 10	77	85	78	81	74	76	80	85	61	84	90	78	78	79	80	82	85	78	87	87	80	60
JUL 11	76	89	79	85	83	84	85	84	77	87	83	85	75	83	84	79	88	83	89	85	83	60
JUL 12	76	87	80	81	83	86	90	82	82	86	83	83	80	85	81	79	90	86	91	86	84	61
JUL 13	78	86	81	76	82	88	91	76	87	85	87	83	86	89	82	85	86	88	88	88	85	62
JUL 14	78	79	84	78	89	88	93	78	82	82	85	85	83	89	84	90	86	85	88	91	85	62
JUL 15	80	79	84	74	87	88	93	80	77	78	82	86	81	88	88	90	84	79	88	88	84	62
JUL 16	80	79	80	85	85	85	91	81	85	76	70	87	82	90	88	87	79	76	84	87	83	62
JUL 17	84	80	85	85	86	79	90	80	82	80	73	85	84	88	87	86	83	75	87	88	83	62
JUL 18	88	82	87	86	86	80	87	81	83	83	71	81	83	88	87	88	85	75	88	82	84	61
JUL 19	90	82	83	88	89	83	84	79	85	83	81	83	83	91	87	94	85	73	84	82	84	62
JUL 20	88	85	87	88	81	81	72	76	85	83	82	82	83	76	94	91	87	85	83	75	83	61
JUL 21	87	87	83	89	80	82	75	75	88	83	85	82	87	67	94	89	89	84	81	79	83	62
JUL 22	90	84	85	87	81	82	81	76	87	85	85	81	89	80	94	89	90	85	77	79	84	62
JUL 23	89	87	84	86	85	84	81	75	87	88	84	82	87	85	90	96	88	82		85	86	63
JUL 24	84	89	83	85	86	86	81	83	81	90	78	82	89	86	90	91	87	80		88	85	62
JUL 25	84	88	87	86	87	87	81	87	81	91	83	80	85	87	96	85	86	79	88	88	86	63
JUL 26	84	88	87	88	81	88	79	87	81	90	86	85	80	85	96	87	84	83	87	82	85	63
JUL 27	86	91	85	82	82	90	86	84	84	88	76	87	82	84	90	91	85	87	82	88	86	63
JUL 28	92	85	79	82	81	88	91	83	87	82	81	87	83	86	90	90	87	86	81	83	85	63
JUL 29	93	82	80	84	78	87	84	83	82	73	81	88	87	89	85	87	89	88		73	84	63
JUL 30	78	85	77	86	80	86	78	84	82	70	81	90	87	90	86	85	91	91	63	72	83	63
JUL 31	80	86	67	85	83	87	85	82	79	74	68	92	88	90	84	86	90	85	72	78	82	62

TABLE E-22. AUGUST TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	62	0.00	0	62	0.0000	62
1	62	61.67	1	62	0.0064	62
2	62	123.63	4	62	0.0128	62
3	62	184.82	9	62	0.0192	62
4	61	242.74	16	62	0.0256	61
5	62	309.47	25	61	0.0320	62
6	62	369.15	36	61	0.0384	62
7	61	430.15	49	61	0.0448	61
8	62	492.20	64	61	0.0513	62
9	62	560.48	81	61	0.0577	62
10	61	608.50	100	60	0.0641	61
11	61	674.30	121	60	0.0705	61
12	61	729.00	144	60	0.0769	61
13	60	776.58	169	60	0.0833	60
14	59	828.21	196	60	0.0897	59
15	59	888.00	225	59	0.0961	59
16	60	956.80	256	59	0.1025	60
17	60	1012.35	289	59	0.1089	60
18	58	1048.50	324	59	0.1153	58
19	58	1094.40	361	59	0.1217	58
20	58	1151.58	400	58	0.1281	58
21	59	1234.28	441	58	0.1345	59
22	57	1255.10	484	58	0.1410	57
23	57	1315.60	529	58	0.1474	57
24	58	1394.53	576	58	0.1538	58
25	58	1440.00	625	57	0.1602	58
26	57	1482.65	676	57	0.1666	57
27	57	1542.38	729	57	0.1730	57
28	58	1617.78	784	57	0.1794	58
29	56	1630.44	841	57	0.1858	56
30	57	1705.26	900	56	0.1922	57
465	1844	27160.52	9455			

TRENDLINE SLOPE (b): -0.198

MON AVG TEMP: 59.47

MON AVG TEMP: (CORRECTED) 59.57

STANDARD ERROR: 0.66

ABSOLUTE MIN MIN TEMPERATURE: 19
MEAN MIN TEMPERATURE: 37

MEAN MAX TEMPERATURE: 82
ABSOLUTE MAX MAX TEMPERATURE: 96

TABLE E-23. MINIMUM DAILY TEMPERATURES FOR AUGUST

RH=37	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
AUG 1 :	45	47	42	37	28	44	41	36	42	28	43	37	40	38		36	47	41	44	31	39
AUG 2 :	44	46	42	41	31	42	29	38	42	31	34	50	40	37			32	44	41	36	39
AUG 3 :	42	42	43	45	32	44	32	46	42	34	32	38	42	38		29	36	46	38	38	39
AUG 4 :	45	44	32	37	39	47	37	46	51	36	26	40	50	46		30	37	35	44	41	40
AUG 5 :	36	39	32	33	33	50	38	38	47	37	31	31	41	45		32	33	41	37	36	37
AUG 6 :	34	34	34	29	36	45	38	51	38	48	38	34	45	41		35	40	44	38	40	39
AUG 7 :	32	32	43	30	38	45	36	39	37	27	25	35	47	53	44	36	55	48	38	37	39
AUG 8 :	38	37	42	30	28	43	35	41	36	28	28	21	45	44	51	37	37	50	43	44	38
AUG 9 :	34	37	39	37	32	43	39	38	38	30	31	27	44	39	39	36	47	41	44	34	37
AUG 10 :	37	39	42	48	34	41	43	34	35	40	33	31	42	44	38	43	34	52	51	35	40
AUG 11 :	36	41	36	44	40	41	38	35	33	36	33	31	43	42	43	36	42	37	42	37	38
AUG 12 :	37	40	41	37	41	43	36	34	39	36	37	39	48	38	43	36	35	44	42	33	39
AUG 13 :	39	40	42	34	41	40	38	42	39	33	29	35	47	43	39	40	37	42	56	37	40
AUG 14 :	40	42	27	40	38	45	31	41	25	36	48	28	32	46		39	36	45	44	37	38
AUG 15 :	38	46	27	41	36	39	33	39	31	35	40	31	32	35		40	36	50	55	37	38
AUG 16 :	40	43	35	41	40	37	27	39	33	33	21	33	43	35	34	40	38	42	45	39	37
AUG 17 :	41	42	26	49	46	38	31	37	32	32	32	55	44	43	36	42	39	49	48	40	40
AUG 18 :	40	42	35	35	46	35	34	42	35	48	44	43	24	40	39	40	47	49	49	40	40
AUG 19 :	38	43	45	36	42	37	33	42	34	40	46	46	29	33	34	37	40	49	47	30	39
AUG 20 :	36	42	41	36	37	35	32	35	27	35	27	41	34	32	34	34	41	48	40	31	36
AUG 21 :	36	42	19	33	33	36	33	52	28	32	28	44	35	29		30	45	40	48	32	36
AUG 22 :	36	41	19	34	36	34	34	31	31	30	49	40	42	27	36	33	54	45	43	34	36
AUG 23 :	34	44	22	36	34	41	36	26	32	34	28	38	26	29	35	30	53	39	39	35	35
AUG 24 :	41	42	26	38	30	40	34	19	35	30	30	40	27	29	33	31	51	35	38	39	34
AUG 25 :	46	46	30	36	39	37	36	41	36	37	29	47	27	30	33		41	28	37	41	37
AUG 26 :	45	41	29	31	27	37	36	41	35	37	28	49	28	28	35	38	41	30	37	40	36
AUG 27 :	28	39	23	27	45	40	34	26	33	32	27	24	31	32	36	37	38	32	37	44	33
AUG 28 :	32	39	26	28	40	41	30	29	33	24	29	31	32	35	29	36	45	31	37	39	33
AUG 29 :	48	34	30	26	37	37	27	30	33	28	32	29	34	47			47	30	37	42	35
AUG 30 :	31	39	30	28	35	27	30	33	34	29	28	28	34	32			34	31	43	41	33
AUG 31	34	39	29	31	32	32	38	47	33	25	28	28	27	26	31		35	46	42	42	34

TABLE E-24. MAXIMUM DAILY TEMPERATURES FOR AUGUST

RH=37	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
AUG 1	86	86	80	89	85	84	85	83	83	82	69	91	88	90		85	89	85	79	75	84	62
AUG 2	85	87	82	89	88	85	85	80	82	85	70	90	91	91			81	88	81	80	84	62
AUG 3	86	89	83	88	88	83	85	77	82	87	69	87	90	91		86	81	88	85	85	85	62
AUG 4	88	88	80	84	85	85	87	72	73	86	72	82	85	87		89	82	87	83	83	83	62
AUG 5	87	85	82	84	84	81	89	78	75	83	74	81	89	84		95	89	92	80	84	84	61
AUG 6	90	81	87	86	87	83	90	78	78	81	69	82	90	82		95	89	91	85	86	85	62
AUG 7	90	83	80	88	80	85	92	80	76	83	72	78	88	79	86	96	87	85	91	85	84	62
AUG 8	89	83	81	90	87	85	90	86	80	85	75	85	89	79	84	96	85	81	91	79	85	61
AUG 9	90	85	80	91	90	86	92	81	79	85	79	87	88	84	86	93	85	79	92	80	86	62
AUG 10	91	85	77	85	91	89	89	83	82	85	80	87	83	89	85	92	84	75	82	81	85	62
AUG 11	85	83	82	84	88	90	85	87	80	83	81	87	80	84	85	89	80	82	80	73	83	61
AUG 12	88	86	79	82	90	87	81	84	80	83	78	82	84	76	85	92	88	83	83	82	84	61
AUG 13	88	89	70	86	84	85	78	85	74	83	76	82	74	75	85	85	89	82	80	87	82	61
AUG 14	90	87	67	85	87	85	76	86	78	82	68	85	75	73		89	87	80	85	85	82	60
AUG 15	91	86	73	85	88	82	70	83	81	78	60	85	70	77		86	85	81	79	87	80	59
AUG 16	88	87	69	86	86	82	76	83	81	79	68	85	71	77	84	90	88	84	79	87	82	59
AUG 17	89	86	70	82	83	82	78	81	85	76	68	75	64	74	83	86	87	82	83	76	80	60
AUG 18	85	87	65	85	83	85	77	83	81	70	60	82	75	71	85	83	86	74	84	74	79	60
AUG 19	85	84	65	82	82	84	76	80	73	64	63	80	77	73	80	80	83	73	85	80	77	58
AUG 20	84	83	61	90	81	83	76	83	73	65	79	84	77	74	83	87	85	74	85	79	79	58
AUG 21	83	84	58	87	87	83	80	76	80	66	83	87	75	75		85	91	73	79	81	80	58
AUG 22	85	88	65	87	83	81	82	77	83	76	79	87	77	80	86	89	84	75	75	83	81	59
AUG 23	85	84	68	86	81	81	80	69	84	76	80	85	75	76	69	87	84	75	79	87	80	57
AUG 24	86	81	75	84	85	81	79	75	83	76	83	81	74	80	75	85	72	75	79	91	80	57
AUG 25	79	75	71	86	84	84	80	74	81	80	79	73	75	82	81		87	78	73	89	80	58
AUG 26	79	79	76	84	84	78	80	68	82	81	78	71	75	81	82	86	84	80	77	86	80	58
AUG 27	83	81	78	85	83	79	79	69	83	76	85	78	80	83	77	91	86	81	79	80	81	57
AUG 28	82	81	80	78	80	80	77	77	85	82	84	80	84	78	75	92	82	79	84	79	81	57
AUG 29	77	84	80	75	83	79	76	81	83	80	86	86	83	72			85	77	84	81	81	58
AUG 30	68	85	86	82	81	78	78	80	82	81	88	83	78	70			80	77	80	80	80	56
	69	84	84	83	78	77	78	71	81	79	90	82	79	86	77		82	74	80	81	80	57

TABLE E-25. SEPTEMBER TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	57	0.00	0	57	0.0000	57
1	56	56.39	1	57	0.0108	56
2	57	113.55	4	57	0.0216	57
3	57	170.78	9	56	0.0325	57
4	57	227.40	16	56	0.0433	57
5	58	289.00	25	56	0.0541	58
6	56	338.10	36	56	0.0649	56
7	56	391.30	49	55	0.0757	56
8	56	449.20	64	55	0.0865	56
9	55	491.85	81	55	0.0974	55
10	54	539.25	100	54	0.1082	54
11	52	575.58	121	54	0.1190	52
12	53	639.90	144	54	0.1298	53
13	53	682.83	169	53	0.1406	53
14	51	717.15	196	53	0.1515	51
15	52	782.63	225	53	0.1623	52
16	53	842.40	256	52	0.1731	53
17	51	864.03	289	52	0.1839	51
18	51	920.70	324	52	0.1947	51
19	50	945.73	361	51	0.2055	50
20	49	978.50	400	51	0.2164	49
21	49	1036.35	441	51	0.2272	50
22	51	1114.30	484	50	0.2380	51
23	51	1169.55	529	50	0.2488	51
24	50	1201.80	576	50	0.2596	50
25	50	1256.88	625	49	0.2705	51
26	50	1305.20	676	49	0.2813	50
27	49	1318.28	729	49	0.2921	49
28	49	1379.00	784	48	0.3029	50
29	49	1417.95	841	48	0.3137	49
435	1582	22215.54	8555			

TRENDLINE SLOPE (b): -0.324

MON AVG TEMP: 52.75

MON AVG TEMP: (CORRECTED) 52.90

STANDARD ERROR: 0.98

ABSOLUTE MIN MIN TEMPERATURE: 7
MEAN MIN TEMPERATURE: 30

MEAN MAX TEMPERATURE: 76
ABSOLUTE MAX MAX TEMPERATURE: 90

TABLE E-26. MINIMUM DAILY TEMPERATURES FOR SEPTEMBER

RH=43		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
SEP 1	:	27	41	38	32	25	28	41	30	33	39	28	27	32	31	31	35	33	54	32	51	34
SEP 2	:	23	41	37	33	26	34	34	20	33	27	28	28	36	31	31		37	37	34	47	32
SEP 3	:	25	49	28	35	28	24	32	24	34	26	32	30	46	28	32	32	41	34	33	43	33
SEP 4	:	27	42	24	27	40	26	46	24	36	29	36	27	50	28	34	30	33	32	34	39	33
SEP 5	:	30	42	28	33	34	30	46	27	36	29	37	29	47	32	33	30	36	35	48	42	35
SEP 6	:	34	43	29	34	27	50	36	24	35	29	41	29	44	34	36	29	42	39	48	41	36
SEP 7	:	27	40	31	36	31	27	39	19	37	33	33	29	38	35	36	31	45	40	38	42	34
SEP 8	:	22	41	32	35	34	26	43	14	37	32	30	30	19	39	31	38	37	39	39	41	33
SEP 9	:	33	35	34	31	27	42	40	15	35	40	29	28	28	28	32	36	40	38	38	39	33
SEP 10	:	27	29	29	32	30	32	35	19	35	41	45	27	42	28	31	34	35	35	43	26	33
SEP 11	:	36	40	24	31	28	35	32	25	32	38	51	33	22	30	32	34	25	31	42	30	33
SEP 12	:	24	29	25	31	31	36	18	28	23	33	28	27	23	30	35	37	27	30	38	20	29
SEP 13	:	30	30	25	26	41	38	22	31	23	34	28	28	20	32	41	34	33	37	38	29	31
SEP 14	:	15	25	39	28	12	38	23	41	21	36	30	40	31	33	29	34	25	35	42	30	30
SEP 15	:	17	25	22	25	15	30	24	24	19	36	43	17	34	29	23	34	37	32	39	28	28
SEP 16	:	24	28	20	25	16	28	27	25	21	32	28	37	32	30	26	33	32	37	36	28	28
SEP 17	:	25	31	22	26	21	30	27	25	23	34	37	18	28	31	33	32	34	38	42	29	29
SEP 18	:	44	42	24	31	23	16	20	24	24	38	26	16	12	28	34	32	32	33	45	37	29
SEP 19	:	38	30	37	34	40	15	32	24	21	38	24	40	12	20	33	32	39	38	44	25	31
SEP 20	:	33	28	24	39	18	22	22	37	20	35	33	33	12	20	32	30	23	27	37	25	28
SEP 21	:	34	28	10	20	22	19	30	19	23	32	29	17	17	20	30	28	26	30	33	24	25
SEP 22	:	29	32	7	22	16	18	18	20	25	31	29	16	23	20	28	25	27	42	30	31	24
SEP 23	:	31	35	10	26	18	19	18	36	26	29	28	16	24	25	22	23	25	40	42	27	26
SEP 24	:	38	31	13	23	18	23	22	29	27	28	24	34	25	28	23	27	47	40	26	33	28
SEP 25	:	25	31	17	26	11	27	14	16	26	29	29	21	25	31	23	34	50	41	18	35	26
SEP 26	:	35	32	19	28	11	21	27	16	26	28	25	28	33	17	24	24	45	31	19	31	26
SEP 27	:	40	32	21	27	14	14	42	19	27	28	26	22	29	21	27	29	32	31	18	33	27
SEP 28	:	25	34	20	21	16	12	24	20	20	26	26	23	25	23	26	29	21	40	19	31	24
SEP 29	:	27	35	16	38	18	31	22	21	22	24	34	46	26	28	24	34	26	31	28	25	28
SEP 30	:	27	33	27	39	18	24	27	20	23	24	37	18	28	38	28	26	29	38		27	28

TABLE E-27. MAXIMUM DAILY TEMPERATURES FOR SEPTEMBER

RH=43	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
SEP 1	74	83	84	84	82	82	75	67	83	75	89	84	80	78	82	90	84	76	80	77	80	57
SEP 2	80	73	80	85	79	75	75	76	84	80	89	82	78	78	84		87	80	82	79	80	56
SEP 3	84	74	78	80	81	69	77	80	85	82	87	83	78	78	85	90	86	86	81	71	81	57
SEP 4	85	74	82	79	76	80	71	81	84	81	82	87	72	85	84	87	84	86	82	71	81	57
SEP 5	84	74	84	82	56	71	68	88	83	82	67	88	62	88	85	87	86	89	78	68	79	57
SEP 6	82	78	82	84	72	69	72	83	84	86	74	87	66	88	82	82	86	85	78	68	79	58
SEP 7	80	78	83	78	82	73	76	79	80	83	75	85	58	84	82	82	84	81	80	64	78	56
SEP 8	81	77	85	80	81	79	73	74	82	78	75	82	72	82	78	82	86	79	87	64	79	56
SEP 9	83	74	82	82	81	81	73	74	85	74	80	84	68	84	73	82	85	86	88	59	79	56
SEP 10	79	74	76	83	83	84	65	74	85	68	75	85	60	79	69	82	85	85	83	57	77	55
SEP 11	72	75	82	82	83	87	60	74	77	69	66	83	64	83	79	82	70	87	81	50	75	54
SEP 12	69	77	81	79	75	87	67	82	77	74	69	78	62	85	78	82	75	87	80	56	76	52
SEP 13	64	71	78	76	68	88	72	79	73	75	75	80	69	87	70	82	73	83	82	68	76	53
SEP 14	69	73	76	75	64	86	75	80	71	75	74	74	64	88	65	82	70	86	80	67	75	53
SEP 15	73	77	72	76	65	81	72	80	74	75	67	70	66	87	75	82	67	85	81	71	75	51
SEP 16	85	77	72	74	76	80	77	78	77	76	65	65	72	85	83	82	62	83	83	70	76	52
SEP 17	84	73	77	73	80	75	76	80	78	75	63	65	75	83	82	82	64	81	82	72	76	53
SEP 18	78	60	77	73	75	65	71	77	80	77	70	72	47	79	84	82	68	78	78	61	73	51
SEP 19	58	70	69	72	69	76	67	77	80	79	73	60	52	78	82	82	68	74	77	67	72	51
SEP 20	70	76	55	63	65	72	74	71	80	77	70	64	66	80	80	79	77	77	76	69	72	50
SEP 21	80	76	53	67	68	64	67	74	83	76	72	69	76	83	76	80	80	79	68	75	73	49
SEP 22	79	69	61	77	71	73	70	71	83	79	72	64	82	83	72	79	82	72	73	73	74	49
SEP 23	83	69	71	76	76	78	70	64	83	79	74	73	82	78	80	77	80	67	71	75	75	51
SEP 24	78	67	77	77	71	74	69	63	82	80	74	70	82	77	81	70	69	71	64	79	74	51
SEP 25	78	74	79	81	69	60	64	61	80	87	72	79	83	71	82	70	64	70	74	76	74	50
SEP 26	75	77	80	80	77	55	66	71	76	79	75	75	81	72	82	77	68	72	75	78	75	50
SEP 27	63	78	79	77	80	57	66	78	69	78	74	75	81	77	83	76	62	69	78	76	74	50
SEP 28	74	76	67	79	80	60	71	74	75	77	68	73	83	79	83	71	65	69	79	69	74	49
SEP 29	77	73	63	74	78	60	73	81	75	75	62	67	83	74	86	64	42	58	77	72	71	49
SEP 30	74	69	63	75	76	50	70	78	75	78	68	63	83	72	89	69	52	54		69	70	49

TABLE E-28. OCTOBER TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	48	0.00	0	48	0.0000	48
1	48	48.28	1	48	0.0106	48
2	49	97.35	4	48	0.0213	49
3	47	141.15	9	47	0.0319	47
4	48	192.00	16	47	0.0426	48
5	49	243.50	25	47	0.0532	49
6	47	281.40	36	46	0.0638	47
7	45	316.58	49	46	0.0745	45
8	44	354.40	64	46	0.0851	44
9	45	409.05	81	45	0.0958	46
10	45	454.50	100	45	0.1064	46
11	44	487.58	121	45	0.1171	44
12	44	522.60	144	44	0.1277	44
13	42	550.88	169	44	0.1383	43
14	42	585.90	196	44	0.1490	42
15	41	613.50	225	43	0.1596	41
16	42	665.20	256	43	0.1703	42
17	41	702.95	289	43	0.1809	42
18	42	762.75	324	42	0.1915	43
19	43	822.23	361	42	0.2022	43
20	41	826.50	400	42	0.2128	42
21	42	883.05	441	41	0.2235	42
22	42	926.20	484	41	0.2341	42
23	42	963.70	529	41	0.2448	42
24	43	1031.40	576	40	0.2554	43
25	41	1026.88	625	40	0.2660	41
26	41	1054.95	676	40	0.2767	41
27	39	1046.25	729	39	0.2873	39
28	37	1046.50	784	39	0.2980	38
29	39	1117.23	841	39	0.3086	39
30	38	1130.25	900	38	0.3192	38
465	1342	19304.67	9455			

TRENDLINE SLOPE (b): -0.329

MON AVG TEMP: 43.28

MON AVG TEMP: (CORRECTED) 43.43

STANDARD ERROR: 1.18

ABSOLUTE MIN MIN TEMPERATURE: -5
MEAN MIN TEMPERATURE: 21

MEAN MAX TEMPERATURE: 66
ABSOLUTE MAX MAX TEMPERATURE: 89

TABLE E-29. MINIMUM DAILY TEMPERATURES FOR OCTOBER

RH=55		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
OCT 1	:	26	32	22	25	18	5	35	32	23	25	31	12	32	30	28	21	20	38	24	23	25
OCT 2	:	30	32	21	43	18	11	36	21	32	24	32	15	29	27	28	26	19	32	36	25	27
OCT 3	:	22	44	19	32	21	15	32	12	27	35	34	13	24	28	30	40	27	31	26	25	27
OCT 4	:	15	18	22	12	26	15	40	10	29	35	20	14	24	28	31	12	29	28	26	29	23
OCT 5	:	14	36	21	7	22	18	27	28	22	34	21	33	25	38	29	19	19	29	26	28	25
OCT 6	:	20	14	17	9	44	22	33	25	17	36	24	40	22	29	30	22	13	26	29	38	26
OCT 7	:	22	18	13	11	22	22	33	35	23	19	24	10	19	38	27	38	33	25	29	35	25
OCT 8	:	19	19	8	18	13	23	30	29	31	14	25	13	19	34	28	16	17	24	26	33	22
OCT 9	:	22	20	14	14	17	22	23	6	22	23	25	16	29	19	27	17	18	31	30	22	21
OCT 10	:	20	20	14	12	22	22	25	6	31	36	24	14	25	22	26	31	15	23	27	25	22
OCT 11	:	28	23	32	11	16	26	14	10	21	34	23	16	23	22	32	24	16	24	27	21	22
OCT 12	:	39	22	36	6	22	20	18	17	18	30	18	19	22	25	36	14	19	24	21	25	23
OCT 13	:	25	23	39	11	22	22	23	19	16	18	14	16	22	31	16	8	17	34	21	28	21
OCT 14	:	4	27	29	26	23	31	14	22	16	15	17	16	19	21	23	11	24	21	26	14	20
OCT 15	:	8	9	10	32	23	31	23	22	18	15	12	21	33	27	20	21	22	20	18	16	20
OCT 16	:	8	12	13	39	11	22	15	19	19	16	22	19	22	25	17	-1	22	20	14	18	18
OCT 17	:	7	14	14	28	11	17	20	18	17	16	16	11	21	30	12	12	27	24	27	20	18
OCT 18	:	6	11	14	21	20	9	35	19	16	24	15	18	20	25	13	10	12	22	13	21	17
OCT 19	:	12	12	9	17	9	14	25	20	20	15	14	32	20	42	10	15	30	21	13	20	19
OCT 20	:	38	14	20	11	29	19	36	19	25	15	17	18	19	30	16	14	28	24	13	34	22
OCT 21	:	19	18	8	13	26	14	22	24	20	18	12	19	20	13	17	11	24	23	18	28	18
OCT 22	:	13	15	10	16	35	12	19	31	11	32	25	12	17	22	21	13	42	24	13	14	20
OCT 23	:	18	25	13	17	21	38	20	31	15	12	15	24	9	18	14	10	43	30	16	24	21
OCT 24	:	17	16	12	18	25	30	24	14	14	4	10	26	11	22	17	16	37	34	20	23	20
OCT 25	:	18	22	13	13	14	31	12	14	20	12	21	18	19	43	26	16	37	18	18	24	20
OCT 26	:	20	13	16	14	23	11	19	18	18	16	12	18	12	15	28	32	33	19	13	24	19
OCT 27	:	11	14	13	16	-2	25	22	15	23	25	5	32	11	12	25	30	17	15	20	21	18
OCT 28	:	15	32	14	15	0	25	12	16	32	6	3	18	13	21	9	26	18	10	16	20	16
OCT 29	:	15	12	33	12	5	-5	10	12	21	12	7	21	25	18	9	22	32	30	16	19	16
OCT 30	:	12	14	20	9	10	20	8	12	29	32	6	8	21	8	10	11	36	44	18	28	18
OCT 31		13	13	9	8	17	20	5	15	31	20	13	18	22	18	12	15	31	26	16	16	17

TABLE E-30. MAXIMUM DAILY TEMPERATURES FOR OCTOBER

RH=55	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
OCT 1	79	66	67	79	74	55	67	71	76	77	66	71	83	75	89	67	66	59	45	70	70	48
OCT 2	72	68	70	72	75	62	58	64	74	76	61	75	75	78	87	68	75	58	55	71	70	48
OCT 3	67	67	72	57	77	65	68	62	70	75	63	76	80	80	87	62	73	65	68	76	71	49
OCT 4	66	69	74	53	74	67	64	72	63	74	69	74	81	81	86	63	70	71	69	79	71	47
OCT 5	72	56	76	60	71	75	62	70	58	75	72	71	79	82	85	73	66	72	69	80	71	48
OCT 6	73	66	70	66	64	80	64	66	62	68	72	63	79	82	85	75	71	77	75	80	72	49
OCT 7	69	74	67	74	55	78	62	54	63	57	76	70	79	74	84	71	62	77	75	59	69	47
OCT 8	74	78	59	65	65	76	64	50	64	63	80	75	76	67	82	64	61	72	78	57	69	45
OCT 9	74	71	66	61	71	80	62	47	65	68	80	69	71	73	83	66	63	72	74	39	68	44
OCT 10	75	79	70	68	68	82	58	58	66	59	75	68	75	77	86	63	63	67	70	51	69	45
OCT 11	66	79	66	62	75	79	61	63	65	54	65	75	76	78	77	64	66	69	70	65	69	45
OCT 12	62	72	60	57	71	79	63	63	63	50	68	76	74	77	60	51	67	77	70	62	66	44
OCT 13	49	78	60	56	64	82	62	79	68	51	76	78	75	68	56	46	71	74	70	54	66	44
OCT 14	58	61	53	45	61	76	62	79	74	64	74	80	80	70	54	47	72	63	61	62	65	42
OCT 15	55	68	54	47	64	59	57	77	77	72	75	78	76	67	44	46	70	65	54	68	64	42
OCT 16	54	75	58	55	66	38	55	77	78	74	71	77	73	72	53	58	71	68	40	71	64	41
OCT 17	67	79	67	46	66	46	54	76	75	71	69	74	67	71	55	68	69	68	43	70	65	42
OCT 18	71	75	68	47	63	53	51	74	78	66	62	73	67	60	65	70	71	71	55	70	66	41
OCT 19	71	71	71	50	64	64	50	74	75	68	67	66	69	63	68	74	59	75	55	71	66	42
OCT 20	62	74	68	55	59	58	50	75	72	75	63	66	68	48	70	73	65	74	49	68	65	43
OCT 21	59	65	71	61	53	65	65	70	63	71	66	63	61	58	70	71	67	74	52	61	64	41
OCT 22	69	69	71	67	56	68	65	62	55	54	63	69	59	67	68	72	60	74	56	61	64	42
OCT 23	68	70	70	62	60	55	66	51	63	38	61	71	65	71	72	74	58	75	54	67	64	42
OCT 24	75	74	78	66	50	45	56	56	64	49	65	75	71	72	68	69	58	65	59	71	64	42
OCT 25	75	70	78	65	53	49	59	58	63	61	56	77	66	64	67	78	58	76	68	69	66	43
OCT 26	72	68	72	61	43	56	63	60	64	54	50	74	76	60	57	70	58	76	68	67	63	41
OCT 27	72	71	79	65	53	49	55	70	63	54	57	66	75	68	55	70	52	74	56	69	64	41
OCT 28	66	64	78	60	66	39	55	70	51	64	65	64	73	55	61	48	61	74	47	68	61	39
OCT 29	69	56	64	59	71	41	43	58	38	66	68	58	66	42	70	44	61	70	58	67	58	37
OCT 30	73	66	55	60	69	51	38	69	57	57	68	63	46	51	68	52	56	64	60	62	59	39
	68	70	52	61	64	39	55	73	48	55	66	62	40	49	71	59	57	58	63	59	58	38

TABLE E-31. NOVEMBER TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	38	0.00	0	40	0.0000	38
1	40	40.08	1	40	0.0128	40
2	41	81.55	4	39	0.0256	41
3	40	121.20	9	39	0.0385	40
4	41	162.70	16	39	0.0513	41
5	40	201.13	25	38	0.0641	40
6	39	231.60	36	38	0.0769	39
7	38	264.43	49	38	0.0897	38
8	36	290.80	64	37	0.1025	36
9	36	328.05	81	37	0.1154	37
10	37	366.75	100	36	0.1282	37
11	35	386.10	121	36	0.1410	35
12	33	398.10	144	36	0.1538	33
13	34	442.65	169	35	0.1666	34
14	35	491.75	196	35	0.1794	35
15	37	548.63	225	34	0.1923	37
16	34	549.60	256	34	0.2051	35
17	31	532.82	289	34	0.2179	32
18	31	565.58	324	33	0.2307	32
19	32	605.50	361	33	0.2435	32
20	31	622.00	400	33	0.2563	31
21	32	669.38	441	32	0.2692	32
22	33	718.30	484	32	0.2820	33
23	33	761.88	529	31	0.2948	33
24	31	737.40	576	31	0.3076	31
25	29	725.63	625	31	0.3204	29
26	29	750.75	676	30	0.3332	29
27	31	832.95	729	30	0.3461	31
28	32	902.30	784	29	0.3589	33
29	31	886.68	841	29	0.3717	31
435	1040	14216.24	8555			

TRENDLINE SLOPE (b): -0.384

MON AVG TEMP: 34.67

MON AVG TEMP: (CORRECTED) 34.85

STANDARD ERROR: 1.43

ABSOLUTE MIN MIN TEMPERATURE: -9
MEAN MIN TEMPERATURE: 16

MEAN MAX TEMPERATURE: 53
ABSOLUTE MAX MAX TEMPERATURE: 77

TABLE E-32. MINIMUM DAILY TEMPERATURES FOR NOVEMBER

RH=59		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
NOV 1	:	12	13	8	12	12	6	26	32	30	11	12	13	24	9	16	-5	18	31	13	18	16
NOV 2	:	13	16	21	12	11	7	17	25	30	11	14	13	28	15	19	15	17	20	35	19	18
NOV 3	:	30	14	36	13	19	7	18	24	22	12	13	12	12	32	20	16	16	15	29	21	19
NOV 4	:	10	19	9	17	35	10	30	-1	16	12	12	38	22	17	20	17	11	16	15	30	18
NOV 5	:	10	34	16	32	34	6	16	26	24	14	10	33	21	12	20	22	19	30	20	25	21
NOV 6	:	33	16	8	32	36	7	10	42	12	22	12	30	17	14	21	20	20	24	30	18	21
NOV 7	:	25	17	21	17	14	7	30	41	19	23	15	7	15	19	23	18	17	22	22	19	20
NOV 8	:	17	21	16	27	17	7	19	15	16	14	9	3	14	20	29	18	23	16	22	35	18
NOV 9	:	5	12	18	9	29	27	16	14	21	3	5	2	19	13	29	16	13	19	21	26	16
NOV 10	:	15	15	12	10	16	12	15	39	22	30	14	5	8	7	38	23	9	14	10	24	17
NOV 11	:	33	15	11	11	23	40	30	33	12	3	12	24	10	11	32	15	5	36	31	-1	19
NOV 12	:	17	17	24	13	31	30	11	21	15	7	21	10	-7	5	22	27	8	26	30	13	17
NOV 13	:	17	29	20	11	5	25	19	22	22	10	9	12	5	6	11	34	8	26	30	-9	16
NOV 14	:	32	46	5	10	14	3	30	20	22	21	33	7	15	8	8	36	10	19	12	-7	17
NOV 15	:	24	16	18	17	15	22	2	24	19	24	20	10	-1	13	23	34	15	18	15	-8	16
NOV 16	:	36	20	14	24	15	24	11	26	17	36	15	10	18	19	4	28	15	33	15	10	20
NOV 17	:	18	19	18	0	10	5	27	22	15	20	15	10	19	34	16	30	20	13	17	-2	16
NOV 18	:	11	18	19	-1	14	12	-2	19	28	0	13	29	9	13		12	31	12	30	16	15
NOV 19	:	17	28	15	8	8	7	10	11	11	-6	10	28	20	1	11	11	20		14	-5	12
NOV 20	:	35	31	12	8	7	11	-1	12	18	16	10	-9	31	-3		11	11	24	22	4	13
NOV 21	:	18	18	11	15	13	15	-5	11	32	8	10	23	30	-6	9	26	10	15	28	2	14
NOV 22	:	25	11	23	4	25	17	-6	14	20	5	10	34	3	8	22	35	22	2	28	2	15
NOV 23	:	0	15	19	1	22	12	-4	12	8	8	8	22	16	31	15	36	24	17	23	28	16
NOV 24	:	7	12	29	3	18	16	-6	9	10	7	6	19	3	31	12	35	26	12	30	26	15
NOV 25	:	0	12	21	6	36	14	-2	8	30	12	7	16	-4	38	5	14	13	9	11	27	14
NOV 26	:	10	9	6	2	24	20	-8	6	9	9	20	12	5	32	6	12	12	6	2	11	10
NOV 27	:	12	9	8	2	7	25	5	12	12	10	-8	13	-4	8	6	8	11	3	22	29	10
NOV 28	:	28	7	3	-2	25	33	5	11	16	18	-3	15	1	13	11	19	18	4	18	34	14
NOV 29	:	32	9	1	-3	24	23	4	33	18	0	-1	15	20	12	26	16	26	6	12	26	15
NOV 30	:	18	19	23	0	0	29	-4	34	17	10	-2	20	28	11	38	6	24	0	18	-1	14

TABLE E-33. MAXIMUM DAILY TEMPERATURES FOR NOVEMBER

RH=59	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
NOV 1	71	68	59	62	65	63	58	64	38	63	68	71	43	54	68	66	58	52	57	61	60	38
NOV 2	70	59	60	67	64	60	62	52	35	71	77	71	44	60	70	68	57	66	62	70	62	40
NOV 3	61	71	49	72	57	66	63	46	38	65	71	66	58	46	76	71	65	74	64	71	63	41
NOV 4	63	65	56	68	49	70	54	48	47	73	74	66	68	42	77	70	66	73	64	68	63	40
NOV 5	64	64	56	57	51	49	54	52	48	67	77	50	61	51	77	64	67	67	70	57	60	41
NOV 6	55	63	47	46	51	63	57	60	46	63	75	42	63	56	74	64	66	66	63	65	59	40
NOV 7	48	65	51	46	49	61	46	62	46	64	74	53	72	51	68	61	55	60	55	66	58	39
NOV 8	44	64	65	47	62	62	46	66	49	51	67	47	73	53	71	62	45	62	55	62	58	38
NOV 9	52	61	65	50	56	67	47	57	56	57	66	65	65	55	69	62	33	53	53	48	57	36
NOV 10	57	64	68	56	62	67	49	57	59	44	63	64	40	66	66	61	36	49	53	39	56	36
NOV 11	56	64	64	59	59	57	38	52	67	48	54	64	23	60	60	65	45	60	58	28	54	37
NOV 12	61	67	55	60	46	44	48	46	68	51	52	67	39	65	49	62	44	54	57	28	53	35
NOV 13	61	63	34	58	49	42	47	44	68	60	54	60	40	66	50	49	50	44	50	26	51	33
NOV 14	59	66	38	63	60	36	39	49	66	57	51	60	34	61	55	53	55	53	36	27	51	34
NOV 15	58	66	53	55	65	32	33	55	65	62	59	70	51	63	47	57	52	64	50	28	54	35
NOV 16	55	54	55	47	58	40	38	46	53	54	62	69	55	62	45	67	59	59	50	45	54	37
NOV 17	55	62	55	43	65	44	43	36	61	41	70	63	55	53	55	55	53	49	50	40	52	34
NOV 18	59	60	57	50	48	33	35	34	56	27	63	53	62	43		48	47	48	51	34	48	31
NOV 19	61	57	57	61	56	46	41	37	55	46	62	48	60	34	58	60	47		51	38	51	31
NOV 20	52	50	63	64	62	49	33	48	61	50	62	46	46	41		59	42	34	53	46	51	32
NOV 21	43	38	66	56	61	55	38	36	51	46	63	41	38	48	55	61	49	32	35	49	48	31
NOV 22	45	47	63	51	62	55	42	36	38	58	58	50	32	53	59	59	49	30	35	49	49	32
NOV 23	34	50	67	50	70	55	39	38	54	54	64	49	42	48	55	57	39	45	41	42	50	33
NOV 24	35	61	51	64	60	57	42	41	64	60	63	54	37	56	50	52	45	43	43	42	51	33
NOV 25	36	53	37	59	52	55	43	46	52	48	61	55	33	59	48	43	50	45	33	48	48	31
NOV 26	48	50	44	52	43	56	45	35	61	56	50	61	34	50	61	40	43	47	36	44	48	29
NOV 27	48	56	46	52	45	55	42	58	54	44	33	65	37	48	66	31	53	39	49	44	48	29
NOV 28	53	43	48	55	36	49	50	63	50	32	42	69	48	50	70	31	49	36	42	44	48	31
NOV 29	58	45	53	55	35	50	45	59	52	34	50	59	58	63	62	36	49	47	36	44	50	32
NOV 30	50	45	45	54	38	39	39	53	51	50	52	54	55	55	52	43	23	51	42	44	47	31

TABLE E-34. DECEMBER TEMPERATURE STATISTICS

X	Y	X*Y	X²	Y'	TREND CORRECTN	CORRECTD DAILY MEAN
0	30	0.00	0	30	0.0000	30
1	29	29.35	1	30	0.0065	29
2	31	62.95	4	30	0.0130	31
3	30	91.13	9	30	0.0195	30
4	29	114.60	16	29	0.0260	29
5	28	138.75	25	29	0.0325	28
6	29	174.00	36	29	0.0391	29
7	29	199.85	49	29	0.0456	29
8	27	217.60	64	29	0.0521	27
9	28	249.30	81	28	0.0586	28
10	27	267.25	100	28	0.0651	27
11	27	300.76	121	28	0.0716	27
12	28	337.20	144	28	0.0781	28
13	27	352.30	169	28	0.0846	27
14	31	427.00	196	27	0.0911	31
15	30	445.13	225	27	0.0976	30
16	29	462.40	256	27	0.1041	29
17	27	451.35	289	27	0.1106	27
18	27	481.74	324	27	0.1172	27
19	25	476.43	361	26	0.1237	25
20	25	508.00	400	26	0.1302	26
21	24	494.03	441	26	0.1367	24
22	25	539.55	484	26	0.1432	25
23	25	564.08	529	25	0.1497	25
24	25	604.20	576	25	0.1562	25
25	26	646.25	625	25	0.1627	26
26	28	716.30	676	25	0.1692	28
27	25	676.35	729	25	0.1757	25
28	25	700.00	784	24	0.1822	25
29	24	703.25	841	24	0.1887	24
30	22	672.75	900	24	0.1953	23
465	840	12103.83	9455			

TRENDLINE SLOPE (b): -0.201

MON AVG TEMP: 27.11

MON AVG TEMP: (CORRECTED) 27.20

STANDARD ERROR: 1.30

ABSOLUTE MIN MIN TEMPERATURE: -31
MEAN MIN TEMPERATURE: 10

MEAN MAX TEMPERATURE: 45
ABSOLUTE MAX MAX TEMPERATURE: 70

TABLE E-35. MINIMUM DAILY TEMPERATURES FOR DECEMBER

RH=67		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG
DEC 1	:	22	10	20	3	12	24	-4	20	4	25	0	14	26	8	14	12	16	4	11	9	13
DEC 2	:	31	-12	-1	3	19	26	-1	-17	15	14	0	12	5	32	36	12	1	2	12	30	11
DEC 3	:	27	4	0	1	-5	27	27	-10	35	12	-1	15	1	18	34	11	16	4	26	27	13
DEC 4	:	13	18	1	-2	20	20	12	-11	28	16	5	17	9	14	30	15	0	-1	19	15	12
DEC 5	:	29	25	1	-1	3	12	-11	-1	8	26	0	15	14	13	6	17	7	-7	25	14	10
DEC 6	:	31	-13	6	11	0	19	10	3	9	16	-3	14	9	10	3	17	3	4	25	17	10
DEC 7	:	22	19	14	6	12	12	12	14	12	3	-3	25	1	11	12	16	9	6	15	23	12
DEC 8	:	23	8	31	8	31	-4	5	-4	5	7	3	12	-9	12	0	12	14	12	25	19	11
DEC 9	:	13	0	25	3	20	12	-21	-4	4	6	26	14	5	11	4	19	2	10	28	13	10
DEC 10	:	16	3	33	8	-2	8	-4	-4	5	12	-3	19	15	19	-1	12	17	26	20	16	11
DEC 11	:	17	1	14	23	5	5	-22	14	21	8	-1	20	12	8	4	10	4	9	16	2	9
DEC 12	:	15	10	-11	32	11	19	-12	17	18	28	0	12	17	-1	5		10	3	29	-2	11
DEC 13	:	20	2	0	9	0	3	-5	30	12	9	4	22	13	7	12	20	12	19	19	5	11
DEC 14	:	16	-8	26	14	4	-2	-15	16	14	-7	-1	38	7	9	4	24	-4	28	2	7	9
DEC 15	:	14	6	23	6	14	-2	2	19	21	-3	-1	25	4	6	13	29	20	29	13	8	12
DEC 16	:	15	0	-9	8	25	-2	12	17	11	3	-5	21	3	5	12	11	16	24	6	8	9
DEC 17	:	15	-1	-13	3	11	2	25	26	12	1	-5	31	27	3	13	15	29	20	-21	8	10
DEC 18	:	11	12	-15	21	-11	8	17	11	6	-2	-4	0	22	3	22	22	14	25	-15	8	8
DEC 19	:	11	3	9	19	6	6	30	17	6	1	-4	-11	15	22	14		10	32	-11	8	10
DEC 20	:	13	-12	-18	33	-18	5	29	17	13	1	-6	-11	-8	10	15	15	33	21	-9	8	7
DEC 21	:	14	-20	-31	31	19	7	17	16	14	2	-10	22	-15	20	15	22	30	12	-10	6	8
DEC 22	:	11	-6	-22	11	-8	27	37	9	19	18	-11	19	-20	3	25	-10	29	26	-16	7	7
DEC 23	:	9	-2	18	28	-20	23	17	8	12	4	4	26	-17	3	9	14	11	26	-16	6	8
DEC 24	:	7	-2	31	31	-14	29	27	12	-6	10	-4	2	-10	8	14	15	14	26	-14	10	9
DEC 25	:	4	2	20	26	-21	27	13	8	4	10	-1	13	-9	4	16	34	-11	33	-11	11	9
DEC 26	:	6	0	0	11	-14	2	15	17	1	8	-1	17	-11	13	16	35	11	34	5	7	9
DEC 27	:	-5	14	-27	16	5	-3	22	32	20	28	-1	31	5	-9	23	35	17	33	0	7	12
DEC 28	:	-3	3	18	5	-4	-9	20	38	18	13	-5	28	-5	-20	16	16	11	20	1	11	9
DEC 29	:	4	8	-14	-3	21	-23	4	39	-8	9	12	21	-15	8	11	22	4	20	-3	26	7
DEC 30	:	19	-4	-6	2	1	-22	6	23	-6	21	12	31	-17	8	10	28	-5	19	8	32	8
DEC 31		5	-1	-14	0	7	-22	20	18	9	10	9	0	-22	30	8	19	-5	21	-1	29	6

TABLE E-36. MAXIMUM DAILY TEMPERATURES FOR DECEMBER

RH=67	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	20AVG	DAILY MEAN
DEC 1	49	30	38	51	38	39	39	46	58	63	55	59	45	63	57	54	41	51	39	44	48	30
DEC 2	44	39	42	53	34	38	53	24	55	65	63	65	39	58	53	62	30	52	46	40	48	29
DEC 3	43	48	56	51	42	39	48	31	40	65	61	67	44	65	50	59	35	52	42	52	50	31
DEC 4	43	47	60	50	50	46	40	24	41	59	53	63	60	67	43	54	38	52	38	49	49	30
DEC 5	41	40	58	55	36	58	28	35	45	61	48	66	48	64	42	61	34	46	36	49	48	29
DEC 6	46	35	57	53	35	42	28	38	49	53	54	65	16	59	43	61	38	52	44	51	46	28
DEC 7	38	45	61	49	48	33	26	56	41	58	62	60	17	55	29	62	37	53	44	45	46	29
DEC 8	45	36	56	47	55	31	19	37	44	61	58	64	35	69	37	62	34	54	52	36	47	29
DEC 9	46	38	60	41	40	41	10	35	45	64	43	60	45	70	44	65	33	43	45	30	45	27
DEC 10	52	49	50	44	30	35	15	35	46	58	46	58	47	56	49	59	41	55	44	24	45	28
DEC 11	44	56	40	49	40	41	12	47	47	58	58	53	57	40	48	57	36	43	48	25	45	27
DEC 12	52	35	28	58	37	31	35	51	54	42	62	45	46	51	54		36	42	47	33	44	27
DEC 13	55	12	46	63	46	30	27	45	42	32	60	54	48	57	56	54	47	55	44	38	46	28
DEC 14	45	9	46	61	38	44	25	41	45	35	58	59	57	58	55	60	40	60	39	37	46	27
DEC 15	49	28	39	62	45	32	41	44	52	50	57	50	54	64	59	58	53	58	41	38	49	31
DEC 16	51	45	33	62	38	43	44	59	58	45	59	45	53	65	62	55	53	57	31	48	50	30
DEC 17	51	38	30	60	32	50	55	48	55	48	52	40	42	67	59	57	49	49	25	48	48	29
DEC 18	52	34	43	59	23	46	50	46	47	51	52	33	30	63	58	54	50	56	14	46	45	27
DEC 19	54	25	31	50	30	51	48	42	54	50	53	26	32	52	57		50	55	21	53	44	27
DEC 20	56	19	22	58	38	52	56	47	51	49	49	33	15	48	55	52	52	46	23	51	44	25
DEC 21	42	28	12	52	35	50	53	42	52	53	52	44	25	40	53	52	48	46	24	52	43	25
DEC 22	42	32	41	35	33	39	45	37	39	42	45	44	23	38	49	44	43	46	24	52	40	24
DEC 23	52	37	44	52	20	36	49	36	24	46	48	45	27	37	53	45	40	48	26	53	41	25
DEC 24	43	38	41	53	19	38	40	31	32	58	45	31	32	34	54	46	32	53	24	51	40	25
DEC 25	44	42	34	42	23	35	50	46	35	58	54	36	27	36	57	54	25	53	31	53	42	25
DEC 26	31	49	33	34	27	27	55	40	48	60	63	35	20	35	64	55	38	54	42	52	43	26
DEC 27	30	52	41	26	35	28	55	47	45	52	52	43	43	24	60	55	35	47	36	53	43	28
DEC 28	35	41	42	25	41	21	40	50	36	53	58	38	37	22	62	55	36	43	42	53	42	25
DEC 29	39	42	40	36	43	30	34	52	27	60	55	47	36	38	64	47	28	53	36	50	43	25
DEC 30	33	41	29	42	36	18	43	43	30	48	42	47	30	45	63	49	24	51	49	49	41	24
	46	41	32	48	46	15	37	36	25	22	43	37	23	42	63	45	27	53	43	53	39	22

TABLE E-37. COMPUTATION OF INDEX OF SEASONAL VARIATION - SIMPLE AVERAGE METHOD

(1) MONTH	(2) AVERAGE TEMP FOR MONTH	(3) TREND CORRECTN	(4) CORRECTD AVERAGE	(5) INDEX OF SEASONAL VARIATION
JANUARY	24.95	0.0000	24.95	0.60
FEBRUARY	27.94	-0.0794	27.86	0.67
MARCH	33.28	-0.1588	33.12	0.80
APRIL	38.47	-0.2382	38.23	0.92
MAY	47.40	-0.3176	47.08	1.14
JUNE	55.18	-0.3969	54.78	1.32
JULY	60.99	-0.4763	60.51	1.46
AUGUST	59.57	-0.5557	59.01	1.43
SEPTEMBER	52.90	-0.6351	52.26	1.27
OCTOBER	43.43	-0.7145	42.72	1.04
NOVEMBER	34.85	-0.7939	34.06	0.83
DECEMBER	27.20	-0.8733	26.33	0.65
TOTAL			500.92	
AVERAGE			41.74	

APPENDIX F

CALCULATION OF HEATING REQUIREMENTS AND COSTS FOR TEMPORARY ENCLOSURE FOR SCENARIOS C, D, & E

Calculations for the heating requirements for the temporary enclosure were base on the relationship derived by F. Lawrence Bennet [14] where

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (dT)$$

in which dT = difference between inside and outside temperature, in degrees Farenheit.

Daily costs for fuel were then calculated where

$$\text{DAILY FUEL COST} = \text{BTU's/CU FT/DAY} \times \text{CU FT OF ENCLOSURE} \times \text{FUEL COST PER 100,000 BTU}$$

For the purpose of this report, it was assumed that the desired interior temperature of the enclosure was 50°F and that fuel oil for the heaters cost $0.32/100,000 BTU. As noted in Chapter III, the selected enclosure contains 348,348 cubic feet of space.

Fuel calculations for Scenario C (using calculated mean temperatures) are as follows:

NOVEMBER:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (50-34) = 96.64$$

$$\text{Daily Cost} = 96.64\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$107.73/\text{DAY}$$

DECEMBER:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-26) = 101.15$$

$$\text{Daily Cost} = 101.15\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$112.75/\text{DAY}$$

JANUARY:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-25) = 101.71$$

$$\text{Daily Cost} = 101.71\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$113.38/\text{DAY}$$

FEBRUARY:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-28) = 100.02$$

$$\text{Daily Cost} = 100.02\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$111.49/\text{DAY}$$

MARCH:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-33) = 97.21$$

$$\text{Daily Cost} = 97.21\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$108.36/\text{DAY}$$

Fuel calculations for Scenario D (using calculated mean temperatures plus ten degrees) are as follows:

NOVEMBER:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-44) = 91.02$$

$$\text{Daily Cost} = 91.02\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$101.46/\text{DAY}$$

DECEMBER:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-36) = 95.52$$

$$\text{Daily Cost} = 95.52\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$106.48/\text{DAY}$$

JANUARY:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (50-35) = 96.08$$

$$\text{Daily Cost} = 96.08\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$107.10/\text{DAY}$$

FEBRUARY:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (50-38) = 94.39$$

$$\text{Daily Cost} = 94.39\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$105.22/\text{DAY}$$

MARCH:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (50-43) = 91.58$$

$$\text{Daily Cost} = 91.58\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$102.09/\text{DAY}$$

APRIL:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (50-48) = 88.77$$

$$\text{Daily Cost} = 88.77\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$\ 98.95/\text{DAY}$$

Fuel calculations for Scenario E (using calculated mean temperatures minus ten degrees) are as follows:

NOVEMBER:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\ (50-24) = 102.27$$

$$\text{Daily Cost} = 102.27\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$114.00/\text{DAY}$$

DECEMBER:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-16) = 106.78$$

$$\text{Daily Cost} = 106.78\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$119.02/\text{DAY}$$

JANUARY:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-15) = 107.34$$

$$\text{Daily Cost} = 107.34\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$119.65/\text{DAY}$$

FEBRUARY:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-18) = 105.65$$

$$\text{Daily Cost} = 105.65\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$117.77/\text{DAY}$$

MARCH:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-23) = 102.84$$

$$\text{Daily Cost} = 102.84\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$114.63/\text{DAY}$$

APRIL:

$$\text{BTU's/CU FT/DAY} = 87.64 + 0.5628\,(50-28) = 100.02$$

$$\text{Daily Cost} = 100.02\ \frac{\text{BTU/CF}}{\text{DAY}} \times 348{,}348\ \text{CF} \times \frac{\$0.32}{100{,}000\ \text{BTU}}$$

$$= \$111.50/\text{DAY}$$

For the rental of the heaters, it was assumed that three (3) 500 MBH oil fired heaters would be required. At an estimated cost of $480 per month per heater, daily cost for the three heaters was calculated at $47.34 per day.

REFERENCES

1. Simon, Michael S., Construction Contracts and Claims, McGraw-Hill, Inc., 1979, pp. 174-175.

2. Koehn, Enno M. and Brown, Gerald, Climatic Effects on Construction, Journal of Construction Engineering and Management, ASCE, Vol. 111, No. 2, June 85, p. 134.

3. Ibid.

4. Bailey, Robert W., Human Performance Engineering, Bell Laboratories, Inc, 1982, pp. 498-501.

5. Bennett, F. Lawrence, Temporary Protection of Cold Weather Construction, Journal of Construction Engineering and Management, ASCE, Vol. 103, No. 3, September 1977,

6. Koehn and Brown, op. cit., p. 134.

7. Arkin, Herbert and Colton, Raymond R., Statistical Methods, Barnes and Noble Books, 1970, p. 73.

8. Koehn, Enno and Meilhede, Dennis, Cold Weather Construction Costs and Accidents, Journal of Construction Engineering and Management, ASCE, Vol. 107, No. 4, December 1981.

9. Simon, loc. cit.

10. Department of the Navy, Naval Facilities Engineering Command, Contract N62474-81-C-8946, Maintenance/Fire Station Facility at the USMC Mountain Warfare Training Facility, Pickel Meadows, Bridgeport, California.

11. O'Brien, James J., CPM in Construction Management, McGraw-Hill, Inc., 1984, pp. 74-86.

12. Koehn and Brown, op. cit., p. 134.

13. Arkin, op. cit., p. 258.

14. Bennett, op. cit., p. 444.

BIBLIOGRAPHY

Arkin, Herbert and Colton, Raymond R., Statistical Methods, Barnes and Noble Books, 1970.

Bailey, Robert W., Human Performance Engineering, Bell Laboratories, Inc, 1982.

Barrie, Donald S. and Boyd, C. Paulson, Jr., Professional Construction Management, McGraw-Hill, Inc., 1984.

Bennett, F. Lawrence, Half Century of Cold-Regions Construction, Journal of Construction Division, ASCE, Vol. 101, No. 4, December 1975.

Bennett, F. Lawrence, Temporary Protection of Cold Weather Construction, Journal of Construction Engineering and Management, ASCE, Vol. 103, No. 3, September 1977.

Benjamin, Neal B. H. and Greenwald, Theodore W., Simulating Effects of Weather on Construction, Journal of the Construction Division, ASCE, Vol. 99, No. 1, July 1973.

Department of the Navy, Naval Facilities Engineering Command, Contract N62474-81-C-8946, Maintenance/Fire Station Facility at the USMC Mountain Warfare Training Facility, Pickel Meadows, Bridgeport, California.

Department of the Navy, Naval Facilities Engineering Command, Master Plan for U.S. Marine Corps Mountain Warfare Training Facility, Pickel Meadows, Bridgeport, California, 26 February 1982.

Koehn, Enno M. and Brown, Gerald, Climatic Effects on Construction, Journal of Construction Engineering and Management, ASCE, Vol. 111, No. 2, June 85.

Koehn, Enno and Meilhede, Dennis, Cold Weather Construction Costs and Accidents, Journal of Construction Engineering and Management, ASCE, Vol. 107, No. 4, December 1981.

Li, Shu-t'ien, Basic Construction Principles in Higher Latitudes, Journal of the Construction Division, ASCE, Vol. 100, No. 1, March 1974.

Morris, David M., Seasonal Effects on Building Construction, Journal of the Construction Division, ASCE, Vol. 102, No. 1, March 1976

O'Brien, James J., CPM in Construction Management, McGraw-Hill, Inc., 1984.

Simon, Michael S., Construction Contracts and Claims, McGraw-Hill, Inc., 1979.