

AD-A047 357

JET PROPULSION LAB PASADENA CALIF

F/G 9/2

STATISTICAL ANALYSIS OF NOAA SOLAR/WEATHER TAPES. PROGRAM SUMMA--ETC(U)

JUN 77 G GOLTZ, L M KAISER, H WEINER

UNCLASSIFIED

JPL-5040-39

USCG-D-12-77

NL

1 OF 1
AD-A047 357



END
DATE
FILMED

1-78

DDC

AD A 0 4 7 3 5 7

Report No. 5040-39

12 P.S.

CG-D-12-77
June 1977

STATISTICAL ANALYSIS
OF
NOAA SOLAR/WEATHER TAPES

Program Summary

356
542



June 1977

Final Report

Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22161

DDC
RECEIVED
DEC 8 1977
RECEIVED

Prepared for

**DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD**

Office of Research and Development
Washington, D.C. 20590

AD No. _____
DDC FILE COPY

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

NOTICE

The United States Government and the California Institute of Technology do not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

NOTICE

The contents of this report reflect the views of the Jet Propulsion Laboratory which is responsible for the facts and accuracy of data presented. This report does not constitute a standard, specification or regulation.

This work presents the results of one phase of research conducted at the Jet Propulsion Laboratory, California Institute of Technology for the Department of Transportation, United States Coast Guard, Office of Research and Development under Contract MIPR No. Z-70099-5-50352 by agreement with the National Aeronautics and Space Administration.

STATISTICAL ANALYSIS
OF
NOAA SOLAR/WEATHER TAPES

Program Summary



June 1977

Final Report

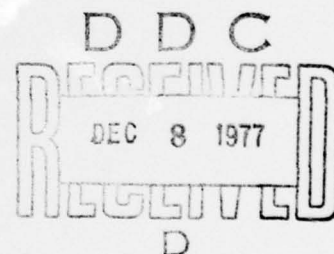
Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22161

Prepared for

**DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD**

Office of Research and Development
Washington, D.C. 20590

REVISION 100	
RTD	Write Section ☒
BOB	Self Section ☐
UNANNOUNCED	☐
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
DISC	AVAIL. AND/OR SPECIAL
A	



18 USCG,
CGR/DC

5040-39

Technical Report Documentation Page

1. Report No. CG-D-12-77, 19/76	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle STATISTICAL ANALYSIS OF NOAA SOLAR/WEATHER TAPES. Program Summary.	5. Report Date June 1977	6. Performing Organization Code
7. Author(s) G. Goltz, L.M./Kaiser, H./Weiner	8. Performing Organization Report No. JPL Document No. 5040-39	9. Work Unit No. (TRAIS)
10. Performing Organization Name and Address Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	11. Contract or Grant No. MIPR No. Z-70099-5-50352	12. Type of Report and Period Covered Final Report.
12. Sponsoring Agency Name and Address Department of Transportation U.S. Coast Guard Office of Research and Development Washington, D.C. 20590	13. Sponsoring Agency Code	
15. Supplementary Notes The contract under which this report was prepared was under the technical supervision of the Coast Guard Research and Development Center, Groton, Connecticut 06340. R&D Center report number 19/76 has been assigned.		
16. Abstract A major mission of the U.S. Coast Guard is the task of providing and maintaining Maritime Aids to Navigation. These aids are located on and near the coastline and inland waters of the United States and its possessions. A computer program, Design Synthesis and Performance Analysis (DSPA), has been developed by the Jet Propulsion Laboratory to demonstrate the feasibility of low-cost solar array/battery power systems for use on flashing lamp buoys. These buoys are exposed to a wide variety of environments. The range of these environments are typified by weather conditions in locations in Alaska and the Florida coastal waters. To provide detailed, realistic temperature, wind, and solar insolation data for analysis of the flashing lamp buoy power systems, the Jet Propulsion Laboratory developed two DSPA support computer program sets: MERGE and STAT. A general description of these two packages is presented in this program summary report. The MERGE program set will enable the Coast Guard to combine temperature and wind velocity data (NOAA TDF-14 tapes) with solar insolation data (NOAA DECK-280 tapes) onto a single sequential "MERGE" file containing up to 12 years of hourly observations. This MERGE file can then be used as direct input to the DSPA program. The STAT program set will enable the Coast Guard to perform a statistical analysis of the MERGE data and produce high or low or mean profiles of the data and/or do a worst case analysis. The STAT output file consists of a one-year set of hourly statistical weather data which can be used as input to the DSPA program.		
17. Key Words Navigation Aids, Power Systems Solar Insolation, Statistical Analysis, Temperature, Weather, Wind Velocity,	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, VA 22161	
19. Security Classification of Report Unclassified	20. Security Classification of this page Unclassified	21. No. of Pages 58
22. Price		

TABLE OF CONTENTS

<u>SECTION</u>		<u>PAGE</u>
1.	INTRODUCTION AND SUMMARY	1-1
2.	MERGE COMPUTER PROGRAM SET DESCRIPTION	2-1
	2.1 Specific Program Requirements	2-1
	2.2 Computer Program Rationale	2-1
	2.3 TDF14 Program	2-6
	2.4 DECK280 Program	2-6
	2.5 LISTMERGE Program	2-7
3.	STAT COMPUTER PROGRAM SET DESCRIPTION	3-1
	3.1 Specific Program Requirements	3-1
	3.2 Computer Program Rationale	3-1
	3.3 STATS Program	3-2
	3.4 PROFILE Program	3-15
4.	REFERENCES	4-1
	APPENDIXES: A STATS Program Mathematical Formulas . .	A-1
	B PROFILE Program Mathematical Formulas. .	B-1
	C LAMBDA Values for Worst Case Analyses. .	C-1
	D Worst Case Days Table	D-1
	FIGURES: 2-1 MERGE Computer Program Set Overview . .	2-2
	2-2 Sample MERGE Output	2-3
	2-3 TDF14 Computer Program	2-6
	2-4 DECK280 Computer Program	2-6
	2-5 LISTMERGE Computer Program	2-7
	3-1 STAT Computer Program Set Overview . . .	3-2
	3-2A Sample STATS Output - Daily Data	3-3
	3-2B Sample STATS Output - Monthly Data . . .	3-5
	3-2C Sample STATS Output - Yearly Data . . .	3-7
	3-3 Sample PROFILE Program Output	3-8
	3-4 STATS Computer Program	3-16
	3-5 PROFILE Computer Program	3-21
	TABLES: 1-1 Index to NOAA Solar Weather Tapes . . .	1-3

1. INTRODUCTION AND SUMMARY

A major mission of the U.S. Coast Guard is the task of providing and maintaining Maritime Aids to Navigation. These aids are located on and near the coastline and inland waters of the United States and its possessions. A computer program, Design Synthesis and Performance Analysis (DSPA), has been developed by the Jet Propulsion Laboratory to demonstrate the feasibility of low-cost solar array/battery power systems for use on flashing lamp buoys.

These buoys are exposed to a wide variety of environments. The range of these environments are typified by weather conditions in locations in Alaska and the Florida Coastal waters. To provide detailed, realistic temperature, wind, and solar insolation data for analysis of the flashing lamp buoy power systems, the Jet Propulsion Laboratory developed two DSPA support computer program sets: MERGE and STAT. A general description of these two packages is presented in this program summary report. Details on the content and usage of these packages are presented in the following reports:

Program Documentation (DS/PA Computer Program):

(JPL Report No. 5040-27)

Volume I - Software Requirements Document.

Volume II - User's Manual.

Volume III - Programmer's Manual.

The MERGE program set will enable the Coast Guard to combine temperature and wind velocity data (NOAA TDF-14 tapes) with solar insolation data (NOAA DECK-280 tapes) onto a single sequential "MERGE" file containing up to 12 years of hourly observations. This MERGE file can then be used as direct input to the DSPA program.

The STAT program set will enable the Coast Guard to perform a statistical analysis of the MERGE data and produce high or low or mean profiles of the data and/or do a worst case analysis. The STAT output file consists of a one-year set of hourly statistical weather data which can be used as input to the DSPA program.

The final phase of the development of the DSPA support programs was the production of MERGE and intermediate STATS (MERGE averages file for subsequent profiling) files for each of the 15 Coast Guard selected locations. The NOAA TDF-14 and DECK-280 data used for generating these files are shown in Table 1-1 below.

TABLE 1-1.-INDEX TO NOAA SOLAR/WEATHER TAPES

Tape Type	Reel No.	Station Number	Station Location	Time Period Covered
TDF14	X788	12839	Miami, Florida	Jan. 1955 to Dec. 1964
	X789	12919	Brownsville, Texas	Jan. 1953 to Dec. 1956
				Jan. 1959 to Dec. 1964
	X790*	13745 (93729)	Hatteras, North Carolina (Cape Hatteras, North Carolina)	Jan. 1955 to Feb. 1957 Mar. 1957 to Dec. 1965
	X791	14607	Caribou, Maine	Jan. 1955 to Dec. 1964
	X792	14732	La Guardia Field, New York	Jan. 1953 to Dec. 1958
				Jan. 1961 to Dec. 1964
	X793	14739	Boston, Massachusetts	Jan. 1955 to Dec. 1964
	X794	14847	Saulte Ste. Marie, Michigan	Jan. 1952 to Dec. 1961
	X795	23174	Los Angeles, California	Jan. 1955 to Dec. 1964
	X796	24233	Seattle, Washington	Jan. 1955 to Dec. 1964
	X797	26615	Bethel, Alaska	Jan. 1952 to Dec. 1961
	X799	13743	Washington, D.C.	Jan. 1955 to Dec. 1964
	X800	13983	Columbia, Missouri	Jan. 1955 to Dec. 1964
	X801	23154	Ely, Nevada	Jan. 1955 to Dec. 1964
	X802	24225	Medford, Oregon	Jan. 1955 to Dec. 1964
	X803	93193	Fresno, California	Jan. 1955 to Dec. 1964
DECK280	X804**	12839	Miami, Florida	Jan. 1955 to Dec. 1964
		12919	Brownsville, Texas	Jan. 1953 to Dec. 1956
				Jan. 1959 to Dec. 1965
		13745	Hatteras, North Carolina	Jan. 1955 to Feb. 1957
		14607	Caribou, Maine	Jan. 1955 to Dec. 1964
		14753	Blue Hill, Massachusetts	Jan. 1955
	X805**	14753	Blue Hill, Massachusetts (cont)	to Dec. 1964
		14847	Saulte Ste. Marie, Michigan	July 1952 to Aug. 1958
		23174	Los Angeles, California	Jan. 1962 to Dec. 1966
		24233	Seattle, Washington	Jan. 1955 to Dec. 1964
		26615	Bethel, Alaska	July 1952 to Oct. 1952
				Dec. 1956 to Apr. 1957
	X806**	93729	Cape Hatteras, North Carolina	Mar. 1957 to Dec. 1964
		94706	New York, New York	Jan. 1953 to Dec. 1958
				Jan. 1963 to Dec. 1964
	X807	13983	Columbia, Missouri	Jan. 1955 to Dec. 1964
		23154	Ely, Nevada	Jan. 1955 to Dec. 1964
	X808	24225	Medford, Oregon	Jan. 1955 to Dec. 1964
		93193	Fresno, California	Jan. 1955 to Dec. 1964
	X809	93722	Silver Hill, Maryland***	Jan. 1955 to Dec. 1960
		93734	Sterling, Virginia***	Jan. 1961 to Dec. 1964

* The Hatteras and Cape Hatteras TDF14 data had to be combined into one file to facilitate the building of the skeleton MERGE file

** No End-of-File mark exists between stations - this problem is handled by the DECK280 program.

*** Solar insolation data from these two files are for use with the Washington, D.C. TDF14 data.

2. MERGE COMPUTER PROGRAM SET DESCRIPTION

The features of the MERGE computer program set, consisting of the TDF14, DECK280, and LISTMERGE routines, are discussed in this section. The elements of this discussion include specific program requirements, computer program rationale, TDF14 program, DECK280 program, and LISTMERGE program. These elements are presented below.

2.1 Specific Program Requirements

The major requirement of the MERGE computer program set is to combine the solar insolation data from the NOAA DECK-280 tapes with the temperature and wind velocity data from the TDF-14 tapes. The resultant output, a MERGE file, is to be a computer data file consisting of no more than 12 years of information. The MERGE file information is to be recorded on an hourly basis and stored on one-day records, all days being stored in Julian date sequence. Temperature data is in degrees Fahrenheit; wind velocity is in knots, and solar insolation is in watts/square meter.

2.2 Computer Program Rationale

The basis for selecting the proper computer program for meeting the Coast Guard requirements was determined by examination of the necessary DSPA weather data input. Generally the DSPA program requires that temperature and solar insolation values be known (wind velocity was added as a possible future requirement). Accuracy requirements further dictated that data observations should be hourly. Use of the NOAA weather tapes provided the needed data, though not in a very accessible form.

Investigation of the NOAA tapes revealed that the TDF-14 data was edited and sequentially stored, but the DECK-280 data was unedited and unsorted. Hence, it was determined that the MERGE process should be performed in two separate steps:

- 1) Generation of a skeletal MERGE file from the TDF-14 tape data.
- 2) Addition of the DECK-280 data to the MERGE file.

An overview flow diagram of the MERGE program is shown in Figure 2-1 below. A sample of the MERGE output file contents is provided in Figure 2-2.

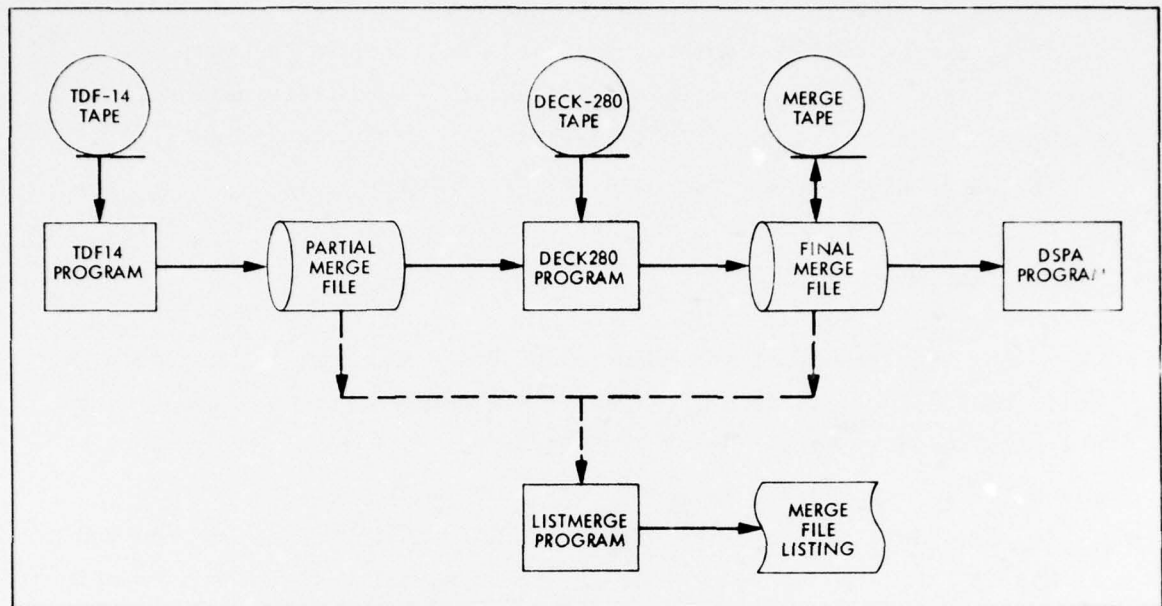


FIGURE 2-1. MERGE COMPUTER PROGRAM SET OVERVIEW

ENTER START DATE (YYDD) AND NO. OF RECORDS TO DISPLAY

DATE = 55001	SECTOR = 0	50.00	50.00	50.00	51.00	51.00	50.00	54.00	54.00	55.00
TEMP =	49.00	50.00	50.00	50.00	51.00	51.00	50.00	54.00	54.00	55.00
WIND =	55.00	54.00	54.00	54.00	53.00	54.00	50.00	54.00	54.00	60.00
QST =	3.00	6.00	4.00	4.00	4.00	4.00	2.00	3.00	3.00	4.00
	00	3.00	4.00	3.00	4.00	2.00	3.00	2.00	6.00	4.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	19.76	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 55002	SECTOR = 3	61.00	62.00	57.00	58.00	59.00	50.00	55.00	55.00	54.00
TEMP =	60.00	60.00	59.00	56.00	56.00	56.00	50.00	55.00	55.00	54.00
WIND =	54.00	50.00	57.00	55.00	56.00	56.00	50.00	55.00	55.00	53.00
QST =	6.00	1.00	12.00	16.00	16.00	11.00	19.00	7.00	7.00	8.00
	10.00	12.00	13.00	9.00	4.00	8.00	5.00	8.00	8.00	10.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	540.43	412.59	203.39	40.68	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 55003	SECTOR = 6	48.00	48.00	48.00	48.00	47.00	40.00	51.00	52.00	52.00
TEMP =	52.00	50.00	51.00	49.00	49.00	49.00	40.00	48.00	47.00	46.00
WIND =	54.00	50.00	51.00	47.00	47.00	47.00	40.00	48.00	47.00	46.00
QST =	9.00	8.00	9.00	10.00	10.00	8.00	9.00	8.00	10.00	10.00
	10.00	11.00	10.00	6.00	6.00	7.00	9.00	8.00	10.00	10.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	579.95	438.16	249.68	54.62	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 55004	SECTOR = 9	53.00	52.00	52.00	52.00	52.00	50.00	53.00	52.00	54.00
TEMP =	47.00	50.00	57.00	54.00	53.00	50.00	50.00	51.00	50.00	49.00
WIND =	54.00	50.00	12.00	10.00	10.00	10.00	13.00	13.00	15.00	11.00
QST =	3.00	7.00	3.00	4.00	4.00	3.00	3.00	7.00	5.00	4.00
	9.00	6.00	4.00	4.00	4.00	3.00	3.00	7.00	5.00	4.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	503.24	244.07	196.42	55.79	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 55005	SECTOR = 12	49.00	49.00	48.00	47.00	47.00	40.00	48.00	48.00	50.00
TEMP =	49.00	50.00	48.00	47.00	47.00	47.00	40.00	48.00	48.00	47.00
WIND =	50.00	50.00	12.00	14.00	13.00	15.00	17.00	15.00	11.00	14.00
QST =	8.00	9.00	8.00	8.00	6.00	10.00	7.00	5.00	5.00	5.00
	12.00	11.00	8.00	8.00	6.00	6.00	7.00	5.00	5.00	5.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	382.37	270.80	163.87	34.87	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 55006	SECTOR = 15	49.00	50.00	59.00	60.00	59.00	60.00	60.00	62.00	63.00
TEMP =	48.00	49.00	60.00	60.00	59.00	60.00	50.00	60.00	49.00	47.00
WIND =	44.00	64.00	60.00	4.00	13.00	13.00	10.00	13.00	16.00	15.00
QST =	4.00	6.00	1.00	4.00	12.00	15.00	19.00	20.00	21.00	21.00
	15.00	15.00	11.00	16.00	17.00	16.00	19.00	20.00	21.00	21.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	511.38	299.85	127.84	44.16	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00

FIGURE 2-2. SAMPLE MERGE OUTPUT (Sheet 1 of 3)

ENTER START DATE (YYDDDD) AND NO. OF RECORDS TO DISPLAY

DATE = 59363	SECTOR = 5478	54.00	56.00	54.00	54.00	53.00	50.00	54.00	53.00	54.00	53.00	54.00	54.00
TEMP =	64.00	62.00	50.00	57.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
WIND =	55.00	54.00	50.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00	54.00
	18.00	20.00	13.00	19.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
QST =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	448.62	348.67	437.00	206.88	47.65	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 59364	SECTOR = 5481	48.00	46.00	47.00	46.00	45.00	44.00	40.00	44.00	47.00	48.00	49.00	49.00
TEMP =	49.00	50.00	48.00	48.00	45.00	44.00	44.00	40.00	44.00	47.00	45.00	45.00	45.00
WIND =	11.00	11.00	11.00	13.00	14.00	8.00	8.00	4.00	4.00	7.00	9.00	10.00	10.00
QST =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	609.00	389.34	212.69	139.47	31.38	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 59365	SECTOR = 5484	46.00	47.00	45.00	47.00	43.00	42.00	40.00	42.00	45.00	47.00	46.00	46.00
TEMP =	46.00	44.00	40.00	43.00	42.00	41.00	42.00	40.00	42.00	45.00	41.00	41.00	41.00
WIND =	6.00	6.00	4.00	8.00	8.00	6.00	7.00	3.00	7.00	12.00	13.00	14.00	14.00
QST =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	301.02	409.10	307.99	224.31	41.84	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 60001	SECTOR = 5490	41.00	40.00	40.00	40.00	39.00	39.00	40.00	42.00	42.00	42.00	43.00	43.00
TEMP =	45.00	44.00	40.00	43.00	42.00	42.00	42.00	40.00	45.00	45.00	45.00	45.00	45.00
WIND =	7.00	10.00	11.00	8.00	10.00	6.00	5.00	4.00	8.00	8.00	9.00	10.00	10.00
QST =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	524.16	380.05	223.31	112.74	27.89	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 60002	SECTOR = 5493	46.00	48.00	47.00	48.00	49.00	48.00	40.00	51.00	53.00	56.00	56.00	56.00
TEMP =	58.00	61.00	60.00	60.00	59.00	60.00	60.00	60.00	61.00	61.00	62.00	62.00	62.00
WIND =	8.00	8.00	7.00	10.00	9.00	9.00	9.00	9.00	10.00	10.00	10.00	10.00	10.00
QST =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	576.46	391.67	242.90	130.17	30.22	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DATE = 60003	SECTOR = 5496	63.00	62.00	64.00	65.00	63.00	63.00	60.00	64.00	65.00	67.00	67.00	67.00
TEMP =	65.00	64.00	60.00	57.00	56.00	54.00	54.00	50.00	52.00	52.00	50.00	50.00	50.00
WIND =	17.00	17.00	13.00	19.00	20.00	24.00	26.00	24.00	27.00	27.00	26.00	26.00	26.00
QST =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	106.92	65.08	80.19	97.63	60.44	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00

FIGURE 2-2. SAMPLE MERGE OUTPUT (Sheet 2 of 3)

2.3 TDF14 Program

The TDF14 program, shown in Figure 2-3, controls the building of the skeletal MERGE file from the NOAA TDF-14 data tape. The user requests the creation of a MERGE file to span a particular period of years for a selected TDF-14 location. The TDF14 program then extracts the temperature, and wind velocity information from the input tape, as a one-day record consisting of 24 hourly observations of temperature and wind velocity and space for solar insolation, and sequentially writes the day's data to a MERGE file.

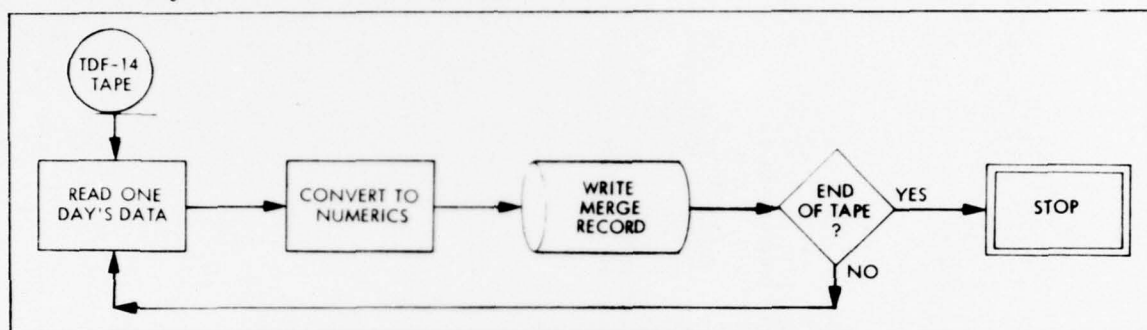


FIGURE 2-3. TDF14 COMPUTER PROGRAM

2.4 DECK280 Program

Addition of solar insolation data to a MERGE file created by TDF14 is performed by the DECK280 program (Figure 2-4). The user requests that, for a particular MERGE location, NOAA DECK-280 tape data from a specified location be inserted into the file. The DECK280 program extracts the solar radiation data (in Langleys) from the NOAA tape, converts the data

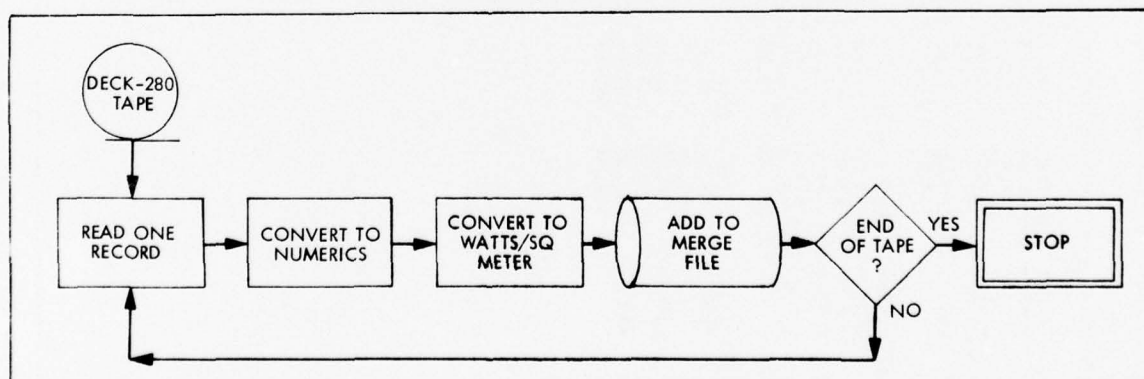


FIGURE 2-4. DECK280 COMPUTER PROGRAM

to watts/square meter, and adds the data to the appropriate day and hour position in the MERGE file.

2.5 LISTMERGE Program

The average MERGE file consists of from 10 to 12 years of hourly temperature, wind velocity, and solar insolation data. The LISTMERGE program permits the user to randomly view any number of sequential days beginning at any date contained within the file. (See Figure 2-5).

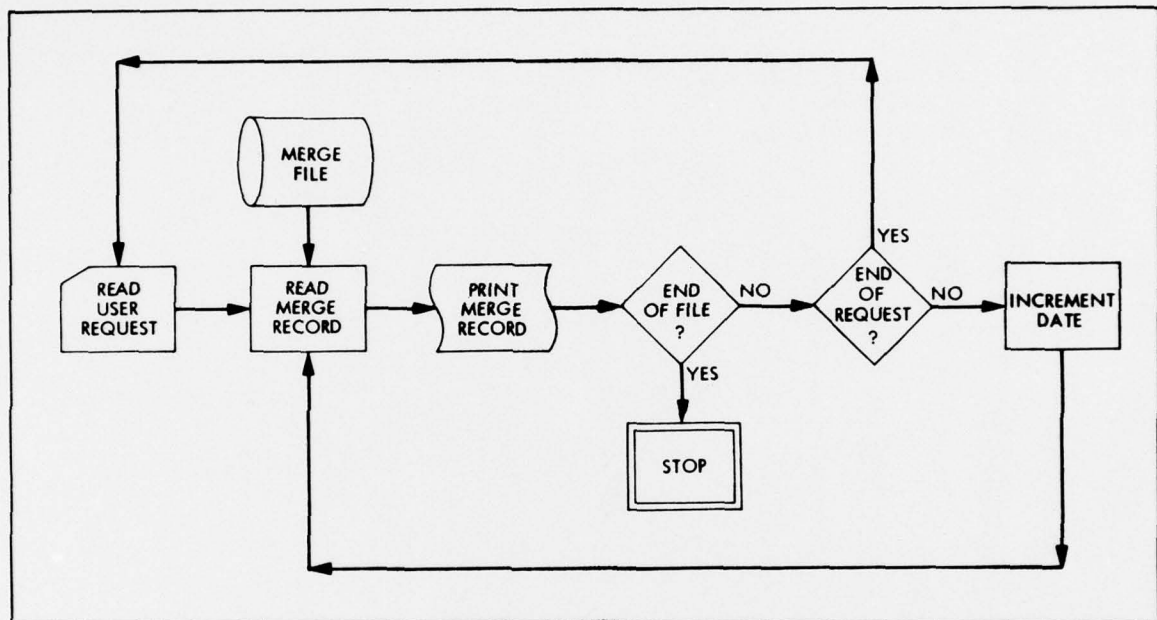


FIGURE 2-5. LISTMERGE COMPUTER PROGRAM

3. STAT COMPUTER PROGRAM SET DESCRIPTION

The features of the STAT computer program set, consisting of the STATS and PROFILE routines, are discussed in this section. The elements of this discussion include specific program requirements, computer program rationale, STATS program, and PROFILE program. These elements are presented below.

3.1 Specific Program Requirements

The major requirement of the STAT computer program set is to perform a statistical analysis of the MERGE weather data, producing high or low or mean or worst case environmental profiles. The user must be able to control the selection of alternative profile types on a monthly basis. The resultant output is to be a computer data file consisting of one year of statistical weather information stored in the same format as the MERGE file data.

3.2 Computer Program Rationale

The basis for selecting the proper computer program for meeting the Coast Guard requirements was determined by examination of the process involved in profiling data. To produce a profile, the MERGE data must first be averaged over all years. This "means" data represents a "smoothed over" year with an extremely small likelihood of occurrence. The user, therefore, needs to be able to adjust the information by applying some scaling factor to the averaged data and, if desired, performing a worst case analysis of the data. The Coast Guard required that the user be permitted to treat each month separately, yielding different scale factors and/or worst case periods.

Investigations indicated that a process involving reading and averaging and profiling of the 10 to 12 years of MERGE data, all in one step and for each time a new statistical profile was required, would be prohibitively

expensive. Hence, it was determined that the statistical analysis process should be performed in two separate steps:

- 1) Generation of a one-year averages file, directly from the MERGE file, for permanent storage on magnetic tape (i.e., executed one time only for each location).
- 2) Profiling of the averages data, as required, for input to the SPA program (approximately 4 times less expensive than step 1).

An overview flow diagram of the STAT program is shown in Figure 3-1 below. Samples of the STATS and PROFILE output files are provided in Figures 3-2 and 3-3 respectively.

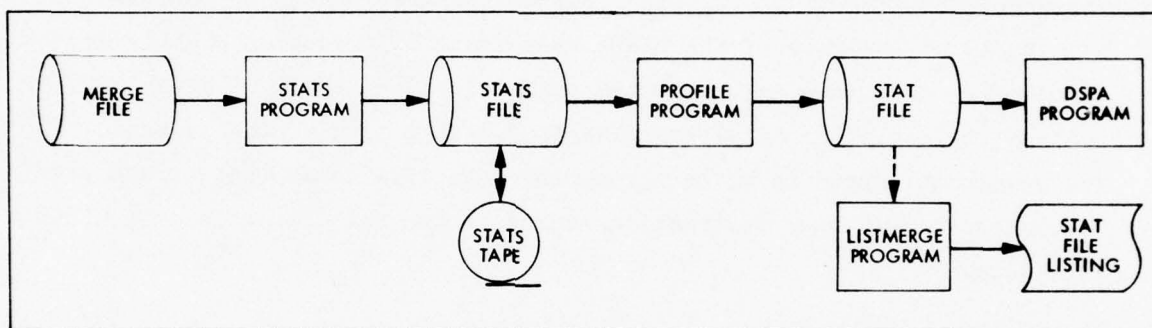


FIGURE 3-1 STAT COMPUTER PROGRAM SET OVERVIEW

3.3 STATS Program

The STATS program uses the 10 to 12 years of MERGE file weather data to produce a one-year statistical file. The procedure involves the averaging of data for a given hour of a given day for each of the years contained in the MERGE file. The statistical data is then written onto a STATS file which is used as input to the PROFILE program (Section 3.4 below). Specifically, the STATS program computes and outputs (both to the STATS and to the printer) the following statistics:

- 1a) Average temperature for each hour of one year.
- 1b) Average wind velocity for each hour of one year.
- 1c) Average solar insolation for each hour of one year.
- 2a) Average wind velocity for each day of each data year.
- 2b) Average solar insolation for each day of each data year.

STATISTICAL ANALYSIS FOR STATION NUMBER 13745

LIMIT DATES = 55001 TO 64366

TIME SPAN = 10 YEARS

DAY = 1	SECTOR = 0	AVERAGE DAILY WIND VELOCITY = 45.70	45.10	41.00	10.96 KNOTS,	AVERAGE DAILY SOLAR INSOLATION = 47.20	47.40	282.17 WATTS/SQ.M	49.90	50.80
TEMP =		50.90	51.00	50.10	49.30	47.50	45.70	40.00	45.50	45.00
WIND =		10.80	10.80	10.20	10.70	10.50	10.70	10.30	11.10	11.50
QDT =		11.40	11.60	12.70	11.90	10.90	10.50	9.40	11.40	11.50
DAILY WIND =		33.01	350.83	236.45	96.76	1000.00	102.13	223.44	344.94	512.04
DAILY QDT =		3.17	7.71	12.58	10.46	9.38	14.42	10.58	13.00	18.08
		-1000.00	402.13	326.82	217.22	161.88	257.20	-1000.00	365.29	286.84
DAY = 2	SECTOR = 4	AVERAGE DAILY WIND VELOCITY = 44.90	44.10	40.00	11.03 KNOTS,	AVERAGE DAILY SOLAR INSOLATION = 42.80	41.90	329.43 WATTS/SQ.M	43.20	44.10
TEMP =		44.90	45.80	42.00	46.30	43.70	43.40	41.00	44.50	43.30
WIND =		12.80	13.00	10.30	12.40	13.20	13.00	12.40	11.20	11.50
QDT =		11.80	11.30	11.40	11.10	10.20	8.60	6.30	9.20	10.20
DAILY WIND =		984.90	411.04	-1000.00	-1000.00	-1000.00	31.38	87.64	202.64	349.20
DAILY QDT =		9.71	8.46	255.69	122.96	36.73	-1000.00	-1000.00	-1000.00	-1000.00
		282.07	132.96	375.98	300.58	-1000.00	321.70	489.41	410.70	15.42
DAY = 3	SECTOR = 8	AVERAGE DAILY WIND VELOCITY = 43.10	42.80	38.00	11.17 KNOTS,	AVERAGE DAILY SOLAR INSOLATION = 42.20	41.70	266.46 WATTS/SQ.M	45.90	46.90
TEMP =		48.30	48.10	46.10	46.50	44.80	44.50	40.00	44.20	43.70
WIND =		10.30	10.10	9.30	10.30	11.50	11.90	12.40	11.90	11.80
QDT =		12.90	13.30	13.00	12.30	11.10	10.60	11.00	9.50	9.30
DAILY WIND =		914.75	345.44	-1000.00	-1000.00	-1000.00	30.22	73.48	205.42	353.76
DAILY QDT =		8.04	5.33	250.87	105.60	57.72	-1000.00	-1000.00	-1000.00	-1000.00
		384.35	188.74	342.62	139.93	313.30	67.76	-1000.00	417.70	-1000.00
DAY = 4	SECTOR = 12	AVERAGE DAILY WIND VELOCITY = 43.90	44.10	39.00	11.28 KNOTS,	AVERAGE DAILY SOLAR INSOLATION = 42.60	42.50	296.68 WATTS/SQ.M	46.20	47.10
TEMP =		48.10	48.40	46.00	46.40	47.00	45.80	43.00	43.10	42.40
WIND =		11.00	11.50	9.80	11.00	11.10	10.10	9.50	10.60	12.20
QDT =		12.90	12.20	12.10	13.00	11.50	11.30	11.00	10.40	11.60
DAILY WIND =		500.66	357.71	267.31	125.52	47.65	-1000.00	-1000.00	-1000.00	-1000.00
DAILY QDT =		7.04	16.42	12.12	17.50	9.17	6.75	12.17	9.08	11.46
		260.34	308.45	283.12	275.21	329.37	405.85	421.19	-1000.00	-1000.00
DAY = 5	SECTOR = 16	AVERAGE DAILY WIND VELOCITY = 42.20	41.40	37.00	10.44 KNOTS,	AVERAGE DAILY SOLAR INSOLATION = 39.20	39.10	329.83 WATTS/SQ.M	43.00	44.10
TEMP =		44.90	45.00	41.00	44.70	44.50	41.10	40.30	40.10	40.40
WIND =		11.70	11.70	9.70	11.50	11.00	12.70	11.90	10.80	10.30
QDT =		11.40	11.90	10.40	10.40	9.20	7.90	8.30	8.90	8.50
DAILY WIND =		533.11	445.01	245.32	140.75	54.04	-1000.00	-1000.00	-1000.00	-1000.00
DAILY QDT =		9.62	18.92	13.50	13.62	17.67	5.83	5.29	7.93	7.37

FIGURE 3-2A. SAMPLE STATS OUTPUT-DAILY DATA (Sheet 1 of 2)

DAILY QDT =	306.71	358.66	68.45	369.35	416.89	341.34	389.81	381.33	352.80	245.56	-1000.00	-1000.00
DAY = 6	SECTOR = 20											
AVERAGE DAILY WIND VELOCITY =	39.80	41.20	37.00	41.10	40.10	40.00	40.90	41.80	39.00	45.21	47.80	
TEMP =	48.70	49.10	46.00	49.70	49.60	49.20	49.60	46.10	43.00	46.50	47.70	
WIND =	8.90	8.70	8.20	9.70	9.20	10.10	9.40	9.20	9.20	9.30	9.60	
QDT =	10.20	9.90	10.40	9.50	9.60	8.80	8.40	8.70	9.20	9.90	8.40	
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	
DAILY WIND =	438.27	318.19	211.85	47.50	34.63	-1000.00	39.81	107.85	254.59	348.77	490.07	
DAILY QDT =	12.79	8.71	10.42	4.08	16.12	6.67	8.37	14.21	3.13	9.21	-1000.00	
	333.79	349.48	262.08	397.71	416.42	43.23	405.38	85.77	181.89	-1000.00	-1000.00	
DAY = 7	SECTOR = 24											
AVERAGE DAILY WIND VELOCITY =	44.30	45.20	41.00	45.00	44.70	44.40	44.40	43.50	42.00	45.80	46.30	
TEMP =	48.30	49.30	44.00	48.30	47.70	46.20	45.80	46.00	40.00	45.50	45.30	
WIND =	6.50	11.20	10.30	12.50	11.90	11.90	10.90	11.50	9.30	11.00	12.90	
QDT =	13.40	13.60	14.40	15.50	16.40	13.90	14.30	14.40	16.70	15.30	14.80	
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	
DAILY WIND =	427.44	352.80	240.06	113.25	40.68	-1000.00	17.72	59.14	151.48	253.62	404.31	
DAILY QDT =	15.79	16.17	9.58	15.21	8.96	8.83	11.67	15.58	10.62	12.29	-1000.00	
	379.70	293.34	309.50	24.41	326.70	69.97	343.79	387.37	-1000.00	68.76	-1000.00	
DAY = 8	SECTOR = 28											
AVERAGE DAILY WIND VELOCITY =	44.70	44.10	40.00	43.00	42.60	41.70	41.30	40.80	39.00	42.20	43.40	
TEMP =	47.30	44.60	40.00	45.00	44.60	43.30	42.40	42.20	39.00	43.00	42.70	
WIND =	14.40	14.30	12.50	13.60	13.70	12.90	12.30	12.90	12.90	12.90	12.10	
QDT =	11.80	11.30	9.70	10.50	10.70	9.90	9.90	10.80	10.10	12.50	12.30	
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	
DAILY WIND =	335.75	243.37	201.99	108.23	38.55	-1000.00	36.80	91.38	246.78	348.17	384.70	
DAILY QDT =	9.25	22.54	10.00	14.12	10.87	9.67	12.12	13.37	8.92	4.50	-1000.00	
	396.43	76.82	414.91	341.93	130.05	402.13	228.83	195.02	216.84	49.16	-1000.00	
DAY = 9	SECTOR = 32											
AVERAGE DAILY WIND VELOCITY =	42.30	41.60	37.00	40.80	40.20	39.80	39.70	39.10	36.00	42.10	43.40	
TEMP =	44.80	45.30	40.00	46.30	45.60	44.50	43.40	42.30	38.00	41.90	43.60	
WIND =	13.10	12.60	11.90	13.00	12.60	12.30	12.10	11.20	10.30	11.40	13.50	
QDT =	13.40	13.80	12.40	11.30	11.00	10.60	12.00	10.90	10.70	11.80	12.50	
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	
DAILY WIND =	426.65	377.84	277.54	134.95	59.51	-1000.00	18.60	71.59	196.65	315.54	431.30	
DAILY QDT =	8.67	19.12	11.58	13.92	16.75	9.33	14.71	7.50	6.04	13.54	-1000.00	
	119.94	49.63	41.03	384.46	507.46	402.13	429.56	437.34	339.37	41.36	-1000.00	
DAY = 10	SECTOR = 36											
AVERAGE DAILY WIND VELOCITY =	43.00	42.80	38.00	43.70	43.40	43.40	43.10	43.10	39.00	44.60	46.50	
TEMP =	46.30	47.10	42.00	46.40	45.80	43.80	43.40	42.70	39.00	42.20	41.80	
WIND =	11.90	11.70	14.20	11.20	11.50	12.50	12.90	12.80	13.00	14.20	15.00	
QDT =	14.70	15.00	15.50	12.50	12.80	12.40	13.40	12.10	12.40	12.90	12.10	
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	
DAILY WIND =	409.97	274.57	219.66	130.30	45.04	-1000.00	34.54	90.65	214.87	307.70	363.78	
DAILY QDT =	9.79	14.92	22.21	12.21	13.79	12.29	8.62	14.75	6.71	14.67	-1000.00	
	240.93	43.12	241.97	405.38	-1000.00	256.27	-1000.00	30.92	345.88	407.55	-1000.00	

FIGURE 3-2A. SAMPLE STATS OUTPUT-DAILY DATA (Sheet 2 of 2)

MONTH	1	2	3	4	5	6	7	8	9	10	11
TEMP	42.89	44.92	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
WIND	11.80	12.33	12.51	10.34	9.64	10.17	8.29	8.78	8.86	10.86	11.59
QDT	253.50	329.23	335.42	355.04	478.58	471.71	490.22	497.79	424.21	341.77	328.16
1464	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1468	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1472	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1476	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1480	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1484	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1488	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1492	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1496	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1500	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1504	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1508	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1512	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1516	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1520	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1524	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1528	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1532	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1536	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1540	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1544	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1548	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1552	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1556	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1560	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1564	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1568	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1572	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75
1576	44.78	49.51	49.51	49.96	62.65	67.74	70.97	77.33	75.81	61.53	57.75

MONTH = 12 SECTOR = 1508
 TEMP = 43.04 55.89 51.24 43.94 48.93 41.39 48.90 43.44 41.13 51.19 .00 46.71 5.00
 WIND = 11.79 11.97 11.57 11.04 11.28 10.20 9.11 10.80 9.28 8.18 .00 10.52 1.28
 QDT = 274.79 297.05 278.87 275.61 268.28 286.43 259.13 216.95 243.02 204.31 .00 240.44 30.18

FIGURE 3-2B. SAMPLE STATS OUTPUT-MONTHLY DATA (Sheet 2 of 2)

YEARLY STATISTICS:
 10 VALID YEARS OF DATA FOUND
 TMIN = 20.00 .00 10.00 19.00 20.00 20.00 10.00 20.00 1000.00 1000.00
 MEAN TMIN = 13.90 TMIN STANDARD DEVIATION 8.16
 TMAX = 91.00 87.00 90.00 93.00 89.00 90.00 90.00 87.00 90.00 -1000.00 -1000.00
 MEAN TMAX = 90.20 TMAX STANDARD DEVIATION 2.15

FIGURE 3-2C. SAMPLE STATS OUTPUT-YEARLY DATA

***FOR MONTH 12, DELTA/SCALE FACTORS =
 TEMP: -10.0691 -ING: .7545 QDT: .7648

SLIPT = .9000000E+00
 ALPHAQ = .9000000E+00
 ALPHAT = .9000000E+00
 ALPHAV = .9000000E+00
 ALPHW = .9000000E+00
 ALPHX = .9000000E+00
 ALPHY = .9000000E+00
 LH = -1.
 PHV = .7500000E+00
 PLQ = .7500000E+00
 PLV = .7500000E+00
 PQ = .9000000E+00
 PT = .9000000E+00
 PV = .9000000E+00
 SEND

DAY = 335	SECTOR = 1002	TEMP = 31.43	30.03	24.03	29.63	29.33	28.73	26.13	26.73	26.93	33.23	34.43	34.03
WIND = 31.63	37.53	32.03	36.23	37.13	34.33	32.93	32.63	7.85	8.15	6.64	8.22	8.83	9.58
QDT = 3.37	8.90	8.90	8.00	7.92	7.47	6.87	6.71	7.39	8.07	8.30	8.00	8.37	8.36
QDT = -1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
QDT = 372.99	240.51	144.86	40.70	.30	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 336	SECTOR = 1005	TEMP = 31.43	31.43	24.43	31.63	30.53	30.33	30.83	31.33	28.93	38.03	40.03	41.23
WIND = 32.53	43.23	33.93	43.93	43.43	42.03	43.43	40.93	40.93	40.43	34.93	39.53	41.63	41.73
QDT = 7.54	7.54	7.54	6.71	6.41	6.49	6.49	6.64	6.94	7.47	7.02	6.79	7.09	7.54
QDT = -1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
QDT = 302.54	214.37	123.17	37.87	.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 337	SECTOR = 1008	TEMP = 41.63	40.73	34.93	41.83	41.63	41.53	40.73	40.13	37.93	44.53	46.23	47.03
WIND = 47.73	48.53	44.93	47.33	46.83	44.83	44.13	44.13	44.13	44.43	38.93	43.63	42.93	43.23
QDT = 6.53	8.53	13.19	9.96	9.43	8.98	8.53	8.53	8.53	8.60	8.60	8.37	8.37	7.77
QDT = -1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
QDT = 285.16	229.46	131.38	36.43	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 339	SECTOR = 1011	TEMP = 43.33	43.23	39.93	42.73	42.43	41.23	41.03	40.73	37.93	44.43	45.43	45.93
WIND = 45.73	46.83	42.93	47.33	46.03	42.93	42.93	41.33	41.33	40.73	34.93	38.93	38.93	38.83
QDT = 7.77	7.24	6.19	7.92	7.54	6.87	6.87	7.02	7.02	6.71	5.51	7.39	7.77	8.07
QDT = -1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
QDT = 373.61	238.74	125.83	29.59	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 339	SECTOR = 1014	TEMP = 43.33	43.23	39.93	42.73	42.43	41.23	41.03	40.73	37.93	44.43	45.43	45.93
WIND = 45.73	46.83	42.93	47.33	46.03	42.93	42.93	41.33	41.33	40.73	34.93	38.93	38.93	38.83
QDT = 7.77	7.24	6.19	7.92	7.54	6.87	6.87	7.02	7.02	6.71	5.51	7.39	7.77	8.07
QDT = -1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
QDT = 373.61	238.74	125.83	29.59	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00

FIGURE 3-3. SAMPLE PROFILE PROGRAM OUTPUT (Sheet 1 of 6)

TEMP =	34.13	36.93	33.93	39.83	39.73	39.23	39.23	38.83	34.93	44.03	45.83	47.63
WIND =	44.23	44.73	42.93	48.93	48.13	45.63	44.23	43.93	33.93	43.43	42.23	41.53
QDT =	7.47	7.85	8.22	7.17	6.64	6.26	5.72	5.58	4.07	5.04	5.58	6.11
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	294.97	193.77	105.65	27.13	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 340 SECTOR = 1017												
TEMP =	40.93	40.73	35.93	39.23	38.33	37.33	36.93	36.93	34.93	40.13	41.43	42.33
WIND =	42.73	43.23	37.93	43.03	41.93	40.33	39.23	38.83	31.93	37.93	37.93	38.03
QDT =	8.83	5.66	5.43	6.04	6.58	7.39	7.09	7.09	7.92	8.53	8.75	9.20
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	282.89	217.33	115.45	25.40	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 341 SECTOR = 1020												
TEMP =	37.93	37.83	32.93	37.73	36.93	36.43	36.23	35.93	30.93	39.03	40.33	41.33
WIND =	41.33	42.03	37.93	41.83	41.03	38.13	36.93	36.83	33.93	36.53	37.13	37.03
QDT =	9.66	9.51	8.83	9.73	9.51	8.98	8.68	8.37	10.03	9.36	10.11	9.66
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	366.70	265.67	136.90	31.64	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 342 SECTOR = 1023												
TEMP =	36.93	37.03	31.93	36.83	36.43	36.13	36.03	35.33	33.93	40.63	42.03	43.63
WIND =	45.13	44.53	37.93	44.73	43.63	42.13	41.43	40.53	33.93	39.63	37.73	36.93
QDT =	7.39	8.07	7.85	7.17	7.02	6.87	7.32	6.41	6.41	7.54	7.32	7.32
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	272.98	224.35	114.16	25.25	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 343 SECTOR = 1026												
TEMP =	36.73	37.63	33.93	37.13	36.43	35.33	34.93	34.53	31.93	38.93	39.53	41.03
WIND =	42.03	42.03	36.93	41.13	39.83	38.83	38.43	38.13	33.93	38.43	37.13	36.43
QDT =	5.66	6.41	5.05	6.87	6.64	6.41	6.87	6.49	7.70	7.62	9.28	9.36
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	266.73	214.67	123.77	31.64	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 344 SECTOR = 1029												
TEMP =	36.13	35.43	29.93	34.43	34.13	33.63	33.13	33.23	29.93	35.83	37.33	37.43
WIND =	37.83	38.13	33.93	38.23	37.13	35.63	35.53	35.23	29.93	34.63	34.53	34.63
QDT =	6.83	6.48	9.68	9.36	9.13	9.13	8.75	8.83	7.85	8.98	9.81	9.36
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	347.94	259.82	136.94	29.51	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 345 SECTOR = 1032												
TEMP =	34.73	34.43	30.93	33.43	34.33	34.93	34.53	34.03	33.93	40.03	42.13	43.53
WIND =	43.63	43.43	38.93	44.13	43.63	42.93	41.53	40.63	35.93	40.63	40.13	39.63
QDT =	5.81	6.41	3.85	6.49	7.02	6.79	6.64	6.56	4.98	7.32	8.30	8.30
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	167.14	135.79	80.47	14.93	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 346 SECTOR = 1035												
TEMP =	39.93	39.33	33.93	37.43	37.23	37.03	36.53	36.03	31.93	36.23	38.73	39.53

FIGURE 3-3. SAMPLE PROFILE PROGRAM OUTPUT (Sheet 2 of 6)

WIND =	37.53	9.81	10.79	10.49	10.34	38.13	39.13	38.83	36.93	36.83	31.93	35.83	34.73	34.63
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 347	200.60	136.52	83.96	15.55	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1034														
TEMP =	34.53	33.93	28.93	33.93	33.63	33.13	33.03	33.03	33.03	33.03	27.93	34.43	35.93	36.93
WIND =	37.53	30.93	30.93	36.93	36.53	35.13	34.13	34.13	34.13	34.13	29.93	34.63	34.73	34.73
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 348	300.59	247.23	138.51	34.37	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1041														
TEMP =	34.93	34.93	29.93	37.13	34.13	33.93	34.43	34.43	34.43	34.43	30.93	36.33	37.33	37.63
WIND =	36.23	38.23	37.93	38.03	37.03	35.93	36.23	36.73	36.73	36.73	32.93	35.43	34.93	34.73
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 349	259.22	191.16	98.72	25.15	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1044														
TEMP =	34.13	33.53	28.93	32.93	32.33	31.73	31.63	31.63	31.63	31.63	27.93	34.53	35.93	36.33
WIND =	36.93	37.43	32.93	37.43	36.53	34.53	32.63	31.93	31.93	31.93	27.93	32.73	32.33	32.53
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 350	297.11	222.61	124.40	29.80	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1047														
TEMP =	32.93	32.33	28.93	32.13	32.13	31.73	31.13	31.03	31.03	31.03	28.93	33.33	34.73	36.13
WIND =	36.93	36.23	33.93	38.03	37.13	35.23	33.73	34.93	34.93	34.93	30.93	35.63	35.93	35.43
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 351	363.19	311.10	197.12	86.44	23.04	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1050														
TEMP =	34.93	35.03	29.93	33.93	33.23	32.73	33.93	33.63	33.63	33.63	27.93	35.43	37.03	39.53
WIND =	41.43	42.23	37.93	43.23	41.53	39.73	40.03	39.53	39.53	39.53	34.93	38.43	38.43	38.33
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 352	355.30	293.34	211.50	87.33	24.06	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1053														
TEMP =	38.03	38.33	33.93	37.53	38.33	38.03	37.73	37.53	37.53	37.53	34.93	42.63	42.43	43.03
WIND =	43.33	42.83	35.93	41.43	40.93	39.73	38.63	38.63	38.63	38.63	32.93	38.13	38.13	37.13
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 353	221.89	234.99	168.16	83.32	25.21	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
SECTOR = 1056														
TEMP =	36.03	35.73	30.93	33.53	33.43	33.33	32.93	33.03	33.03	33.03	29.93	36.33	37.73	39.53
WIND =	40.53	41.33	36.93	41.53	40.43	38.03	36.73	36.63	36.63	36.63	30.93	37.53	38.63	39.13
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00

FIGURE 3-3. SAMPLE PROFILE PROGRAM OUTPUT (Sheet 3 of 6)

FIGURE 3-3. SAMPLE PROFILE PROGRAM OUTPUT (Sheet 4 of 6)

QDT =	9.20	9.51	8.37	6.37	7.92	7.77	7.17	7.77	8.98	6.56	7.85	8.15
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	331.01	305.07	235.66	118.92	29.23	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 361	SECTOR = 1080											
TEMP =	37.73	37.43	32.93	37.73	37.13	36.83	36.43	35.63	31.93	39.33	40.43	41.23
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	42.83	43.03	38.93	41.93	41.53	39.93	38.53	38.53	33.93	38.23	37.53	37.33
WIND =	7.54	7.32	8.00	7.02	7.17	6.94	7.39	7.39	6.54	8.00	8.53	8.15
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	8.53	8.07	8.26	7.82	7.85	7.17	7.09	6.71	6.34	7.39	7.17	7.54
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	384.54	323.09	167.76	93.30	29.41	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 362	SECTOR = 1083											
TEMP =	37.63	37.73	32.93	38.03	37.63	37.73	37.53	37.53	32.93	40.93	42.13	43.13
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	43.23	43.63	37.93	41.93	40.73	39.83	39.13	39.33	35.93	40.13	39.53	38.93
WIND =	7.70	7.47	8.00	6.87	6.94	8.30	7.70	7.77	8.83	8.60	9.13	9.43
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	9.88	10.49	10.26	10.41	10.19	10.26	10.56	9.96	10.41	10.03	9.96	9.05
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	249.71	182.77	130.37	60.33	16.49	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 363	SECTOR = 1086											
TEMP =	38.73	36.23	33.93	37.83	37.23	36.73	36.33	35.93	31.93	37.03	36.93	37.53
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	37.23	37.73	33.93	38.53	37.63	36.33	35.13	34.73	27.93	33.73	32.93	31.73
WIND =	8.15	8.07	6.71	8.07	7.54	7.47	8.30	7.92	7.92	8.07	8.37	8.00
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	8.07	8.83	9.66	9.73	8.68	8.45	8.53	8.22	9.81	7.92	8.60	9.20
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	230.80	221.30	170.01	87.53	22.87	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 364	SECTOR = 1089											
TEMP =	31.33	32.13	27.93	32.63	32.53	31.13	30.53	30.13	26.93	32.83	33.73	34.83
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	35.33	35.43	30.93	35.13	34.73	33.23	33.13	32.63	26.93	32.13	32.03	32.73
WIND =	8.30	8.83	8.43	8.75	8.68	9.75	6.30	8.37	8.22	8.90	9.51	9.58
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	10.41	11.17	10.79	10.11	9.51	9.13	8.75	7.92	8.90	8.30	8.37	8.98
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	335.36	268.25	184.47	104.96	29.59	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
DAY = 365	SECTOR = 1092											
TEMP =	32.63	32.73	28.93	32.53	32.53	32.23	31.53	31.23	26.93	34.43	36.33	36.53
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	36.83	37.63	32.93	37.33	36.73	34.93	34.13	35.13	31.93	35.13	35.33	35.33
WIND =	9.46	9.96	8.98	10.79	10.64	10.44	9.96	9.66	9.58	8.81	10.34	9.73
	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	10.79	11.02	10.94	10.11	9.43	8.75	8.30	8.95	6.04	8.60	8.53	8.90
QDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	374.08	315.17	211.89	108.72	30.15	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00

FIGURE 3-3. SAMPLE PROFILE PROGRAM OUTPUT (Sheet 5 of 6)

***WORST CASE DATA CHANGES FOR MONTH 12															
DAY = 349	SECTOR = 1044														
WDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	290.61	217.74	121.84	29.15	225.06	225.06	225.06	225.06	225.06	225.06	225.06	225.06	225.06	225.06	225.06
DAY = 350	SECTOR = 1047														
WDT =	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00	-1000.00
	374.82	304.30	192.41	84.55	225.54	225.54	225.54	225.54	225.54	225.54	225.54	225.54	225.54	225.54	225.54
DAY = 344	SECTOR = 1029														
WIND =	8.77	8.62	9.82	9.30	9.07	9.07	9.07	9.07	9.07	9.07	9.07	9.07	9.07	9.07	9.07
	9.52	8.92	8.47	8.32	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
DAY = 345	SECTOR = 1032														
WIND =	5.77	6.37	3.82	6.45	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97
	8.55	9.00	9.90	9.67	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
DAY = 354	SECTOR = 1059														
WIND =	8.68	8.53	9.46	9.05	8.83	8.83	8.83	8.83	8.83	8.83	8.83	8.83	8.83	8.83	8.83
	9.73	9.43	9.15	8.30	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13	9.13
DAY = 355	SECTOR = 1062														
WIND =	9.20	9.51	9.43	9.43	9.51	10.26	9.13	8.90	9.51	9.51	9.51	9.51	9.51	9.51	9.51
	9.13	9.05	7.39	6.37	7.39	6.79	6.71	6.34	4.68	7.17	6.94	6.79	6.79	6.79	6.79

FIGURE 3-3 SAMPLE PROFILE PROGRAM OUTPUT (Sheet 6 of 6)

- 3a) Average wind velocity for each day of one year.
- 3b) Average solar insolation for each day of one year.
- 4a) Average temperature for each month of each data year.
- 4b) Average wind velocity for each month of each data year.
- 4c) Average solar insolation for each month of each data year.
- 5a) Average temperature for each month of one year.
- 5b) Average wind velocity for each month of one year.
- 5c) Average solar insolation for each month of one year.
- 6a) Standard deviation of statistics gathered in 4a.
- 6b) Standard deviation of statistics gathered in 4b.
- 6c) Standard deviation of statistics gathered in 4c.
- 7a) Minimum temperature for each year.
- 7b) Maximum temperature for each year.
- 8a) Mean and standard deviation of statistics gathered in 7a.
- 8b) Mean and standard deviation of statistics gathered in 7b.

For statistics 1a, 1b, and 1c the STATS program averages the MERGE values stored for a given hour, day, and month over all data years contained in the file. The total number of values computed and stored for 1a, 1b, or 1c is thus $24 \times 365 = 8760$, giving one complete year of average hourly temperature, wind velocity, and solar insolation values. This constitutes the bulk of the STATS file content.

These hourly averages can be used to give a reasonable weather profile for any hour of a sample year. However, using mean values for an entire year produces an uncharacteristically mild profile (a mean year) with an extremely small likelihood of occurrence. Statistics 2a through 8b, as described below, are therefore gathered to allow the user to scale the hourly average values up or down (Section 3.4 discusses this scaling).

For each data year, the STATS program averages the 24 hourly values for a given day to produce statistics 2a and 2b. The total number of values computed and stored, therefore, is $365 \times Y_\ell$ for each statistic (where Y_ℓ is the number of years of data available for location ℓ).

The STATS program then averages the Y_{ℓ} values of 2a or 2b to get statistics 3a and 3b, respectively, for each day of the year. Thus, the total number of values stored for each of these statistics is 365.

For statistics 4a, 4b, and 4c, averages of all hourly temperature, wind velocity, and solar insolation values, respectively, are computed corresponding to a given month of each data year. The total number of stored values for each of the 4a, 4b, or 4c statistics is, therefore, $12 \times Y_{\ell}$.

The program averages the Y_{ℓ} values of 4a, 4b, or 4c to generate statistics 5a, 5b, or 5c, respectively, and computes the standard deviation (6a, 6b, or 6c) of the Y_{ℓ} values corresponding to each month of the year. Hence, the total number of values stored for each of these six statistics is 12.

Statistics 7a and 7b are simply the minimum and maximum temperatures observed at a location during a given data year. Thus, there are Y_{ℓ} values of each of these statistics.

Finally, the program computes the means and standard deviations of the Y_{ℓ} values of 7a or 7b to yield statistics 8a or 8b, respectively. Each of the 8a and 8b statistics has, therefore, only two stored values.

The mathematical formulas for the above statistics are provided in Appendix A. A flow diagram of the STATS program is shown in Figure 3-4.

3.4 PROFILE Program

The PROFILE program uses the one year of statistically prepared STATS data to produce a modified statistical file for use with the DSPA program. The procedure involves the scaling of the STATS file data on a monthly basis by factors computed from user-specified proportions and confidence levels. In addition, the PROFILE program will, upon request, perform a worst case analysis for low solar insolation, low wind, or high wind periods. The exact type and use of these input requests and their results

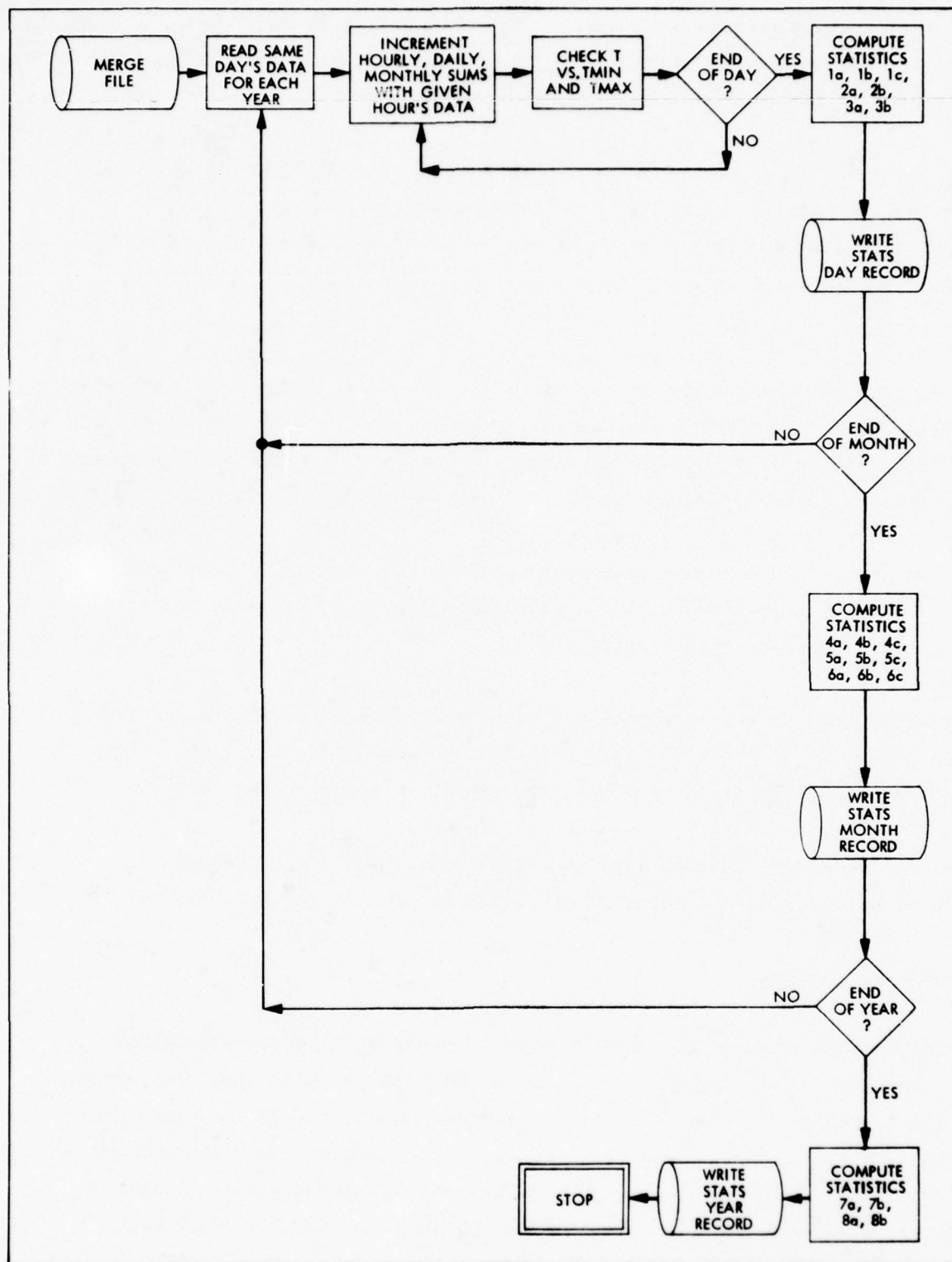


FIGURE 3-4. STATS COMPUTER PROGRAM

are discussed below. The revised weather data is written onto a STAT file for subsequent use as input to the DSPA program.

1) Low or High Temperature Months

In constructing the hour-by-hour profile year for temperature, the following options are available for each month:

- a) Use the average hourly values for temperature directly from the STATS file.
- b) Construct a month for which the temperatures are low, in the sense described below, at a user-specified confidence level.
- c) Construct a month for which the temperatures are high, in the sense described below, at a user-specified confidence level.

A low temperature month is defined as one having an average temperature $C_{lm, temp}^{low}$ such that 100P% of all actual monthly average temperatures can be expected to exceed $C_{lm, temp}^{low}$ at a 100α% confidence level. The proportion P and the confidence level α are input by the user. The PROFILE program calculates $C_{lm, temp}^{low}$ using P, α, the monthly temperature average for each year of data (statistic 4a of Section 3.3) and the mean and standard deviation of these values (5a and 6a of Section 3.3). The difference, $D_{lm, temp}^{low} = \bar{T}_{lm} - C_{lm, temp}^{low}$, is used to scale down all hourly temperature values for the month.

Similarly a high temperature month is defined as one having an average temperature $C_{lm, temp}^{high}$ such that 100P% of all actual monthly temperatures can be expected to fall below $C_{lm, temp}^{high}$ with 100α% confidence, and the difference, $D_{lm, temp}^{high} = \bar{T}_{lm} - C_{lm, temp}^{high}$, is used to increase each hourly temperature value for the month.

2) Low or High Solar Insolation Month

The options and descriptions of the low or high solar insolation construction are exactly analogous to those for temperature above, except that, since solar insolation is on a ratio scale (i.e., has

a naturally occurring zero point and equal interval measurements), a multiplicative scaling factor is more appropriate than the difference technique applied to temperature scaling. Hence, $R_{\ell m, \text{insol.}}^{\text{low}} = C_{\ell m, \text{insol.}}^{\text{low}} / \bar{Q}_{\ell m}$ and $R_{\ell m, \text{insol.}}^{\text{high}} = C_{\ell m, \text{insol.}}^{\text{high}} / \bar{Q}_{\ell m}$, where $\bar{Q}_{\ell m}$ is the observed monthly solar insolation (statistic 5c in Section 3.3).

3) Low or High Wind Velocity Month

The explanations and computations involved in scaling the hourly values of wind velocity to produce a low or high month are the same as those for solar insolation. The scaling ratios $R_{\ell m, \text{wind vel.}}^{\text{low}}$ and $R_{\ell m, \text{wind vel.}}^{\text{high}}$ are used to lower or raise, respectively, the hourly wind velocity observations.

4) Period of Low Solar Insolation

In addition to producing uniformly low or high or mean solar insolation values for any given month, the PROFILE program also provides an option for creating a string of "worst case" days for which the daily insolation values fall below some user-specified fraction of the observed average for that day. The fraction P and probability of occurrence α are input by the user for each month.

For each month, in which a low period is requested, the PROFILE program compares the daily average for a given day of each data year (statistic 2a of Section 3.3) with the average over all years (statistic 3a). If the average for a particular day is less than 100P% of the average for the same day over all remaining years, then the day is classified as "low"; otherwise, the day is termed "normal."

A pattern of "low" and "normal" days is thus created for a given month for all data years. The lengths ($B_{\ell m}^1$) and the number of occurrences (n) of strings of "low" days are considered as realizations of a random variable having a Poisson type distribution (rare event). The PROFILE program uses the patterns of these "low" strings

to determine the average number of consecutive "worst case" days ($\bar{B}_{\lambda m}$). The value of $\bar{B}_{\lambda m}$, as discussed in Appendix B, is a justifiable approximation to the true Poisson maximum likelihood estimate, λ . From the value of $\bar{B}_{\lambda m}$ (hereafter referred to as λ) and the user-specified confidence level α , the program computes a string length N such that the probability of N or fewer "low" days in a row is α .

This N -day string is centered about the 15th day of the month, and the hourly solar insolation values for each of these days is scaled down by the factor P . It is, of course, possible that a user-defined "low" day may be higher than the same day's values in the low solar insolation month generated by item 2 above. In such cases, the PROFILE program will select the minimum of the two computed values.

The number of sequential "low" days generated is directly determined by the values of α and λ . To assist the user in planning "worst case" insolation analyses, Appendix D contains a table of the number of "low" days as a function of α and λ . The value of λ is dependent on the particular station, month of the year, and user-input fraction P . Appendix C gives, for each station (see Table 1-1 for a cross reference to station location and station number), a table of λ (actually $\bar{B}_{\lambda m}$) as a function of the month and P . Hence, the user may select a P and an α for a particular station and month and determine the resultant PROFILE program λ from Appendix C, and subsequently, the resultant number of sequential "low" days from Appendix D. The user may then vary either P (to get a different λ) or α to obtain a more desirable "low" string length.

Note that the largest value of λ found is 8.235 for $P = 1.00$ for month 7 of location 93193. Using this value for illustrative purposes, Appendix D indicates that a string of 13 "low" solar insolation days will occur for $\alpha = 0.93$ (93%). However, a P of 1.00 is really somewhat useless for a "worst case" since all values

would remain as 100% of the original averages. More reasonably, for $P < 1.00$, the value of λ will be less than 2.0 yielding "low" strings of fewer than 6 days for $\alpha < 0.99$ (99%). In any case, with the aid of Appendix C and Appendix D, the user can predetermine the results of his "worst case" analysis.

5) Period of Low or High Wind Velocity

As in the case of low solar insolation periods (item 4 above), a low or high wind velocity day is defined as one in which the average daily wind velocity is less than $100P_1\%$ or greater than $100P_2\%$ of the daily average for the same day over all years. The PROFILE program fits a Poisson distribution to the strings of low days and of high days. The user-input occurrence probabilities, α_1 , and α_2 , are then used to determine the number of sequential "low" days, N_1 , and the number of sequential "high" days, N_2 , in the same manner described for low insolation periods above.

The N_1 "low" days are centered around the 10th day of the month, and the N_2 high days are centered about the 20th day. The "low" days are then scaled down by the factor P_1 , and the "high" days are scaled up by the factor P_2 (> 1.00). The remaining days of the month may be taken from the mean year data or from low or high month values.

The mathematical formulas used for all of the above PROFILE computations are provided in Appendix B. A flow diagram of the PROFILE program is provided in Figure 3-5.

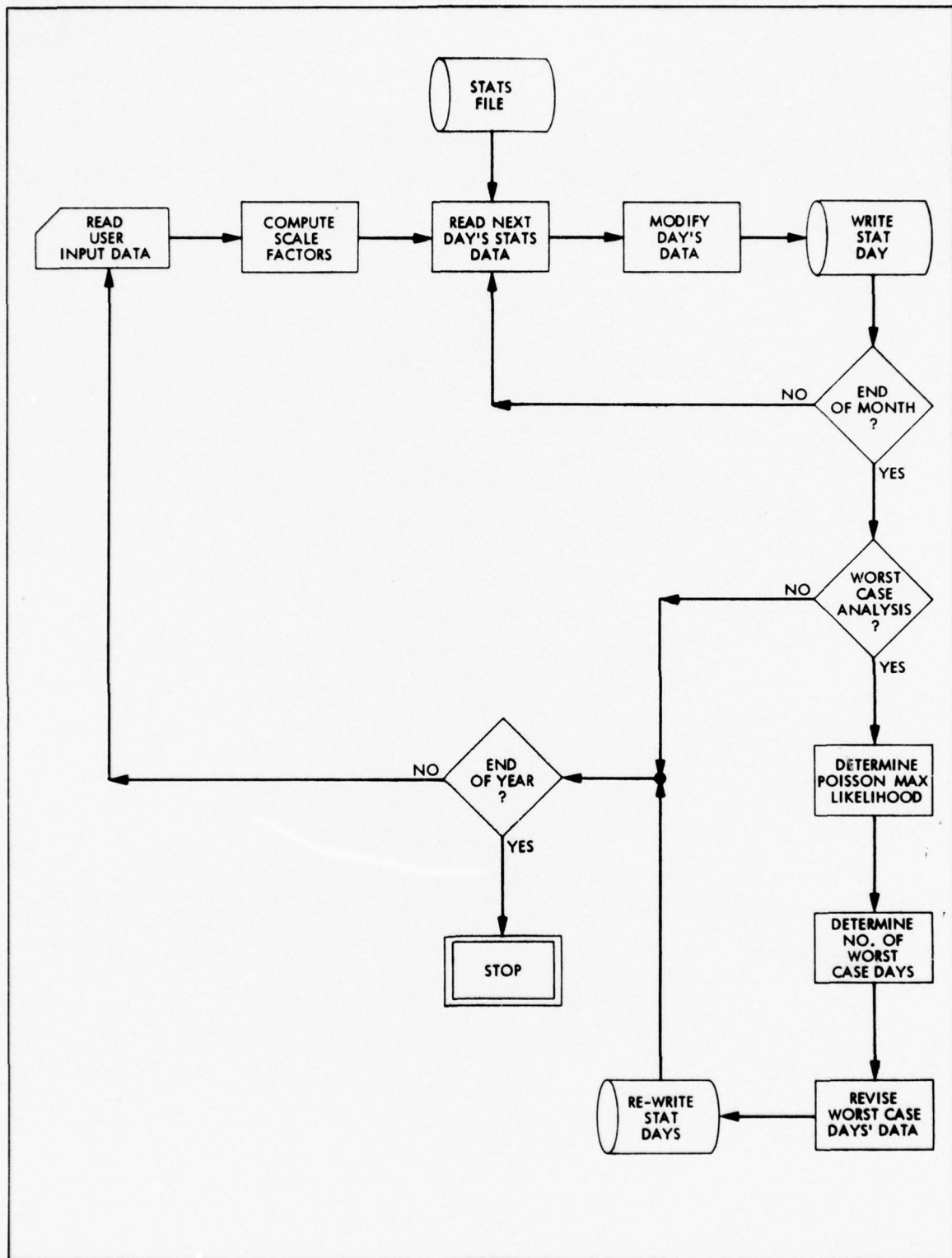


FIGURE 3-5. PROFILE COMPUTER PROGRAM

4. REFERENCES

- (1) "Surface Observations; TDF-14," National Oceanic and Atmospheric Administration, Asheville, North Carolina, October 1975.
- (2) "Solar Radiation - Hourly: DECK-280," National Oceanic and Atmospheric Administration, Asheville, North Carolina, April 1967.
- (3) "Analysis of NOAA Tapes," JPL-IOM 393.2-659, L.M. Kaiser, August 1975.
- (4) Introduction to Statistical Analysis, Second Edition, Dixon, W.J. and Massey, F., McGraw-Hill, New York. 1957.
- (5) Applied General Statistics, Second Edition, Croxton, F.E. and Cowden, D.J., Prentice-Hall, New Jersey, 1955.
- (6) "Determining Appropriate Statistical Analysis", Clark, V. et al., unpublished notes, UCLA, 1974.
- (7) The Advanced Theory of Statistics, Volume 2, Third Edition, Kendall, M.G. and Stuart, A., Hafner, New York, 1967.
- (8) "Estimate of the Parameter in a Right-Truncated Poisson Distribution," JPL-TM 393-307, L.M. Kaiser, June 1976.

5040-39

APPENDIX A

STATS PROGRAM MATHEMATICAL FORMULAS

A-1/A-2

Input (from Merge Tape):

T_{lmdhy} , V_{lmdhy} , Q_{lmdhy} = Temperature, wind velocity, solar insolation for location l, month m, day d, hour h, year y

Y_{lm} = Number of years of data for month m, at location l

D_m = Number of days in month m

Y_l = Total number of years of data at location l

Statistic	Formula
1a) $\bar{T}_{lmdh}$	$= \sum_y T_{lmdhy} / Y_{lm}$
1b) $\bar{V}_{lmdhy}$	$= \sum_y V_{lmdhy} / Y_{lm}$
1c) $\bar{Q}_{lmdh}$	$= \sum_y Q_{lmdhy} / Y_{lm}$
2a) $\bar{V}_{lmdy}$	$= \sum_y V_{lmdhy} / 24$
2b) $\bar{Q}_{lmdy}$	$= \sum_y Q_{lmdhy} / 24$
3a) $\bar{\bar{V}}_{lmd}$	$= \sum_y \bar{V}_{lmdy} / Y_{lm}$
3b) $\bar{\bar{Q}}_{lmd}$	$= \sum_y \bar{Q}_{lmdy} / Y_{lm}$
4a) $\bar{T}_{lmy}$	$= \sum_d \sum_h T_{lmdhy} / 24 D_m$
4b) $\bar{V}_{lmy}$	$= \sum_d \sum_h V_{lmdhy} / 24 D_m$
4c) $\bar{Q}_{lmy}$	$= \sum_d \sum_h Q_{lmdhy} / 24 D_m$

Statistic	Formula
5a) $\bar{\bar{T}}_{lm}$	$= \sum_y \bar{T}_{lm}/Y_{lm}$
5b) $\bar{\bar{V}}_{lm}$	$= \sum_y \bar{V}_{lm}/Y_{lm}$
5c) $\bar{\bar{Q}}_{lm}$	$= \sum_y \bar{Q}_{lm}/Y_{lm}$
6a) ST_{lm}	$= \left[\left(\sum_y \bar{T}_{lmy}^2 - Y_{lm} \bar{\bar{T}}_{lm}^2 \right) / (Y_{lm} - 1) \right]^{1/2}$
6b) SV_{lm}	$= \left[\left(\sum_y \bar{V}_{lmy}^2 - Y_{lm} \bar{\bar{V}}_{lm}^2 \right) / (Y_{lm} - 1) \right]^{1/2}$
6c) SQ_{lm}	$= \left[\left(\sum_y \bar{Q}_{lmy}^2 - Y_{lm} \bar{\bar{Q}}_{lm}^2 \right) / (Y_{lm} - 1) \right]^{1/2}$
7a) $T_{max,ly}$	$= \min_{m,d,h} \{T_{lmdhy}\}$
7b) $T_{min,ly}$	$= \max_{m,d,h} \{T_{lmdhy}\}$
8a) $\bar{T}_{max,l}$	$= \sum_y T_{max,ly}/Y_l$
$ST_{max,l}$	$= \left[\left(\sum_y T_{max,ly}^2 - Y_l \bar{T}_{max,l}^2 \right) / (Y_l - 1) \right]^{1/2}$
8b) $\bar{T}_{min,l}$	$= \sum_y T_{min,ly}/Y_l$
$ST_{min,l}$	$= \left[\left(\sum_y T_{min,ly}^2 - Y_l \bar{T}_{min,l}^2 \right) / (Y_l - 1) \right]^{1/2}$

5040-39

APPENDIX B

PROFILE PROGRAM MATHEMATICAL FORMULAS

B-1/B-2

1. Tolerance Limits - Temperature.

Input: α , P , Y_{lm} , $\bar{T}_{lm}$, ST_{lmy}

$$z\alpha = \Phi^{-1}(1 - \alpha), \quad z_{1-P} = \Phi^{-1}(P)$$

$$\text{where: } \Phi(x) = \int_{-\infty}^x \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt$$

$$a_{lm} = 1 - z_{\alpha}^2 / [2(Y_{lm} - 1)]$$

$$b_{lm} = z_{1-P}^2 - z_{\alpha}^2 / Y_{lm}$$

$$k_{lm} = \left[z_{1-P} + \sqrt{z_{1-P}^2 - a_{lm} b_{lm}} \right] / a_{lm}$$

$$C_{lm, \text{temp.}}^{\text{low}} = \bar{T}_{lm} - k_{lm} ST_{lm}$$

$$C_{lm, \text{temp.}}^{\text{high}} = \bar{T}_{lm} + k_{lm} ST_{lm}$$

2. Tolerance limits - solar insolation.

$$C_{lm, \text{insol.}}^{\text{low}} = \bar{Q}_{lm} - k_{lm} SQ_{lm}$$

$$C_{lm, \text{insol.}}^{\text{high}} = \bar{Q}_{lm} + k_{lm} SQ_{lm}$$

3. Tolerance limits - wind velocity.

$$C_{lm, \text{ wind vel. }}^{\text{low}} = \bar{V}_{lm} - k_{lm} SV_{lm}$$

$$C_{lm, \text{ wind vel. }}^{\text{high}} = \bar{V}_{lm} + k_{lm} SV_{lm}$$

4. Translation Factors for low/high temperature months.

$$D_{lm, \text{ temp. }}^{\text{low}} = \bar{T}_{lm} - C_{lm, \text{ temp. }}^{\text{low}}$$

$$D_{lm, \text{ temp. }}^{\text{high}} = \bar{T}_{lm} + C_{lm, \text{ temp. }}^{\text{low}}$$

5. Scaling Factors for low/high solar insolation months.

$$R_{lm, \text{ insol. }}^{\text{low}} = C_{lm, \text{ insol. }}^{\text{low}} / \bar{Q}_{lm}$$

$$R_{lm, \text{ insol. }}^{\text{high}} = C_{lm, \text{ insol. }}^{\text{high}} / \bar{Q}_{lm}$$

6. Scaling Factors for low/high wind velocity months.

$$R_{lm, \text{ wind vel. }}^{\text{low}} = C_{lm, \text{ wind vel. }}^{\text{low}} / \bar{V}_{lm}$$

$$R_{lm, \text{ wind vel. }}^{\text{high}} = C_{lm, \text{ wind vel. }}^{\text{high}} / \bar{V}_{lm}$$

7. Generation of period of low solar insolation days.

Input: $P, \alpha, \bar{Q}_{lmdy}, \bar{Q}_{lmd}$

$$X_{lm} = \begin{cases} 1 & \text{if } \bar{Q}_{lmdy} \leq P \cdot \bar{Q}_{lmd}^* \\ 0 & \text{if } \bar{Q}_{lmdy} > P \cdot \bar{Q}_{lmd}^* \end{cases}$$

where $\bar{Q}_{lmd}^*$ is the mean of all $\bar{Q}_{lmdy}$ values excluding the current one.

A value of X_{lm} is recorded for each day of data for month m . Patterns of 0's and 1's are thus observed.

Let $B_{lm} = n$ if the pattern 0, 1, 1, ..., 1, 0 is observed, where there are n consecutive 1's. The mean $\bar{B}_{lm}$ of all B_{lm} values is calculated and used as $\bar{x}$ (in Reference 8) to produce an estimate $\hat{\lambda}$ of the parameter λ in a truncated Poisson distribution.

The truncated Poisson distribution is summed until the cumulative probability level is greater than α , that is, until a value N is produced such that

$$\frac{\sum_{i=0}^N \hat{\lambda}^i / i!}{\sum_{i=0}^m \hat{\lambda}^i / i!} \leq \alpha$$

and

$$\frac{\sum_{i=0}^{N+1} \hat{\lambda}^i / i!}{\sum_{i=0}^m \hat{\lambda}^i / i!} > \alpha$$

The N low solar insolation days are produced having hourly insolation values:

$$\tilde{Q}_{\text{lmdh}} = P \cdot \bar{Q}_{\text{lmdh}}$$

8. Generation of periods of low/high wind velocity computations are exactly the same as in 7., except that 2 strings are generated, one for low wind velocity days ($P_1 < 1$) and one for high wind velocity days ($P_2 > 1$). N_1 low days having hourly wind velocities:

$$\tilde{V}_{\text{lmdh}}^{\text{low}} = P_1 \cdot \bar{V}_{\text{lmdh}}$$

and N_2 high days having hourly wind velocities:

$$\tilde{V}_{\text{lmdh}}^{\text{high}} = P_2 \cdot \bar{V}_{\text{lmdh}}$$

are then generated.

Distribution Fitting in the PROFILE Program

The Profile program calculates $\bar{B}_{lm}$, the average number of consecutive low days observed for location l , month m in all years.

The distribution to be fitted is a right-truncated Poisson with parameter λ . The truncation point is D_m , the number of days in month m . $D_m = 28, 30$ or 31 . The frequency function is

$$f(x; \lambda, D_m) = K \lambda^x / x! \quad x = 0, \dots, D_m$$

where

$$K = \left[\sum_{y=0}^{D_m} \lambda^y / y! \right]^{-1}$$

In the PROFILE program, we need to calculate the $(1 - \alpha)$ tail of this distribution. We need an integer D^* such that

$$\sum_{x=D^*}^{D_m} f(x; \lambda, D_m) \approx 1 - \alpha$$

To do this, an estimate of the unknown parameter λ is needed. The usual technique of maximum likelihood produces an estimate $\hat{\lambda}$ which is the unique positive real solution to the D_m^{th} degree polynomial equation

$$\sum_{y=0}^{D_m} \left(\frac{\bar{B}_{\ell m} - y}{y!} \right) \hat{\lambda}^y = 0. \quad (1)$$

Reference 8 shows that when $\bar{B}_{\ell m}$ itself, rather than the maximum likelihood estimate $\hat{\lambda}$, is used to estimate λ , the error is negligible for values of D_m and $\bar{B}_{\ell m}$ encountered in the PROFILE program. For derivation of equation (1) and more details on accuracy of $\bar{B}_{\ell m}$ as an estimate, see Reference 8.

APPENDIX C

LAMBDA VALUES FOR WORST CASE ANALYSES

TABLE OF LAMBDA VALUES FOR STATION 12639

PLG	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	.125000	.000000	.16667	.000000	.000000	.50000	.000000	.000000	.16667	.25000	.000000	.200000
.40	.214286	.142857	.200000	.500000	.000000	.428571	.000000	.000000	.625000	.125000	.333333	.222222
.50	.300000	.166667	.157895	.400000	.150000	.500000	.181818	.333333	.818182	.111111	.214286	.214286
.60	.425000	.266667	.260870	.181818	.375000	.578947	.500000	.411765	.434783	.160000	.363636	.217391
.70	.525000	.366667	.500000	.304348	.531250	.689655	.423077	.708333	.628571	.222222	.533333	.424242
.80	.652174	.384615	.487805	.454545	.571429	.921053	.657895	.500000	.833333	.471273	.942857	.750000
.90	.867925	.529787	.735849	.541667	.1279070	.1390244	.1000000	.877193	.1117647	.566667	.732143	1.06957
1.00	1.186441	1.103448	1.229508	1.177419	1.755510	1.687500	1.527273	1.500000	1.456140	.821918	1.181818	1.283333

TABLE OF LAMBDA VALUES FOR STATION 12919

PLG	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	.000000	.000000	.250000	.100000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.222222
.30	.000000	.454545	.625000	.166667	.666667	.000000	.000000	.000000	.666667	.000000	.200000	.809091
.40	.636364	.600000	.636364	.357143	.1000000	.250000	.500000	.250000	.285714	.300000	.263158	.819048
.50	.940000	.650000	.555556	.421053	.666667	.428571	.285714	.272727	.875000	.230769	.684211	.833333
.60	.900000	.429430	.500000	.400000	.416667	.777778	.444444	.375000	.700000	.333333	.708333	.793103
.70	.916667	.727273	.529412	.807692	.450000	.571429	.454545	.650000	.825000	.541667	.800000	1.000000
.80	1.166667	.970588	.800000	1.178571	.689655	.500000	.555556	.916667	.520000	.681655	1.156250	1.12857
.90	1.486486	1.212121	1.000000	1.281250	1.064514	.785714	.733333	1.206897	.806452	.939394	1.558824	1.315789
1.00	1.805556	1.542857	1.657895	1.384615	1.875000	2.100000	1.852941	2.000000	1.166667	1.275000	2.088235	1.292683

TABLE OF LAMBDA VALUES FOR STATION 13745

PLG	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	.105263	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	.300000	.000000	.055556	.000000	.000000	.117647	.000000	.100000	.066667	.157895	.235294	.076923
.40	.307692	.000000	.074074	.050000	.071429	.260870	.200000	.117647	.285714	.2592	.318182	.187500
.50	.366364	.217391	.285714	.161250	.173913	.625000	.142857	.190476	.500000	.2777	.266667	.254910
.60	.400000	.392157	.348837	.289474	.343750	.642857	.333333	.333333	.500000	.5135	.72432	.358854
.70	.549020	.537037	.511111	.311111	.394737	.617647	.205882	.588235	.540541	.547617	.511111	.489362
.80	.564038	.616667	.591837	.388889	.448980	.702317	.780488	.780488	.651143	.87209	.400000	.563636
.90	.553846	.600000	.583333	.545455	.607143	.829787	.777778	1.000000	.750000	1.065217	.785714	.685940
1.00	.805970	.738462	.796875	.725806	.901639	.918033	1.163636	.875000	1.018182	1.347826	.993333	.769231

TABLE OF LAMBDA VALUES FOR STATION 14607

PLG	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	1	.083333	.166667	.090909	.071429	.391304	.250000	.11765	.150000	.064514	.272727	.07619	.090000
.40	1	.260870	.294118	.050000	.162162	.548387	.242424	.307692	.192308	.125000	.340709	.390244	.400000
.50	1	.352941	.360000	.133333	.166667	.657143	.348837	.242424	.186047	.304348	.461538	.673469	.487179
.60	1	.346939	.485714	.243902	.272727	.622222	.416667	.365854	.288462	.411765	.543860	.714286	.468085
.70	1	.491525	.565217	.384615	.413793	.618182	.611111	.440000	.396552	.553571	.569231	.883333	.784314
.80	1	.621212	.711538	.745455	.555556	.816066	.945455	.666667	.532258	.616667	.695652	1.032258	.864907
.90	1	.728571	.931034	.825397	.833333	1.04514	.893939	.965517	.703125	.642857	.970588	1.106061	1.049180
1.00	1	1.231884	1.078125	1.084507	1.215385	1.387097	1.058624	1.142857	.889565	.710524	1.086957	1.289855	1.426230

TABLE OF LAMBDA VALUES FOR STATION 14732

PLG	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	1	.666667	.071429	.312500	.153846	.000000	.000000	.333333	.000000	.285714	.307492	.133333	.133333
.40	1	.653846	.133333	.347826	.400000	.428571	.125000	.250000	.166667	.300000	.315789	.12857	.318182
.50	1	.687500	.17471	.533333	.571429	.521739	.166667	.363836	.277778	.375000	.409091	.192308	.478261
.60	1	.714286	.250000	.645141	.545455	.540000	.238095	.352941	.400000	.529412	.500000	.400000	.424242
.70	1	.666667	.405405	.774194	.575758	.625000	.480000	.384615	.433333	.518519	.730749	.48484	.500000
.80	1	.790698	.589744	.935464	.685714	.621622	.678571	.468750	.617647	.870768	.705882	.648649	.604651
.90	1	.931818	.619048	1.030303	.675000	.725000	.750000	.589744	.750000	1.057143	1.000000	.850000	.717391
1.00	1	1.068182	1.050000	1.281250	.928571	1.073171	.975610	1.025641	.900000	1.105263	1.742857	1.000000	.847826

TABLE OF LAMBDA VALUES FOR STATION 14739

PLG	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.529412	.000000	.000000	.157895	.071429	.125000	.000000	.428571	.000000	.571429	.217391	.304348
.30	1	.437500	.151515	.157895	.250000	.260870	.263158	.166667	.277778	.333333	.517241	.323529	.393939
.40	1	.380952	.284474	.306122	.342857	.323529	.444444	.166667	.285714	.379310	.638889	.571429	.439024
.50	1	.365385	.333333	.339286	.463415	.357143	.531250	.437500	.333333	.315789	.707317	.687500	.489796
.60	1	.403774	.423077	.508475	.488889	.404255	.611111	.475000	.400000	.609754	.781818	.603774	.603774
.70	1	.400000	.450000	.500000	.500000	.520000	.604651	.555556	.408143	.659574	.764706	.857143	.603448
.80	1	.582090	.539883	.772723	.551724	.666667	.788462	.648148	.518519	.840000	.833333	.948274	.681270
.90	1	.714286	.712121	.808824	.830508	.737705	.896552	.654649	.677419	1.054545	.816667	1.032258	.787878
1.00	1	.716216	.913043	1.000000	.934426	1.133333	1.131148	1.046154	.746479	1.177419	.969231	1.090709	.985294

TABLE OF LAMBDA VALUES FOR STATION 14847

PLQ	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	1	.250000	.168667	.000000	.210526	.000000	.000000	.000000	.000000	.142857	.146667	.000000	.333333
.40	1	.333333	.090909	.000000	.375000	.000000	.100000	.166667	.090909	.250000	.272727	.250769	.500000
.50	1	.454545	.058824	.250000	.518519	.115385	.250000	.117647	.125000	.263158	.352941	.500000	.529412
.60	1	.653846	.208333	.222222	.516129	.212121	.454545	.240000	.130435	.333333	.333333	.500000	.407407
.70	1	.781250	.290323	.206897	.500000	.378378	.517241	.277778	.129032	.346154	.370370	.466667	.483871
.80	1	.805556	.606061	.500000	.600000	.540541	.694970	.512821	.216216	.393939	.785714	.757576	.500000
.90	1	.000000	.783784	.111426	.815789	.642857	.694444	.555556	.533333	.731707	1.030345	1.025641	.886364
1.00	1	1.268293	1.323529	1.307492	1.076923	.762669	.951220	.875000	.666667	.800000	1.586207	1.410256	1.272723

TABLE OF LAMBDA VALUES FOR STATION 23174

PLQ	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	1	.000000	.750000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.500000
.40	1	.000000	1.000000	.000000	.000000	.000000	.500000	.000000	.000000	.000000	.000000	.000000	.750000
.50	1	.28571	1.000000	.000000	.000000	.500000	.250000	.000000	.000000	.500000	.000000	.000000	.666667
.60	1	.666667	.857143	.000000	.500000	.285714	.600000	1.000000	.000000	.333333	.428571	.125000	.625000
.70	1	.727273	.750000	.285714	.285714	.428571	.857143	.666667	.000000	.750000	.300000	.181818	.700000
.80	1	.750000	.909091	.375000	.272727	.636364	1.200000	.600000	.800000	.428571	.538462	.230769	.818182
.90	1	.750000	1.545455	.384615	.357143	.714286	1.214286	1.166667	.800000	.700000	.647059	.600000	.733333
1.00	1	1.000000	2.545455	.550000	1.125000	1.375000	2.642857	2.153846	1.312500	1.714286	1.526316	1.538462	1.266667

TABLE OF LAMBDA VALUES FOR STATION 24233

PLQ	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.000000	.333333	.000000	.000000	.666667	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	1	.272723	.055556	.090909	.100000	.250000	.250000	.000000	.142857	.205333	.136364	.291667	.277778
.40	1	.348837	.187500	.074074	.210526	.214286	.272727	.111111	.285714	.205333	.324324	.285714	.305556
.50	1	.400000	.372093	.405405	.290323	.296296	.370370	.142857	.275862	.361111	.294118	.433962	.363636
.60	1	.500000	.553191	.541647	.400000	.461538	.323529	.300000	.358974	.409091	.410714	.655172	.500000
.70	1	.825000	.860000	.660714	.833061	.530612	.575000	.461538	.545455	.580000	.584615	.903226	.671429
.80	1	.013699	1.240000	.784615	.824581	.690909	.787234	.727273	.764706	.750000	.823529	1.145161	.943662
.90	1	1.191781	1.452830	1.000000	1.175439	.868652	.966102	.967925	1.074074	1.037736	1.134326	1.208955	1.061081
1.00	1	1.558824	1.811321	1.382363	1.327869	1.090909	1.349206	1.375000	1.500000	1.114754	1.323529	1.523077	1.383562

TABLE OF LAMBDA VALUES FOR STATION 13743

PLQ	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.333333	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.230769	.000000	.056424	.333333	.000000	.000000	.000000	.000000	.222222	.000000	.041667	.266667
.30	1	.185185	.235294	.300000	.304348	.210526	.166667	.000000	.000000	.294118	.080000	.058824	.296296
.40	1	.255814	.232558	.394737	.517241	.346154	.227273	.000000	.125000	.545455	.250000	.170732	.406250
.50	1	.300000	.264151	.488372	.542857	.433333	.370370	.083333	.333333	.642857	.358974	.260000	.511628
.60	1	.333333	.355932	.555556	.666667	.384615	.375000	.142857	.406250	.588235	.386364	.259259	.620000
.70	1	.456140	.466667	.527273	.739130	.444444	.452381	.317073	.461538	.731707	.464286	.431034	.69429
.80	1	.634921	.622951	.74118	.685185	.600000	.560000	.562500	.529412	.829787	.694915	.538462	.692308
.90	1	.676471	.651515	.746875	.918033	.593750	.629032	.905660	.733333	.980769	.935484	.68567	.923077
1.00	1	.685714	.739130	.970588	1.044118	1.046675	1.000000	1.315789	.906991	1.032258	1.174603	.830786	1.190476

TABLE OF LAMBDA VALUES FOR STATION 13983

PLQ	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.250000	.100000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.250000	.000000
.20	1	.357143	.117647	.550000	.083333	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.117647
.30	1	.615385	.200000	.607143	.300000	.250000	.142857	.250000	.000000	.000000	.312500	.190476	.416667
.40	1	.525000	.35854	.750000	.354839	.166667	.181818	.100000	.083333	.100000	.321429	.303030	.456250
.50	1	.612245	.533333	.707317	.375000	.259259	.315789	.210526	.111111	.240870	.424242	.625000	.939394
.60	1	.777778	.604167	.750000	.468085	.386889	.275862	.400000	.125000	.297297	.555556	.857143	1.105263
.70	1	.864407	.764706	.679245	.462963	.511628	.358974	.342105	.147059	.477273	.627907	.854167	1.000000
.80	1	1.120490	.867925	.888889	.616667	.685185	.489796	.413043	.209302	.630435	.739130	.736842	1.183673
.90	1	1.275842	1.000000	1.000000	.709477	.442105	.614035	.472727	.537037	.820000	.940000	.870968	1.207547
1.00	1	1.333333	1.175439	1.224508	.969697	.686750	1.155172	.620896	.898305	1.087719	1.052632	1.015152	1.315789

TABLE OF LAMBDA VALUES FOR STATION 23154

PLQ	1	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	1	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	1	.666667	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.40	1	.428571	.166667	.000000	.000000	.000000	.250000	.000000	.000000	.000000	.090909	.100000	.166667
.50	1	.250000	.416667	.055556	.074923	.200000	.285714	.000000	.000000	.000000	.142857	.312500	.250000
.60	1	.225806	.384615	.260870	.217391	.296296	.266667	.000000	.333333	.150000	.200000	.200000	.375000
.70	1	.421053	.275000	.264706	.454545	.485714	.650000	.130435	.380952	.240000	.444444	.387097	.623333
.80	1	.586957	.400000	.384615	.590709	.727273	.900000	.300000	.617647	.363636	.621622	.534884	1.000000
.90	1	.857143	.924528	.890909	.882353	1.060000	1.095238	1.232558	.847824	.510638	.733333	.627451	.916667
1.00	1	1.213115	1.293103	1.362049	1.333333	1.338596	1.460000	2.044444	1.450960	1.207547	1.076923	.822581	1.052632

TABLE OF LAMBDA VALUES FOR STATION 24225

PLQ	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	.066667	.222222	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.250000
.40	.225806	.222222	.187500	.000000	.000000	.000000	.000000	.000000	.375000	.000000	.444444	.282231
.50	.525000	.517241	.250000	.000000	.095238	.071429	.166667	.200000	.545455	.333333	.487805	.291667
.60	.588235	.512821	.487805	.103448	.235294	.285714	.300000	.250000	.625000	.666667	.500000	.784314
.70	.919672	.638298	.740000	.365854	.500000	.440000	.312500	.500000	.692308	.764706	.689655	1.071429
.80	1.140625	.842105	.941481	.653846	.795918	.656250	.285714	.368421	.727273	.857143	1.137931	1.350877
.90	1.406250	1.400000	1.166667	.813559	.848889	1.000000	.354839	.655172	.833333	1.145833	1.482759	1.745455
1.00	1.851515	1.625000	1.637931	1.456140	1.357143	1.100000	1.074074	1.367347	1.173913	1.580000	1.925926	2.479167

TABLE OF LAMBDA VALUES FOR STATION 93193

PLQ	MONTH 01	MONTH 02	MONTH 03	MONTH 04	MONTH 05	MONTH 06	MONTH 07	MONTH 08	MONTH 09	MONTH 10	MONTH 11	MONTH 12
.00	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.10	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.20	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
.30	.200000	.222222	.142857	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.400000
.40	.555556	.333333	.222222	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.100000	.705882
.50	.646667	.363636	.214286	.214286	.200000	.000000	.000000	.000000	.000000	.000000	.166667	.913043
.60	.772727	.756757	.185185	.450000	.200000	.000000	.000000	.000000	.000000	.222222	.260870	.941174
.70	.860000	1.028571	.307692	.521739	.153846	.125000	.000000	.000000	.090909	.555556	.531250	1.289474
.80	1.035714	1.153846	.458333	.821429	.343750	.071429	.538462	.307692	.285714	.625000	.525000	1.382979
.90	1.321429	1.295455	.826923	.777778	.558140	1.111111	1.618182	1.148148	.933333	.717949	.796498	1.571429
1.00	1.327869	1.714286	1.321429	1.500000	1.200000	5.478261	8.235294	3.189189	3.333333	1.370370	1.109091	2.127660

APPENDIX D

WORST CASE DAYS TABLE

TABLE OF NUMBERS OF SEQUENTIAL WORST CASE DAYS

LAMBDA	.00	.10	.20	.30	.40	.50	ALPHA .60	.70	.80	.90	.93	.95	.98	.99	.9900	.9990	.9999	1.00000
.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

** INDICATES THAT ENTIRE MONTH IS TO BE USED