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Electric Utility Value Determination for Wind Energy

Volume II: A User's Guide

David Percival
James Harper

SERI

Solar Energy Research Institute
A Division of Midwest Research Institute

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Golden, Colorado 80401

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PREFACE

This report, the second of two volumes prepared within the Utility Applications and Policy Branch of SERI for the Department of Energy's Wind Energy Systems Division under Subtask 3532.15, is a user's guide to the computer programs used to determine the value of wind energy conversion systems to electric utilities. Volume I describes the value determination methodology and gives detailed discussion on each computer program available from SERI.

We would like to thank the following people for their constructive review: John H. Bannick, New England Regional Commission; John T. Day, Westinghouse Electric Corp.; and Doug Madison, Solar Energy Research Institute.

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SUMMARY

Objective:

The objective of this two-volume report is to describe a method developed by the Solar Energy Research Institute (SERI) for determining the value of Wind Energy Conversion Systems (WECS) to electric utilities. The method involves using a package of computer models available from SERI. These models vary in sophistication and may be used with most utility planning models. Only minimal effort should be required to make the programs operational on hardware other than the Control Data Corporation CDC hardware on which the programs were developed and used.

Discussion:

The first volume of this report describes the value determination method and gives detailed discussion on each computer program available from SERI. The second volume is a user's guide for these computer programs.

The value determination process begins with the processing of weather data by computer programs WTP or WEIBUL to produce hourly wind speed data or wind probability distributions, respectively. These data are then provided as input to the program ROSEW, which estimates wind-derived electricity production.

The results from ROSEW, which can provide probabilities of certain WECS power levels being produced, are next input to the program ULMOD so that the utility load forecast may be modified to incorporate the WECS generation. These results, which are for as many years as desired, are provided to the utility planning models. The expansion planning model develops an optimal scenario of conventional generating unit additions. This number of conventional units is given to a production cost model to develop a more accurate estimate of the variable operating costs needed for the conventional generating system. This cost information and the conventional capacity information from the expansion model for the base case (zero WECS) and for all the change cases (varying WECS capacity) are provided to FINAM. This final routine determines the break-even cost of each WECS penetration ($/rated kW) and the WECS marginal value ($/rated kW), where value is the utility's present worth savings of reduced operating costs and modified capital additions. These values may be combined with total WECS cost to determine the maximum amount of WECS capacity that can be economically justified for addition to the utility system.

If the WECS value obtained exceeds the amount for which WECS may be purchased, the utility planner might next perform a financial analysis by the utility's corporate model to determine effects on cash flow, debt requirements, etc.

While the analysis was primarily developed for utility-owned and controlled WECS, it easily could be applied to nonutility-owned WECS with proper treatment of WECS availability.

Conclusions and Recommendations:

A planning group interested in this wind value determination method should obtain copies of the SERI-developed computer programs (WTP, WEIBUL, ROSEW, ULMOD, and FINAM) along with Volumes I and II of this report. The utility expansion planning and production cost models are currently used by many utilities and are not available through SERI. The utility may also prefer to use its own financial model instead of FINAM in the last step of the method.

This group of programs and associated materials are identified by the name WECS. The SERI codes are available through two sources. Qualifying organizations may use the SERI Solar Energy Information Data Bank (SEIDB) network, which houses these computer models. To determine qualification status, contact: Rafael Ubico, SEIDB Coordinator, SERI, 1617 Cole Blvd., Golden, CO 80401; 303-231-1032 (FTS-327-1032). These models are also available through National Energy Software Center, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL 60439.

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SECTION 1.0

INTRODUCTION

This volume is intended for those who will be utilizing the computer programs available from SERI to determine the value of intermittent power generation sources, specifically Wind Energy Conversion Systems (WECS). Reference should be made to Volume I: A Methodology for a complete description of how the various routines may be used together and how each routine performs its tasks. All programs are written in the FORTRAN IV language and are presently installed on Control Data Corporation (CDC) hardware. The CDC compiler currently in use is the FTN compiler. Some knowledge of the FORTRAN will be needed to use this guide. There is a separate section for each computer program (WTP, WEIBUL, ROSEW, ULMOD, and FINAM). Each section includes, where appropriate, a description of: (1) features and peculiarities required for installation at SERI, (2) all manually created (or card-type) input data required, (3) computer data file inputs, (4) printed results, and (5) program-created data file results. Samples are provided for inputs, outputs, and a CDC runstream for each routine.

SECTION 2.0

WTP - WEATHER TAPE PREPROCESSOR

As explained in Vol. I, WTP is the starting point in the analysis if the Weibull option is not chosen. WTP's basic job is to process any one of four types of raw weather data. WTP reads only the necessary data, replaces missing or faulty data by interpolation, converts to the proper units, and finally outputs the data in an acceptable format. This output proceeds to ROSEW for hourly power or typical day operation. Volume I, Sec. 3.0, provides much more detail on WTP.

2.1 FACILITY SPECIFICS

Since WTP was designed to run on a CDC system, two program specifics may cause problems on other systems. First, a PROGRAM card is required at the beginning of the code on the CDC system and may not be required for other systems. Second, two hexidecimal constants, 000072B and 000066B, exist at the end of subroutine BLOCK DATA. For normal CDC systems, these represent a zero overstruck with a plus and a zero overstruck with a minus. When using other systems, these must be changed to the proper representation for the overstrike characters.

2.2 WTP INPUT DATA

WTP requires a small amount of manually created input data for execution. Each input type is identified in the first two columns of the card; with the types as follow:

WA--Header card

WB--Title cards

WC--Weather card

2.2.1 WA--Header Card

One card is required, placed first in the input deck.

FORMAT (A2,2X,10A4,3I2)

CRDTYP -- WA

USER -- Name of user, 40 characters

IMONTH -- Month of run

IDAY -- Day of run

IYEAR -- Year of run

2.2.2 WB--Title Cards

Three cards are required, placed after the WA card. Each has a 40-character title.

FORMAT (A2,2X,10A4)

CRDTYP -- WB

TITLE -- 40-character title

2.2.3 WC--Weather Cards

One card is required, placed after the third WB card.

FORMAT (A2,3X,I1,I5,I4,2F5.1,I2,F4.1,5A4)

CRDTYP -- WC

ISOURC -- Weather data source:
- 1 = TDF-14
- 2 = Aerospace
- 3 = SOLMET
- 4 = TMY

NWSTAT -- National Climatic Center weather station number;
Must match number on weather tape

NWYEAR -- Weather year desired;
Must be four digits and match year on weather tape

WSLAT -- Latitude of station, degrees;
North is positive, south is negative

WSLONG -- Longtitude of station, degrees;
West is positive, no negatives allowed

NTZWS -- Time zone of weather station:
- 5 = Eastern
- 6 = Central
- 7 = Mountain
- 8 = Pacific

HTWIND -- Height of wind recorder (m)

WSNAME -- Weather station name;
20-character identification

This completes the card input data requirements. These data are expected on "TAPE5" as shown in the sample control card sequence of Sec. 2.6. Figure 2-1 gives a data sample.

2.3 WTP INPUT WEATHER DATA

As described previously, one year of any of four types of weather data can be selected for WTP input: TDF-14, Aerospace, SOLMET, or TMY. One of these tapes must be provided to WTP as "TAPE10," as shown in the sample runstream in Sec. 2.6.

2.4 WTP PRINTED OUTPUT

For visual inspection, WTP outputs a file containing the input data and a missing data summary. A sample of this output is given in Fig. 2-2. This file is output on "TAPE6" of the sample control card deck of Sec. 2.6.

2.5 WTP OUTPUT FILE

The WTP output file for use by ROSEW contains a header line followed by 8760 (365 × 24) lines of hourly weather data (8784 in leap year).

2.5.1 Header

```
FORMAT (I5,1X,I2,1X,I1,1X,F5.1,1X,F5.1,1X,I2,1X,5A4,
        6X,I1,1X,F4.1,1X,F4.2,1X,F5.3,1X,7I1)
```

Column	Variable
1-5	Weather station number
7-8	Weather year, 2 digit
10	Leap year; 1 = yes, 0 = no
12-16	Weather station latitude; degrees
18-22	Weather station longitude; degrees
24-25	Weather station time zone: 05 = Eastern 06 = Central 07 = Mountain 08 = Pacific
27-46	Weather station name
53	Weather data source 1 = TDF-14 2 = Aerospace 3 = SOLMET 4 = TMY
55-58	Height of wind speed recorder (m)
60-63	Ground reflectivity at station; Fractional

65-69	Terrain factor at station; Range: 0-1.
71	Dry-bulb temperature code
72	Barometric pressure code
73	Relative humidity code
74	Wind speed code
75	Opaque sky cover code
76	Direct insolation code
77	Total insolation code

(Codes are 0 = not provided, 1 = provided)

2.5.2 Weather Data

FORMAT (I4,1X,I2,1X,I2,1X,I2,2X,F5.1,1X,F6.4,1X,F5.3, 1X,F5.1,1X,F5.3,1X,F5.3,1X,F5.3)

Column	Variable
1-4	Hour of year
6-7	Month of year
9-10	Day of month
12-13	Hour of day
16-20	Dry-bulb temperature (°C)
22-27	Barometric pressure; bars
29-33	Relative humidity; fractional
35-39	Wind speed (m/s)
41-45	Opaque sky cover; fractional
47-51	Direct insolation; kW/m^2
53-57	Total insolation; kW/m^2

A sample of this output file is given in Fig. 2-3. The file is represented by "TAPE11" in the sample runstream in Sec. 6.0.

2.6 WTP SAMPLE CONTROL CARD SEQUENCE

A sample control card sequence for a standard CDC-SCOPE system is shown in Fig. 2-4.

```
WA  SAMPLE PROBLEM - ALBUQUERQUE, N.M.        120180
WB   ***  ALBUQUERQUE, N.M.- TMY TAPE
WB   ***  TAPE OBTAINED FROM NCC
WB   ***  TAPE ALSO RESIDES ON SERI DISKPACK
WC   4230501999 35.0107.0 711.9 ALBUQUERQUE,N.M.
```

Figure 2-1. WTP Manually Created Input Data

```
CORELATE - COST & RELIABILITY ANALYSIS          * * * STONE & WEBSTER ENGINEERING CORPORATION * * *          12/ 1/80
WTP - WEATHER TAPE PREPROCESSOR                    ---SAMPLE PROBLEM - ALBUQUERQUE, N.M.    ---          PAGE   1
**********************************************************************************************************************

  CCCCCC      000000     RRRRRRR     EEEEEEEE   LL          AA       TTTTTTTT   EEEEEEEE
 CCCCCCCC    00000000    RRRRRRRR    EEEEEEEE   LL         AAAA      TTTTTTTT   EEEEEEEE
CC    CC    00    00    RR    RR    EE         LL        AA  AA        TT      EE
CC          00    00    RR    RR    EEEEEE     LL       AA    AA       TT      EEEEEE
CC          00    00    RRRRRRR     EEEEEE     LL       AAAAAAAA       TT      EEEEEE
CC    CC    00    00    RRRRRR      EE         LL       AAAAAAAA       TT      EE
CCCCCCCC    00000000    RR    RR    EEEEEEEE   LLLLLLLL AA    AA       TT      EEEEEEEE
 CCCCCC      000000     RR    RR    EEEEEEEE   LLLLLLLL AA    AA       TT      EEEEEEEE


***  ALBUQUERQUE, N.M.- TMY TAPE
***  TAPE OBTAINED FROM NCC
***  TAPE ALSO RESIDES ON SERI DISKPACK
```

Figure 2-2. WTP Printed Output

INPUT DATA

SOURCE DATA FORMAT - 4 - NATIONAL CLIMATIC CENTER - TMY TAPE FORMAT

WEATHER STATION NO. 23050 - ALBUQUERQUE,N.M.

WEATHER YEAR - TYPICAL

LOCATION
LATITUDE - 35.0 DEGREES
LONGITUDE - 107.0 DEGREES
TIME ZONE - 7 (MOUNTAIN)

HEIGHT OF WIND SPEED RECORDER - 11.9 METERS

MISSING DATA SUMMARY

PARAMETER	NUMBER OF HOURS DATA WAS MISSING
DRY BULB TEMPERATURE	0
BAROMETRIC PRESSURE	0
WIND SPEED	0
PERCENT OPAQUE SKY COVER	2432
DIRECT INSOLATION	0
TOTAL INSOLATION	0

Figure 2-2. WTP Printed Output (Concluded)

```
23050 99 0   35.0 107.0  7  ALBUQUERQUE,N.M.          4 11.9 0.00   .143 1101111
   1  1  1  1    -3.3   .8459 0.000    2.1 0.000 0.000 0.000
   2  1  1  2    -4.4   .8459 0.000    0.0 0.000 0.000 0.000
   3  1  1  3    -5.0   .8459 0.000    0.0 0.000 0.000 0.000
   4  1  1  4    -4.4   .8456 0.000    3.1 0.000 0.000 0.000
   5  1  1  5    -5.6   .8456 0.000    3.6 0.000 0.000 0.000
   6  1  1  6    -6.7   .8459 0.000    3.6 0.000 0.000 0.000
   7  1  1  7    -7.8   .8463 0.000    3.1 0.000 0.000 0.000
   8  1  1  8    -6.1   .8469 0.000    3.1 0.000   .215   .043
   9  1  1  9    -5.6   .8473 0.000    0.0   .100   .491   .182
  10  1  1 10    -3.3   .8473 0.000    2.1   .100   .838   .354
  11  1  1 11    -1.1   .8473 0.000    0.0   .100   .970   .499
8759 12 31 23     0.0   .8358 0.000    1.5   .300 0.000 0.000
8760 12 31 24     0.0   .8358 0.000    1.5   .300 0.000 0.000
```

Figure 2-3. WTP Output File

```
WTP,T100,YD1.
COMMENT. FILE,TAPE10,RT=F,FL=163,BT=K,RB=24,MBL=3912,CM=YES.
COMMENT.  ABOVE FOR SOLMET.  BELOW FOR TMY.
FILE,TAPE10,RT=F,FL=132,BT=K,RB=24,MBL=3168,CM=YES.
FILE,TAPE11.
FILE,TAPE5,FL=80.
FILE,TAPE6,FL=80.
FILE,WTP,FL=80.
GETPF,WTP,ID=UID.
GETPF,TAPE5,ID=UID.
COMMENT. REQUEST,WTPX,*PF.
FTN,I=WTP,B=WTPX,R=0,L=0,ER.
COMMENT. CATALOG,WTPX,ID=UID.
COMMENT. VSN-S00183=TMY,  VSN-S00035=ALBQ SOLMET.
STAGE,TAPE10,PRE,VSN=S00183,PE,NT,EB.
LDSET,FILES=TAPE10.
WTPX.
REWIND,TAPE5.
COPYSBF,TAPE5,OUTPUT.
REWIND,TAPE6.
COPYSBF,TAPE6,OUTPUT.
REWIND,TAPE11.
SAVEPF,TAPE11,SAVEF,ID=UID.
EXIT.
```

(Lines beginning in "COMMENT." are inactive, but removing the "COMMENT." will activate the command.)

Figure 2-4. WTP Sample Runstream

SECTION 3.0

WEIBUL WIND DISTRIBUTION

WEIBUL's objective is to create Weibull wind speed probability distributions, given weather data as input. Multiyear data from any of the four weather-data types previously discussed can be used. A Weibull distribution is created for each hour of a monthly typical day, with these 288 distributions available to ROSEW for Weibull option execution. In Vol. I, Sec. 4.0, the WEIBUL methodology is discussed.

3.1 FACILITY SPECIFICS

Since WEIBUL was created by strongly modifying WTP, the two specifics mentioned for WTP also apply. These give consideration of the PROGRAM statement and the code required to represent the overstruck characters at the end of subroutine BLOCK DATA.

3.2 WEIBUL INPUT DATA

Like WTP, the manually created input data required by WEIBUL are identified by the card's first two columns. The types are:

WA--Header Card

WB--Title Cards

WC--Weather Card

WD--Curve Parameter Card

3.2.1 WA--Header Card

One card is required at the beginning of the data.

FORMAT (A2,2X,10A4,3I2)

CRDTYP -- WA

USER -- Name of user; 40 characters

IMONTH -- Month of run

IDAY -- Day of run

IYEAR -- Year of run

3.2.2 WB--Title Cards

Three cards are required, placed after the WA card. Each is a 40-character title.

FORMAT (A2,2X,10A4)

CRDTYP -- WB

TITLE -- 40-character title

3.2.3 WC--Weather Card

One card is required, placed after the third WB card.

FORMAT (A2,1X,I1,1X,I5,1X,I4,1X,I4,1X,F4.1,1X,5A4)

CRDTYP -- WC

ISOURCE -- Weather data source:
1 = TDF-14
2 = Aerospace
3 = SOLMET
4 = TMY

NWSTAT -- National Climatic Center weather station number;
Must match number on weather tape

NWYEAR -- First weather year desired in the wind speed probability distribution development;
Must be four digits and match year on weather tape

LASTYR -- Last weather year desired;
If only 1 year of data desired, enter same year as NWYEAR

HTWIND -- Height of wind recorder (m)

WSNAME -- Weather station name;
20-character identification

3.2.4 WD--Curve Parameter Card

One card is required, placed after the WC card.

FORMAT (A2,1X,I1,1X,I3,1X,F5.2,1X,F5.2)

CRDTYP -- WD

IOPT -- Calculation option, (see Vol. I, Sec. 4.0):
0 = maximum likelihood technique
1 = ordinary least squares technique

IBINS -- Number of wind bins (divisions between cut-in and maximum wind speed) for calculation purposes;
Range: 1-100
Recommendation: As large as possible for accuracy's sake--tradeoff with CPU time (see Vol. I, Sec. 4.0)

WSMAX -- Maximum wind speed expected [m/s (see Vol. 1, Sec. 4.0)]

WSCUTIN -- Wind machine cut-in wind speed (m/s) at height of wind data recordings. The following hand calculation is required to determine the proper input value:

$$WSCUTIN = W_{CI}(H_a/H_h)^{\alpha}$$

where:

W_{CI} = wind machine cut-in wind speed at machine hub height (m/s). If more than one wind machine is to be analyzed, then the smallest cut-in value of all the wind machines should be entered (see Vol. I, Sec. 4.0).

H_a = height of wind-speed recorder used to collect data (m).

H_h = hub height of wind machine (m). The machine with the smallest cut-in velocity should again be used.

α = terrain factor to be input to ROSEW (see Sec. 4.2.5).

Only wind speeds above this value are used to create a Weibull distribution.

This completes the card input requirements. This data is to be input on "TAPE5" in the sample runstream in Sec. 6.0. A sample of this data is given in Fig. 3-1.

3.3 WEIBUL INPUT WEATHER DATA

Multiyear weather data from TDF-14, Aerospace, SOLMET, or TMY must be made available to WEIBUL. The sample control card sequence of Sec. 3.6 shows this data entering as "TAPE10."

3.4 WEIBUL PRINTED OUTPUT

WEIBUL outputs a file for visual inspection on "TAPE6" of the sample runstream. This file includes input data, a missing data summary, and some interesting Weibull output parameters for each hour of the month's typical days. A sample of this output, shown in Fig. 3-2, is generally printed on paper.

3.5 WEIBUL OUTPUT FILE

Important results are output to a file identified for later input to ROSEW. These results contain one line of header information and 288 (24 × 12) lines of Weibull information--each line describing one hour of a monthly typical day.

3.5.1 Header

FORMAT (I5,1X,I4,1X,I4,1X,I1,16X,5A4,1X,I1,
1X,F5.2,1X,I3,1X,F5.2,1X,F5.2)

Column	Variable
1-5	Weather station number
7-10	First weather year; 2 digits
12-15	Last weather year; 2 digits
17	Leap year; 1 = yes, 0 = no
34-53	Weather station name
55	Weather data source 1 = TDF-14 2 = Aerospace 3 = SOLMET 4 = TMY
57-61	Height of wind speed recorder (m)
63-65	Number of calculation bins
67-71	Maximum expected wind speed
73-77	Cut-in wind speed input on WD card

3.5.2 Results

FORMAT (2I2,2F5.2,4F7.3,2X,F6.4)

Column	Description
1-2	Month
3-4	Hour of monthly typical day
5-9	K - Weibull shape parameter
10-14	C - Weibull scale parameter
15-21	Average pressure; bars
22-28	Average temperature (°C)
29-35	Average relative humidity; fractional
36-42	Average wind speed (m/s)
45-50	Probability of the wind being below cut-in wind speed

A sample of this output file is shown in Fig. 3-3. The file is identified as "TAPE11" in the following sample runstream.

3.6 WEIBUL SAMPLE CONTROL CARD SEQUENCE

Figure 3-4 gives a sample control card sequence for a normal CDC-SCOPE operating system.

```
WA  TEST RUN FOR CALCULATION COMPARISON      120480
WB  TMY - ALBUQUERQUE,NM
WB   MAXIMUM LIKELIHOOD TECHNIQUE
WB
WC 4 23050 1999 1999 11.9 TMY ALBUQUERQUE
WD 0 100 40.     0.00
```

Figure 3-1. WEIBUL Manually Created Input Data

```
                    * * * SOLAR ENERGY RESEARCH INSTITUTE * * *                12/ 4/80
WEIBUL -WEIBULL WIND DISTRIBUTION          ---TEST RUN FOR CALCULATION COMPARISON ---          PAGE   1
**********************************************************************************************************

                    INPUT DATA
                    ----- ----

SOURCE DATA FORMAT  -  4 - NATIONAL CLIMATIC CENTER  -  TMY TAPE FORMAT

WEATHER STATION NO. 23050   -   TMY ALBUQUERQUE

A TYPICAL METEOROLOGICAL YEAR IS USED - TMY

** THE MAXIMUM LIKLIHOOD TECHNIQUE HAS BEEN CHOSEN TO  CALCULATE THE WEIBULL PARAMETERS

HEIGHT OF WIND SPEED RECORDER  -  11.6  METERS


NUMBER OF DAYS OF DATA USED IN WEIBUL CALCULATION -   365

WSMAX =  40.000 METERS/SEC      TOTAL BINS =  100      WSDIVB =  .40000

CUTIN WIND SPEED AT ANEMOMETER HEIGHT =  5.030  METERS/SEC

  NUMBER OF ITERATIONS=      8
  1      1        1.211      1.931       .838       -.781       0.000       3.077       .806
  NUMBER OF ITERATIONS=      6
  1      2         .940      1.242       .838      -1.161       0.000       2.839       .774
  NUMBER OF ITERATIONS=      3
  1      3        1.026      1.406       .838      -1.649       0.000       3.068       .839
  NUMBER OF ITERATIONS=      4
  1      4        1.200      1.770       .838      -1.777       0.000       2.945       .903
  NUMBER OF ITERATIONS=     10
  1      5         .941       .869       .838      -2.281       0.000       2.832       .871
  NUMBER OF ITERATIONS=      7
  1      6        1.493       .667       .838      -2.719       0.000       2.742       .935
  NUMBER OF ITERATIONS=      4
  1      7        1.274      1.781       .839      -3.006       0.000       2.577       .903
  NUMBER OF ITERATIONS=      2
  1      8         .500      1.800       .839      -2.919       0.000       2.361       .935
  NUMBER OF ITERATIONS=      7
  1      9        1.675      2.902       .840      -1.445       0.000       2.310       .935
  NUMBER OF ITERATIONS=      4
  1     10        1.278      1.647       .840       .735       0.000       2.742       .903
  NUMBER OF ITERATIONS=      9
  1     11        1.162      1.556       .840      2.258       0.000       2.632       .839
  NUMBER OF ITERATIONS=      4
  1     12        1.029      1.170       .839      4.394       0.000       2.868       .742
          .
          .
          .
          .
```

Figure 3-2. WEIBUL Printed Output

```
                    * * * SOLAR ENERGY RESEARCH INSTITUTE * * *                12/ 4/80
WEIBUL -WEIBULL WIND DISTRIBUTION          ---TEST RUN FOR CALCULATION COMPARISON ---          PAGE  2
```

MISSING DATA SUMMARY

PARAMETER	NUMBER OF HOURS DATA WAS MISSING
DRY BULB TEMPERATURE	0
BAROMETRIC PRESSURE	0
WIND SPEED	0

Figure 3-2. WEIBUL Printed Output (Concluded)

```
23050 1999 1999                          TMY ALBUQUERQUE        4 11.90 100 40.00  5.03
  1  1 1.21 1.93    .838   -.781  0.000  3.077    .8065
  1  2  .94 1.24    .838  -1.161  0.000  2.839    .7742
  1  3 1.03 1.41    .838  -1.645  0.000  3.068    .8387
  1  4 1.20 1.77    .838  -1.777  0.000  2.945    .9032
  1  5  .94  .87    .838  -2.281  0.000  2.832    .8710
  1  6 1.49  .67    .838  -2.719  0.000  2.742    .9355
  1  7 1.27 1.78    .839  -3.006  0.000  2.577    .9032
  1  8  .50 1.80    .839  -2.919  0.000  2.361    .9355
  1  9 1.67 2.90    .840  -1.445  0.000  2.310    .9355
 110 1.28 1.65    .840    .735  0.000  2.742    .9032
 111 1.16 1.56    .840   2.258  0.000  2.632    .8387
 112 1.03 1.17    .839   4.394  0.000  2.868    .7419
 113 1.02 2.14    .838   5.539  0.000  3.200    .8065
 114 3.18 2.58    .837   6.503  0.000  3.435    .7742
 115 1.32 3.18    .837   7.090  0.000  4.071    .7097
 116 1.34 2.78    .837   6.935  0.000  4.429    .6129
 117 1.53 1.55    .837   5.739  0.000  4.384    .5484
 118 1.02 1.32    .837   4.103  0.000  3.700    .6774
 119 1.05 1.82    .838   3.029  0.000  3.929    .7419
 120 1.39 2.44    .838   2.268  0.000  3.532    .7419
 121 1.04 1.90    .838   1.742  0.000  3.748    .7097
 122 1.49 2.19    .838   1.116  0.000  2.816    .8065
 123 2.54 3.72    .838    .455  0.000  3.084    .8710
 124 1.68 3.10    .838   -.258  0.000  3.287    .8387
 2  1  .62 1.47    .838  1.004  0.000  2.846    .8929
 2  2  .74 1.82    .838   .200  0.000  3.257    .8571
 2  3  .67  .92    .838  -.407  0.000  3.179    .8571
  ↕                                      ↕
1224 1.92  .68    .841  1.210  0.000  2.810    .9032
```

Figure 3-3. WEIBUL Output File

```
WEB,YD1,YL1.
COMMENT. FILE,TAPE10,RT=F,FL=163,BT=K,RB=24,MBL=3912,CM=YES.
COMMENT.  ABOVE FOR SOLMET.  BELOW FOR TMY.
FILE,TAPE10,RT=F,FL=132,BT=K,RB=24,MBL=3168,CM=YES.
FILE,TAPE11,FL=80.
FILE,TAPE5,FL=80.
GETPF,TAPE5,WEBDAT,ID=UID.
COMMENT. PURGE,WEIBX,ID=UID.
COMMENT. REQUEST,WEIBX,*PF.
FILE,WEIBUL,FL=80.
GETPF,WEIBUL,TY=G,ST=CNS.
FTN,I=WEIBUL,B=WEIBX,R=0,L=0,ER.
COMMENT. CATALOG,WEIBX,ID=UID,XR=UID.
COMMENT. VSN-S00183=TMY,  VSN-S00035=ALBQ SOLMET.
STAGE,TAPE10,PRE,VSN=S00183,PE,NT,EB,ST=CNS.
LDSET,FILES=TAPE10.
WEIBX.
REWIND,TAPE5.
COPYSBF,TAPE5,OUTPUT.
REWIND,TAPE6.
COPYSBF,TAPE6,OUTPUT.
REWIND,TAPE11.
SAVEPF,TAPE11,SAVEF,ID=UID.
EXIT.
```

(Lines beginning in "COMMENT." are inactive, but removing the "COMMENT." will activate the command.)

Figure 3-4. WEIBUL Sample Runstream

SECTION 4.0

ROSEW—REPRESENTATION OF SOLAR ELECTRIC—WIND

As Vol. I, Sec. 5.0 indicates, ROSEW's basic responsibility is to calculate the amount of wind-derived electric power available. Input to ROSEW includes a data set to describe the wind machines, plus an output file from either WTP or WEIBUL. WTP's results are to be used if the hourly power option or typical day option are chosen, and WEIBUL's results are used with the Weibull option (see Vol. I, Sec. 5.0). ROSEW's output varies with the type of option chosen; each type is treated in this section. This output is sent to ULMOD for utility load modification.

4.1 FACILITY SPECIFICS

Since ROSEW was designed to run on a CDC system, two characteristics of the program may require modification for use on other systems. First, the PROGRAM card required at the beginning of the code for CDC systems may not be needed for other systems. The second problem concerns the free-formatted inputs that are used, with only a comma or space needed to separate the user input data. If another system does not recognize a statement of the form READ (5,*) as a free format, then the appropriate corrections must be made to each READ statement of this kind. Corresponding formatted read statements for each instance have been left in the code but commented out. Thus, the user may comment out the free-formatted READ statements and remove the comment from the formatted READs (and associated FORMATs) if this trouble arises.

4.2 ROSEW INPUT DATA

ROSEW requires user selected values to control certain execution options and to describe the wind machines. Each manually created input data card type is identified in the first two or three columns as:

RA--Header Card

RB--Title Card

RC--Control Card

RD--Time Period Card

RF--Wind Enhancements Card

RJA--Design Label Card

RJB--Design Parameters Card

RJC--Gear Box Efficiency Table

RJD--Generator Efficiency Table

RJE--Transformer Efficiency Table

RJF--Aerodynamic Efficiency Table

4.2.1 RA--Header Card

One card is required, placed first in the input deck.

FORMAT (A2,2X,10A4,3I2)

CRDTYP -- RA

USER -- Name of user

IMONTH -- Month of run

IDAY -- Day of run

IYEAR -- Year of run

4.2.2 RB--Title Cards

Three cards are required, placed after the RA card. Each contains a 40-character title.

FORMAT (A2,2X,10A4)

CRDTYP -- RB

TITLE -- 40-character title

4.2.3 RC--Control Card

One card is required, placed after the last RB card.

FORMAT (FREE)

This free format means that only a space or comma is necessary to separate the data. Zeros must be included if the value is zero (i.e., no blanks). Alphanumeric (A) format data must be enclosed in quotes. See previous section on facility specifics for possible problems if used on a non-CDC system.

CRDTYP -- RC

IWBLOP -- Weibull option; 1 = on, 0 = off

IFOROP -- Forced outage rate option;
0 = WECS power outputs modified by the forced outage rate,
1 = The probabilities (of certain power outputs) are modified by the forced outage rate;
This must be zero if IWBLOP equals zero since probability information exists only with the Weibull option.

NPER -- Number of time periods;
Range: 1-52, but normally 12;
Can be input as zero if IWBLOP = 1

NDESIN -- Total number of wind-machine designs;
Range: 1-9

RAIR -- Gas constant for dry air; bar $m^3/kg°K$;
If zero is input, the program defaults to the value 0.00287

RVAP -- Gas constant for water vapor; bar $m^3/kg°K$;
If zero is input, the program defaults to the value 0.0046

INTER -- Number of intervals between VCUTIN and VRATED for Weibull computation purposes;
Enter a zero if IWBLOP = 0;
Range: 1-25, default = 5 if 0 entered and IWBLOP = 1;
Will be the same for all wind-machine designs
See Vol. I, Sec. 5.2.1.2 for more details.

NSLOTS -- Number of divisions for each interval above;
Enter a zero if IWBLOP = 0;
Range: 1-10, default = 5 if 0 entered and IWBLOP = 1
See Vol. I, Sec. 5.2.1.2 for more details.

4.2.4 RD--Time Period Card

One card is required for each time period (see NPER on RC card); all placed in sequence after the RC card. These cards are not to be input if IWBLOP = 1.

FORMAT (FREE)

CRDTYP -- RD

IP -- Time period index,
Range: 1-52, usually 1-12;
RD cards must be in order according to this field

JTPER -- Time period (month) label;
Any four-character description to describe the month;
Must have characters inside quotation marks

IUBEG -- First time unit (hour of the year) for this month;
Range: 1-8784

IUEND -- Last time unit (hour of the year) for this month;
Range: 1-8784

NUPF -- Number of time units (hours) per frame (day);
Usually 24

NTDAY -- Number of typical days;
Range: 0-3;
If 0, then straight hourly powers are output

NFDAY1 -- Number of values to make up first typical day's averages (see Vol. I, Sec. 5.0);
Zero if IWBLOP = 1 or NTDAY = 0

NFDAY2 -- Number of values to make up second typical day's averages;
Zero if IWBLOP = 1 or NTDAY = 0

NFDAY3 -- Number of values to make up third typical day's averages;
Zero if IWBLOP = 1 or NTDAY = 0

4.2.5 RE--Weather Station Card

One card is required, following RD card (or RC if no RD)

FORMAT (FREE)

CRDTYP -- RE

MWSTAT -- Desired weather station number;
Must match number on weather or WEIBUL input

MWYEAR -- Desired weather year, four digits;
Must match year on weather or WEIBUL input file

STTERR -- Terrain factor (power law exponent for vertical projection);
Range: 0-0.7
Note: This value should be 0.0 if IALOPT on RF card is 1

4.2.6 RF--Wind Enhancements Card

One card is required; placed after RE card. See Vol. I, Sec. 5.0 for details on each variable.

FORMAT (FREE)

CRDTYP -- RF

IALOPT -- Alpha (terrain factor) calculation option;
0 = off, 1 = on

IWOPT -- Enhancements option;
0 = off, 1 = on;
If 0, all following values on this card should be zeros

SIGS -- Gust-power correction factor;
Generally ≈ 0.2

SIGTHE -- Anemometer theta correction factor;
Generally ≈ 0.2

SIGW -- Anemometer vertical gust correction factor;
Generally ≈ 0.2

SIGU -- Anemometer longitude gust factor;
Generally ≈ 0.2

ISHROPT -- Shear correction option;
0 = off, 1 = on

4.2.7 RJA--Design Label Card

One card is required for each wind-machine design and follows the RF card. This RJA card should be followed by RJB-RJH cards for the specific design, with this package followed by another wind-machine design package if more than one design is considered.

FORMAT (A3,1X,I1,1X,I1,1X,5A4)

CRDTYP — RJA

JDESIN -- Design number of this specific wind-machine design;
Range: 1--NDESIN on RC card

INNOV(D) -- Innovative design flag for design D;
If 1, then a velocity-power table is used for power calculations;
If 0, then the standard power calculations are used

PLNTLB -- Wind-machine label;
20-character description of wind-machine design

4.2.8 RJB--Design Parameters Card

One card required for each design, placed behind RJA card.

FORMAT (FREE)

If INNOV(D) on the RJA card is zero (no power table), then the input is:

CRDTYP -- RJB

DROTOR -- Wind-turbine rotor diameter (m);
Range: 1-200.0

FORWGU -- Forced outage rate of a single unit, fractional;
Range: 0-0.9999

HUBHT -- Hub height (m);
Range: 1.0-100.0

RPMROT -- RPM of rotor;
Range: 1.0-500.0

VCUTIN -- Cut-in velocity at hub height, (m/s);
Range: 0-20.0

VRATED -- Rated velocity at hub height, (m/s);
Range: 0-30.0

VCUTUT -- Cut-out velocity at hub height, (m/s);
Range: 0-50.0

If INNOV(D) on RJA card is one (power table desired), then the following is input instead of the previously mentioned parameters:

FORMAT (FREE)

CRDTYP — RJB

FORWGU -- Forced outage rate of a single unit, fractional;
Range: 0-0.9999

HUBHT -- Representative centerline height of wind turbine for power calculations, meters;
Range: 0-100.0

VCUTIN -- Cut-in velocity at hub height, (m/s);
Range: 0-20.0

VRATED -- Rated velocity at hub height, (m/s);
Range: 0-30.0

VCUTUT -- Cut-out velocity at hub height, (m/s);
Range: 0-50.0

HGTINN -- Wind-speed recorder height that velocity values in the velocity-power table are based upon, meters;
Range: 0-200.0

4.2.9 RJC--Number of Generators Card

One card is required for each design, placed behind RJB card.

FORMAT (FREE)

CRDTYP -- RJC

NWGU(M) -- Number of wind generators of this design for month M;
Range: 0-999

NWGU(M+1) -- Same for next month, continue until all months are represented

4.2.10 RJD-RJH--Tabular Input Cards

If INNOV on the RJA card is zero, then the RJD card is not needed and the RJE-RJH cards enter gearbox, generator, transformer, and aerodynamic efficiencies as functions of an independent variable. If INNOV is one, the RJD card inputs the wind-generator power output as a function of wind velocity at a certain height, and the RJE-RJH cards are not needed. Either way, the program takes this set of independent variables (range: 2-25 points) and an equal number of dependent variables and, in effect, plots a curve of one variable versus the other. Linear interpolation between these known points determines intermediate values, and points outside the range are assigned the value of the closest known point (first or last). Values of the independent variable must be input in ascending order with no two values the same. The table is input in free format as follows:

- The initial input on the first card indicates the number of points, followed by the first 10 values of the independent variable. If less than 10 points are to be input, zeros should be input in order to have 10 values on the card. If more than 10 points are needed, a second card should be used. For 21 to 25 points, a third card is required.
- After the entire independent array has been input, the dependent array is similarly input on one, two, or three cards. The number of points is not to be input on the first dependent variable card.

  If a constant dependent variable value is desired, only two points of that value need to be input.

RJD--Power Table Cards (INNOV = 1). Two to six cards are required, as described, placed after the RJC card. If INNOV = 1, then the RJD cards replace the RJE-RJH cards. If INNOV = 0, no RJD cards are included.

FORMAT (FREE)

CRDTYP — RJD

NVELP -- Number of points;
Range: 2-25

XVEL -- Independent variable, wind velocity (m/s);
Range: 0-100.

XPOW -- Dependent variable, wind-turbine power output, MW;
Range: 0-10.

RJE--Gearbox Efficiency Table Cards (INNOV = 0). Two to six cards are required, as described, and are placed after the RJC card. If INNOV = 0, then the RJE-RJH cards are required.

FORMAT (FREE)

CRDTYP -- RJE

NEFFGB -- Number of points;
Range: 2-25

EFFGBX -- Independent variable, power input to gearbox, MW;
Range: 0.0-999.9

EFFGB -- Dependent variable, gearbox efficiency;
Range: 0-1.0

RJF--Generator Efficiency Table Cards. Two to six cards are required, placed after the last RJF card. These are needed only if INNOV = 0.

FORMAT (FREE)

CRDTYP — RJF

NEFFGN -- Number of points;
Range: 2-25

EFFGNX -- Power input to generator, MW;
Range: 0-999.9

EFFGN -- Generator efficiency;
Range: 0-1.0

RJG--Transformer Efficiency Table Cards. Two to six cards are required, placed after the last RJF card. These are needed only if INNOV = 0.

FORMAT (FREE)

CRDTYP — RJG

NEFFTN -- Number of points;
Range: 2-25

EFFTFX -- Power input to transformer, MW;
Range: 0-999.9

EFFTF -- Transformer efficiency;
Range: 0-1.00

RJH--Aerodynamic Efficiency Table Cards. Two to six cards are required, placed after the last RJG card. These are needed only if INNOV = 0.

FORMAT (FREE)

CRDTYP -- RJH

NEFFAD -- Number of points;
Range: 2-25

EFFADX -- Tip speed ratio;
Range: 0-999.9

EFFAD -- Aerodynamic efficiency;
Range: 0-1.00

That completes the input requirements for ROSEW. Recall that if more than one wind-generator design is used, the second design deck of RJA-RJF cards is placed at the end, followed by a third design, etc.

For clarification, several examples of ROSEW input data are presented. Figure 4-1 gives data for a Weibull option with two wind-machine designs and no wind enhancements. Figure 4-2 supplies data for hourly power outputs with one wind-machine design and wind enhancements.

4.3 ROSEW FILE INPUTS

If the Weibull option is chosen, then the WEIBUL-created output file must be provided as input to ROSEW. The hourly power and typical day options require WTP's output file as input. These two files have been previously discussed and are identified as "TAPE10" in the sample control card sequence of Sec. 4.6.

4.4 ROSEW PRINTED OUTPUT

For visual inspection and easy reference, ROSEW creates a file for printed output. In a convenient format, this file exhibits input data, execution options, and useful calculation values. A sample portion of this output is given in Fig. 4-3. This output is identified as "TAPE6" in the sample runstream.

4.5 ROSEW OUTPUT FILE

ROSEW's main output file is saved for input to ULMOD. The file's contents will be different for each of the three execution options (Weibull, hourly power, or typical day).

4.5.1 Weibull Option

This option's output file contains a header card, a comment card, and power-probability results for each hour of the monthly typical day.

4.5.1.1 Header Card

```
FORMAT("PP", 1X,I5,1X,I4,1X,I4,1X,5A4,1X,I1,1X,
       I2,1X,F5.2,1X,I2,1X,I2,1X,I1,1X,I1,1X,I1,1X,I1)
```

Column	Variable
1-2	"PP"
4-8	Weather station number
10-13	First weather year
15-18	Last weather year
20-39	Weather station name
41	Weather data source; 1 = TDF-14 2 = Aerospace 3 = SOLMET 4 = TMY
43-44	Number of bins in Weibull calculation
46-50	Maximum wind speed expected in Weibull calculation
52-53	Number of intervals between VCUTIN and VRATED for calculation purposes
55-56	Number of slots in each interval
58	Height projection calculation option; 1 = on, 0 = off
60	Wind enhancements option, 1 = on, 0 = off
62	Forced outage option; 1 = on, 0 = off
64	Number of wind-machine designs considered

4.5.1.2 Comment Card

One 20-character plant description (PLNTLB variable) is included for each wind-machine design.

4.5.1.3 Results

For each hour of the month's typical day, general results, along with results for each interval between cut-in and rated wind speeds, are given for each design.

General Results

FORMAT (3I2,2X,F10.4,2X,F10.4,2X,F10.4)

Column	Variable
1-2	Number of wind-machine designs; Range: 1-9
3-4	Month
5-6	Hour of month's typical day
9-18	Probability of zero power output from wind machine; Range: 0-1.0
21-30	Rated power output of this design, MW
33-42	Probability of rated power being produced; Range: 0-1

Interval Results

For each interval between VCUTIN and VRATED, the output is:

FORMAT (I2,2X,F10.4,2X,F10.4)

Column	Variable
1-2	Interval number
5-14	Representative power of this wind-speed interval, MW
17-26	Probability of the wind being in this wind-speed interval; Range: 0-1.0

A sample of this output file is shown in Fig. 4-4.

4.5.2 Hourly Power Option

This type of output file contains a header card, a comment card, and output results.

4.5.2.1 Header Card

```
FORMAT ("HR",1X,I5,1X,I4,1X,I4,1X,5A4,1X,I1,16X,I1,
       1X,I1,3X,I1)
```

Column	Variable
1-2	"HR"
4-8	Weather station number
10-13	Weather year
15-18	Weather year repeated
20-39	Weather station name; 20 characters
41	Weather data source: 1 = TDF-14 2 = Aerospace 3 = SOLMET 4 = TMY
58	Height projection calculation option; 1 = on, 0 = off
60	Wind enhancements option; 1 = on, 0 = off
64	Number of wind-machine designs considered;

4.5.2.2 Comment Card

One 20-character plant description (PLNTLB variable) is included for each wind-machine design.

4.5.2.3 Results

Hourly average power values are output on two lines for each day of the year:

```
FORMAT (3I2, "1X  ",  I1," HR ENGY  ", 12F5.1,/,3I2, "2   ",I1,
       " HR ENGY  ", 12F5.1)
```

Column	Variable
1-2	Month
3-4	Day

5-6	Weather year
10	Machine design number; Range: 1-9
21-80	First 12 hourly average powers, MW

The above procedure is repeated once more for the second 12 hourly average powers of the day.

An example of this output is shown in Fig. 4-5.

4.5.3 Typical Days Option

As described in Vol. I, either one, two, or three "typical days" can be selected. All choices have output containing a header card, a comment card, and the typical day results.

4.5.3.1 Header Card

```
FORMAT ("T",I1,1X,I5,1X,I4,1X,I4,1X,5A4,1X,I1,16X,I1,1X
       I1,3X,I1)
```

Column	Variable
1	"T"
2	Number of typical days; Range: 1-3
4-8	Weather station number
10-13	Weather year
15-18	Weather year repeated
20-39	Weather station name
41	Weather data source; 1 = TDF-14 2 = Aerospace 3 = SOLMET 4 = TMY
58	Height projection calculation option; 1 = on, 0 = off
60	Number of wind-machine designs considered

4.5.3.2 Comment Card

One 20-character plant description (PLNTLB variable) is included for each wind-machine design.

4.5.3.3 Results

As discussed, the typical day results are average hourly power values for one, two, or three monthly typical days.

```
FORMAT (I2,2X,I2,"1   ",I1,'   T1  ',I2,2X,12F5.1,/,
        I2,2X,I2,"    ",I1'2   T1  ',I2,X2X,12F5.1)
```

Column	Variable
1-2	Month
5-6	Year
10	Machine design number; Range: 1-9
17-18	Number of days used for typical day 1. (If only 1 typical day is selected, this will equal days in month)
21-80	First 12 hourly powers, MW

The above procedure is repeated once more for the second 12 hourly average powers for the first typical day.

If two typical days are selected, the same results will be output for day two; T1 in the above FORMAT will change to T2. If three typical days are selected, all three days will have the same type output. The third typical day will be identified by a T3 in the FORMAT statement. Sample output for all three typical day cases is shown in Fig. 4-6.

4.6 SAMPLE CONTROL CARD SEQUENCE

A sample control card sequence for each of the three options is given in Fig. 4-7. These runstreams utilize the CDC-SCOPE operating system.

```
RA  SAMPLE PROBLEM - ALBUQUERQUE, N.M.       120180
RB  * TMY DATA - ALBUQUERQUE, N.M.
RB  * 25 MOD-2 AND 50 MOD-1 WIND TURBINES
RB  * WEIBUL PROBABILITY EXECUTION
"RC" 1 1 12 2     0 0 5 5
"RE" 23050 1999     0.143
"RF" 0 0 0. 0. 0. 0.  0
RJA 1 1 MOD-2 WIND GENERATOR
"RJB"      0.08  60.96    6.355 12.52 20.52  60.96
"RJC" 25 25 25 25 25 25 25 25 25 25 25 25
"RJD"  14  6.35 6.7 7.15 7.6 8.05 8.5 8.9 9.4 9.84 10.3
"RJD"    10.7  11.2   11.6  12.1  12.5  20.5
"RJD"   .119   .261   .39   .528   .665   .812  1.016 1.203  1.395 1.582
"RJD"  1.776 1.974 2.155 2.339 2.5 2.5
RJA 2 0 MOD-1 WIND GENERATOR
"RJB" 60.0   .1   40.   35.   7. 15. 20.
"RJC" 50 50 50 50 50 50 50 50 50 50 50 50
"RJE" 12      0.0      .084   .117   .151   .201   .302   .436   .620   .824 1.038
"RJE"         1.390 1.675
"RJE"         0.0      .456   .565   .639   .713   .787   .849   .893   .918   .935
"RJE"           .951   .960
"RJF" 11      0.0      .064   .096   .113   .161   .257   .434   .563   .965 1.318
"RJF"         1.608
"RJF"         0.0      .571   .717   .785   .838   .885   .920   .930   .945   .948
"RJF"           .947
"RJG" 11      0.0      .062   .092   .108   .153   .245   .413   .536   .914 1.249
"RJG"         1.523
"RJG"         0.0      .975   .975   .975   .980   .980   .980   .980   .985   .985
"RJG"           .985
"RJH" 12      0.0    1.0    4.0    6.0    8.0    9.0   10.0   12.0   14.0   16.0
"RJH"        18.0   20.0
"RJH"           .019   .020   .133   .324   .424   .448   .455   .440   .397   .320
"RJH"           .210 0.0
```

Figure 4-1. ROSEW Manually Created Input Data Weibull Option — 2 Designs

```
RA  SAMPLE PROBLEM - ALBUQUERQUE, N.M.        120180
RB  * TMY DATA - ALBUQUERQUE, N.M.
RB  * 25 MOD-2 WIND TURBINES - POWER TABLE
RB  * HOURLY POWER OPTION
"RC" 0 0 12 1     0 0 0 0
"RD" 1 "JAN"          1  744 24 0 0 0 0
"RD" 2 "FEB"        745 1416 24 0 0 0 0
"RD" 3 "MAR"       1417 2160 24 0 0 0 0
"RD" 4 "APR"       2161 2880 24 0 0 0 0
"RD" 5 "MAY"       2881 3624 24 0 0 0 0
"RD" 6 "JUNE"      3625 4344 24 0 0 0 0
"RD" 7 "JULY"      4345 5088 24 0 0 0 0
"RD" 8 "AUG"       5089 5832 24 0 0 0 0
"RD" 9 "SEPT"      5833 6552 24 0 0 0 0
"RD" 10 "OCT"      6553 7296 24 0 0 0 0
"RD" 11 "NOV"      7297 8016 24 0 0 0 0
"RD" 12 "DEC"      8017 8760 24 0 0 0 0
"RE" 23050 1999 0.143
"RF" 1 1 .2 .2 .2 .2 1
RJA 1 1 MOD-2 WIND GENERATOR
"RJB"      0.08  60.96   6.35 12.52 20.52  60.96
"RJC" 25 25 25 25 25 25 25 25 25 25 25 25
"RJD"  18 6.349 6.35 6.7 7.15 7.6 8.05 8.5 8.94 9.39 9.84
"RJD"  10.28 10.73 11.18 11.63 12.07 12.52 20.52 20.521
"RJD" 0. .119 .261 .39 .528 .665 .812 1.016 1.203 1.395
"RJD" 1.582 1.776 1.974 2.155 2.339 2.5 2.5 0.
```

Figure 4-2. ROSEW Manually Created Input Data Hourly Option — 1 Design

```
REPRESENTATION OF SOLAR ELECTRIC--WIND          * * *  SOLAR ENERGY RESEARCH INSTITUTE  * * *          12/ 1/80
---SAMPLE PROBLEM - ALBUQUERQUE, N.M.      ---                                                          PAGE   1
********************************************************************************************************************

                                    * THY DATA - ALBUQUERQUE, N.M.
                                    * 25 MOD-2 AND 50 MOD-1 WIND TURBINES
                                    * WEIBUL PROBABILITY EXECUTION

REPRESENTATION OF SOLAR ELECTRIC--WIND          * * *  SOLAR ENERGY RESEARCH INSTITUTE  * * *          12/ 1/80
---SAMPLE PROBLEM - ALBUQUERQUE, N.M.      ---                                                          PAGE   2
********************************************************************************************************************

                    INPUT DATA
                    ----- ----

THIS RUN ENCOMPASSES

     12 TIME PERIODS    2 WGEN DESIGNS

WEIBUL OPTION - 1

GAS CONSTANTS

     DRY AIR      -    .002E70 BAR M**3/(KG K)
     WATER VAPOR  -    .004E00 BAR M**3/(KG K)

FORCED OUTAGE OPTION - 1

WEIBUL INTERVALS = 5
WEIBUL SLOTS PER INTERVAL     = 5


SITE AND PLANT PARAMETERS
---- --- ----- ----------

DATA FROM WEATHER STATION 23050

WEATHER YEAR - 1999

SITE TERRAIN FACTOR =  .1430

** MODIFICATIONS FOR GUST, ANEMOMETER READINGS, AND     SHEAR EFFECT NOT UTILIZED **
```

Figure 4-3. ROSEW Printed Output

```
REPRESENTATION OF SOLAR ELECTRIC--WIND          * * *  SOLAR ENERGY RESEARCH INSTITUTE  * * *          12/ 1/80
---SAMPLE PROBLEM - ALBUQUERQUE, N.M.      ---                                                          PAGE   3
**********************************************************************************************************************

PLANT DESIGN  1 - MOD-2 WIND GENERATOR

THIS DESIGN USES AN INPUT TABLE OF VELOCITY VS. POWER  FOR ITS CALCULATIONS

FORCED OUTAGE RATE -          .080
CUT IN VELOCITY (M/S) -      6.355
RATED VELOCITY (M/S)  -     12.520
CUT OUT VELOCITY (M/S)-     20.520

RECORDER HEIGHT WIND SPEED TABLE IS BASED ON - 60.960 M

NUMBER OF WIND MACHINES OF THIS DESIGN FOR EACH TIME PERIOD:
   25    25    25    25    25    25    25    25    25    25
   25    25

POWER OUTPUT            TABLE

    WIND VELOCITY          6.355     6.700     7.150     7.600     8.050     8.500     8.900     9.400     9.840    10.300
                          10.700    11.200    11.600    12.100    12.500    20.500

    POWER OUTPUT            .119      .261      .390      .528      .665      .812     1.016     1.203     1.395     1.582
                           1.775     1.974     2.155     2.339     2.500     2.500
```

Figure 4-3. ROSEW Printed Output (Continued)

```
REPRESENTATION OF SOLAR ELECTRIC--WIND          * * *  SOLAR ENERGY RESEARCH INSTITUTE  * * *          12/ 1/80
---SAMPLE PROBLEM - ALBUQUERQUE, N.M.  ---                                                          PAGE   4
**********************************************************************************************************

PLANT DESIGN  2 - MOD-1 WIND GENERATOR

DIAMETER OF ROTOR (M)              60.000     CUT IN VELOCITY (M/S)              7.000
FORCED OUTAGE RATE                   .100     RATED VELOCITY (M/S)              15.000
HUB HEIGHT (M)                     40.000     CUT-OUT VELOCITY (M/S)            20.000
RPM OF ROTORS                      35.000
NUMBER OF WIND MACHINES OF THIS DESIGN FOR EACH TIME PERIOD:
   50    50    50    50    50    50    50    50    50    50
   50    50

GEAR BOX EFFICIENCY      TABLE

    POWER TO GEAR BOX  (MW)     0.000     .884     .117     .151     .201     .302     .436     .620     .824    1.038
                                1.390    1.675

    GEAR BOX EFFICIENCY         0.000     .456     .565     .639     .713     .787     .849     .893     .918     .935
                                 .951     .960

GENERATOR EFFICIENCY     TABLE

    POWER TO GENERATOR  (MW)    0.000     .054     .096     .113     .161     .257     .434     .563     .965    1.318
                                1.608

    GENERATOR EFFICIENCY        0.000     .571     .717     .785     .838     .885     .920     .930     .945     .948
                                 .947

TRANSFORMER EFFICIENCY   TABLE

    POWER TO TRANSFORMER(MW)    0.000     .062     .092     .108     .153     .245     .413     .536     .914    1.249
                                1.523

    TRANSFORMER EFFICIENCY      0.000     .985     .975     .975     .980     .980     .980     .930     .985     .985
                                 .985

AERODYNAMIC EFFICIENCY   TABLE

    TIP SPEED RATIO             0.000    1.000    4.000    6.000    8.000    9.000   10.000   12.000   14.000   16.000
                               18.000   20.000

    AERODYNAMIC EFFICIENCY      .019     .020     .133     .324     .424     .448     .455     .440     .397     .320
                                 .210    0.000

DESIGN- 1 MON- 1 HR- 1 HOURLY CF- .0657
DESIGN- 2 MON- 1 HR- 1 HOURLY CF- .0252
DESIGN- 1 MON- 1 HR- 2 HOURLY CF- .0567
DESIGN- 2 MON- 1 HR- 2 HOURLY CF- .0177
DESIGN- 1 MON- 1 HR- 3 HOURLY CF- .0436
DESIGN- 2 MON- 1 HR- 3 HOURLY CF- .0143
DESIGN- 1 MON- 1 HR- 4 HOURLY CF- .0306
DESIGN- 2 MON- 1 HR- 4 HOURLY CF- .0111
DESIGN- 1 MON- 1 HR- 5 HOURLY CF- .0251
DESIGN- 2 MON- 1 HR- 5 HOURLY CF- .0056
DESIGN- 1 MON- 1 HR- 6 HOURLY CF- .0098
DESIGN- 2 MON- 1 HR- 6 HOURLY CF- .0010
DESIGN- 1 MON- 1 HR- 7 HOURLY CF- .0304
DESIGN- 2 MON- 1 HR- 7 HOURLY CF- .0110
DESIGN- 1 MON- 1 HR- 8 HOURLY CF- .0202
DESIGN- 2 MON- 1 HR- 8 HOURLY CF- .0098
```

Figure 4-3. ROSEW Printed Output (Concluded)

```
PP 23050 1999 1999 TMY ALBUQUERQUE          4 100 40.0  5  5 0 0 1 2
C    MOD-2 WIND GENERATOR
C    MOD-1 WIND GENERATOR
 1 1 1          .8220      62.5000          .0043
 1        9.9039          .0564
 2       18.1497          .0572
 3       30.2638          .0351
 4       43.4551          .0175
 5       56.0463          .0075
 2 1 1          .8750      89.4320          .0003
 1        9.6198          .0723
 2       21.6469          .0349
 3       38.0196          .0127
 4       57.5897          .0038
 5       78.1249          .0010
 1 1 2          .7924      62.5000          .0023
 1        9.3322          .1114
 2       17.7940          .0563
 3       29.9958          .0241
```

```
21224          .9831      89.1009          .0000
 1        6.0564          .0169
 2       18.4731          .0000
 3       33.1265          .0000
 4       51.3888          .0000
 5       70.9209          .0000
```

Figure 4-4. ROSEW Output File — Weibull

```
HR 23050 1999 1999  ALBUQUERQUE,N.M.     4                    1 1    1
C    MOD-2 WIND GENERATOR
 1 1991   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0 0    0.0   0.0   0.0   0.0
 1 1992   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0    0.0   0.0   0.0   0.0
 1 2991   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0 0    0.0   0.0   0.0   0.0
 1 2992   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0 0    0.0   0.0   0.0   0.0
 1 3991   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0    0.0    .3    .3   0.0
 1 3992   1 HR ENGY     0.0   0.0   0.0   0.0    .5   1.3   2.3   2 5    2.5   2.5   2.5   2.5
 1 4991   1 HR ENGY     2.5   1.8   2.1   2.3   2.1   0.0   0.0   0.0    0.0   0.0   0.0   2.1
 1 4992   1 HR ENGY     2.1   2.1   2.1   1.8   2.1   2.5   2.1   1.8    1.6   1.8   2.5   2.1
 1 5991   1 HR ENGY     2.5   2.5   2.3   1.6   0.0   0.0   0.0   0.0    0.0   0.0   0.0   0.0
 1 5992   1 HR ENGY     0.0   0.0   1.8   2.1   1.8   1.6   0.0    .3    .7   0.0   0.0   0.0
 1 6991   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0    0.0    .3    .7    .7
 1 6992   1 HR ENGY      .5   0.0   0.0   0.0    .5    .3    .3   0.0    0.0   0.0   0.0   0.0

1230992   1 HR ENGY     0.0   0.0    .5    .5    .3    .3    .5   0.0    .3    .3   0.0   0.0
1231991   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0    0.0   0.0   0.0   0.0
1231992   1 HR ENGY     0.0   0.0   0.0   0.0   0.0   0.0   0.0    .5    0.0   0.0   0.0   0.0
```

Figure 4-5. ROSEW Output File — Hourly

```
T3 23050 1999 1999  ALBUQUERQUE,N.M.     4                  1 1   1
C   MOD-2 WIND GENERATOR
 1   991  1  T1    5    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0

 1   992  1  T1    5    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0

 1   991  1  T2   21     .1   .1   .0   .0   .0  0.0  0.0  0.0   .0   .1   .1   .1

 1   992  1  T2   21     .2   .3   .6   .6   .2   .2   .2   .2   .1   .1   .1   .1

 1   991  1  T3    5    1.5  1.4  1.1  1.0   .6   .9   .7   .8  1.0  1.4  1.6  1.8

 1   992  1  T3    5    2.1  2.3  2.3  1.9  1.9  2.1  2.1  2.1  1.9  1.8  1.9  1.8

 2   991  1  T1    5    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0

 2   992  1  T1    5    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0

 2   991  1  T2   18     .1   .1   .1  0.0   .2   .1   .1   .1   .0   .2   .4   .5

 2   991  1  T2   18     .1   .1   .1  0.0   .2   .1   .1   .1   .0   .2   .4   .5

 2   992  1  T2   18     .5   .7   .8  1.2   .9   .7   .8   .4   .3   .4   .1   .0

 2   991  1  T3    5    1.3  1.0  2.1  1.7  2.2  1.3  1.4  2.0  2.0  2.3  2.5  2.5
      ↕                                                         ↕

12   992  1  T3    5    1.8  1.6  2.5  2.3  2.0  1.9  1.7  1.2  1.6  1.0   .8  1.6
```

Figure 4-6. ROSEW Output File — 3 Typical Days

```
SUBSG,T50.
REQUEST,ROSEWX,*PF.
FILE,TAPE7,RT=Z.
FILE,TAPE5,FL=80.
FILE,TAPE16,FL=80.
COMMENT. FILE,TAPE10,FL=80.
ATTACH,ROSEWX,ID=UID.
GETPF,TAPE5,ROSDAT,ID=UID.
GETPF,TAPE16,WTHRDAT,ID=UID.
COMMENT. TAPE16-WEIBULL,  TAPE10-CORELATE FROM WTP
COMMENT.GETPF,TAPE10,WTHRDAT,ID=UID.
COMMENT. PURGE,ROSEWX,ID=UID.
COMMENT. REQUEST,ROSEWX,*PF.
COMMENT. FILE,ROSEW,FL=80.
COMMENT.GETPF,ROSEW,ID=UID.
COMMENT. FTN,I=ROSEW,B=ROSEWX,R=0,L=0,ER.
COMMENT. CATALOG,ROSEWX,ID=UID.
ROSEWX.
REWIND,TAPE6.
COPY,TAPE6,OUTPUT.
REWIND,TAPE7.
SAVEPF,TAPE7,SAVEF,ID=UID.
EXIT.
```

Figure 4-7. ROSEW Sample Runstream

SECTION 5.0

ULMOD - UTILITY-LOAD MODIFICATION

The purpose of ULMOD is to subtract the estimated electrical output of alternative generation sources, such as WECS, from forecasted utility loads and to model the variability in utility load forecasting. Refer to Vol. I, Sec. 6.0 for a description of the specific calculations performed in ULMOD.

5.1 FACILITY SPECIFICS

ULMOD utilizes the CDC Sort/Merge package for the development of all load duration curves. The necessary CDC calls are contained in the subroutine CDCSRT. Any other sort routine could be utilized by the replacement of CDCSRT. The comments within CDCSRT should assist making the substitution.

ULMOD uses a LEVEL 2 statement within several of the routines. This command designates that specific data are to reside in the large central memory of a CDC 7600 computer. For use on other computers, delete all the LEVEL 2 commands and the preceding comment cards. Also, CDC equipment requires a PROGRAM card before the main routine. If you are not using CDC hardware, this card may not be needed.

Like most of the other routines, ULMOD uses a free format or list-directed input data. Most versions of FORTRAN have an equivalent input capability. The CDC version uses an * in place of a format number in the READ command. This means that the data do not have to reside in specific fields on the cards but that each value needs to be separated by only a space or comma. Each free formatted data card type is usually preceded by a single, user-provided comment card that has no operational effect. Its purpose is to assist the user in making modifications to a data set.

5.2 ULMOD INPUT DATA

Figure 5-1 is a listing of a sample set of manually created card type data required by ULMOD.

5.2.1 Title (Card Type A)

FORMAT (20A4)

The title of this ULMOD execution has a maximum of 80 characters. This card is always required.

5.2.2 Options (Card Type B)

FORMAT (FREE)

Must be preceded by a comment card.

IULFG -- Flag on what amount of hourly utility loads is to be input:
1 = A typical week per month
2 = A whole month
Note: Utility loads should be in local Standard Time and not shifted for Daylight Savings Time.

ISOLFG -- Flag what type of alternative generation is to be input:
0 = None
1 = Power-probability sets for a monthly typical day
2 = A whole month of hourly values
3 = A typical day per month
4 = 2 typical days per month
5 = 3 typical days per month

IVARFG -- Flag whether to incorporate the variability in utility-load forecasting:
< 0 = Do not consider variability
> 1 = Consider variability

NSECTM -- Number of large sections to divide the final monthly load duration curves into. A legal value less than or equal to 15 must be entered.

NSECTA -- Number of large sections to divide the final annual load duration curves into. A legal value less than or equal to 15 must be entered.

IDESGN -- Specific alternative generation design to be used in this execution;
Must be consistent with ROSEW design numbering

5.2.3 Print Flags 1-6 (Card Type C)

FORMAT (FREE)

These flags, which must be preceded by a comment card, indicate whether or not the specified input data or results are to be printed:

Print if > 1
Do not print if < 0

IP1 -- Input utility loads

IP2 -- Input alternative generation

IP3 -- Resulting residual loads; probabilities if appropriate

IP4 -- Load duration curve of residuals; probabilities if appropriate

IP5 -- Sectionalized LDC; both monthly and annual

IP6 -- Annual LDC

5.2.4 Print Flags 7-10 (Card Type D)

FORMAT (FREE)

These flags, which must be preceded by a comment card, indicate whether or not the specified input data or results are to be printed:

Print if > 1
Do not print if < 0

IP7 -- Expected value of chronological loads

IP8 -- Load duration curve made from these expected values

IP9 -- Accumulated load duration curve made from the power-probability data

IP10 -- Estimated chronological loads made from the accumulated load duration curve

5.2.5 File Output Flags 1-6 (Card Type E)

FORMAT (FREE)

These flags, which must be preceded by a comment card, indicate whether or not the specified input data or results are to be sent to a computer data file (TAPE11) for possible use by other routines such as utility expansion or production cost models:

Write if flag > 1
Do not write if flag < 0

I01 -- Input utility loads

I02 -- Input alternative generation

I03 -- Resulting residual loads; probabilities if appropriate

I04 -- Load duration curve of the residuals; probabilities if appropriate

I05 -- Sectionalized load duration curve; both monthly and annual

I06 -- Annual LDC

5.2.6 File Output Flags 7-10 (Card Type F)

FORMAT (FREE)

These flags, which must be preceded by a comment card, indicate whether or not the specified input data or results are to be sent to a computer data file (TAPE11) for possible use by other routines such as utility expansion or production cost models:

Write if flag > 1
Do not write if flag < 0

I07 -- Expected-value chronological loads

I08 -- LDC made from these expected values

I09 -- Accumulated LDC made from the power-probability data

I010 -- Estimated chronological loads made from the accumulated LDC

5.2.7 Monthly Sectionalized LDC (Card Type G)

FORMAT (FREE)

One comment card must precede this group of data cards. One data card is required for each LDC section indicated by NSECTM on the type B card. If sectioning is not desired (both IP5 and I05 < 0), do not provide any type G cards or the preceding comment card.

PSECM(I) -- Percentage of the monthly load duration curve that Section I will cover; I=1,NSECTM;
Assumes data are provided from top of LDC down. If the sum of all PSECM does not equal 100, a message will be printed and all PSECM will be scaled as needed to yield 100.

NPIECM(I) -- The number of smaller and equally spaced segments this section will be divided into

5.2.8 Annual Sectionalized LDC (Card Type H)

FORMAT (FREE)

One comment card must precede this group of cards. One data card is required for each LDC section indicated by NSECTA on the type B card. If sectioning is not desired (both IP5 and I05 < 0), do not provide any type H cards or the preceding comment card.

PSECA(I) -- Percentage of the monthly load duration curve that Section I will cover; I=1,NSECTA;
Assumes data are provided from top of LDC. If the sum of all PSECA does not equal 100, a message will be printed and all PSECA will be scaled as needed to yield 100.

NPIECA(I) -- The number of smaller and equally spaced segments this section will be divided into

5.2.9 Load Forecast Uncertainty Data (Card Type I)

One comment card must precede this group of data cards. Two or three data cards (I1,I2,I3) are required as a group for each month (I=1,12). If no uncertainty analysis is desired (IVARFG < 0 on the type B card), then no type I cards or the preceding comment should be provided. If the desired uncertainty analysis is to apply the same uncertainty to all portions of the LDC, then only card types I1 and I2 may be provided by the user. If the

uncertainty is to be different for the upper and lower portions of the LDC, then a group of I1, I2, and I3 cards is required for each month. If uncertainty is being investigated, either flags I09,I010,IP9, or IP10 should be activated in order to get results.

I1. Month, Split Top to Bottom, and Taper Option

FORMAT (FREE)

Required for all months

IMO -- Current input data month

VARTOP(I,1) -- Percent of time for Month I that uncertainty will be applied to the top of the load duration

IVARTF(I) -- A flag on whether the MW modification amounts are to be applied to all parts of the LDC ("F") or taper from the input maximums to near zero ("T"). Flag "N" indicates uncertainty analysis not desired this month.

NT -- Desired number of uncertainty intervals for top portion of LDC (< 5)

NB -- Desired number of uncertainty intervals for bottom portion of LDC (< 5)

I2. Top of LDC Uncertainty

FORMAT (FREE)

VARTOP(I,2) -- MW variation from the forecast mean points for the first uncertainty interval applied to top portion of LDC. Positive value for increase above mean points, negative value for below mean points

VARTOP(I,3) -- Probability, represented as a percent, of actual load occurring within the first interval

VARTOP(I,J) -- Same descriptions as J = 2 and 3 for the second, third, fourth, and, fifth intervals (up to NT); J = 4 to 11 in pairs. May input zero MW variation and/or probability for any interval

I3. Bottom of LDC Uncertainty

FORMAT (FREE)

Card type I3 must not be given for any month where VARTOP(I,1) is greater than or equal to 100. I3 cards immediately follow I2 cards.

VARBOT(I,1) -- Percent of time for month I that uncertainty will be applied to the bottom of the load duration curve.

VARBOT(I,2) -- MW variation from the forecast mean points for the first uncertainty interval applied to the bottom portion of LDC. Positive value for increase above mean points, negative value for below mean points

VARBOT(I,3) -- Probability, represented as a percent, of actual load occurring within the first interval

VARBOT(I,J) -- Same descriptions as J = 2 and 3 for the second, third, fourth, and fifth intervals (up to NB); J = 4 to 11 in pairs. May input zero MW variation and/or probability for any interval

5.3 DATA FILE INPUTS

5.3.1 Intermittent Generation

These program-created data will be read from "TAPE9" or unit number 9. A complete description of this file for wind generation is provided in Sec. 4.0 under the ROSEW output file subheading.

5.3.2 Utility Load Data

These data will be read from "TAPE10" or unit number 10. Note that all utility-load data should be in accordance with local Standard Time and not shifted for Daylight Savings Time.

FORMAT (3I2,I1,13X,12I5)

Each column includes:

Column	Variable
1-2	Month (e.g., November = 11)
3-4	Day of month
5-6	Year (e.g., 1977 = 77)
7	Sequence--one for hours 1 through 12; two for hours 13 through 24
8-20	Not used
21-80	Twelve hourly MW load values with 5 positions/values

Using this format, two cards are required for each day of utility loads.

There are two possible groupings of these data, and the program knows which to expect by the initial input variable IULFG (Card Type B). Both input possibilities utilize the standard EEI format for utility-load data. The difference between the two is the number of days of hourly data provided each

month. If IULFG = 1, then a typical week (seven days) of hourly loads is provided per month. If IULFG = 2, then each month will include as many days of hourly loads as exist in the month. Unlike the data read from "TAPE5," none of the utility-load data is preceded by a comment card.

5.4 PRINTED OUTPUTS

ULMOD printed outputs begin with two pages that report all the data input via cards types (Fig. 5-2). There can be up to ten additional types of printed output generated. These outputs correspond to the print flags given on input card types C and D. Since probability information is needed to perform certain calculations, not all of these outputs are available if the particular execution data do not contain power-probability, if two or three typical days of intermittent generation have been chosen, or if variability is not needed. An example of each possible output is presented in a separate figure. These are discussed briefly below and correspond to the print flags IP1 through IP10:

IP1 Figure 5-3 -- The utility-load data as echoed by ULMOD;
Always available;
Example shows 31 days, could be 7 if IULFG = 1

IP2 Figure 5-4 -- The intermittent generation data as echoed by ULMOD;
Available if ISOLFG ≠ 0;
Appropriate probability information included if needed

IP3 Figure 5-5 -- Calculated residual loads;
Available if ISOLFG ≠ 0;
Appropriate probability information included if needed

IP4 Figure 5-6 -- Load duration curve developed from the residuals;
Available if ISOLFG ≠ 0;
Probability or duration of each point is included if appropriate

IP5 Figure 5-7 -- Monthly sectionalized LDC made from the residual loads if ISOLFG = 0, 2, or 3 and variability not desired;
Made from accumulated LDC for all other conditions;
Always available

IP6 Figure 5-8 -- Annual LDC;
Made from all residual loads if ISOLFG = 0, 2, or 3 and variability not desired;
Made from accumulated whole hour points for all other conditions;
Always available

IP7 Figure 5-9 -- Expected chronological residual loads;
Available if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG

IP8 Figure 5-10 -- LDC made from the expected chronological residual loads;
Available if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG

IP9 Figure 5-11 -- Accumulated whole hour LDC made from the full power-probability data;
Available if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG

IP10 Figure 5-12-- Estimated chronological order created from the accumulated residuals;
Available if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG

5.5 DATA FILE OUTPUTS

The data file written to by ULMOD is "TAPE11" or unit 11. The first record is the input TITLE written in FORMAT (5X, 20A4). Since this file might be used as direct input to a utility model, the output file is in EEI format, where possible, but preceded by a single line title the same as those printed and shown in the previous subheading's figures. The standard EEI format is:

EEI FORMAT (3I2,I1,13X,12I5)

Each column includes:

Column	Variable
1-2	Month
3-4	Day of month
5-6	Year
7	Sequence - 1 for hours 1-12, 2 for hours 13-24
8-20	Not used
21-80	12 hourly MW values

Where EEI format is the output, this will be merely mentioned. If this is not the format, the exact format will be given. In the non-EEI format case, this output will look exactly like the printed examples already provided. These outputs will be described in the order corresponding to the output flags IO1 through IO10.

EEI FORMAT

IO1--Utility-load data

EEI FORMAT

IO2--Intermittent generation

If ISOLFG = 2 or 3, EEI FORMAT

If ISOLFG = 4 or 5, EEI FORMAT but preceded by a line containing the probability of each typical day type;
FORMAT (5X, "***** PROBABILITY OF EACH TYPICAL DAY = ",2X,3F8.4)

If ISOLFG = 1, write both powers in groups of 12 followed by corresponding probabilities;
Powers;
FORMAT (2X,"HOUR ",I2,5X,"POWERS",5X,12F8.4)
Probabilities;
FORMAT (14X,"PROBS ",5X,12F8.4)

I03--Residual loads

If ISOLFG = 2 or 3, EEI FORMAT

If ISOLFG = 1, 4 or 5, write residuals in groups of 12 followed by corresponding probabilities;
Powers;
FORMAT (1X,"DAY ",I2," HOUR ",I2," POWERS ", 12F8.1)
Probabilities;
FORMAT (15X," PROBS. ",12F8.4)

I04--Residual LDC

If ISOLFG = 2 or 3 and no variability;
FORMAT (27X,12F8.1)

If ISOLFG = 1, 4, or 5, or if variability desired, write residuals in groups of 12 followed by corresponding probabilities
Residuals;
FORMAT(12X,"POWERS",7X,12F8.1)
Probabilities;
FORMAT (17X,"PROBS.",2X,12F8.4)

I05--Segmented LDC

2 formats for each large section;

FORMAT (1X,"SECTION ",I2," = ", F7.4,"FRACTION OF TIME, PIECES = ",12F7.1)
FORMAT (1X,"EACH PIECE = ",F7.0, " HOURS LONG",T48,12F7.1)

I06--Annual LDC

If ISOLFG = 2, FORMAT (9X,"RESIDUAL LOADS",2X,12F8.1)

If ISOLFG =1, write out residuals in groups of 12 followed by corresponding duration;
Residuals;
FORMAT (1X,"ACCUMULATED RESID. LOADS",2X, 12F8.1)
Durations;
FORMAT (16X,"DURATIONS",2X,12F8.4)

I07--Expected chronological residuals

Only if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG;

EEI FORMAT

I08--Expected residuals LDC

Only if ISOLFG = 1, 4 or, 5, or if variability desired for any ISOLFG;

FORMAT (27X,12F8.1)

I09--Accumulated LDC

Only if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG;
FORMAT (27X,12F8.1)

I010--Estimated chronological of accumulated residuals

Only if ISOLFG = 1, 4, or 5, or if variability desired for any ISOLFG;
EEI FORMAT

5.6 SAMPLE CONTROL CARD SEQUENCE

A sample control card sequence necessary to run ULMOD is given as Fig. 5-13. This runstream uses the CDC-SCOPE operating system.

```
** TEST ULMOD DATA; 25 MOD2'S,  ALBQ. N.M. SOLAR DATA
IULFG,ISOLFG,IVARFG, LDC. SECTIONS- MONTHLY THEN ANNUAL,DESIGN
2 1 1 5 7 1
PRNT 1-6: LOADS,ALT GEN.,RESIDS.,LDC.,SECT LDC.,ANNUAL LDC.
0 0 0 0 1 1
PRNT 7-10: EXPECTEDS CHRON.,LDC. OF EXPECT.,ACCUM.,EST. CHRON.
0 0 0 1
KOUT 1-6: LOADS,ALT GEN.,RESIDS.,LDC.,SECT LDC.,ANNUAL LDC.
0 0 0 0 0 0
KOUT 7-10: EXPECTEDS CHRON.,LDC. OF EXPECT.,ACCUM.,EST. CHRON.
0 0 0 1
MONTHLY % OF SECTION, NUMBER OF PIECES IN THIS SECTION.
5 2
5 2
20 2
50 2
20 2
ANNUAL % OF SECTION, NUMBER OF PIECES IN THIS SECTION.
5 2
5 2
10 2
20 2
20 2
20 2
20 2
UNCERTAINTY DATA
 1 100 "F" 5 0
000.00 38.3 179.80 24.2 -179.80 24.2 378.92 6.65 -378.92 6.65
 2 100 "F" 5 0
000.00 38.3 171.78 24.2 -171.78 24.2 361.85 6.65 -361.85 6.65
 3 100 "F" 5 0
000.00 38.3 165.76 24.2 -165.76 24.2 349.16 6.65 -349.16 6.65
 4 100 "F" 5 0
000.00 38.3 163.68 24.2 -163.68 24.2 344.78 6.65 -344.78 6.65
 5 100 "F" 5 0
000.00 38.3 188.01 24.2 -188.01 24.2 396.03 6.65 -396.03 6.65
 6 100 "F" 5 0
000.00 38.3 229.00 24.2 -229.00 24.2 482.36 6.65 -482.36 6.65
 7 100 "F" 5 0
000.00 38.3 217.80 24.2 -217.80 24.2 458.77 6.65 -458.77 6.65
 8 100 "F" 5 0
000.00 38.3 216.40 24.2 -216.40 24.2 455.82 6.65 -455.82 6.65
 9 100 "F" 5 0
000.00 38.3 233.57 24.2 -233.57 24.2 491.98 6.65 -491.98 6.65
10 100 "F" 5 0
000.00 38.3 193.23 24.2 -193.23 24.2 407.01 6.65 -407.01 6.65
11 100 "F" 5 0
000.00 38.3 174.03 24.2 -174.03 24.2 366.58 6.65 -366.58 6.65
12 100 "F" 5 0
000.00 38.3 173.48 24.2 -173.48 24.2 365.42 6.65 -365.42 6.65
```

Figure 5-1. ULMOD Manually Created Input Data

```
**********************************************************************************************************************
**********  ** TEST U.MOD DATA; 25 MODELS, ALBQ, N.M. SOLAR DATA                                  **********
**********************************************************************************************************************

        DESIRED OPTIONS


    UTILITY LOADS - INPUT A WHOLE MONTH OF DATA.
    ALTERNATIVE GENERATION - INPUT POWER-PROBABILITY DATA.


    SOLAR DESIGN NUMBER 1 TO BE USED.


    OPTIONS ON PRINTING AND OUTPUT TO TAPE11
                                PRINT    TAPE11
    LOADS                         1         0
    ALT. GENERATION.              1         0
    RESIDUALS                     1         0
    RESIDUALS L.D.C.              1         0
    SECTIONALIZED L.D.C.          1         0
    ANNUAL L.D.C.                 1         0
    EXPECTED CHRONOLOGICAL        1         0
    EXPECTED L.D.C.               1         0
    ACCUMULATED PO.ER-PROBS.      1         0
    ESTIMATED CHRONOLOGICAL       1         1
```

Figure 5-2. ULMOD Echo of Input Data

```
**********************************************************************************************************************************
********************** ** TEST ULMOD DATA; 25 MOD2*S, ALBQ. N.M. SOLAR DATA ***********************
**********************************************************************************************************************************

 MONTHLY L.O.C.'S WILL BE DIVIDED INTO  5 LARGE SECTIONS.

 * SECTION * FRACTION OF TIME * SMALLER PIECES *
 *    1    *        .0500     *         2       *
 *    2    *        .0500     *         2       *
 *    3    *        .2000     *         2       *
 *    4    *        .5000     *         2       *
 *    5    *        .2000     *         2       *


 ANNUAL L.O.C.'S WILL BE DIVIDED INTO  7 LARGE SECTIONS.

 * SECTION * FRACTION OF TIME * SMALLER PIECES *
 *    1    *        .0500     *         2       *
 *    2    *        .0500     *         2       *
 *    3    *        .1000     *         2       *
 *    4    *        .2000     *         2       *
 *    5    *        .2000     *         2       *
 *    6    *        .2000     *         2       *
 *    7    *        .2000     *         2       *


                                        UNCERTAINTY IN UTILITY LOADS IS DESIRED.

MONTH * T OR 3 * % OF TIME *    MW      %   **    MW      %   **    MW      %   **    MW      %   **    MW      %   **TAPER**
  1   *   TOP  *   100.00  *    0.0   38.30 **  179.8   24.20 ** -179.8   24.20 **  378.9   6.65 ** -378.9   6.65 **  F  **
  2   *   TOP  *   100.00  *    0.0   38.30 **  171.8   24.20 ** -171.8   24.20 **  361.9   6.65 ** -361.9   6.65 **  F  **
  3   *   TOP  *   100.00  *    0.0   38.30 **  165.8   24.20 ** -165.8   24.20 **  349.2   6.65 ** -349.2   6.65 **  F  **
  4   *   TOP  *   100.00  *    0.0   38.30 **  163.7   24.20 ** -163.7   24.20 **  344.8   6.65 ** -344.8   6.65 **  F  **
  5   *   TOP  *   100.00  *    0.0   38.30 **  188.0   24.20 ** -188.0   24.20 **  396.0   6.65 ** -396.0   6.65 **  F  **
  6   *   TOP  *   100.00  *    0.0   38.30 **  229.0   24.20 ** -229.0   24.20 **  482.4   6.65 ** -482.4   6.65 **  F  **
  7   *   TOP  *   100.00  *    0.0   38.30 **  217.8   24.20 ** -217.8   24.20 **  458.8   6.65 ** -458.8   6.65 **  F  **
  8   *   TOP  *   100.00  *    0.0   38.30 **  216.4   24.20 ** -216.4   24.20 **  455.8   6.65 ** -455.8   6.65 **  F  **
  9   *   TOP  *   100.00  *    0.0   38.30 **  233.6   24.20 ** -233.6   24.20 **  492.0   6.65 ** -492.0   6.65 **  F  **
 10   *   TOP  *   100.00  *    0.0   38.30 **  193.2   24.20 ** -193.2   24.20 **  407.0   6.65 ** -407.0   6.65 **  F  **
 11   *   TOP  *   100.00  *    0.0   38.30 **  174.0   24.20 ** -174.0   24.20 **  366.6   6.65 ** -366.6   6.65 **  F  **
 12   *   TOP  *   100.00  *    0.0   38.30 **  173.5   24.20 ** -173.5   24.20 **  365.4   6.65 ** -365.4   6.65 **  F  **
```

Figure 5-2. ULMOD Echo of Input Data (Concluded)

***** FOR THE MONTH 1 INPUT HOURLY UTILITY LOADS.

DAY 1	5697.	5439.	5252.	5151.	5167.	5248.	5224.	5554.	5775.	5907.	5966.	5933.
	5884.	5764.	5687.	5819.	6603.	7250.	7227.	7092.	6940.	6603.	5876.	5414.
DAY 2	5302.	5224.	5199.	5274.	5483.	6327.	7352.	8145.	9081.	8520.	8227.	8315.
	8276.	8189.	8227.	8211.	8775.	9328.	9095.	8793.	8472.	7529.	6923.	6120.
DAY 3	5814.	5629.	5600.	5586.	5624.	6426.	7575.	8341.	8649.	8606.	8458.	8316.
	8288.	8202.	8157.	7984.	8502.	9205.	8975.	8743.	8419.	7698.	6989.	6163.
DAY 4	5842.	5637.	5594.	5568.	5818.	6447.	7519.	8226.	8470.	8472.	8449.	8226.
	8210.	8181.	8087.	7979.	8757.	9111.	8994.	8666.	8281.	7543.	6856.	6170.
DAY 5	5770.	5608.	5550.	5519.	5791.	6489.	7532.	8404.	8673.	8772.	8792.	8657.
	8668.	8600.	8519.	8499.	8936.	9208.	8931.	8561.	8165.	7498.	6966.	6305.
DAY 6	5586.	5561.	5424.	5385.	5416.	5685.	5947.	6532.	6869.	7176.	7129.	7042.
	6910.	6789.	6658.	6695.	7511.	7938.	7766.	7521.	7128.	6793.	6212.	5658.
DAY 7	5367.	5122.	5055.	5004.	5015.	5103.	5189.	5590.	5974.	6352.	6413.	6439.
	6343.	6311.	6195.	6323.	6935.	7598.	7468.	7257.	6997.	6526.	5918.	5465.
DAY 8	5309.	5174.	5226.	5220.	5501.	6166.	7202.	8053.	8387.	8440.	8380.	8203.
	8207.	8176.	8181.	8189.	8731.	9225.	9099.	8788.	8337.	7582.	6886.	6254.
DAY 9	5803.	5609.	5457.	5368.	5614.	6282.	7272.	8130.	8339.	8499.	8663.	8176.
	8155.	8121.	8051.	7904.	8376.	9045.	8951.	8674.	8258.	7506.	6758.	6062.
DAY 10	5729.	5548.	5454.	5472.	5739.	6393.	7339.	8139.	8331.	8429.	8344.	8131.
	8176.	8058.	8047.	7873.	8335.	9162.	8939.	8590.	8208.	7516.	6725.	6047.
DAY 11	5660.	5569.	5480.	5478.	5667.	6385.	7318.	8133.	8357.	8352.	8376.	8180.
	8230.	8182.	8073.	7865.	8344.	9059.	8832.	8557.	8176.	7398.	6635.	5956.
DAY 12	5726.	5515.	5428.	5422.	5615.	6130.	7306.	7866.	8344.	8441.	8421.	8171.
	8202.	8092.	7944.	7773.	8030.	8740.	8621.	8291.	7909.	7349.	6758.	6085.
DAY 13	5605.	5407.	5367.	5302.	5419.	5561.	5875.	6505.	6898.	7142.	7026.	6877.
	6685.	6648.	6596.	6578.	7306.	7797.	7597.	7328.	7023.	6535.	6126.	5580.
DAY 14	5277.	5079.	4963.	4922.	4898.	5043.	5142.	5539.	5997.	6230.	6372.	6487.
	6617.	6672.	6670.	6827.	7353.	7694.	7611.	7378.	7046.	6603.	6009.	5468.
DAY 15	5323.	5226.	5130.	5201.	5421.	6131.	7342.	8189.	8503.	8744.	8985.	8669.
	8693.	8705.	8694.	8606.	8998.	9385.	9062.	8829.	8395.	7573.	6824.	6062.
DAY 16	5724.	5557.	5455.	5454.	5644.	6266.	7470.	8257.	8517.	8470.	8302.	8211.
	8244.	8435.	8298.	8159.	8635.	9189.	8952.	8630.	8279.	7516.	6790.	6127.
DAY 17	5755.	5534.	5413.	5402.	5554.	6270.	7408.	8116.	8362.	8392.	8350.	8080.
	8103.	8079.	8019.	7894.	8232.	9068.	8908.	8633.	8233.	7586.	6710.	5995.
DAY 18	5627.	5504.	5423.	5425.	5580.	6243.	7381.	8096.	8425.	8476.	8469.	8354.
	8442.	8364.	8221.	8154.	8429.	9254.	9135.	8855.	8426.	7707.	6912.	6245.
DAY 19	5956.	5769.	5639.	5700.	5901.	6563.	7679.	8338.	8459.	8505.	8327.	8138.
	8129.	8074.	7922.	7663.	7984.	8860.	8704.	8420.	8082.	7534.	6893.	6132.
DAY 20	5797.	5585.	5518.	5428.	5528.	5807.	6047.	6535.	6955.	7076.	7023.	6913.
	6743.	5550.	6474.	6495.	7088.	7867.	7703.	7438.	7033.	6649.	6140.	5615.
DAY 21	5289.	5093.	4987.	4943.	4914.	5027.	5156.	5602.	6065.	6303.	6356.	6358.
	6257.	6090.	6112.	6206.	6735.	7484.	7340.	7228.	6878.	6413.	5931.	5428.
DAY 22	5152.	5097.	5100.	5144.	5354.	6131.	7217.	8030.	8330.	8367.	8335.	8071.
	8182.	8182.	8023.	7949.	8355.	9051.	8830.	8609.	8179.	7408.	6711.	6009.
DAY 23	5650.	5494.	5412.	5430.	5686.	6393.	7425.	8146.	8403.	8422.	8306.	8051.
	8062.	8054.	7941.	7828.	8265.	9033.	8959.	8602.	8190.	7409.	6623.	5980.
DAY 24	5568.	5403.	5323.	5347.	5589.	6210.	7401.	8141.	8426.	8502.	8452.	8209.
	8241.	8186.	8016.	7953.	8225.	9073.	8913.	8601.	8192.	7462.	6712.	6039.
DAY 25	5657.	5476.	5451.	5464.	5670.	6342.	7490.	9264.	8493.	8526.	8466.	8322.
	8284.	8225.	8129.	8079.	9338.	9274.	9130.	9865.	8473.	7717.	6891.	6246.
DAY 26	5892.	5755.	5710.	5760.	6008.	6706.	7787.	8461.	8585.	8498.	8547.	8265.
	8225.	8145.	7983.	7717.	7969.	8927.	8789.	8336.	8242.	7603.	7020.	6305.
DAY 27	5957.	5781.	5662.	5657.	5737.	6001.	6360.	6828.	7134.	7198.	7142.	6903.
	6717.	6541.	6426.	6393.	6815.	7854.	7668.	7326.	7140.	6714.	6234.	5702.
DAY 28	5381.	5256.	5118.	5148.	5155.	5262.	5384.	5850.	6173.	6421.	6383.	6441.
	6426.	6340.	6463.	6621.	7000.	7819.	7792.	7679.	7445.	6928.	6363.	5768.
DAY 29	5624.	5555.	5559.	5638.	5886.	6668.	7824.	8594.	8753.	8760.	8646.	8310.
	8315.	8177.	8047.	7916.	8318.	9180.	9069.	8945.	8552.	7981.	7108.	6356.
DAY 30	6017.	5855.	5713.	5731.	5921.	6630.	7783.	8577.	8817.	8931.	8876.	8772.
	8901.	8951.	8912.	8880.	9253.	9766.	9540.	9166.	8714.	7940.	7089.	6387.
DAY 31	6125.	5851.	5776.	5717.	5904.	6555.	7622.	8359.	8617.	8573.	8678.	8465.
	8524.	8608.	8659.	8579.	8717.	9336.	9188.	8856.	8428.	7691.	6907.	6209.

Figure 5-3. ULMOD Echo of Provided Load Data

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     ***** FOR MONTH  1      INPUT TYPICAL DAY OF HOURLY ALTERNATIVE GENERATION POWER-PROBABILITY DATA.
HOUR  1      POWERS      0.0000 18.1497 30.2638 43.4551 56.0463 62.5000  9.9039
             PROBS.       .8220   .0572   .0351   .0175   .0075   .0043   .0564
HOUR  2      POWERS      0.0000 17.7940 29.9958 43.2881 56.0049 62.5000  9.3322
             PROBS.       .7924   .0563   .0241   .0097   .0038   .0023   .1114
HOUR  3      POWERS      0.0000 17.8816 30.0265 43.2750 55.9938 62.5000  9.5316
             PROBS.       .8516   .0443   .0205   .0084   .0032   .0017   .0703
HOUR  4      POWERS      0.0000 18.0828 30.1616 43.3322 55.9476 62.5000  9.8630
             PROBS.       .9109   .0295   .0165   .0074   .0029   .0016   .0314
HOUR  5      POWERS      0.0000 17.4694 29.6037 42.7659 55.6013 62.5000  9.1285
             PROBS.       .8815   .0277   .0077   .0020   .0005   .0001   .0805
HOUR  6      POWERS      0.0000 15.8544 26.9237 51.1034 62.5000 62.5000  9.4205
             PROBS.       .9407   .0085   .0001   0.0000  0.0000  0.0000  .0507
HOUR  7      POWERS      0.0000 18.1071 30.1252 43.2345 55.8376 62.5000  9.9598
             PROBS.       .9109   .0309   .0173   .0074   .0026   .0010   .0299
HOUR  8      POWERS      0.0000 17.9349 30.4468 43.9570 56.5856 62.5000  8.5307
             PROBS.       .9446   .0087   .0051   .0034   .0024   .0067   .0291
HOUR  9      POWERS      0.0000 18.6454 30.7367 43.8014 56.1814 62.5000 10.4938
             PROBS.       .9404   .0153   .0160   .0115   .0062   .0037   .0067
HOUR 10      POWERS      0.0000 18.6410 30.6990 43.8621 55.6480 62.5000  9.9467
             PROBS.       .9109   .0319   .0162   .0060   .0018   .0006   .0326
HOUR 11      POWERS      0.0000 17.9708 30.0286 43.1846 55.8416 62.5000  9.7598
             PROBS.       .8517   .0492   .0241   .0095   .0032   .0013   .0610
HOUR 12      POWERS      0.0000 17.7172 29.8180 42.9848 55.7340 62.5000  9.4440
             PROBS.       .7626   .0491   .0256   .0082   .0024   .0009   .1312
HOUR 13      POWERS      0.0000 18.1357 30.4126 43.7462 56.3415 62.5000  9.6517
             PROBS.       .8220   .0477   .0311   .0187   .0107   .0121   .0577
HOUR 14      POWERS      0.0000 19.4391 30.7656 41.9856 53.4260 62.5000 11.3084
             PROBS.       .7924   .0565   .1039   .0398   .0019   0.0000  .0055
HOUR 15      POWERS      0.0000 18.4456 30.7197 43.9883 56.4668 62.5000 10.1461
             PROBS.       .7331   .0605   .0561   .0431   .0292   .0382   .0398
HOUR 16      POWERS      0.0000 18.4240 30.6230 43.8472 56.3381 62.5000 10.1508
             PROBS.       .6439   .0929   .0802   .0555   .0331   .0316   .0628
HOUR 17      POWERS      0.0000 18.0062 29.6467 42.2574 54.8685 62.5000 10.2174
             PROBS.       .5845   .1768   .0733   .0160   .0020   .0002   .1472
HOUR 18      POWERS      0.0000 17.8290 29.9700 43.2010 55.9088 62.5000  9.4877
             PROBS.       .7033   .0875   .0379   .0145   .0052   .0025   .1491
HOUR 19      POWERS      0.0000 18.0602 30.2726 43.5633 56.1873 62.5000  9.6532
             PROBS.       .7627   .0693   .0403   .0210   .0102   .0082   .0883
HOUR 20      POWERS      0.0000 18.3850 30.5004 43.6497 56.1483 62.5000 10.1868
             PROBS.       .7625   .0712   .0566   .0341   .0169   .0108   .0479
HOUR 21      POWERS      0.0000 18.0821 30.3148 43.6193 56.2350 62.5000  9.6507
             PROBS.       .7330   .0762   .0459   .0250   .0127   .0113   .0959
HOUR 22      POWERS      0.0000 18.3651 30.3484 43.3652 55.8551 62.5000 10.2757
             PROBS.       .8220   .0609   .0447   .0224   .0083   .0031   .0386
HOUR 23      POWERS      0.0000 19.2665 31.3802 44.2704 56.2911 62.5000 11.0644
             PROBS.       .8814   .0140   .0298   .0352   .0248   .0126   .0022
HOUR 24      POWERS      0.0000 18.6830 30.8118 43.9103 56.2819 62.5000 10.5093
             PROBS.       .8517   .0347   .0385   .0299   .0178   .0129   .0145
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Figure 5-4. ULMOD Echo of Intermittent Generation Data Provided from ROSEW

***** FOR MONTH 1 RESIDUAL LOADS AND PROBABILITIES.

DAY	1	HOUR	1	POWERS	5697.0	5687.1	5678.9	5666.7	5653.5	5641.0	5634.5
				PROBS.	.8220	.0564	.0572	.0351	.0175	.0075	.0043
DAY	1	HOUR	2	POWERS	5439.0	5429.7	5421.2	5409.0	5395.7	5383.0	5376.5
				PROBS.	.7924	.1114	.0563	.0241	.0097	.0038	.0023
DAY	1	HOUR	3	POWERS	5252.0	5242.5	5234.1	5222.0	5208.7	5196.0	5189.5
				PROBS.	.8516	.0703	.0443	.0205	.0084	.0032	.0017
DAY	1	HOUR	4	POWERS	5151.0	5141.1	5132.9	5120.8	5107.7	5095.1	5088.5
				PROBS.	.9109	.0314	.0295	.0165	.0074	.0029	.0014
DAY	1	HOUR	5	POWERS	5167.0	5157.9	5149.5	5137.4	5124.2	5111.4	5104.5
				PROBS.	.8815	.0805	.0277	.0077	.0020	.0005	.0001
DAY	1	HOUR	6	POWERS	5248.0	5238.6	5232.1	5221.1	5196.9	5185.5	5185.5
				PROBS.	.9407	.0507	.0085	.0001	0.0000	0.0000	0.0000
DAY	1	HOUR	7	POWERS	5224.0	5214.0	5205.9	5193.9	5180.8	5168.2	5161.5
				PROBS.	.9109	.0299	.0309	.0173	.0074	.0026	.0010
DAY	1	HOUR	8	POWERS	5554.0	5545.5	5536.1	5523.6	5510.0	5497.4	5491.5
				PROBS.	.9446	.0291	.0087	.0051	.0034	.0024	.0067
DAY	1	HOUR	9	POWERS	5[illegible]	[illegible]	[illegible]	[illegible]	5731.2	5718.8	5712.5
				PROBS.	.9406	.0067	.0153	.0160	.0115	.0062	.0037
DAY	1	HOUR	10	POWERS	5897.0	5887.1	5879.0	5877.0	5863.9	5851.3	5844.5
				PROBS.	.9109	.0326	.0319	.0162	.0060	.0018	.0006
DAY	1	HOUR	11	POWERS	5969.0	5956.2	5948.0	5936.0	5922.8	5910.2	5903.5
				PROBS.	.8517	.0610	.0492	.0241	.0095	.0032	.0013
DAY	1	HOUR	12	POWERS	5933.0	5923.6	5915.3	5903.2	5890.0	5877.3	5870.5
				PROBS.	.7926	.1312	.0691	.0256	.0082	.0024	.0009
DAY	1	HOUR	13	POWERS	5884.0	5874.3	5865.9	5853.6	5840.3	5827.7	5821.5
				PROBS.	.8220	.0577	.0477	.0311	.0187	.0107	.0121
DAY	1	HOUR	14	POWERS	5744.0	5732.7	5724.6	5733.2	5722.0	5710.6	5701.5
				PROBS.	.7924	.0955	.0582	.1039	.0398	.0019	0.0000
DAY	1	HOUR	15	POWERS	5687.0	5676.9	5668.5	5656.3	5643.0	5630.5	5624.5
				PROBS.	.7331	.0398	.0505	.0561	.0431	.0292	.0382
DAY	1	HOUR	16	POWERS	5819.0	5808.8	5800.6	5788.4	5775.2	5762.7	5756.5
				PROBS.	.6439	.0628	.0929	.0802	.0555	.0331	.0316
DAY	1	HOUR	17	POWERS	6603.0	6592.8	6585.0	6573.4	6560.7	6548.1	6540.5
				PROBS.	.5845	.1472	.1768	.0733	.0160	.0020	.0002
DAY	1	HOUR	18	POWERS	7250.0	7240.5	7232.2	7220.0	7206.8	7194.1	7187.5
				PROBS.	.7033	.1491	.0875	.0379	.0145	.0052	.0025
DAY	1	HOUR	19	POWERS	7227.0	7217.3	7208.9	7196.7	7183.4	7170.8	7164.5
				PROBS.	.7627	.0883	.0693	.0403	.0210	.0102	.0082
DAY	1	HOUR	20	POWERS	7092.0	7081.8	7073.6	7061.5	7048.4	7035.9	7029.5
				PROBS.	.7625	.0479	.0712	.0566	.0341	.0169	.0108
DAY	1	HOUR	21	POWERS	6940.0	6930.3	6921.9	6909.7	6896.4	6883.8	6877.5
				PROBS.	.7330	.0959	.0762	.0459	.0250	.0127	.0113
DAY	1	HOUR	22	POWERS	6403.0	6392.7	6384.6	6372.7	6359.6	6347.1	6340.5
				PROBS.	.8220	.0386	.0609	.0447	.0224	.0083	.0031
DAY	1	HOUR	23	POWERS	5876.0	5864.9	5856.7	5844.6	5831.7	5819.7	5813.5
				PROBS.	.8814	.0022	.0140	.0298	.0352	.0248	.0126
DAY	1	HOUR	24	POWERS	5414.0	5403.5	5395.3	5383.2	5370.1	5357.7	5351.5
				PROBS.	.8517	.0145	.0347	.0385	.0299	.0178	.0129
DAY	2	HOUR	1	POWERS	5302.0	5292.1	5283.9	5271.7	5258.5	5246.0	5239.5
				PROBS.	.8220	.0564	.0572	.0351	.0175	.0075	.0043
DAY	2	HOUR	2	POWERS	5224.0	5214.7	5206.2	5194.0	5180.7	5168.0	5161.5
				PROBS.	.7924	.1114	.0563	.0241	.0097	.0038	.0023
DAY	2	HOUR	3	POWERS	5199.0	5189.5	5181.1	5169.0	5155.7	5143.0	5136.5
				PROBS.	.8516	.0703	.0443	.0205	.0084	.0032	.0017
DAY	2	HOUR	4	POWERS	5274.0	5264.1	5255.9	5243.8	5230.7	5218.1	5211.5
				PROBS.	.9109	.0314	.0295	.0165	.0074	.0029	.0014
DAY	2	HOUR	5	POWERS	5483.0	5473.9	5465.5	5453.4	5440.2	5427.6	5420.5
				PROBS.	.8815	.0805	.0277	.0077	.0020	.0005	.0001
DAY	2	HOUR	6	POWERS	6327.0	6317.6	6311.1	6300.1	6275.9	6264.5	6264.5
				PROBS.	.9407	.0507	.0085	.0001	0.0000	0.0000	0.0000
DAY	2	HOUR	7	POWERS	7352.0	7342.0	7333.9	7321.9	7308.8	7296.2	7289.5
				PROBS.	.9109	.0299	.0309	.0173	.0074	.0026	.0010
DAY	2	HOUR	8	POWERS	8145.0	8136.5	8127.1	8114.8	8101.0	8088.4	8082.5

Figure 5-5. ULMOD Residual Loads

***** FOR MONTH 1 RESIDUAL LOAD DURATION CURVE POWERS AND PROBABILITIES.

POWERS	10140.1	9943.0	9915.9	9882.9	9764.2	9742.3	9718.0	9705.5	9693.4	9676.8	9653.6	9634.9
PROBS.	.0660	.2280	.0739	.0066	.3837	.0619	.2557	.0748	.0319	.0121	.0517	.0630
POWERS	9627.4	9605.6	9593.7	9585.6	9576.1	9568.1	9564.5	9558.3	9553.3	9549.7	9542.2	9539.7
PROBS.	.0669	.0669	.0125	.2795	.0490	.0739	.2745	.0742	.0643	.0778	.0163	.3097
POWERS	9530.3	9526.0	9521.8	9515.3	9508.2	9506.0	9500.1	9497.8	9489.5	9481.4	9476.0	9468.7
PROBS.	.0405	.0068	.0326	.2260	.2383	.0430	.0093	.0701	.0828	.0199	.1173	.0180
POWERS	9461.7	9454.0	9451.9	9447.4	9444.5	9439.7	9436.0	9433.3	9429.6	9423.5	9420.6	9416.3
PROBS.	.1190	.1900	.0499	.1016	.0457	.1143	.0387	.3214	.0682	.0857	.0199	.0278
POWERS	9413.2	9409.7	9404.7	9402.5	9395.4	9392.6	9387.6	9384.9	9378.6	9376.3	9374.0	9368.9
PROBS.	.0965	.0100	.1821	.0316	.0390	.0110	.2422	.4418	.0397	.1076	.0965	.1978
POWERS	9367.6	9361.2	9359.5	9355.1	9352.0	9346.2	9344.0	9342.0	9336.1	9333.6	9330.3	9327.7
PROBS.	.2404	.3739	.2486	.0312	.1654	.2076	.0342	.0476	.3045	.0626	.1237	.3469
POWERS	9324.6	9323.9	9318.6	9317.6	9314.8	9311.8	9309.9	9306.1	9305.0	9301.7	9299.9	9297.5
PROBS.	.0152	.0551	.1004	.0646	.2403	.0126	.3308	.0690	.0403	.0207	.0357	.0295
POWERS	9293.5	9291.2	9290.6	9286.7	9282.0	9279.9	9278.8	9274.3	9273.0	9269.8	9268.5	9264.9
PROBS.	.0867	.0728	.1842	.0652	.0570	.0627	.2010	.4585	.0318	.0328	.0067	.1990
POWERS	9264.1	9260.8	9258.4	9255.4	9254.0	9252.9	9248.8	9247.8	9246.7	9244.2	9242.2	9238.8
PROBS.	.1186	.2570	.0659	.1295	.2767	.3977	.2009	.1757	.0334	.1322	.2821	.2806
POWERS	9237.2	9235.0	9234.1	9230.9	9229.8	9229.0	9225.0	9223.6	9221.6	9220.1	9217.4	9215.4
PROBS.	.0894	.1459	.0566	.2190	.0362	.0504	.2794	.0632	.0571	.0388	.0195	.0713
POWERS	9212.7	9210.8	9208.9	9207.9	9205.1	9203.3	9200.5	9198.5	9196.0	9195.4	9192.6	9191.0
PROBS.	.2037	.0669	.0639	.3613	.4483	.0427	.0234	.0658	.0701	.1324	.0098	.0085
POWERS	9188.6	9187.2	9184.7	9182.0	9179.9	9177.9	9177.1	9173.6	9171.3	9170.3	9166.5	9164.3
PROBS.	.4020	.0613	.0051	.2855	.3323	.1936	.0061	.2665	.1423	.0898	.4305	.0438
POWERS	9162.8	9160.4	9156.4	9154.8	9153.0	9151.1	9149.9	9148.1	9146.5	9144.3	9141.5	9138.9
PROBS.	.0649	.1193	.1960	.2592	.0114	.1328	.0230	.2205	.0439	.0536	.0162	.1042
POWERS	9137.5	9135.2	9134.7	9131.4	9130.0	9126.0	9124.9	9124.0	9122.4	9120.4	9118.8	9116.9
PROBS.	.0499	.3683	.1935	.4455	.3228	.0225	.2526	.0110	.1462	.0397	.2536	.0481
POWERS	9115.7	9112.7	9111.4	9110.9	9109.6	9106.8	9105.8	9104.7	9101.7	9100.9	9099.1	9097.1
PROBS.	.1544	.0500	.0206	.6806	.0773	.1723	.0618	.0287	.0768	.0531	.3426	.1208
POWERS	9095.0	9093.8	9092.8	9091.8	9089.5	9088.6	9087.5	9084.9	9082.9	9081.0	9080.8	9078.2
PROBS.	.3065	.2541	.2121	.1985	.0664	.0246	.2209	.3926	.0882	.4097	.2179	.0418
POWERS	9076.7	9075.5	9074.2	9073.1	9072.4	9070.3	9068.5	9067.6	9066.8	9064.8	9063.3	9062.6
PROBS.	.0574	.0660	.1998	.4313	.1089	.0355	.5810	.0163	.0442	.2706	.0992	.0327
POWERS	9062.0	9059.3	9057.5	9055.6	9055.0	9054.2	9052.4	9051.0	9049.8	9049.0	9047.4	9045.1
PROBS.	.3126	.4598	.1448	.2924	.0318	.0108	.1567	.3087	.1195	.0098	.1199	.4321
POWERS	9043.9	9042.8	9041.2	9040.0	9038.8	9037.9	9036.1	9035.3	9034.5	9032.9	9031.1	9030.1
PROBS.	.0591	.0280	.0877	.2085	.2139	.0834	.0617	.4180	.0205	.3221	.0107	.0575
POWERS	9029.1	9028.1	9027.0	9025.9	9025.1	9023.1	9020.9	9018.7	9018.2	9017.2	9015.9	9014.9
PROBS.	.0602	.2398	.0369	.0447	.2464	.0856	.0347	.0501	.0110	.0237	.0730	.0642
POWERS	9013.7	9011.8	9009.9	9009.1	9008.5	9007.2	9005.9	9003.8	9002.2	9000.3	8999.9	8998.1
PROBS.	.0477	.2369	.2183	.2250	.3852	.0330	.0659	.0347	.2099	.1841	.1121	.2692
POWERS	8996.8	8996.0	8995.2	8994.0	8992.4	8990.9	8990.2	8988.8	8987.6	8985.9	8984.6	8983.1
PROBS.	.2410	.0856	.0179	.3168	.0618	.0710	.0461	.0077	.1672	.2314	.1213	.0058
POWERS	8982.0	8981.1	8979.9	8978.8	8977.9	8976.0	8975.0	8972.8	8971.8	8970.3	8969.0	8968.7
PROBS.	.0945	.0668	.1324	.0834	.0183	.0446	.3014	.2526	.2180	.0169	.0596	.2372
POWERS	8967.7	8966.1	8965.2	8963.9	8962.3	8959.5	8957.5	8956.2	8955.3	8954.9	8953.9	8952.6
PROBS.	.1970	.0133	.0505	.0819	.0318	.0335	.1081	.1012	.2080	.4524	.0214	.0112
POWERS	8951.9	8951.0	8950.2	8949.0	8947.4	8945.5	8944.9	8944.0	8942.4	8941.7	8939.9	8939.5
PROBS.	.7577	.3341	.1932	.0771	.0152	.0610	.3468	.0051	.0879	.0200	.2944	.0246
POWERS	8939.0	8937.4	8936.8	8935.9	8934.0	8932.8	8931.5	8931.0	8929.4	8927.8	8926.7	8925.7
PROBS.	.3070	.0210	.2302	.2953	.0540	.2458	.0398	.8640	.0533	.0126	.4453	.0048
POWERS	8925.1	8923.9	8922.8	8921.8	8921.5	8920.0	8919.1	8917.8	8916.4	8915.1	8913.0	8912.7
PROBS.	.0360	.2452	.1909	.0343	.0935	.2471	.2340	.1310	.0091	.2146	.3599	.0241
POWERS	8912.0	8910.7	8909.4	8908.9	8908.0	8906.4	8905.3	8903.8	8901.8	8901.1	8900.7	8898.7
PROBS.	.2933	.1886	.0629	.0345	.3216	.0368	.2057	.1702	.0519	.5687	.0608	.1009
POWERS	8897.1	8896.4	8895.8	8895.0	8893.8	8893.2	8892.7	8890.5	8889.2	8888.9	8888.2	8887.0
PROBS.	.2222	.0049	.1122	.0777	.1938	.1980	.0617	.0617	.1881	.0212	.1806	.0686
POWERS	8885.0	8884.6	8883.7	8882.7	8882.0	8880.3	8879.2	8878.2	8877.0	8876.0	8875.3	8875.1
PROBS.	.3465	.2791	.2456	.0278	.2250	.3496	.2050	.1977	.0683	.3528	.0516	.0618
POWERS	8873.9	8872.8	8871.4	8870.7	8869.9	8869.0	8868.0	8867.2	8866.0	8865.0	8864.0	8863.3
PROBS.	.2399	.2224	.2567	.0297	.0824	.0167	.0201	.0467	.0563	.3103	.0455	.0368
POWERS	8862.0	8861.4	8860.0	8858.9	8857.8	8856.0	8855.0	8854.7	8853.7	8853.0	8851.9	8850.8

Figure 5-6. ULMOD Residual Load Duration Curve

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***** MONTH  1 SEGMENTED LOAD DURATION CURVE.

SECTION  1 =  .0500 FRACTION OF TIME, PIECES = 9348.7 9062.5
EACH PIECE =   18.6 HOURS LONG

SECTION  2 =  .0500 FRACTION OF TIME, PIECES = 8707.8 8709.1
EACH PIECE =   18.6 HOURS LONG

SECTION  3 =  .2000 FRACTION OF TIME, PIECES = 8571.2 8309.2
EACH PIECE =   74.4 HOURS LONG

SECTION  4 =  .5000 FRACTION OF TIME, PIECES = 7681.2 6301.2
EACH PIECE =  186.0 HOURS LONG

SECTION  5 =  .2000 FRACTION OF TIME, PIECES = 5581.5 5183.1
EACH PIECE =   74.4 HOURS LONG
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Figure 5-7. ULMOD Sectionalized Residual LDC

***** ANNUAL LOAD DURATION CURVE

RESIDUAL LOADS	12969.8	12900.2	12729.6	12686.9	12664.4	12599.6	12553.7	12535.6	12512.2	12490.5	12477.8	12452.9
RESIDUAL LOADS	12411.7	12398.4	12376.1	12339.5	12338.3	12319.6	12301.0	12285.1	12266.5	12253.8	12248.3	12234.8
RESIDUAL LOADS	12211.4	12203.3	12178.7	12161.9	12158.9	12119.1	12115.4	12111.2	12096.3	12071.7	12050.7	12050.5
RESIDUAL LOADS	12038.6	12027.4	12025.2	12019.2	12003.9	11987.6	11986.0	11959.8	11959.2	11942.8	11940.7	11917.3
RESIDUAL LOADS	11895.2	11878.4	11874.1	11858.9	11854.1	11840.2	11824.4	11810.5	11803.0	11800.2	11784.2	11781.3
RESIDUAL LOADS	11772.9	11760.2	11755.3	11753.0	11742.8	11725.1	11718.7	11715.3	11702.7	11701.1	11672.7	11668.8
RESIDUAL LOADS	11667.1	11662.7	11650.4	11633.9	11624.4	11623.1	11602.5	11594.0	11593.3	11588.4	11582.4	11567.8
RESIDUAL LOADS	11561.8	11554.2	11552.8	11539.8	11531.6	11530.6	11524.2	11515.6	11503.3	11499.2	11493.5	11486.4
RESIDUAL LOADS	11475.9	11472.5	11463.0	11458.4	11455.4	11438.7	11433.1	11421.1	11419.1	11417.5	11412.3	11400.5
RESIDUAL LOADS	11395.8	11385.5	11376.0	11373.2	11368.3	11363.8	11358.1	11356.5	11346.4	11342.9	11340.7	11338.5
RESIDUAL LOADS	11321.7	11316.7	11314.0	11307.6	11304.9	11297.7	11291.7	11285.5	11278.3	11277.6	11268.8	11261.5
RESIDUAL LOADS	11258.7	11255.2	11249.5	11234.0	11233.2	11232.2	11230.3	11223.4	11207.9	11206.4	11206.3	11196.2
RESIDUAL LOADS	11193.6	11187.2	11186.7	11180.7	11172.6	11166.2	11158.0	11157.5	11152.5	11144.7	11141.5	11139.3
RESIDUAL LOADS	11133.8	11128.0	11123.9	11120.7	11118.2	11116.3	11116.2	11107.5	11100.5	11095.1	11094.9	11091.1
RESIDUAL LOADS	11082.4	11079.9	11079.3	11073.6	11069.2	11066.5	11066.3	11059.8	11049.0	11048.7	11046.2	11037.7
RESIDUAL LOADS	11033.3	11029.8	11025.9	11019.9	11017.8	11014.9	11006.9	10999.2	10997.5	10994.1	10991.6	10982.1
RESIDUAL LOADS	10977.1	10976.2	10973.8	10965.1	10959.5	10952.4	10947.9	10947.8	10939.0	10937.9	10933.7	10926.2
RESIDUAL LOADS	10924.9	10924.5	10923.4	10917.1	10907.8	10906.6	10904.4	10903.9	10897.6	10896.6	10890.8	10885.8
RESIDUAL LOADS	10894.7	10883.4	10881.6	10868.2	10865.6	10864.3	10863.0	10861.9	10859.9	10850.2	10846.4	10843.0
RESIDUAL LOADS	10840.0	10839.2	10836.4	10829.9	10822.8	10822.8	10813.9	10812.5	10809.2	10803.2	10801.8	10796.5
RESIDUAL LOADS	10792.1	10787.1	10783.0	10774.5	10773.2	10767.9	10765.8	10764.3	10751.6	10750.4	10748.1	10740.5
RESIDUAL LOADS	10736.8	10735.6	10729.2	10727.6	10726.0	10717.1	10715.8	10714.1	10711.7	10705.7	10703.0	10699.9
RESIDUAL LOADS	10694.2	10693.7	10687.3	10687.1	10682.1	10680.7	10680.6	10677.7	10669.5	10667.0	10665.9	10664.9
RESIDUAL LOADS	10660.2	10655.3	10648.8	10644.9	10642.4	10641.7	10635.9	10629.2	10624.8	10624.4	10623.4	10619.2
RESIDUAL LOADS	10611.1	10606.7	10604.6	10601.2	10597.9	10592.7	10584.5	10584.1	10580.8	10574.8	10574.6	10567.0
RESIDUAL LOADS	10563.0	10556.3	10555.0	10551.0	10547.8	10545.7	10539.8	10537.8	10533.1	10531.3	10529.4	10522.4
RESIDUAL LOADS	10520.8	10519.9	10517.1	10515.8	10506.9	10504.7	10497.9	10494.1	10493.9	10491.2	10488.0	10483.8
RESIDUAL LOADS	10480.7	10480.5	10474.3	10473.6	10468.6	10465.3	10464.9	10463.3	10459.1	10458.5	10449.8	10448.5
RESIDUAL LOADS	10446.6	10436.7	10435.4	10432.9	10431.9	10427.8	10414.3	10412.8	10411.6	10411.2	10403.2	10403.2
RESIDUAL LOADS	10401.2	10393.2	10390.7	10386.9	10382.3	10380.7	10376.0	10371.4	10368.9	10367.0	10364.5	10362.5
RESIDUAL LOADS	10356.8	10351.1	10348.6	10347.0	10342.9	10342.4	10339.1	10331.4	10331.3	10330.0	10326.2	10322.3
RESIDUAL LOADS	10318.9	10318.1	10312.6	10306.4	10306.1	10304.5	10300.4	10300.0	10295.5	10291.8	10287.5	10285.9
RESIDUAL LOADS	10279.8	10279.5	10276.4	10270.8	10270.4	10269.8	10265.2	10265.1	10259.2	10255.6	10252.6	10250.4
RESIDUAL LOADS	10245.0	10244.8	10244.0	10243.5	10238.3	10236.9	10232.4	10230.3	10227.2	10226.8	10219.6	10216.9
RESIDUAL LOADS	10210.2	10209.6	10208.8	10204.7	10195.4	10188.7	10186.1	10184.8	10178.1	10174.9	10174.6	10173.8
RESIDUAL LOADS	10171.4	10168.0	10167.3	10158.3	10157.8	10155.3	10149.1	10146.8	10145.2	10145.2	10143.0	10137.6
RESIDUAL LOADS	10137.2	10136.6	10136.5	10132.0	10124.3	10123.7	10122.3	10121.3	10120.7	10114.0	10109.6	10109.3
RESIDUAL LOADS	10108.0	10105.2	10098.3	10094.0	10093.7	10092.0	10086.6	10084.0	10082.4	10080.4	10074.5	10073.3
RESIDUAL LOADS	10072.9	10065.8	10063.5	10062.9	10059.0	10057.7	10056.8	10052.3	10050.8	10049.8	10047.7	10046.9
RESIDUAL LOADS	10043.0	10040.6	10037.5	10034.0	10030.4	10027.3	10025.0	10024.7	10021.1	10016.1	10015.8	10014.1
RESIDUAL LOADS	10008.1	10004.4	10003.4	10003.1	10001.3	9999.3	9999.0	9997.1	9990.8	9990.0	9988.1	9983.5
RESIDUAL LOADS	9978.8	9974.2	9970.3	9968.9	9968.1	9965.6	9960.8	9959.4	9956.9	9952.5	9950.4	9947.0
RESIDUAL LOADS	9946.9	9946.9	9941.4	9940.1	9938.1	9935.4	9931.7	9929.8	9924.1	9922.0	9920.7	9920.2
RESIDUAL LOADS	9913.0	9911.6	9911.2	9910.8	9908.4	9905.4	9903.7	9899.6	9898.0	9897.1	9896.8	9895.9
RESIDUAL LOADS	9890.6	9887.7	9885.5	9882.5	9876.6	9876.3	9875.2	9868.5	9867.6	9867.5	9862.9	9862.1
RESIDUAL LOADS	9861.2	9855.6	9851.2	9849.9	9848.4	9846.5	9841.0	9840.4	9837.8	9834.4	9834.3	9832.1
RESIDUAL LOADS	9831.5	9829.2	9826.7	9826.4	9824.5	9823.8	9821.8	9818.5	9818.2	9817.6	9815.0	9814.7
RESIDUAL LOADS	9811.6	9808.6	9805.6	9802.4	9802.2	9801.0	9799.3	9790.8	9790.6	9786.2	9785.9	9784.2
RESIDUAL LOADS	9781.3	9779.8	9779.8	9775.5	9774.7	9771.7	9770.1	9769.5	9765.3	9763.9	9761.3	9758.7
RESIDUAL LOADS	9758.6	9754.9	9748.7	9747.9	9742.0	9740.5	9740.0	9739.7	9736.2	9733.0	9730.5	9727.8
RESIDUAL LOADS	9724.9	9722.8	9722.5	9720.7	9716.5	9716.0	9712.2	9710.0	9707.7	9703.3	9702.8	9700.9
RESIDUAL LOADS	9699.6	9698.5	9695.0	9691.2	9691.0	9690.9	9686.3	9685.4	9682.0	9679.7	9677.6	9679.1
RESIDUAL LOADS	9674.6	9673.6	9669.9	9668.4	9665.1	9664.4	9664.1	9662.0	9656.3	9656.1	9655.5	9653.4
RESIDUAL LOADS	9652.5	9647.5	9647.1	9647.0	9639.8	9639.7	9639.0	9634.4	9634.0	9631.6	9630.2	9624.0
RESIDUAL LOADS	9622.1	9620.1	9618.8	9617.6	9616.6	9615.3	9615.2	9612.3	9611.3	9607.6	9607.2	9605.2
RESIDUAL LOADS	9603.8	9601.0	9600.2	9599.9	9599.6	9599.0	9593.7	9593.3	9592.2	9589.8	9588.7	9589.9
RESIDUAL LOADS	9585.1	9584.2	9584.0	9583.4	9579.6	9577.8	9576.5	9575.0	9572.7	9571.2	9567.7	9567.3
RESIDUAL LOADS	9564.9	9564.7	9564.2	9561.8	9561.4	9557.7	9556.5	9552.2	9551.7	9550.8	9550.7	9542.7
RESIDUAL LOADS	9540.5	9538.6	9537.8	9537.4	9534.4	9533.5	9532.6	9527.3	9524.8	9523.6	9523.0	9521.7
RESIDUAL LOADS	9518.5	9517.7	9517.6	9515.7	9509.8	9507.1	9506.1	9504.6	9504.1	9502.6	9500.9	9499.1
RESIDUAL LOADS	9496.4	9492.2	9490.6	9489.5	9489.2	9486.0	9484.5	9484.1	9481.2	9480.1	9478.3	9477.9
RESIDUAL LOADS	9476.5	9475.7	9474.6	9471.8	9467.0	9466.3	9464.7	9464.7	9464.4	9457.3	9456.6	9455.7
RESIDUAL LOADS	9455.2	9453.6	9452.7	9450.1	9449.1	9447.9	9445.3	9441.7	9439.9	9439.5	9437.8	9437.5

Figure 5-8. ULMOD Annual LDC

***** FOR MONTH 1 EXPECTED CHRONOLOGICAL HOURLY RESIDUAL LOADS FROM PROBABILITY DATA.

DAY 1	5692.9	5435.5	5249.3	5149.1	5165.4	5247.4	5222.1	5552.7	5773.1	5905.2	5963.1	5929.2
	5879.5	5757.9	5677.8	5807.9	6595.3	7244.8	7221.7	7085.4	6933.8	6398.5	5871.0	5408.9
DAY 2	5297.9	5220.5	5196.3	5272.1	5481.4	6326.4	7350.1	8143.7	9079.1	8518.2	8224.1	8311.2
	8271.5	8182.9	8217.8	8199.9	8767.3	9322.8	9089.7	8786.4	8465.8	7624.5	6918.0	6114.9
DAY 3	5809.9	5625.5	5597.3	5584.1	5822.4	6425.4	7573.1	8339.7	8647.1	8604.2	8455.1	8312.2
	8283.5	8195.9	8147.8	7972.9	8494.3	9199.8	8969.7	8736.4	8412.8	7693.5	6984.0	6157.9
DAY 4	5837.9	5633.5	5591.3	5566.1	5816.4	6446.4	7517.1	8224.7	8468.1	8470.2	8446.1	8222.2
	8205.5	8174.9	8077.8	7967.9	8749.3	9105.8	8988.7	8659.4	8274.8	7538.5	6851.0	6164.9
DAY 5	5765.9	5604.5	5547.3	5517.1	5789.4	6488.4	7530.1	8402.7	8671.1	8770.2	8789.1	8653.2
	8663.5	8593.9	8509.6	8487.9	8928.3	9202.8	8925.7	8554.4	8158.8	7493.5	6961.0	6299.9
DAY 6	5581.9	5557.5	5421.3	5383.1	5414.4	5684.4	5945.1	6530.7	6867.1	7174.2	7126.1	7038.2
	6905.5	6782.9	6648.8	6683.9	7503.3	7932.8	7760.7	7514.4	7121.8	6788.5	6207.0	5652.9
DAY 7	5362.9	5118.5	5052.3	5002.1	5013.4	5102.4	5187.1	5588.7	5972.1	6350.2	6410.1	6435.2
	6338.5	6304.9	6185.8	6311.9	6927.3	7592.8	7462.7	7250.4	6990.8	6521.5	5913.0	5459.9
DAY 8	5304.9	5170.5	5223.3	5218.1	5499.4	6165.4	7200.1	8051.7	8385.1	8438.2	8377.1	8199.2
	8202.5	8169.9	8171.8	8177.9	8723.3	9219.8	9093.7	8781.4	8330.8	7577.5	6981.0	6248.9
DAY 9	5798.9	5605.5	5454.3	5366.1	5612.4	6281.4	7270.1	8128.7	8337.1	8497.2	8440.1	8172.2
	8180.5	8114.9	8041.8	7892.9	8368.3	9079.8	8949.7	8667.4	8252.8	7501.5	6753.0	6056.9
DAY 10	5724.9	5544.5	5451.3	5470.1	5737.4	6392.4	7337.1	8137.7	8329.1	8426.2	8341.1	8131.2
	8175.5	8081.9	8037.8	7861.4	8328.3	9170.8	8953.7	8593.4	8201.8	7511.5	6720.0	6041.9
DAY 11	5655.9	5565.5	5477.3	5476.1	5668.4	6370.4	7316.1	8121.7	8355.1	8350.2	8375.1	8170.2
	8225.5	8175.9	8013.8	7853.9	8336.3	9053.8	8826.7	8550.4	8169.8	7393.5	6630.0	5950.9
DAY 12	5721.9	5511.5	5425.3	5420.1	5613.4	6119.4	7304.1	7864.7	8342.1	8439.2	8418.1	8167.2
	8147.5	8085.9	7954.8	7761.9	8022.3	8734.8	8615.7	8284.4	7902.8	7343.5	6753.0	6079.9
DAY 13	5600.9	5403.5	5364.3	5300.1	5417.4	5660.4	5873.1	6503.7	6896.1	7140.2	7023.1	6873.2
	6680.5	6641.9	6598.8	6566.9	7258.3	7791.8	7591.7	7321.4	7016.8	6630.5	6121.0	5574.9
DAY 14	5272.9	5075.5	4960.3	4920.1	4896.4	5042.4	5140.1	5537.7	5995.1	6228.2	6389.1	6483.2
	6612.5	6665.9	6660.8	6815.9	7345.3	7688.8	7505.7	7371.4	7039.8	6598.5	6004.0	5462.9
DAY 15	5318.9	5222.5	5127.3	5199.1	5419.4	6130.4	7340.1	8187.7	8601.1	8742.2	8882.1	8669.2
	8688.5	8698.9	8684.8	8594.9	8990.3	9379.8	9056.7	8822.4	8388.8	7568.5	6819.0	6056.9
DAY 16	5719.9	5553.5	5452.3	5452.1	5642.4	6287.4	7468.1	8255.7	8515.1	8468.2	8299.1	8207.2
	8239.5	8428.9	8288.8	8147.9	8627.3	9183.8	8946.7	8623.4	8272.8	7511.5	6785.0	6121.9
DAY 17	5750.9	5530.5	5410.3	5400.1	5552.4	6269.4	7406.1	8114.7	8360.1	8380.2	8347.1	8076.2
	8098.5	8072.9	8009.8	7882.9	8224.3	9062.8	8902.7	8626.4	8226.8	7581.5	6705.0	5989.9
DAY 18	5622.9	5500.5	5420.3	5423.1	5578.4	6242.4	7379.1	8094.7	8423.1	8474.2	8466.1	8350.2
	8437.5	8357.9	8211.8	8142.9	8421.3	9248.8	9129.7	8848.4	8419.8	7702.5	6907.0	6239.9
DAY 19	5951.9	5765.5	5636.3	5698.1	5899.4	6562.4	7677.1	8336.7	8457.1	8503.2	8324.1	8134.2
	8124.5	8067.9	7912.8	7851.9	7976.3	8854.8	8698.7	8413.4	8075.8	7529.5	6888.0	6126.9
DAY 20	5792.9	5581.5	5515.3	5426.1	5526.4	5806.4	6045.1	6533.7	6953.1	7074.2	7020.1	6909.2
	6738.5	6543.9	6464.8	6483.9	7080.3	7861.8	7697.7	7431.4	7026.8	6644.5	6135.0	5609.9
DAY 21	5284.9	5089.5	4984.3	4941.1	4912.4	5026.4	5154.1	5600.7	6063.1	6301.2	6353.1	6354.2
	6252.5	6083.9	6102.8	6194.9	6727.3	7478.8	7334.7	7221.4	6871.8	6408.5	5926.0	5422.9
DAY 22	5147.9	5093.5	5097.3	5142.1	5352.4	6130.4	7215.1	8028.7	8328.1	8365.2	8332.1	8067.2
	8177.5	8175.9	8013.8	7937.9	8347.3	9045.8	8824.7	8602.4	8172.8	7403.5	6706.0	6003.9
DAY 23	5645.9	5490.5	5409.3	5428.1	5684.4	6392.4	7423.1	8144.7	8401.1	8420.2	8303.1	8047.2
	8057.5	8047.9	7931.8	7816.9	8257.3	9027.8	8853.7	8595.4	8183.8	7404.5	6618.0	5974.9
DAY 24	5563.9	5399.5	5320.3	5345.1	5587.4	6209.4	7399.1	8139.7	8424.1	8500.2	8449.1	8205.2
	8236.5	8179.9	8006.8	7941.9	8217.3	9067.8	8907.7	8594.4	8185.8	7457.5	6707.0	6039.9
DAY 25	5652.9	5472.5	5448.3	5462.1	5668.4	6341.4	7488.1	8262.7	8491.1	8524.2	8463.1	8318.2
	8279.5	8218.9	8119.8	8067.9	8330.3	9268.8	9124.7	8858.4	8466.8	7712.5	6886.0	6240.9
DAY 26	5887.9	5751.5	5707.3	5758.1	6006.4	6705.4	7785.1	8459.7	8583.1	8496.2	8544.1	8261.2
	8220.5	8138.9	7973.8	7705.9	7961.3	8421.8	8783.7	8329.4	8235.8	7598.5	7015.0	6299.9
DAY 27	5952.9	5777.5	5659.3	5655.1	5735.4	6000.4	6358.1	6826.7	7132.1	7196.2	7139.1	6899.2
	6712.5	6934.9	6416.8	6381.9	6807.3	7848.8	7662.7	7319.4	7133.8	6709.5	6229.0	5696.9
DAY 28	5376.9	5252.5	5115.3	5146.1	5153.4	5261.4	5382.1	5848.7	6171.1	6419.2	6380.1	6437.2
	6421.5	6333.9	6453.8	6609.9	6992.3	7813.8	7786.7	7672.4	7438.8	6923.5	6358.0	5762.9
DAY 29	5619.9	5551.5	5556.3	5636.1	5884.4	6667.4	7822.1	8592.7	8751.1	8758.2	8643.1	8306.2
	8310.5	8170.9	8037.8	7904.9	8310.3	9174.8	9063.7	8938.4	8545.8	7976.5	7103.0	6350.9
DAY 30	6012.9	5851.5	5710.3	5729.1	5919.4	6629.4	7781.1	8575.7	8815.1	8929.2	8873.1	8768.2
	8896.5	8944.9	8902.8	8868.9	9245.3	9760.8	9534.7	9159.4	8707.8	7935.5	7084.0	6381.9
DAY 31	6120.9	5847.5	5773.3	5715.1	5902.4	6554.4	7620.1	8357.7	8615.1	8571.2	8675.1	8461.2
	8519.5	8601.9	8649.8	8567.9	8709.3	9330.8	9182.7	8849.4	8421.8	7676.5	6902.0	6203.9

Figure 5-9. ULMOD Expected Chronological Residuals

***** FOR MONTH 1 LOAD DURATION CURVE OF EXPECTED HOURLY RESIDUAL LOADS FROM PROBABILITY DATA.

9760.8	9534.7	9379.8	9330.8	9322.8	9268.8	9248.8	9245.3	9219.8	9202.8	9199.8	9183.8
9182.7	9176.8	9174.8	9159.4	9129.7	9124.7	9105.8	9093.7	9089.7	9079.8	9079.1	9067.8
9063.7	9062.8	9056.7	9053.8	9045.8	9027.8	8990.3	8988.7	8969.7	8949.7	8946.7	8944.9
8938.4	8933.7	8929.2	8928.3	8925.7	8921.8	8907.7	8902.8	8902.7	8896.5	8887.1	8873.1
8868.9	8858.4	8854.8	8853.7	8849.4	8848.4	8826.7	8824.7	8822.4	8815.1	8789.1	8786.4
8783.7	8781.4	8770.2	8768.2	8767.3	8758.2	8751.1	8749.3	8742.2	8736.4	8734.8	8723.3
8709.3	8707.8	8698.9	8698.7	8688.5	8684.8	8675.1	8671.1	8667.4	8665.2	8663.5	8659.4
8653.2	8649.8	8647.1	8643.1	8627.3	8626.4	8623.4	8615.7	8615.1	8604.2	8602.4	8601.9
8601.1	8595.4	8594.9	8594.4	8593.9	8592.7	8583.4	8583.1	8575.7	8571.2	8567.9	8554.4
8550.4	8545.8	8544.1	8524.2	8519.5	8518.2	8515.1	8509.8	8503.2	8500.2	8497.2	8496.2
8494.3	8491.1	8487.9	8476.2	8470.2	8468.2	8468.1	8466.8	8466.1	8465.8	8463.1	8461.2
8460.1	8459.7	8457.1	8455.1	8449.1	8446.1	8439.2	8438.2	8437.5	8428.9	8426.2	8424.1
8423.1	8421.8	8421.3	8420.2	8419.8	8418.1	8413.4	8412.8	8402.7	8401.1	8388.8	8385.1
8380.2	8377.1	8373.1	8368.3	8365.2	8360.1	8357.9	8357.7	8355.1	8350.2	8350.2	8347.3
8347.1	8342.1	8341.1	8339.7	8337.1	8336.7	8336.3	8332.1	8330.8	8330.3	8329.4	8329.1
8328.3	8328.1	8324.1	8318.2	8312.2	8311.2	8310.5	8310.3	8306.2	8303.1	8299.1	8288.8
8284.4	8283.5	8279.5	8274.8	8272.8	8271.5	8262.7	8261.2	8257.3	8255.7	8252.8	8239.5
8236.5	8235.8	8226.8	8225.5	8224.7	8224.3	8224.1	8222.2	8220.5	8218.9	8217.8	8217.3
8211.8	8207.2	8205.5	8205.2	8202.5	8201.8	8199.9	8199.2	8197.5	8195.9	8187.7	8185.8
8183.8	8182.9	8180.5	8179.9	8177.9	8177.5	8176.2	8175.9	8175.9	8174.9	8173.5	8172.8
8172.2	8171.8	8170.9	8159.9	8149.8	8167.2	8158.8	8147.9	8147.8	8144.7	8143.7	8142.9
8139.7	8139.9	8137.7	8134.2	8131.7	8131.2	8128.7	8124.5	8119.8	8114.9	8114.7	8098.5
8094.7	8085.9	8081.9	8077.8	8076.2	8075.8	8072.9	8067.9	8067.9	8067.2	8057.5	8051.7
8047.9	8047.2	8041.8	8037.8	8037.8	8028.7	8022.3	8013.8	8013.8	8009.8	8006.8	7976.5
7976.3	7973.8	7972.9	7967.9	7961.3	7954.8	7941.9	7937.9	7935.5	7932.8	7931.8	7912.8
7904.9	7902.8	7892.9	7882.9	7864.7	7861.9	7861.8	7853.9	7848.8	7822.1	7816.9	7813.8
7791.8	7786.7	7785.1	7781.1	7761.9	7760.7	7712.5	7705.9	7702.5	7697.7	7693.5	7688.8
7677.1	7676.5	7672.4	7662.7	7651.9	7624.5	7620.1	7605.7	7598.5	7592.8	7591.7	7581.5
7577.5	7573.1	7568.5	7536.5	7530.1	7529.5	7517.1	7514.4	7511.5	7511.5	7503.3	7501.5
7493.5	7488.1	7478.8	7468.1	7462.7	7457.5	7438.8	7431.4	7423.1	7406.1	7404.5	7403.5
7399.1	7393.5	7379.1	7371.4	7350.1	7345.3	7343.5	7340.1	7337.1	7334.7	7321.4	7319.4
7316.1	7304.1	7298.3	7270.1	7250.4	7244.8	7221.7	7221.4	7215.1	7200.1	7196.2	7174.2
7140.2	7139.1	7133.8	7132.1	7126.1	7121.8	7103.0	7085.4	7084.0	7080.3	7074.2	7039.8
7038.2	7026.8	7023.1	7020.1	7016.8	7015.0	6992.3	6990.8	6984.0	6961.0	6953.1	6933.8
6927.3	6923.5	6918.0	6909.2	6907.0	6905.5	6902.0	6899.2	6896.1	6888.0	6886.0	6881.0
6873.2	6871.8	6867.1	6851.0	6826.7	6819.0	6815.9	6807.3	6788.5	6785.0	6782.9	6753.0
6753.0	6738.5	6727.3	6720.0	6712.5	6709.5	6707.0	6706.0	6705.4	6705.0	6683.9	6680.5
6667.4	6665.9	6660.8	6648.8	6644.5	6641.9	6630.5	6630.0	6629.4	6618.0	6612.5	6609.9
6598.5	6595.3	6588.8	6566.9	6562.4	6554.4	6534.9	6533.7	6530.7	6521.5	6503.7	6488.4
6483.9	6483.2	6464.8	6453.8	6446.4	6437.2	6435.2	6425.4	6421.5	6419.2	6416.8	6410.1
6408.5	6398.5	6392.4	6392.4	6381.9	6381.9	6380.1	6379.4	6369.1	6358.1	6358.0	6354.2
6353.1	6350.9	6350.2	6341.4	6338.5	6333.9	6326.4	6311.9	6304.9	6301.2	6299.9	6299.9
6287.4	6281.4	6269.4	6252.5	6248.9	6242.4	6240.9	6239.9	6229.0	6228.2	6209.4	6207.0
6203.9	6194.9	6185.8	6171.1	6165.4	6164.9	6157.9	6135.0	6130.4	6130.4	6126.9	6121.9
6121.0	6120.9	6119.4	6114.9	6102.8	6083.9	6079.9	6063.1	6056.9	6056.9	6045.1	6041.9
6033.9	6012.9	6006.4	6004.0	6003.9	6000.4	5995.1	5989.9	5974.9	5972.1	5963.1	5952.9
5951.9	5950.9	5945.1	5929.2	5926.0	5919.4	5913.0	5905.2	5902.4	5899.4	5887.9	5884.4
5879.5	5873.1	5871.0	5851.5	5848.7	5847.5	5837.9	5822.4	5816.4	5809.9	5807.9	5806.4
5798.9	5792.9	5789.4	5777.5	5773.3	5773.1	5765.9	5765.5	5762.9	5758.1	5757.9	5751.9
5750.9	5737.4	5735.4	5729.1	5724.9	5721.9	5719.9	5715.1	5710.3	5707.3	5698.1	5696.9
5692.9	5684.4	5684.4	5677.8	5668.4	5665.4	5660.4	5659.3	5655.9	5655.1	5652.9	5652.9
5645.9	5642.4	5636.3	5636.1	5633.5	5625.5	5622.9	5619.9	5613.4	5612.4	5609.9	5605.5
5604.5	5600.9	5600.7	5597.3	5591.3	5588.7	5587.4	5584.1	5581.9	5581.5	5578.4	5574.9
5566.1	5565.5	5563.9	5557.5	5556.3	5553.5	5552.7	5552.4	5551.9	5547.3	5544.5	5543.9
5537.7	5530.5	5526.4	5517.1	5515.3	5511.5	5500.2	5499.4	5490.5	5481.4	5477.3	5476.1
5472.5	5470.1	5462.9	5462.1	5459.9	5454.3	5452.3	5452.1	5451.3	5448.3	5435.5	5428.1
5426.1	5425.3	5423.1	5422.9	5421.3	5420.3	5420.1	5419.4	5417.4	5414.4	5410.3	5409.3
5408.9	5403.5	5400.1	5399.5	5383.1	5382.1	5376.9	5366.1	5364.3	5362.9	5352.4	5349.1
5320.3	5318.9	5304.9	5300.1	5297.9	5284.9	5272.9	5272.1	5261.4	5252.5	5249.3	5247.4
5223.3	5222.5	5222.1	5220.5	5218.1	5199.1	5196.3	5187.1	5170.5	5165.4	5154.1	5153.4
5149.1	5147.9	5146.1	5142.1	5140.1	5127.3	5118.5	5115.3	5102.4	5097.3	5093.5	5089.5
5075.5	5052.3	5042.4	5026.4	5013.4	5002.1	4984.3	4960.3	4941.1	4920.1	4912.4	4896.4

Figure 5-10. ULMOD LDC from Chronological Residuals

***** FOR MONTH 1 THE ACCUMULATED LOAD DURATION CURVE CREATED FROM THE FULL POWER-PROBABILITY DATA.

9832.1	9619.2	9538.6	9478.3	9427.4	9386.0	9364.8	9344.4	9321.6	9296.8	9272.2	9256.3
9246.6	9233.5	9214.7	9200.9	9185.3	9174.2	9160.4	9142.2	9131.5	9119.8	9109.6	9097.4
9090.3	9082.1	9073.3	9066.5	9059.4	9051.2	9042.0	9034.0	9022.6	9009.6	9000.7	8992.6
8980.3	8970.6	8957.5	8952.2	8947.6	8938.6	8932.7	8928.5	8921.4	8913.9	8907.7	8900.4
8892.9	8885.4	8880.7	8875.4	8868.3	8859.2	8854.8	8850.8	8845.0	8836.0	8829.6	8823.5
8815.6	8808.4	8799.3	8792.9	8788.4	8784.2	8778.5	8773.0	8770.0	8762.6	8757.9	8754.2
8749.7	8743.4	8739.1	8732.6	8727.8	8719.9	8713.8	8705.8	8702.7	8697.8	8693.6	8685.6
8680.5	8677.9	8674.2	8670.6	8665.6	8657.8	8652.9	8649.9	8647.9	8644.0	8638.8	8634.5
8629.2	8621.2	8617.4	8611.7	8608.4	8606.6	8605.2	8602.4	8600.5	8596.7	8591.8	8587.3
8582.7	8578.3	8574.4	8569.3	8563.5	8560.4	8557.1	8552.7	8546.9	8541.2	8535.8	8531.5
8525.3	8523.9	8520.4	8518.1	8516.3	8513.2	8508.0	8503.5	8500.1	8498.0	8494.8	8491.8
8487.1	8481.1	8476.5	8472.3	8470.3	8468.6	8465.6	8462.4	8459.4	8456.5	8452.0	8447.7
8442.5	8440.2	8436.5	8430.8	8427.8	8426.1	8424.2	8421.7	8420.5	8416.2	8410.9	8407.1
8405.0	8403.2	8398.5	8393.7	8389.5	8385.8	8381.8	8378.9	8374.5	8369.6	8366.7	8363.7
8361.7	8359.8	8357.7	8355.8	8352.4	8348.4	8344.3	8342.7	8339.5	8338.0	8336.6	8334.8
8330.6	8326.7	8324.8	8321.5	8318.9	8317.2	8314.9	8311.8	8308.3	8303.7	8298.7	8294.3
8291.0	8288.8	8284.9	8281.4	8278.9	8278.4	8276.1	8269.0	8261.7	8254.1	8253.6	8250.0
8246.4	8243.1	8241.2	8236.7	8232.3	8229.6	8226.9	8225.6	8224.3	8221.3	8218.5	8216.3
8208.2	8205.1	8202.3	8200.3	8195.9	8190.9	8188.7	8185.4	8182.3	8181.4	8179.6	8177.6
8175.1	8172.9	8169.0	8164.5	8162.6	8159.5	8157.7	8155.4	8151.2	8146.9	8145.2	8142.2
8138.9	8136.2	8133.6	8129.7	8127.7	8122.2	8119.2	8114.3	8105.6	8100.0	8095.4	8090.3
8086.5	8083.2	8079.5	8076.5	8071.7	8063.5	8059.4	8053.3	8051.3	8048.0	8046.7	8045.4
8041.7	8033.2	8029.9	8026.4	8022.8	8018.7	8012.1	8008.1	8003.5	8001.3	7998.3	7994.5
7986.7	7982.8	7979.2	7975.1	7968.9	7965.5	7962.8	7959.0	7954.2	7951.0	7947.5	7940.8
7936.9	7925.7	7918.1	7910.2	7904.3	7898.6	7894.2	7886.6	7879.3	7873.3	7868.8	7865.6
7860.1	7852.9	7847.7	7842.2	7833.4	7824.9	7814.7	7805.4	7801.3	7795.5	7788.8	7784.1
7778.6	7771.3	7764.7	7759.5	7752.7	7738.9	7724.5	7716.3	7709.9	7702.1	7697.2	7692.2
7685.6	7680.1	7675.9	7668.3	7658.7	7647.4	7637.9	7624.8	7614.1	7605.4	7600.2	7591.8
7586.3	7580.0	7573.2	7558.7	7539.9	7532.6	7525.4	7520.2	7517.5	7513.1	7506.0	7499.4
7493.5	7486.5	7478.1	7467.4	7454.2	7441.9	7430.8	7420.8	7409.4	7407.1	7401.2	7395.9
7383.7	7374.5	7356.1	7349.7	7341.0	7337.7	7329.4	7323.1	7317.9	7310.4	7305.6	7294.7
7285.9	7272.8	7263.3	7253.5	7238.6	7227.8	7222.0	7214.0	7203.7	7200.1	7190.3	7174.4
7166.3	7155.1	7143.6	7139.2	7132.8	7126.7	7114.5	7104.4	7092.5	7089.5	7083.8	7075.6
7068.1	7054.2	7046.3	7037.4	7028.6	7022.6	7016.9	7004.9	6997.1	6985.4	6970.1	6962.8
6954.5	6943.7	6934.7	6925.6	6915.9	6911.0	6906.4	6899.3	6894.2	6890.9	6884.7	6875.6
6866.9	6857.0	6849.1	6842.1	6830.8	6825.3	6817.0	6810.2	6800.6	6792.2	6785.7	6774.6
6760.2	6755.5	6744.5	6737.2	6730.9	6724.0	6717.4	6711.4	6711.1	6707.6	6700.4	6689.6
6680.9	6671.0	6666.1	6654.1	6647.9	6640.6	6633.3	6625.6	6619.7	6613.2	6606.7	6601.9
6593.5	6582.3	6575.3	6566.8	6560.2	6552.2	6543.0	6537.5	6534.4	6531.7	6526.9	6520.3
6509.7	6503.8	6493.9	6488.9	6484.5	6474.2	6465.8	6456.1	6448.0	6441.4	6436.4	6426.7
6424.9	6421.0	6413.7	6407.7	6395.4	6391.8	6386.8	6381.8	6375.6	6366.0	6358.8	6355.3
6351.7	6345.1	6341.5	6332.2	6324.1	6313.5	6309.6	6305.7	6303.1	6296.0	6288.8	6277.2
6268.0	6259.9	6251.8	6245.7	6243.5	6238.3	6231.7	6222.3	6215.1	6210.6	6205.7	6197.5
6190.1	6183.2	6177.4	6173.9	6168.2	6162.4	6156.4	6146.4	6138.4	6132.7	6129.7	6126.0
6123.2	6117.3	6110.2	6102.0	6092.3	6085.3	6077.4	6067.3	6064.3	6060.8	6053.0	6046.7
6038.2	6031.5	6026.1	6016.5	6009.1	6004.5	5998.5	5994.4	5988.7	5982.6	5976.9	5969.5
5962.1	5956.6	5953.8	5949.6	5946.9	5942.7	5937.2	5932.4	5926.0	5918.5	5911.5	5906.3
5902.7	5894.8	5888.3	5883.4	5879.0	5873.7	5866.4	5859.1	5851.4	5846.1	5840.5	5836.3
5830.1	5825.1	5819.3	5817.1	5811.6	5806.1	5801.4	5795.7	5792.6	5787.6	5782.4	5777.5
5774.9	5769.7	5767.5	5764.5	5759.9	5754.9	5750.0	5745.1	5739.5	5736.6	5732.6	5729.2
5726.0	5721.4	5715.0	5710.1	5704.0	5699.3	5695.9	5687.4	5683.3	5674.3	5668.8	5662.9
5660.2	5657.5	5654.2	5647.2	5642.6	5638.4	5635.8	5632.1	5627.9	5623.4	5616.6	5613.4
5608.7	5606.6	5603.5	5601.4	5598.5	5594.8	5591.8	5589.3	5586.5	5584.2	5580.4	5577.2
5569.9	5566.2	5560.5	5557.4	5554.2	5550.7	5548.5	5545.9	5539.0	5533.9	5528.9	5523.0
5518.4	5511.4	5504.5	5500.1	5491.0	5483.3	5480.9	5478.0	5474.7	5469.6	5464.8	5459.4
5455.9	5453.5	5448.1	5440.6	5435.1	5430.3	5428.0	5426.4	5423.4	5421.4	5418.0	5413.8
5410.9	5406.6	5404.8	5402.1	5398.0	5389.3	5384.4	5380.7	5376.6	5371.4	5367.9	5363.3
5354.3	5347.7	5339.8	5333.8	5326.1	5322.5	5314.8	5305.2	5301.2	5295.4	5288.0	5282.0
5277.1	5274.2	5268.0	5259.1	5252.0	5248.1	5244.1	5238.7	5233.5	5226.8	5224.1	5221.5
5210.6	5203.0	5197.0	5188.3	5180.2	5170.7	5162.2	5153.4	5147.2	5142.7	5132.5	5122.5
5114.6	5101.8	5096.6	5090.4	5079.0	5070.9	5051.5	5044.3	5037.8	5023.5	5010.2	4993.5
4978.6	4967.6	4954.8	4937.5	4921.0	4909.6	4888.5	4852.9	4817.0	4771.2	4732.2	4627.6

Figure 5-11. ULMOD Accumulated LDC from Power-Probability Data

***** FOR MONTH 1 THE CHRONOLOGICAL ESTIMATE MADE FROM THE ACCUMULATED FULL POWER-PROBABILITY DATA.

DAY 1	5726.0	5418.0	5224.1	5114.6	5142.7	5221.5	5197.0	5548.5	5806.1	5932.4	5976.9	5949.6
	5902.7	5782.4	5710.1	5840.9	6582.3	7227.8	7222.0	7104.4	6962.8	6421.0	5888.3	5354.8
DAY 2	5252.0	5188.3	5162.2	5238.7	5469.6	6309.6	7341.0	8095.4	9109.6	8560.4	8226.9	8317.2
	8274.3	8172.9	8213.5	8188.7	8788.4	9427.4	9131.5	8823.5	8498.0	7647.4	6934.7	6102.0
DAY 3	5846.1	5638.4	5601.4	5589.3	5859.1	6456.1	7580.0	8355.8	8674.2	8644.0	8472.3	8318.9
	8288.5	8181.4	8105.6	7918.1	8525.3	9272.2	9022.6	8762.6	8421.7	7697.2	6997.1	6156.4
DAY 4	5866.4	5642.6	5598.5	5569.9	5851.4	6484.5	7525.4	8232.3	8508.0	8516.3	8468.6	8225.6
	8202.3	8146.9	8026.4	7910.2	8773.0	9160.4	9034.0	8685.6	8281.4	7558.7	6842.1	6162.4
DAY 5	5801.4	5608.7	5533.9	5500.1	5819.3	6520.3	7539.9	8420.5	8705.8	8799.3	8829.6	8680.5
	8693.6	8608.4	8552.7	8520.4	8952.2	9296.8	8947.6	8587.3	8119.2	7493.5	6985.4	6286.8
DAY 6	5586.5	5557.4	5398.0	5326.1	5371.4	5715.0	5953.8	6534.4	6849.1	7174.4	7132.8	7068.1
	6911.0	6785.7	6654.1	6700.4	7506.0	7873.3	7738.9	7520.2	7126.7	6800.6	6197.5	5668.8
DAY 7	5295.4	5051.5	4967.6	4909.6	4921.0	5037.8	5153.4	5594.8	5982.6	6341.5	6426.7	6465.8
	6324.1	6303.1	6177.4	6305.7	6954.5	7605.4	7454.2	7238.6	7004.9	6531.7	5937.2	5435.1
DAY 8	5268.0	5147.2	5210.6	5180.2	5478.0	6168.2	7200.1	7994.5	8407.1	8462.4	8403.2	8185.4
	8195.9	8129.7	8136.2	8162.6	8754.2	9321.6	9142.2	8808.4	8339.5	7586.3	6875.6	6243.5
DAY 9	5830.1	5613.4	5430.3	5305.2	5623.4	6259.5	7253.5	8059.4	8352.4	8535.8	8487.1	8138.9
	8169.0	8048.0	7979.2	7847.7	8393.7	9119.8	9009.6	8702.7	8255.6	7499.4	6774.6	6060.8
DAY 10	5759.9	5528.9	5423.4	5453.5	5769.7	6413.7	7317.9	8079.5	8334.8	8452.0	8357.7	8063.5
	8145.2	8029.9	7975.1	7824.9	8330.6	9233.5	8970.6	8605.2	8190.9	7517.5	6737.2	6046.7
DAY 11	5683.3	5566.2	5464.8	5459.4	5699.3	6381.8	7285.9	8071.7	8374.5	8366.7	8398.5	8157.7
	8236.7	8155.4	7959.0	7805.4	8344.3	9066.5	8954.8	8582.7	8127.7	7374.5	6625.6	5956.6
DAY 12	5754.9	5483.3	5406.6	5384.4	5627.9	6110.2	7272.6	7833.4	8359.8	8465.6	8426.1	8122.2
	8192.3	8033.2	7898.6	7752.7	7962.8	8757.9	8649.9	8291.0	7852.9	7329.4	6760.2	6077.4
DAY 13	5606.6	5247.7	5301.2	5259.1	5376.6	5695.9	5894.8	6526.9	6894.2	7166.3	7046.3	6866.9
	6689.6	6640.6	6575.3	6566.8	7263.3	7778.6	7600.2	7305.6	7028.6	6633.3	6123.2	5577.2
DAY 14	5244.1	4978.6	4852.9	4771.2	4627.6	4954.8	5079.0	5518.4	5998.5	6210.6	6375.6	6503.8
	6606.7	6671.0	6666.1	6817.0	7337.7	7692.2	7624.8	7349.7	7075.6	6593.5	6016.5	5448.1
DAY 15	5274.2	5203.0	5070.9	5170.7	5280.7	6132.7	7323.1	8179.6	8629.2	8770.0	8907.7	8697.8
	8727.8	8739.1	8719.9	8617.4	9042.0	9538.6	9073.3	8845.0	8410.9	7573.2	6825.3	6064.3
DAY 16	5750.0	5550.7	5428.0	5426.4	5657.5	6268.0	7467.4	8259.1	8557.1	8513.2	8298.7	8205.1
	8250.0	8456.5	8296.3	8114.3	8665.6	9256.3	9000.7	8652.9	8278.3	7513.1	6792.2	6126.0
DAY 17	5774.9	5511.4	5367.9	5339.8	5545.9	6251.8	7407.1	8046.7	8385.8	8405.0	8361.7	8022.8
	8045.4	8012.1	7951.0	7842.2	8229.6	9082.1	8921.4	8657.8	8241.2	7591.8	6707.6	5994.4
DAY 18	5635.8	5480.9	5389.3	5404.8	5580.4	6238.3	7356.1	8041.7	8442.5	8518.1	8500.1	8369.6
	8459.4	8381.8	8208.2	8090.3	8436.5	9364.8	9185.3	8859.2	8427.8	7709.9	6915.9	6225.3
DAY 19	5962.1	5795.7	5654.2	5732.6	5918.5	6560.2	7685.6	8348.4	8476.5	8546.9	8324.8	8076.5
	8053.3	8003.5	7865.6	7658.7	7936.9	8880.7	8732.6	8424.2	8018.7	7532.6	6890.9	6129.7
DAY 20	5825.1	5584.2	5491.0	5410.9	5504.5	5836.3	6053.0	6537.5	6970.1	7083.8	7037.4	6925.6
	6755.5	5523.0	6493.9	6509.7	7089.5	7814.7	7702.1	7420.8	7054.2	6647.9	6146.4	5616.6
DAY 21	5248.1	4993.5	4888.5	4817.0	4732.2	4937.5	5132.5	5603.5	6067.3	6296.0	6351.7	6355.3
	6245.7	6085.3	6092.3	6183.2	6744.5	7478.1	7310.4	7214.0	6857.0	6424.9	5946.9	5402.1
DAY 22	5101.8	5010.2	5023.5	5090.4	5288.0	6138.4	7203.7	7965.5	8326.7	8389.5	8342.7	8001.3
	8159.5	8151.2	7954.2	7886.6	8363.7	9059.4	8850.8	8638.8	8142.2	7395.9	6713.4	6009.1
DAY 23	5660.2	5474.7	5363.3	5413.8	5721.4	6467.7	7409.4	8100.0	8416.2	8430.8	8303.7	7982.8
	7998.3	7986.7	7868.8	7788.8	8261.7	9051.2	8879.4	8621.2	8176.1	7401.2	6613.2	5988.7
DAY 24	5560.5	5333.8	5277.1	5282.0	5591.8	6205.7	7383.7	8086.5	8447.7	8541.2	8470.3	8200.3
	8246.4	8164.5	7947.5	7894.2	8210.3	9097.4	8932.7	8611.7	8177.6	7441.9	6717.4	6038.2
DAY 25	5662.9	5455.9	5421.4	5440.6	5704.0	6332.2	7486.5	8269.1	8523.9	8569.3	8494.8	8321.5
	8284.5	8221.3	8051.3	8008.1	8338.0	9386.0	9174.2	8885.4	8503.5	7724.5	6884.7	6231.7
DAY 26	5911.5	5777.5	5736.6	5787.6	6026.1	6711.1	7764.7	8481.1	8602.4	8531.5	8574.4	8265.0
	8224.5	8083.2	7925.7	7716.3	7904.3	8938.6	8815.6	8336.6	8243.1	7614.1	7022.6	6277.2
DAY 27	5969.5	5817.1	5687.4	5674.3	5767.5	6004.5	6366.0	6830.8	7139.2	7190.3	7155.1	6899.3
	6730.9	6543.0	6436.4	6395.4	6810.2	7801.3	7668.3	7294.7	7143.6	6724.0	6219.1	5729.2
DAY 28	5314.8	5226.8	5044.3	5096.6	5122.5	5233.5	5322.5	5879.0	6173.9	6441.4	6386.8	6474.2
	6448.0	6313.5	6488.9	6601.9	7016.9	7784.1	7771.3	7675.9	7430.8	6943.7	6358.8	5792.6
DAY 29	5632.1	5539.0	5554.2	5647.2	5906.3	6680.9	7795.5	8606.6	8778.5	8784.2	8670.6	8308.3
	8314.9	8133.6	7968.9	7860.1	8311.8	9214.7	9090.3	8980.3	8578.3	7940.8	7114.5	6345.1
DAY 30	6031.5	5883.4	5739.5	5764.5	5942.7	6619.7	7759.5	8600.5	8836.0	8957.5	8900.4	8792.9
	8913.9	8992.6	8928.9	8892.9	9344.4	9832.1	9615.2	9200.9	8743.4	7879.3	7092.5	6391.8
DAY 31	6117.3	5873.7	5811.6	5745.1	5926.0	6552.2	7637.9	8378.9	8647.9	8596.7	8713.8	8491.8
	8563.5	8634.5	8677.9	8591.8	8749.7	9478.3	9246.6	8868.3	8440.2	7680.1	6906.4	6190.1

Figure 5-12. ULMOD Estimated Chronological Order

```
/JOB
ULMOD,T600.
ACCOUNT,DUM1234.
REQUEST,ULMODX,*PF.
REQUEST,DATA.
REQUEST,TAPE9.
REQUEST,TAPE10.
REQUEST,TAPE11,A2.
REQUEST,TAPE20,A2.
REQUEST,TAPE21,A2.
REQUEST,TAPE22,A1.
REQUEST,TAPE23,A2.
REQUEST,TAPE24,A2.
REQUEST,TAPE25,A0.
REQUEST,TAPE26,A0.
FILE,DATA,FL=80.
FILE,TAPE9,FL=80.
FILE,TAPE10,FL=80.
FILE,TAPE11,FL=132.
GETPF,DATA,ULDATA,ID=UID.
GETPF,TAPE9,SOLAR,ID=UID.
GETPF,TAPE10,LOADS,ID=UID.
ATTACH,ULMODX,ID=UID,PW=PSWORD.
COMMENT. PURGE,ULMODX,ID=UID.
COMMENT. FILE,ULMOD,FL=132.
COMMENT. GETPF,ULMOD,ULMOD,ID=UID.
COMMENT. FTN,I=ULMOD,R=ULMODX,R=0,L=0,ER,OPT=2.
COMMENT. CATALOG,ULMODX,ID=UID,XR=PSWORD.
COMMENT. AUDIT,ID=UID.
ULMODX.
REWIND,DATA.
COPYSBF,DATA,OUTPUT.
REWIND,TAPE11.
CATALOG,TAPE11,SAVEF,ID=UID.
EXIT.
/EOR
```

(Lines beginning in "COMMENT." are inactive, but removing the "COMMENT." will activate the command.)

Figure 5-13. Sample Runstream for ULMOD

SECTION 6.0

FINAM - FINANCIAL ANALYSIS MODEL

The purpose of FINAM is to determine the value of the alternative generation penetration assumed for each change case when compared with the base case. The inputs to this model are derived from the execution of electric utility expansion planning and production cost models. The results are the gross and marginal value of each alternative generation penetration. Refer to Sec. 7.0 of Vol. I for a description of the specific calculations performed in FINAM.

6.1 FACILITY SPECIFICS

FINAM uses a commercially available polynomial curve-fitting routine in the process of developing the marginal values. The routines are from the International Mathematical and Statistical Library (IMSL) and are called from the subroutine CFIT. If the IMSL package is not available, any other polynomial fitting routine can be used. The comments contained in CFIT should assist in this matter.

FINAM uses a LEVEL 2 statement within several routines. This command designates that specific data are to reside in the large central memory of a CDC 7600 computer. For use on other computers, delete all occurences of the LEVEL 2 command and the preceding comment cards. Also, CDC equipment requires a PROGRAM card before the main routine. If CDC hardware is not used, this card may not be needed.

Like most other routines, FINAM utilizes a free format or list-directed input for data. This means that the data does not have to reside in specific fields on the cards but that each data value need only be separated by a space or comma. Most versions of FORTRAN have an equivalent input capability. The CDC version uses a * in place of a format number in the READ command. Each free-formatted data card type is usually preceded by a single, user-provided comment card that has no operational effect. Its purpose is to assist the user when making modifications to a data set.

6.2 FINAM INPUT DATA

Figure 6-1 is a listing of a sample set of manually created card type data required by FINAM. Card types A and B are required for all FINAM executions. Card type B determines if types C through S are required. If required, types E through I supply to FINAM the operational result of the utility planning models for the base case (L = 1) and each change case (L = 2, NCASES + 1). Card types E through I are grouped together first for the base case and then for each change case. These groups are followed by card types K through T, which provide to FINAM specific data concerning each conventional generating unit type. First come groups of types K through N to cover operating cost parameters for each generation type. These are followed by a group of types O through Q cards to cover capital cost parameters for each generation type. These groups are followed by a single group of type R

through T cards to cover expected unserved energy parameters. Card types U through BB are needed only if sensitivity studies are to be performed.

6.2.1 Title (Card Type A)

FORMAT (20A4)

Do not precede card type A with a comment card.

For future reference, the title for the initial execution of FINAM should be descriptive of the particular data being input. This card is required and has a maximum of 80 characters.

6.2.2 Sensitivity Run Flag (Card Type B)

FORMAT (FREE)

This card type must be preceded by a comment card.

ISENSI -- Flags whether this is a normal execution (ISENSI $\leq$ 0) or a sensitivity-only execution (ISENSI $\geq$ 1) where all initial data is provided from a computer data file (unit number 11 or "TAPE11") created by a previous normal execution. If ISENSI $\geq$ 1, card types C through T must not be provided. If ISENSI $\leq$ 0, card types C through T must be provided.

6.2.3 Execution Descriptive Information (Card Type C)

FORMAT (FREE)

This card type must be preceded by a comment card.

IYRPW -- Present worth year for all the reported results

PWDISC -- Present worth discount rate, percent

GNPDEF -- GNP deflator, percent

NSIM -- Number of years of detailed simulation data to be provided, $\leq$ 20

NCAPYR -- Number of capacity addition years to be used, $\leq$ 20

NCASES -- Number of change cases to be analyzed in this execution, $\leq$ 10

NGENT -- Number of conventional generation types, $\leq$ 12

NYRAGN -- Expected life of alternative generation device, years

FCRAGN -- Assumed fixed charge rate for alternative generation device, percent

ICOST -- Flag to designate when costs are incurred;
$\leq$ 0, assume costs at end of year = DOE-EPRI standard
$\geq$ 1, assume costs at beginning of year

6.2.4 Base Case Identifier (Card Type D)

FORMAT (NONE)

This card type is simply a comment card corresponding to the comment preceding card type J. All the base-case system cost data must precede the change cases.

6.2.5 Generation Type Capacity Additions (Card Type E)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. There must be one type E card for each simulation year (J = 1, NSIM), and a value must be given for each generation type (K = 1, NGENT). The years must be in increasing order.

IYR(J) -- Year this card is for; e.g., 1985

CAPADD(J,K,L) -- Added capacity of all generation types this year (MW):
K = 1, NGENT
L = 1 for base case
L = 2, (NCASES+1) for change cases.

6.2.6 Total Operating Cost and All Fuel Costs (Card Type F)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. There must be one type F card for each simulation year (J = 1, NSIM), and a value must be given for each generation type.

IYR(J) -- Year this card is for

SSDAT(J,1,L) -- Total operating cost (1000$)

SYSDAT(J,K,L) -- Fuel cost for each generation type:
K = 2, (1 + NGENT)
L = 1 for base case
L = 2, (NCASES+1) for change cases

6.2.7 Fixed O&M Operating Costs (Card Type G)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. There must be one type G card for each simulation year (J = 1, NSIM), and a value must be given for each generation type.

IYR(J) -- Year this card is for

SYSDAT(J,K,L) -- Fixed O&M cost for each generation type (1000$);
K = 12, (11+NGENT)
L = 1 for base case
L = 2, (NCASES+1) for change cases

6.2.8 Variable O&M Operating Costs (Card Type H)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. There must be one type H card for each simulation year (J = 1, NSIM), and a value must be given for each generation type.

IYR(J) -- Year this card is for

SYSDAT(J,K,L) -- Variable O&M costs for each generation type (1000$):
K = 22, (21+NGENT)
L = 1 for base case
L = 2, (NCASES+1) for change case

6.2.9 System Unserved Energy Cost (Card Type I)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. There must be one type I card for each simulation year (J = 1, NSIM).

IYR(J) -- Year this card is for

SYSDAT(J,38,L) -- System cost of expected unserved energy (1000$):
L = 1 for base case
L = 2, (NCASES+1) for change cases

6.2.10 Change Case Title and Capacity (Card Type J)

FORMAT (3A4,1X,F10.1)

This card type must be preceded by a comment card.

CASETL(I,L) -- Change case title;
I = 1,3

CASCAP(L) -- Change case alternative generation capacity (MW);
L = 1, NCASES

The type J card will be followed by type E,F,G,H, and I cards for the system cost information data for this change case. A group of J,E,F,G,H, and I cards is required for each change case. The value of L increases for each change case.

6.2.11 Generating Unit Type Title (Card Type K)

FORMAT (3A4)

This card type must be preceded by a comment card.

GENTL(I,L) -- Conventional generating unit type title:
I = 1,3
L = 1, NGENT

A set of K, L, and M cards must be provided for each generating unit type. There will, therefore, be NGENT groups of K, L, and M cards.

6.2.12 Generation Type Costs (Card Type L)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. There must be one type L card for each simulation year (J = 1, NSIM).

IYR(J) -- Year this data is for

GENDAT(J,K) -- Generation specific data:
K = 1 - Fuel Cost ($/MBtu)
K = 2 - Fixed O&M ($/kW/yr)
K = 3 - Variable O&M ($/MWh)

6.2.13 Number of Escalation Time Periods (Card Type M)

FORMAT (FREE)

This card must be preceded by a comment card. This card must not be included if there are no calculations beyond the last simulation year (IYREXT ≤ last simulation year).

NESFCS -- Number of fuel cost escalation time periods for this generation type (1 ≤ NESFCS ≤ 10)

NESFOM -- Number of fixed O&M cost escalation time period (1 ≤ NESFOM ≤ 10)

NESVOM -- Number of variable O&M cost escalation time periods (1 ≤ NESVOM ≤ 10)

6.2.14 Escalation Time Period Data (Card Type N)

FORMAT (FREE)

This group of cards must not be preceded by a comment card. The number of type N cards required is equal to the larger of NESFCS, NESFOM, and NESVOM given on the above type M card. A value must be provided on each card for

each variable listed below. If the number of escalation periods desired are not equal (e.g., NESFCS = 3 and NESFOM = NESVOM = 1), then any number may be entered for the latter card entries for these cost components (e.g., second and third type N cards may have ESFOM (IZ,IQ) = ESVOM (IZ,IQ) = any number for IZ = 2 and 3 and IQ = 1 and 2). The year numbers given must increase from one card to the next.

ESFCST(IZ,1) -- Beginning year for fuel cost escalation period IZ

ESFCST(IZ,2) -- Escalation rate (percentage) for IZ

ESFOM(IZ,1) -- Beginning year for fixed O&M cost escalation period IZ

ESFOM(IZ,2) -- Escalation rate (percentage) for IZ

ESVOM(IZ,1) -- Beginning year for variable O&M cost escalation period IZ

ESVOM(IZ,2) -- Escalation rate (percentage) for IZ

6.2.15 Capital Costs (Card Type O)

FORMAT (FREE)

A single comment card must precede this group of cards. There must be one type O card for each capacity addition year (J = 1, NCAPYR) and a value must be given for each generation type (K = 1, NGENT).

ICAPYR(J) -- Year this card is for

CAPCST(K,J) -- Capital cost ($/KW) for each generation type; K = 1, NGENT

6.2.16 Fixed Charge Rate for Capital Costs (Card Type P)

FORMAT (FREE)

A single comment card must precede this group of cards. There must be one type P card for each capacity addition year (J = 1, NCAPYR), and a value must be given for each generation type (K = 1, NGENT).

FCR(K) -- Fixed Charge Rate (percentage);
K = 1, NGENT

6.2.17 Fixed Charge Rate Years (Card Type Q)

FORMAT (FREE)

A single comment card must precede this group of cards. There must be one type Q card for each capacity addition year (J = 1, NCAPYR), and a value must be given for each generation type (K = 1, NGENT).

NFCRYR(K) -- Number of payout years fixed charge rate was based on;
K = 1, NGENT

6.2.18 Expected Unserviced Energy Cost (Card Type R)

FORMAT (FREE)

A single comment card must precede this group of cards. A type R card must be provided for each simulation year (J = 1, NSIM).

IYR(J) -- Year these data are for

EUE(J) -- Cost of expected unserviced energy in this year ($/MWh)

6.2.19 Number of Escalation Periods for Expected Unserviced Energy (Card Type S)

FORMAT (FREE)

A comment card must precede this card. This card must not be given if there are to be no calculations beyond the last simulation year.

NESEUE -- Number of escalation periods

6.2.20 Escalation Data for Expected Unserved Energy (Card Type T)

FORMAT (FREE)

This group of cards must not be preceded by a comment card. The number of type T cards needed is equal to NESEUE given on the type S card above. The year numbers provided must increase from card to card.

ESEUE(IZ,1) -- Beginning year for expected unserved energy costs escalation period IZ

ESEUE(IZ,2) -- Escalation rate (percentage) for IZ

6.2.21 Sensitivity Title (Card Type U)

FORMAT (20A4)

Do not precede card type U with a comment card.

The title of the sensitivity case to be performed using the information that follows. Any number of sensitivity cases may be requested, but only one at a time. This request requires providing groups of card types U and V, plus additional types indicated in the discussion of each TSTSEN option on type V. To indicate the end of requested sensitivity cases, the flag "XXXX" is used on card type V.

6.2.22 Sensitivity Option and Variables (Card Type V)

FORMAT (FREE)

This card type does not require a preceding comment card since card type U serves this function.

TSTSEN -- Defines which single sensitivity changes are to be made. This flag consists of four alphanumeric characters in quotation marks. The quotation marks comply with FREE format requirements. Only one of the following sensitivities may be examined at a time.

"XXXX" -- No more sensitivity cases are desired

"MISC" -- Wish to change the present worth discount year, the life or fixed charge rate of the alternative generation device and/or assumption about when costs are incurred:
Requires a card type W to follow

"PWD " -- Wish to change present worth discount rate or GNP deflator;
Requires a card type X to follow

"FCST" -- Wish to change one or more generating types' fuel costs;
Requires card types Y, Z, and/or AA with BB to follow

"CAP " -- Wish to change one or more generating types' capital cost;
Requires card types Y and Z to follow

"FOM " -- Wish to change one or more generating types' fixed O&M costs;
Requires card types Y, Z, and/or AA with BB to follow

"VOM " -- Wish to change one or more generating types' variable O&M costs;
Requires card types Y, Z, and/or AA with BB to follow

"EUE " -- Wish to change the system expected unserved energy cost;
Requires card types Z and/or AA with BB to follow

IEXT -- This flags whether the sensitivity case is to: (1) change the cost in each simulation year and the escalation rate for extension calculations (IEXT $\leq$ or (2) change only the extension escalation rate (IEXT $\geq$ 1). The user should not attempt to set IEXT $\geq$ 1 if extension calculations are not desired (type C card, IYREXT).

NCHNG -- For TSTSEN = "FCST", "CAP ", "FOM ", and "VOM ", the desired number of generating unit types that wish to make a change in cost

6.2.23 Sensitivity--Miscellaneous (Card Type W)

FORMAT (FREE)

This card type must be preceded by a comment card. This card is needed only if TSTSEN = "MISC".

IYRPW -- Year for all present worth results

NYRAGN -- Expected life of alternative generation device, years

FCRAGN -- Assumed fixed charge rate of alternative generation device, percentage

ICOST -- Flag to designate when costs are incurred;
≤ 0, assume costs at end of year = DOE-EPRI standard
≥ 1, assume costs at beginning of year

6.2.24 Sensitivity--Discount Rate (Card Type X)

FORMAT (FREE)

This card type must be preceded by a comment card. This card is needed only if TSTSEN = "PWD".

PWDISC -- Present worth discount rate; percentage

GNPDEF -- GNP deflator; percent

6.2.25 Sensitivity--Generation Types (Card Type Y)

FORMAT (FREE)

Preceded by a comment card, this card type must be provided if TSTSEN = "FCST", "CAP ", "FOM " or "VOM ".

IGENCG(JJ) -- Numeric identifier of the generation type (types) to which a cost change is desired;
JJ = 1, NCHNG

6.2.26 Sensitivity--Cost Changes (Card Type Z)

FORMAT (FREE)

This group of cards must be preceded by a single comment card. This card type must be provided only if

(1) TSTSEN = "FCST", "CAP ", "FOM ", or "VOM " and IEXT ≤ 0, or

(2) TSTSEN = "EUE ".

One type W card is needed for each simulation year; J = 1, NSIM.

IYR(J) -- Year this data is for

RNEW(JJ) -- New cost for generation type JJ = IGENCG (J), J = 1, NCHNG; New costs given as $/MMBTU, $/KW, $/KW/YR, $/MWh or $/MWh if TSTSEN = "FCST", "CAP ", "FOM ", "VOM ", or "EUE ", respectively

6.2.27 Sensitivity--Number of Escalation Periods (Card Type AA)

FORMAT (FREE)

A single comment card must precede only the first type AA card. A group of types AA and BB cards will be required for each generation type (NCHNG) if TSTSEN = "FCST", "FOM ", or "VOM ". A single group is needed of TSTSEN = "EUE ".

NES -- Number of escalation periods (1 ≤ NES ≤ 10)

6.2.28 Sensitivity--Escalation Data (Card Type BB)

FORMAT (FREE)

A group of type BB cards must follow immediately after the type AA card. A comment card is not allowed. The number of BB cards required is equal to NES given on the AA card. The year numbers input must increase from card to card.

ES(IZ,1) -- Beginning year for escalation period IZ

ES(IZ,2) -- Escalation rate (percentage) for IZ

6.3 PRINTED OUTPUTS

FINAM printed outputs begin with all data input by card types (Fig. 6-2). If this execution is for sensitivity cases only, then the same output is produced using the original execution's input data. Each page has the title provided by input displayed across the top. If this is not a sensitivity-only execution, the results, using the original data, are presented on a separate page (Fig. 6-3). These results include, for each change case or alternative generation penetration, the change case title, capacity in MW, total value when compared with the base case (1000$), the gross and marginal breakeven value per installed kW, and the coefficients of the gross and marginal value polynomial curve fits.

Each sensitivity case first reports the data being changed (Fig. 6-4) and then the results exactly as already described.

6.4 SAMPLE CONTROL CARD SEQUENCE

A sample control card sequence necessary to run FINAM is given as Fig. 6-5. This runstream uses the CDC-SCOPE operating system.

```
***** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****
***** BASE CASE WITH 2 CHANGE CASES (10,254 WIND MACHINES)
0
IYRPW,PWDISC,GNPDEF,NSIM,NCAPYR,NCASES,NGENT,NYRAGN,FCRAGN,ICOST
     1980   15.0  10.1  4  4  2  11  30  21.9  0
***** BASE CASE - NO TITLE NEEDED.
     YEAR - CAP. TO ADD TO ALL GEN. TYPES (MW).
1980          0.0          0.0          0.0          0.0          0.0
      0.0        0.0        0.0        0.0        0.0        0.0
1983         81.         64.0          0.0          0.0          0.0
     1947.0          0.0        0.0        0.0        0.0        0.0
1985          0.0        390.0          0.0          0.0         61.0
      187.0        0.0        9.0        0.0        0.0        0.0
1986          0.0        390.0          0.0          0.0        291.0
      188.0        0.0       44.0      320.0        0.0        0.0
     YEAR - TOTAL COST THEN FUEL COSTS BY TYPE (1000$).
     1980      2705380.
               2407550.    32465.    65842.    39566.       0.0
                     0.    9503.       0.       0.    0.    0.
     1983      3649838.
               3135130.    56489.    73539.    43484.       0.0
                103851.    12391.       0.       0.    0.    0.
     1985      4784187.
               4173658.    62393.    93886.    39424.    1451.0
                137160.    15362.     4102.       0.    0.    0.
     1995     11914221.
                8216416.  731015.  175425.    83392.  39151.
        388826.   30025.  376104.       0.    261385.   440084.
     YEAR - FIXED O&M COSTS (1000$).
     1980     54606.     8765.    40463.    22286.       0.0
                 0.     3682.        0.    16665.7     0.    0.
     1983     72486.    11702.    53136.    29265.       0.0
              22104.     4835.        0.    21882.9     0.    0.
     1985     87062.    14610.    63828.    25893.     1316.
              29980.     5808.      107.    26286.    0.    0.
     1995     212587.   53944.    159628.    62708.    25242.
       101833.     14525.     12260.    74973.    189540.    240219.
     YEAR - VARIABLE O&M (1000$).
     1980  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
     1983  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
     1985  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
     1995  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
     YEAR - TOTAL COST OF EXPECTED UNSERVED ENERGY (1000$).
     1980    3978.7
     1983    9547.3
     1985    1906.6
     1995   25101.3
```

Figure 6-1. FINAM Manually Created Input Data

```
***** DATA SPECIFIC TO THE GEN. TYPES AND THE E.U.E.; BLR GEN. TYPE
BLR
      YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
      1980        6.00            5.86       0.0
      1983        8.54            7.71       0.0
      1985       10.57            9.25       0.0
      1995       21.38           23.12       0.0
      NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
      5 3 1
      1981 12.5 1981 12.6 1981 9.6
      1985 10.0 1982 10.6 0000 000
      1986  9.0 1983  9.6 0000 000
      1987  8.0 0000  000 0000 000
      1988  7.0 0000  000 0000 000
DIST GEN. TYPE TABLE
DIST
      YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
      1980        6.50            8.34       0.0
      1983        9.25           10.50       0.0
      1985       11.45            9.7        0.0
      1995       23.16           18.01       0.0
      NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
      5 3 1
      1981 12.5 1981 12.6 1981 9.6
      1985 10.0 1982 10.6 0000 000
      1986  9.0 1983  9.6 0000 000
      1987  8.0 0000  000 0000 000
      1988  7.0 0000  000 0000 000
COAL 1 GEN. TYPE TABLE
COAL 1
      YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
      1980        1.06           45.78       0.0
      1983        1.41           60.11       0.0
      1985        1.68           72.20       0.0
      1995        3.42          180.57       0.0
      NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
      3 3 1
      1981 10.0 1981 12.6 1981 9.6
      1985  8.0 1982 10.6 0000 000
      1990  7.0 1983  9.6 0000 000
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
COAL4 GEN. TYPE TABLE
COAL4
          YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
          1980        0.00          00.00       0.0
          1983        0.00          00.00       0.0
          1985        0.00          00.00       0.0
          1995        4.58         206.92       0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
          3 3 1
          1981 10.0 1981 12.6 1981 9.6
          1985  8.0 1982 10.6 0000 000
          1990  7.0 1983  9.6 0000 000
COAL5 GEN. TYPE TABLE
COAL5
          YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
          1980        0.00          00.00       0.0
          1983        0.00          00.00       0.0
          1985        0.00          00.00       0.0
          1995        5.49         179.27       0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
          3 3 1
          1981 10.0 1981 12.6 1981 9.6
          1985  8.0 1982 10.6 0000 000
          1990  7.0 1983  9.6 0000 000
YEAR - CAPITAL COSTS OF EACH GEN. TYPE ($/KW)
          1980  600.0 330.0 1200.0 1200.0 1200.0 1500.0 1500.0
                      1500.0 2200.0 1200.0 1200.0
          1983  828.0 455.4 1655.9 1655.9 1655.9 2069.9 2069.9
                      2069.9 3035.9 1655.9 1655.9
          1985 1020.1 561.1 2040.3 2040.3 2040.3 2550.4 2550.4
                      2550.4 3740.5 2040.3 2040.3
          1986 1132.4 622.8 2264.7 2264.7 2264.7 2830.9 2830.9
                      2830.9 4152.0 2264.7 2264.7
FIXED CHARGE RATE FOR EACH GEN. TYPE (%) EACH CAP. ADDITION YEAR.
          1980 21.9 21.9 23.8 23.8 23.8 23.9 23.9 22.8 24.7 23.8 23.8
          1983 21.9 21.9 23.8 23.8 23.8 23.9 23.9 22.8 24.7 23.8 23.8
          1985 21.9 21.9 23.8 23.8 23.8 23.9 23.9 22.8 24.7 23.8 23.8
          1986 21.9 21.9 23.8 23.8 23.8 23.9 23.9 22.8 24.7 23.8 23.8
NUMBER OF YEARS FOR CALCULATED ON IN EACH CAP. ADDITION YEAR.
          1980 30 30 35 35 35 30 30 30 60 35 35
          1983 30 30 35 35 35 30 30 30 60 35 35
          1985 30 30 35 35 35 30 30 30 60 35 35
          1986 30 30 35 35 35 30 30 30 60 35 35
YEAR - EXPECTED UNSERVED ENERGY COST ($/MWH).
          1980       100.0
          1983       121.8
          1985       138.9
          1995       277.0
     ESCALATIONS OF E.U.E. TO BE USED FOR EXTENSIONS (%).
          1
          1981 6.8
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
***** CHANGE CASE 1 - 10 MOD-2 MACHINES - 25 MW
 10 MOD-2       25.
      YEAR - CAP. TO ADD TO ALL GEN. TYPES (MW).
1980            0.0             0.0             0.0             0.0             0.0
       0.0         0.0             0.0             0.0             0.0             0.0
1983           81.             64.0             0.0             0.0             0.0
      1947.0            0.0             0.0             0.0             0.0             0.0
1985            0.0           379.0             0.0             0.0            61.0
       187.0            0.0             9.0             0.0             0.0             0.0
1986            0.0           390.0             0.0             0.0           291.0
       188.0            0.0            44.0           320.0             0.0             0.0
      YEAR - TOTAL COST THEN FUEL COSTS BY TYPE (1000$).
      1980        2701982.
                  2404207.      32470.      65841.      39566.          0.0
                        0.       9503.          0.    0.      0.      0.
      1983        3644890.
                  3130779.      56010.      73530.      43484.          0.0
                   103851.      12391.          0.      0.    0.      0.
      1985        4777609.
                  4167113.      62406.      93881.      39423.     1450.0
                   137160.      15362.       4102.      0.    0.    0.
      1995       11899604.
                    8211090.   722066.   175403.      83392.   39147.
          388814.     30025.   376095.      0.        261326.    439953.
      YEAR - FIXED O&M COSTS (1000$).
      1980       54606.       8765.      40468.      22286.          0.0
                     0.       3682.          0.     16665.7     0.    0.
      1983       72486.      11702.      53136.      29265.          0.0
                 22104.       4835.          0.     21882.9       0.   0.
      1985       87062.      14583.      63828.      25893.       1316.
                 29980.       5808.        107.      26286.     0.   0.
      1995       212587.     53803.     159628.      62708.     25242.
        101833.       14525.      12260.      74973.     189540.     240219.
      YEAR - VARIABLE O&M (1000$).
      1980   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      1983   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      1985   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      1995   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
      YEAR - TOTAL COST OF EXPECTED UNSERVED ENERGY (1000$).
      1980    3915.6
      1983    9457.0
      1985    1896.5
      1995   25103.5
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
***** CHANGE CASE 2 - 254 MOD-2 MACHINES - 635 MW
 254 MOD-2    635.
     YEAR - CAP. TO ADD TO ALL GEN. TYPES (MW).
1980          0.0          0.0          0.0          0.0          0.0
       0.0          0.0          0.0          0.0          0.0          0.0
1983         81.          64.0          0.0          0.0          0.0
     1947.0          0.0          0.0          0.0          0.0          0.0
1985          0.0        222.0          0.0          0.0         61.0
      187.0          0.0          9.0          0.0          0.0          0.0
1986          0.0        390.0          0.0          0.0        291.0
      188.0          0.0         44.0        320.0          0.0          0.0
     YEAR - TOTAL COST THEN FUEL COSTS BY TYPE (1000$).
     1980       2622307.
                2329096.     28858.     65778.     39963.         0.0
                      0.      9503.         0.         0.    0.    0.
     1983       3535639.
                3028912.     50577.     73176.     43479.         0.0
                 103726.     12389.         0.         0.     0.    0.
     1985       4639611.
                4040157.     52402.     93556.     39424.    1446.0
                 137075.     15362.      4102.         0.     0.    0.
     1995     11614765.
                8025631.   633674.   174636.    83392.   38974.
          388283.    30024.   376103.        0.   259066.   435490.
     YEAR - FIXED O&M COSTS (1000$).
     1980      54606.      8765.     40468.     22286.         0.0
                  0.      3682.         0.     16665.7     0.    0.
     1983      72486.     11702.     53136.     29265.         0.0
               22104.      4835.         0.     21882.9     0.    0.
     1985      87062.     14180.     63828.     25893.     1316.
               29980.      5808.       107.     26286.     0.    0.
     1995     212587.    52116.    159628.    62708.    25242.
       101833.     14525.     12260.     74973.    189540.    240219.
     YEAR - VARIABLE O&M (1000$).
     1980   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     1983   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     1985   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     1995   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     YEAR - TOTAL COST OF EXPECTED UNSERVED ENERGY (1000$).
     1980    3046.1
     1983    7981.6
     1985    1677.7
     1995   24013.9
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
COAL 2 GEN. TYPE TABLE
COAL 2
     YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
     1980        0.51          21.67       0.0
     1983        0.68          29.41       0.0
     1985        0.81          27.17       0.0
     1995        1.65          84.06       0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
     3 3 1
     1981 10.0 1981 12.6 1981 9.6
     1985  8.0 1982 10.6 0000 000
     1990  7.0 1983  9.6 0000 000
COAL 3 GEN. TYPE TABLE
COAL 3
     YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
     1980        0.00          0.0         0.0
     1983        0.00          0.0         0.0
     1985        2.10         21.57        0.0
     1995        4.29        206.90        0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
     3 3 1
     1981 10.0 1981 12.6 1981 9.6
          1985  8.0 1982 10.6 0000 000
          1990  7.0 1983  9.6 0000 000
NUC 1 GEN. TYPE TABLE
NUC 1
          YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
          1980        0.00          0.0         0.0
          1983        0.76         11.35        0.0
          1985        0.91         14.05        0.0
          1995        1.85         33.70        0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
          4 3 1
          1981 12.5 1981 12.6 1981 9.6
          1982 10.0 1982 10.6 0000 000
          1985  8.0 1983  9.6 0000 000
          1990  7.0 0000  000 0000 000
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
NUC 2 GEN. TYPE TABLE
NUC 2
          YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
          1980        0.38          11.84       0.0
          1983        0.52          15.54       0.0
          1985        0.61          18.67       0.0
          1995        1.25          46.70       0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
          4 3 1
          1981 12.5 1981 12.6 1981 9.6
          1982 10.0 1982 10.6 0000 000
          1985  8.0 1983  9.6 0000 000
          1990  7.0 0000  000 0000 000
GEO GEN. TYPE TABLE
GEO
          YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
          1980        1.63           0.0        0.0
          1983        2.17           0.0        0.0
          1985        2.63          11.89       0.0
          1995        5.30          27.99       0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
          4 3 1
          1981 10.0 1981 12.6 1981 9.6
          1986  9.0 1982 10.6 0000 000
          1987  8.0 1983  9.6 0000 000
          1988  7.0 0000  000 0000 000
HYDRO GEN. TYPE TABLE
HYDRO
          YEAR - FUEL($/MMBTU)   FOM($/KW/YR)  VOM($/MWH)
          1980        0.00          16.29       0.0
          1983        0.00          21.39       0.0
          1985        0.00          25.69       0.0
          1995        0.00          43.01       0.0
     NUMBER OF AND ESCALATIONS TO BE USED FOR EXTENSIONS (%).
          3 3 1
          1981 12.6 1981 12.6 1981 9.6
          1982 10.6 1982 10.6 0000 000
          1983  9.6 1983  9.6 0000 000
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
*CHANGE LIFE OF WIND MACHINE
"MISC",00 00
          P.W MISC -  WIND MACHINE LIFETIME - AND FCR,ICOST
          1980  40  21.9  0
*CHANGE THE PRESENT WORTH DISCOUNT RATE TO 12.
"PWD ",00 00
          P.W. DISCOUNT RATE    GNP DEF.
            12.00  10.1
*CHANGE ONLY FUEL ESCALATION RATES
"FCST" 5 1
      THE FUEL TYPES.
     2 4 6 8 10
          NUMBER AND ESCALATIONS FOR TYPE 2.
               7
               1981 12.5
               1985 10.0
               1986  9.1
               1987  8.9
               1988  8.5
               1989  8.3
               1990  8.4
          NUMBER AND ESCALATIONS FOR TYPE 4.
               7
               1981 10.0
               1985  8.7
               1986  9.1
               1987  8.9
               1988  8.5
               1989  8.3
               1990  8.4
          NUMBER AND ESCALATIONS FOR TYPE 6.
               8
               1981 12.5
               1982 10.0
               1985  8.7
               1986  9.1
               1987  8.9
               1988  8.5
               1989  8.3
               1990  8.4
```

Figure 6-1. FINAM Manually Created Input Data (Continued)

```
          NUMBER AND ESCALATIONS FOR TYPE 8.
               7
               1981 10.0
               1985  8.7
               1986  9.1
               1987  8.9
               1988  8.5
               1989  8.3
               1990  8.4
          NUMBER AND ESCALATIONS FOR TYPE 10.
               7
               1981 10.0
               1985  8.7
               1986  9.1
               1987  8.9
               1988  8.5
               1989  8.3
               1990  8.4
*CHANGE ASSUMED DISTILATE FUEL TYPE CAPITAL COST.
"CAP " 1 0
     THE GENERATOR TYPE
     2
     YEAR - NEW CAPITAL COST ($/KW)
     1980  600.0
     1983  828.0
     1985 1020.1
     1986 1132.4
THAT IS ALL
"XXXX" 0 0
```

Figure 6-1. FINAM Manually Created Input Data (Concluded)

```
**********************************************************************************************************************
**************************** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****                    *********
**********************************************************************************************************************

    YEAR OF PRESENT WORTH RESULTS    = 1980
    FIRST YEAR OF SIMULATION         = 1980          LAST YEAR OF ALTERNATIVE CALCULATIONS = 2009
    PRESENT WORTH DISCOUNT RATE (%)  =  15.00        GNP DEFLATOR RATE (%)          =  10.10
    NUMBER OF SIMULATION YEARS       =   4           NUMBER OF CHANGE CASES =   2
    NUMBER OF GENERATION TYPES       =  11
    NUMBER OF CAPITAL COST YEARS     =   4
    ALTERNATIVE GENERATION LIFE      =  30
      AND FIXED CHARGE RATE          =   21.90 %
    USING END OF YEAR COST ASSUMPTION

******GENERATION DATA FOR TYPE  1 = SLR
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980     6.0000   *       5.9600     *       0.0000   *
    1983     8.5400   *       7.7100     *       0.0000   *
    1985    10.5700   *       9.2500     *       0.0000   *
    1995    21.3800   *      23.1200     *       0.0000   *

                    EXTENSION ESCALATION DATA
       BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
        YEAR     (%)  *   YEAR     (%)  *   YEAR     (%)  *
        1981   12.50  *   1981   12.60  *   1981    9.60  *
        1985   10.00  *   1982   10.60  *      0    0.00  *
        1986    9.00  *   1983    9.60  *      0    0.00  *
        1987    8.00  *      0    0.00  *      0    0.00  *
        1988    7.00  *      0    0.00  *      0    0.00  *

         YEAR      CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
         1980             600.0                 21.900               30
         1983             828.0                 21.900               30
         1985            1020.1                 21.900               30
         1986            1132.4                 21.900               30

******GENERATION DATA FOR TYPE  2 = DIST
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980     6.5000   *       8.3400     *       0.0000   *
    1983     9.2500   *      10.5000     *       0.0000   *
    1985    11.4500   *       9.7000     *       0.0000   *
    1995    23.1600   *      18.0100     *       0.0000   *

                    EXTENSION ESCALATION DATA
       BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
        YEAR     (%)  *   YEAR     (%)  *   YEAR     (%)  *
        1981   12.50  *   1981   12.60  *   1981    9.60  *
        1985   10.00  *   1982   10.60  *      0    0.00  *
        1986    9.00  *   1983    9.60  *      0    0.00  *
        1987    8.00  *      0    0.00  *      0    0.00  *
        1988    7.00  *      0    0.00  *      0    0.00  *

         YEAR      CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
         1980             330.0                 21.900               30
         1983             455.4                 21.900               30
         1985             561.1                 21.900               30
         1986             622.8                 21.900               30
```

Figure 6-2. FINAM Echo of Input Data

```
**********************************************************************************************************************
********************************** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****  ************************
**********************************************************************************************************************

******GENERATION DATA FOR TYPE  3 = COAL 1
    YEAR    FUEL COST *    FIXED O&M   *  VARIABLE O&M *
            ($/MMBTU) *      ($/KW)    *   ($/MW/YR)   *
    1980     1.0600   *     45.7800    *      0.0000   *
    1983     1.4100   *     60.1100    *      0.0000   *
    1985     1.6800   *     72.2000    *      0.0000   *
    1995     3.4200   *    180.5700    *      0.0000   *

                    EXTENSION ESCALATION DATA
      BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
       YEAR    (%)   *   YEAR    (%)   *   YEAR    (%)   *
       1981   10.00  *   1981   12.60  *   1981    9.60  *
       1985    8.00  *   1982   10.60  *      0    0.00  *
       1990    7.00  *   1983    9.60  *      0    0.00  *

        YEAR     CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
        1980          1200.0                 23.800               35
        1983          1655.9                 23.800               35
        1985          2040.3                 23.800               35
        1986          2264.7                 23.800               35


******GENERATION DATA FOR TYPE  4 = COAL 2
    YEAR    FUEL COST *    FIXED O&M   *  VARIABLE O&M *
            ($/MMBTU) *      ($/KW)    *   ($/MW/YR)   *
    1980      .5100   *     21.6700    *      0.0000   *
    1983      .6800   *     29.4100    *      0.0000   *
    1985      .8100   *     27.1700    *      0.0000   *
    1995     1.6500   *     84.0600    *      0.0000   *

                    EXTENSION ESCALATION DATA
      BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
       YEAR    (%)   *   YEAR    (%)   *   YEAR    (%)   *
       1981   10.00  *   1981   12.60  *   1981    9.60  *
       1985    8.00  *   1982   10.60  *      0    0.00  *
       1990    7.00  *   1983    9.60  *      0    0.00  *

        YEAR     CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
        1980          1200.0                 23.800               35
        1983          1655.9                 23.800               35
        1985          2040.3                 23.800               35
        1986          2264.7                 23.800               35
```

Figure 6-2. FINAM Echo of Input Data (Continued)

```
**********************************************************************************************************************
********************************** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****                ***************************
**********************************************************************************************************************


******GENERATION DATA FOR TYPE  5 = COAL 3
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980     0.0000   *        0.0000    *       0.0000   *
    1983     0.0000   *        0.0000    *       0.0000   *
    1985     2.1000   *       21.5700    *       0.0000   *
    1995     4.2900   *      206.9000    *       0.0000   *

                      EXTENSION ESCALATION DATA
      BEGIN   RATE  *  BEGIN   RATE  *  BEGIN   RATE  *
       YEAR    (%)  *   YEAR    (%)  *   YEAR    (%)  *
       1981  10.00  *   1981  12.60  *   1981   9.60  *
       1985   8.00  *   1982  10.60  *      0   0.00  *
       1990   7.00  *   1983   9.60  *      0   0.00  *

        YEAR      CAPITAL COSTS ($/KW)   FIXED CHARGE RATE(%)   BASED ON YEARS
        1980            1200.0                 23.800                35
        1983            1655.9                 23.800                35
        1985            2040.3                 23.800                35
        1986            2264.7                 23.800                35


******GENERATION DATA FOR TYPE  6 = NUC 1
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980     0.0000   *        0.0000    *       0.0000   *
    1983     .7600    *       11.3500    *       0.0000   *
    1985     .9100    *       14.0500    *       0.0000   *
    1995     1.8500   *       33.7000    *       0.0000   *

                      EXTENSION ESCALATION DATA
      BEGIN   RATE  *  BEGIN   RATE  *  BEGIN   RATE  *
       YEAR    (%)  *   YEAR    (%)  *   YEAR    (%)  *
       1981  12.50  *   1981  12.60  *   1981   9.60  *
       1982  10.00  *   1982  10.60  *      0   0.00  *
       1985   8.00  *   1983   9.60  *      0   0.00  *
       1990   7.00  *      0   0.00  *      0   0.00  *

        YEAR      CAPITAL COSTS ($/KW)   FIXED CHARGE RATE(%)   BASED ON YEARS
        1980            1500.0                 23.900                30
        1983            2069.9                 23.900                30
        1985            2550.4                 23.900                30
        1986            2830.9                 23.900                30
```

Figure 6-2. FINAM Echo of Input Data (Continued)

```
**********=**********=******** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****          **********

******GENERATION DATA FOR TYPE  7 = NUC 2
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980      .3800   *      11.8400     *       0.0000   *
    1983      .5200   *      15.5410     *       0.0000   *
    1985      .6100   *      18.6700     *       0.0000   *
    1995     1.2500   *      46.7000     *       0.0000   *

                      EXTENSION ESCALATION DATA
       BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
        YEAR     (%)  *   YEAR     (%)  *   YEAR     (%)  *
        1981   12.50  *   1981   12.60  *   1981    9.60  *
        1982   10.00  *   1982   10.60  *      0    0.00  *
        1985    8.00  *   1983    9.60  *      0    0.00  *
        1990    7.00  *      0    0.00  *      0    0.00  *

         YEAR      CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
         1980           1500.0                  23.900              30
         1983           2069.9                  23.900              30
         1985           2550.4                  23.900              30
         1986           2830.9                  23.900              30

******GENERATION DATA FOR TYPE  8 = GEO
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980      1.6300  *       0.0000     *       0.0000   *
    1983      2.1700  *       0.0000     *       0.0000   *
    1985      2.6300  *      11.8900     *       0.0000   *
    1995      5.3000  *      27.9900     *       0.0000   *

                      EXTENSION ESCALATION DATA
       BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
        YEAR     (%)  *   YEAR     (%)  *   YEAR     (%)  *
        1981   10.00  *   1981   12.60  *   1981    9.60  *
        1986    9.00  *   1982   10.60  *      0    0.00  *
        1987    8.00  *   1983    9.60  *      0    0.00  *
        1988    7.00  *      0    0.00  *      0    0.00  *

         YEAR      CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
         1980           1500.0                  22.800              30
         1983           2069.9                  22.800              30
         1985           2550.4                  22.800              30
         1986           2830.9                  22.800              30
```

Figure 6-2. FINAM Echo of Input Data (Continued)

```
**********************************************************************************************************************
**********************************  TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****  **************************
**********************************************************************************************************************


******GENERATION DATA FOR TYPE  9 = HYDRO
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980     0.0000   *      16.2900     *       0.0000   *
    1983     0.0000   *      21.3900     *       0.0000   *
    1985     0.0000   *      25.6900     *       0.0000   *
    1995     0.0000   *      43.0100     *       0.0000   *

                    EXTENSION ESCALATION DATA
       BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
        YEAR     (%)  *   YEAR     (%)  *   YEAR     (%)  *
        1981   12.60  *   1981   12.60  *   1981    9.60  *
        1982   10.60  *   1982   10.60  *      0    0.00  *
        1983    9.60  *   1983    9.60  *      0    0.00  *

         YEAR      CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
          1980          2200.0                 24.700               60
          1983          3035.9                 24.700               60
          1985          3740.5                 24.700               60
          1986          4152.0                 24.700               60


******GENERATION DATA FOR TYPE 10 = COAL4
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *       ($/KW)     *    ($/MW/YR)   *
    1980     0.0000   *       0.0000     *       0.0000   *
    1983     0.0000   *       0.0000     *       0.0000   *
    1985     0.0000   *       0.0000     *       0.0000   *
    1995     4.5800   *     206.9200     *       0.0000   *

                    EXTENSION ESCALATION DATA
       BEGIN    RATE  *  BEGIN    RATE  *  BEGIN    RATE  *
        YEAR     (%)  *   YEAR     (%)  *   YEAR     (%)  *
        1981   10.00  *   1981   12.60  *   1981    9.60  *
        1985    8.00  *   1982   10.60  *      0    0.00  *
        1990    7.00  *   1983    9.60  *      0    0.00  *

         YEAR      CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
          1980          1200.0                 23.800               35
          1983          1655.9                 23.800               35
          1985          2040.3                 23.800               35
          1986          2264.7                 23.800               35
```

Figure 6-2. FINAM Echo of Input Data (Continued)

```
**********************************************************************************************************************
********************************** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****                ************************
**********************************************************************************************************************


******GENERATION DATA FOR TYPE 11 = COAL5
    YEAR    FUEL COST *     FIXED O&M    *  VARIABLE O&M  *
            ($/MMBTU) *      ($/KW)      *    ($/MWH/YR)  *
    1980     0.0000   *      0.0000      *      0.0000    *
    1983     0.0000   *      0.0000      *      0.0000    *
    1985     0.0000   *      0.0000      *      0.0000    *
    1995     5.4900   *    179.2700      *      0.0000    *

                    EXTENSION ESCALATION DATA
      BEGIN    RATE  *  BEGIN    RATE    *  BEGIN    RATE  *
      YEAR     (%)   *  YEAR     (%)     *  YEAR     (%)   *
      1981    10.00  *  1981    12.60    *  1981     9.60  *
      1985     8.00  *  1982    10.60    *     0     0.00  *
      1990     7.00  *  1983     9.60    *     0     0.00  *

       YEAR     CAPITAL COSTS ($/KW)  FIXED CHARGE RATE(%)  BASED ON YEARS
       1980          1200.0                 23.800                35
       1983          1655.9                 23.800                35
       1985          2040.3                 23.800                35
       1986          2264.7                 23.800                35

**********************************************************************************************************************
********************************** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****                ************************
**********************************************************************************************************************


        YEAR-EXPECTED UNSERVED ENERGY COST ($/MWH)
        1980                              100.000
        1983                              121.900
        1985                              138.900
        1995                              277.000
       BEGIN                      ESCALATION RATE
        YEAR                             (%)
        1981                            6.800
```

Figure 6-2. FINAM Echo of Input Data (Continued)

****
********** TEST DATA - 80,83,85 & 95 WITH CAP. CREDIT, WEIBULL ****
****

BASE CASE SYSTEM COSTS (K$)

YEAR 1980 *											
TOTAL *	GENERATION TYPE										
2705380.0*	1	2	3	4	5	6	7	8	9	10	11
FUELS *	2407550.0	32465.0	65842.0	39566.0	0.0	0.0	9503.0	0.0	0.0	0.0	0.0
FIXED O&M *	54606.0	8765.0	40468.0	22286.0	0.0	0.0	3682.0	0.0	16665.7	0.0	0.0
VAR. O&M *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E.U.E. *	3978.700										

YEAR 1983 *											
TOTAL *	GENERATION TYPE										
3649838.0*	1	2	3	4	5	6	7	8	9	10	11
FUELS *	3135130.0	56489.0	73539.0	43484.0	0.0	103851.0	12391.0	0.0	0.0	0.0	0.0
FIXED O&M *	72486.0	11702.0	53136.0	29265.0	0.0	22104.0	4835.0	0.0	21882.9	0.0	0.0
VAR. O&M *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E.U.E. *	9547.300										

YEAR 1985 *											
TOTAL *	GENERATION TYPE										
4794187.0*	1	2	3	4	5	6	7	8	9	10	11
FUELS *	4173658.0	62393.0	93886.0	39424.0	1451.0	137160.0	15362.0	4102.0	0.0	0.0	0.0
FIXED O&M *	97062.0	14610.0	63828.0	25893.0	1316.0	29980.0	5808.0	107.0	26286.0	0.0	0.0
VAR. O&M *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E.U.E. *	1906.600										

YEAR 1995 *											
TOTAL *	GENERATION TYPE										
11914221.0*	1	2	3	4	5	6	7	8	9	10	11
FUELS *	8216416.0	731015.0	175425.0	83392.0	39151.0	388826.0	30025.0	376104.0	0.0	261385.0	440084.0
FIXED O&M *	212587.0	53944.0	159628.0	62708.0	25242.0	101833.0	14525.0	12260.0	74973.0	189540.0	240219.0
VAR. O&M *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E.U.E. *	25101.300										

Figure 6-2. FINAM Echo of Input Data (Continued)

**** TEST DATA - 80,83,85 & 95 WITH CAP. CREDIT, WEIBULL ****

BASE CASE CAPACITY ADDITIONS (MW)

YEAR	**	GENERATION TYPE 1	2	3	4	5	6	7	8	9	10	11
1980	**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983	**	81.00	64.00	0.00	0.00	0.00	1947.00	0.00	0.00	0.00	0.00	0.00
1985	**	0.00	390.00	0.00	0.00	61.00	187.00	0.00	9.00	0.00	0.00	0.00
1986	**	0.00	390.00	0.00	0.00	291.00	188.00	0.00	44.00	320.00	0.00	0.00

CHANGE CASE 1 = 10 MOD-2 -CAPACITY ADDITIONS (MW)

YEAR	**	GENERATION TYPE 1	2	3	4	5	6	7	8	9	10	11
1980	**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983	**	81.00	64.00	0.00	0.00	0.00	1947.00	0.00	0.00	0.00	0.00	0.00
1985	**	0.00	379.00	0.00	0.00	61.00	187.00	0.00	9.00	0.00	0.00	0.00
1986	**	0.00	390.00	0.00	0.00	291.00	188.00	0.00	44.00	320.00	0.00	0.00

CHANGE CASE 2 = 254 MOD-2 -CAPACITY ADDITIONS (MW)

YEAR	**	GENERATION TYPE 1	2	3	4	5	6	7	8	9	10	11
1980	**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983	**	81.00	64.00	0.00	0.00	0.00	1947.00	0.00	0.00	0.00	0.00	0.00
1985	**	0.00	222.00	0.00	0.00	61.00	187.00	0.00	9.00	0.00	0.00	0.00
1986	**	0.00	390.00	0.00	0.00	291.00	188.00	0.00	44.00	320.00	0.00	0.00

Figure 6-2. FINAM Echo of Input Data (Continued)

```
**********************************************************************************************************************
********************************** TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****                ***************************
**********************************************************************************************************************

                                                CHANGE CASE  1 -  10 MOD-2   -SYSTEM COSTS (K$)

YEAR 1980 *
  TOTAL   *        GENERATION TYPE
-2701982.0*          1          2          3          4          5          6          7          8          9         10         11
FUELS     * 2404207.0     32470.0     65841.0     39566.0         0.0         0.0      9503.0         0.0         0.0         0.0         0.0
FIXED O&M *   54606.0      8765.0     40468.0     22286.0         0.0         0.0      3682.0         0.0     16665.7         0.0         0.0
VAR. O&M  *       0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
E.U.E.    *  3915.600

YEAR 1983 *
  TOTAL   *        GENERATION TYPE
 3644890.0*          1          2          3          4          5          6          7          8          9         10         11
FUELS     * 3130779.0     56010.0     73530.0     43484.0         0.0    103851.0     12391.0         0.0         0.0         0.0         0.0
FIXED O&M *   72486.0     11702.0     53136.0     29265.0         0.0     22104.0      4835.0         0.0     21882.9         0.0         0.0
VAR. O&M  *       0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
E.U.E.    *  9457.000

YEAR 1985 *
  TOTAL   *        GENERATION TYPE
 4777609.0*          1          2          3          4          5          6          7          8          9         10         11
FUELS     * 4167113.0     62406.0     93881.0     39423.0     1450.0    137160.0     15362.0      4102.0         0.0         0.0         0.0
FIXED O&M *   87062.0     14583.0     63838.0     25893.0     1316.0     29980.0      5808.0       107.0     26286.0         0.0         0.0
VAR. O&M  *       0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
E.U.E.    *  1896.500

YEAR 1995 *
  TOTAL   *        GENERATION TYPE
11899604.0*          1          2          3          4          5          6          7          8          9         10         11
FUELS     * 8211090.0     722066.0    175403.0     83392.0     39147.0    388814.0     30025.0    376095.0         0.0    261326.0    439953.0
FIXED O&M *  212587.0      53803.0    159628.0     62708.0     25242.0    101833.0     14525.0     12260.0     74973.0    189540.0    240219.0
VAR. O&M  *       0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0
E.U.E.    * 25103.500
```

Figure 6-2. FINAM Echo of Input Data (Continued)

```
**********  TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****

                    CHANGE CASE  2 =  254 MOD-2  -SYSTEM COSTS (K$)

EAR 1980 *
 TOTAL   *        GENERATION TYPE
2622307.0*          1          2          3          4          5          6          7          8          9         10         11
UELS     *  2329096.0    28858.0    65778.0    39563.0        0.0        0.0     9503.0        0.0        0.0        0.0        0.0
IXED O&M *    54606.0     8765.0    40468.0    22286.0        0.0        0.0     3682.0        0.0    16665.7        0.0        0.0
AR. O&M  *        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
.U.E.    *  3046.100

'EAR 1983 *
 TOTAL   *        GENERATION TYPE
3535639.0*          1          2          3          4          5          6          7          8          9         10         11
:UELS    *  3028912.0    50577.0    73176.0    43479.0        0.0   103726.0    12389.0        0.0        0.0        0.0        0.0
:IXED O&M *    72486.0    11702.0    53136.0    29265.0        0.0    22104.0     4835.0        0.0    21882.9        0.0        0.0
/AR. O&M  *        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
:.U.E.    *  7981.600

'EAR 1985 *
 TOTAL   *        GENERATION TYPE
4639611.0*          1          2          3          4          5          6          7          8          9         10         11
FUELS    *  4040157.0    52402.0    93556.0    39424.0     1446.0   137075.0    15362.0     4102.0        0.0        0.0        0.0
FIXED O&M *    87062.0    14180.0    63828.0    25893.0     1316.0    29980.0     5808.0      107.0    26286.0        0.0        0.0
VAR. O&M  *        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
E.U.E.    *  1677.700

YEAR 1995 *
 TOTAL   *        GENERATION TYPE
11614765.0*         1          2          3          4          5          6          7          8          9         10         11
FUELS    *  8025631.0   633674.0   176636.0    83392.0    38974.0   388283.0    30024.0   376103.0        0.0   259066.0   435490.0
FIXED O&M *   212587.0    52116.0   153628.0    62708.0    25242.0   101833.0    14525.0    12260.0    74973.0   189540.0   240219.0
VAR. O&M  *        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
E.U.E.    *  24013.900
```

Figure 6-2. FINAM Echo of Input Data (Concluded)

```
**********************************************************************************************************************
**********  TEST DATA - 80,83,85 & 95  WITH CAP. CREDIT, WEIBULL ****                  **************************
**********************************************************************************************************************


 CHANGE CASE TITLE   ** CAPACITY (MW) **  P.W. VALUE (1000$) ** BREAKEVEN CAPITAL ($/KW) ** MARGINAL VALUE ($/KW) **
     10 MOD-2        **          25.0  **          49442.5   **              1375.96     **              -.35     **
    254 MOD-2        **         635.0  **        1063239.4   **              1164.43     **              -.35     **


 EQUATION OF GROSS VALUE PER KW ($/KW) CURVE
 GROSS $/KW = C1 + C2*AG
 AG = ALTERNATIVE GENERATION CAPACITY (MW)
 C1 =  1384.006248
 C2 =     -.345788


 EQUATION OF MARGINAL VALUE PER KW ($/KW) CURVE
 MARGINAL $/KW = CC1
 CC1 =     -.345786
```

Figure 6-3. FINAM Results

```
**********CHANGE LIFE OF WIND MACHINE**********

***** CAUTION ***** ALL SENSITIVITY RUNS ASSUME THAT GENERATION TYPE UNIT CAPACITIES
                    AS WELL AS DISPATCH AND COMMITMENT ORDER DO NOT CHANGE.

                SENSITIVITY RUN NO.  1
            ANY OF THESE MAY BE CHANGED
    PRESENT WORTH RESULT YEAR = 1980
    ALTERNATIVE GENERATION LIFE   =  40 YEARS  AND FIXED CHARGE RATE    =   21.90 %
    USING END OF YEAR COST ASSUMPTION
    LAST YEAR OF ALTERNATIVE CALCULATIONS = 2019


    CHANGE CASE TITLE  ** CAPACITY (MW) **  P.W. VALUE (1000$) ** BREAKEVEN CAPITAL  ($/KW) ** MARGINAL VALUE ($/KW) **
        10 MOD-2       **          25.0  **          53662.4  **              1475.71       **              -.38      **
       254 MOD-2       **         635.0  **        1149296.7  **              1244.31       **              -.38      **


    EQUATION OF GROSS VALUE PER KW ($/KW) CURVE
    GROSS $/KW = C1 + C2*AG
    AG = ALTERNATIVE GENERATION CAPACITY (MW)
    C1 =  1485.195417
    C2 =     -.379341


    EQUATION OF MARGINAL VALUE PER KW ($/KW) CURVE
    MARGINAL $/KW = CC1
    CC1 =     -.379341
```

Figure 6-4. FINAM Sensitivity Results

```
**********************************************************************************************************************************
**********************CHANGE THE PRESENT WORTH DISCOUNT RATE TO 12.                                                  **********************
**********************************************************************************************************************************


***** CAUTION ***** ALL SENSITIVITY RUNS ASSUME THAT GENERATION TYPE UNIT CAPACITIES
                    AS WELL AS DISPATCH AND COMMITMENT ORDER DO NOT CHANGE.

                  SENSITIVITY RUN NO.  2
    THE PRESENT WORTH DISCOUNT RATE NOW =     12.000 PERCENT
    THE G.N.P. DEFLATOR RATE NOW =     10.100 PERCENT



    CHANGE CASE TITLE  ** CAPACITY (MW) **  P.W. VALUE (1000$) ** BREAKEVEN CAPITAL  ($/KW) ** MARGINAL VALUE ($/KW) **
        10 MOD-2       **          25.0  **         72414.4      **            1641.97       **             -.45      **
       254 MOD-2       **         635.0  **       1531516.0      **            1367.19       **             -.45      **


    EQUATION OF GROSS VALUE PER KW ($/KW) CURVE
    GROSS $/KW = C1 + C2*AG
    AG = ALTERNATIVE GENERATION CAPACITY (MW)
    C1 =  1653.231886
    C2 =     -.450463


    EQUATION OF MARGINAL VALUE PER KW ($/KW) CURVE
    MARGINAL $/KW = CC1
    CC1 =     -.450463

**********************************************************************************************************************************
**********************CHANGE ASSUMED DISTILATE FUEL TYPE CAPITAL COST.                                               **********************
**********************************************************************************************************************************


***** CAUTION ***** ALL SENSITIVITY RUNS ASSUME THAT GENERATION TYPE UNIT CAPACITIES
                    AS WELL AS DISPATCH AND COMMITMENT ORDER DO NOT CHANGE.

                  SENSITIVITY RUN NO.  4 - CAPITAL COSTS CHANGED -  CHANGES PRESENTED BELOW - ($/KW)
     **      GENERATION TYPE
YEAR **         2
1980 **    600.000
1983 **    828.000
1985 **   1020.100
1986 **   1132.400



    CHANGE CASE TITLE  ** CAPACITY (MW) **  P.W. VALUE (1000$) ** BREAKEVEN CAPITAL  ($/KW) ** MARGINAL VALUE ($/KW) **
        10 MOD-2       **          25.0  **         53052.1      **            1475.77       **             -.41      **
       254 MOD-2       **         635.0  **       1118367.9      **            1224.81       **             -.41      **


    EQUATION OF GROSS VALUE PER KW ($/KW) CURVE
    GROSS $/KW = C1 + C2*AG
    AG = ALTERNATIVE GENERATION CAPACITY (MW)
    C1 =  1486.056822
    C2 =     -.411419


    EQUATION OF MARGINAL VALUE PER KW ($/KW) CURVE
    MARGINAL $/KW = CC1
    CC1 =     -.411419
```

Figure 6-4. FINAM Sensitivity Results (Continued)

```
**********CHANGE ONLY FUEL ESCALATION RATES**********

***** CAUTION ***** ALL SENSITIVITY RUNS ASSUME THAT GENERATION TYPE UNIT CAPACITIES
                   AS WELL AS DISPATCH AND COMMITMENT ORDER DO NOT CHANGE.

                SENSITIVITY RUN NO.  3  - FUEL COSTS CHANGED - CHANGES PRESENTED BELOW - ($/MBTU)

 EXTENSION ESCALATION DATA
   GENERATION TYPE  2
   BEGIN YEAR     RATE(%)
      1981         12.500
      1985         10.000
      1986          9.100
      1987          8.900
      1988          8.500
      1989          8.300
      1990          8.400

 EXTENSION ESCALATION DATA
   GENERATION TYPE  4
   BEGIN YEAR     RATE(%)
      1981         10.000
      1985          8.700
      1986          9.100
      1987          8.900
      1988          8.500
      1989          8.300
      1990          8.400

 EXTENSION ESCALATION DATA
   GENERATION TYPE  6
   BEGIN YEAR     RATE(%)
      1981         12.500
      1982         10.000
      1985          8.700
      1986          9.100
      1987          8.900
      1988          8.500
      1989          8.300
      1990          8.400

 EXTENSION ESCALATION DATA
   GENERATION TYPE  8
   BEGIN YEAR     RATE(%)
      1981         10.000
      1985          8.700
      1986          9.100
      1987          8.900
      1988          8.500
      1989          8.300
      1990          8.400

 EXTENSION ESCALATION DATA
   GENERATION TYPE 10
   BEGIN YEAR     RATE(%)
      1981         10.000
      1985          8.700
      1986          9.100
      1987          8.900
      1988          8.500
      1989          8.300
      1990          8.400


 CHANGE CASE TITLE  ** CAPACITY (MW) **  P.W. VALUE (1000$) ** BREAKEVEN CAPITAL ($/KW) ** MARGINAL VALUE ($/KW) **
     10 MOD-2       **          25.0  **          50348.3  **              1400.56  **              -.37  **
     254 MOD-2      **         635.0  **        1073292.4  **              1175.44  **              -.37  **


 EQUATION OF GROSS VALUE PER KW ($/KW) CURVE
 GROSS $/KW = C1 + C2*AC
 AC = ALTERNATIVE GENERATION CAPACITY (MW)
 C1 =  1409.785755
 C2 =     -.369048


 EQUATION OF MARGINAL VALUE PER KW ($/KW) CURVE
 MARGINAL $/KW = CC1
 CC1 =     -.369048
```

Figure 6-4. FINAM Sensitivity Results (Concluded)

```
/JOB
FINAM.
ACCOUNT,DUM1234.
REQUEST,FINAMX,*PF.
ATTACH,IMSLIB,ID=PUBLIC.
LIBRARY,IMSLIB.
ATTACH,FINAMX,ID=UID,PW=PSWORD.
COMMENT. PURGE,FINAMX,ID=UID.
COMMENT. FILE,FINAM,FL=80.
COMMENT. GETPF,FINAM,FINAM,ID=UID.
COMMENT. FTN,I=FINAM,B=FINAMX,R=0,L=0,ER.
COMMENT. CATALOG,FINAMX,ID=UID,XR=PSWORD.
COMMENT. AUDIT,ID=UID.
FILE,DATA,FL=80.
GETPF,DATA,FINDAT,ID=UID.
FINAMX.
EXIT.
DMP.
REWIND,DATA.
COPYSBF,DATA,OUTPUT.
/EOR
```

(Lines beginning in "COMMENT." are inactive, but removing the "COMMENT." will activate the command.)

Figure 6-5. Sample Runstream for FINAM

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This volume, the second of two volumes, is a user's guide for the computer programs available from SERI. The first volume describes the value determination methodology and gives detailed discussion on each step of the computer modeling.

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