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NOAA Western Region Computer Programs
and Problems NWS WRCP - No. 7

PLOTTING OF OCEAN WAVE ENERGY SPECTRAL DATA

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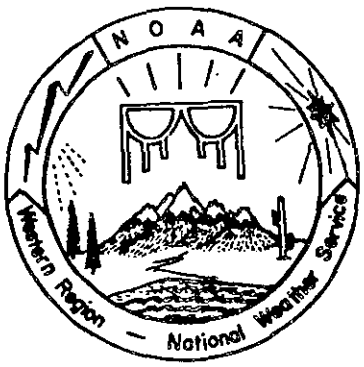
National Weather Service Forecast Office
Seattle, Washington
December 1979

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / National Weather Service



PREFACE

This Western Region publication series is considered as a subset of our Technical Memorandum series. This series will be devoted exclusively to the exchange of information on and documentation of computer programs and related subjects. This series was initiated because it did not seem appropriate to publish computer program papers as Technical Memoranda; yet, we wanted to share this type of information with all Western Region forecasters in a systematic way. Another reason was our concern that in the developing AFOS-era there will be unnecessary and wasteful duplication of effort in writing computer programs in National Weather Service (NWS). Documentation and exchange of ideas and programs envisioned in this series hopefully will reduce such duplication. We also believe that by publishing the programming work of our forecasters, we will stimulate others to use these programs or develop their own programs to take advantage of the computing capabilities AFOS makes available.

We solicit computer-oriented papers and computer programs from forecasters for us to publish in this series. Simple and short programs should not be prejudged as unsuitable.

The great potential of the AFOS-era is strongly related to local computer facilities permitting meteorologists to practice in a more scientific environment. It is our hope that this new series will help in developing this potential into reality.

NOAA Western Region Computer Programs and Problems NWS WRCP

1 Standard Format for Computer Series. June 1979
2 AFOS Crop and Soil Information Report Program. Ken Mielke, July 1979
3 Decoder for Significant Level Transmission of Raobs. John Jannuzzi, August79
4 Precipitable Water Estimate. Elizabeth Morse, October 1979
5 Utah Recreational Temperature Program. Kenneth M. Labas, November 1979
6 Normal Maximum/Minimum Temperature Program for Montana, Kenneth Mielke, Dec. 79
7 Plotting of Ocean Wave Energy Spectral Data. John R. Zimmerman, December, 79

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DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
Richard A. Frank, Administrator

National Weather
Service
Richard E. Hallgren, Director

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Plotting of Ocean Wave Energy Spectral Data

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I. GENERAL INFORMATION

A. Summary:

Environmental Data Buoys, anchored in the ocean, sense meteorological and oceanographic data. This data is automatically relayed via satellite to the Weather Service Communications network, i.e., Marine, Service C, and Request/Reply teletype circuits. Ocean wave energy spectral data are encoded in collectives SXVX20 and SXVX21. Most buoy data can be used by the forecaster without preliminary analysis (for example, winds and significant wave height). However, before ocean wave energy spectral data can be applied by the forecaster, it must be plotted. If the raw encoded wave energy spectral data remains unplotted, the information is generally neglected and valuable data is lost.

This paper describes two programs, SP12 and SP33 which are designed to plot ocean wave energy spectral data from west coast buoys 46004, 46005 or 46010, 46002 respectively. Buoys 46004 and 46005 transmit 12 points of spectral data, while buoys 46010 and 46002 transmit 33 points of spectral data for each observation. Program SP12 can be used for the 33-point reports if the proper 12 points of data are abstracted from the 33 points encoded.

B. Environment

These programs are written in Fortran IV and run on the ECLIPSE S/230 Computer.

C. References:

Britton, Capt. Graham P. R.N. (Ret.), 1977: An Introduction to Sea State Forecasting. Sea Use Foundation, Seattle, Washington, 246 pp.

Januzzi, John A., 1978: Spectral Techniques In Ocean Wave Forecasting. NOAA Technical Memorandum NWS WR-133, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C., 60 pp.

II. APPLICATION

A. Complete Program Description

WSFO Seattle runs this program at least once per day (more if weather is critical). The output plot of ocean wave energy is discussed during morning map discussion. Ocean wave energy density is plotted on a 4-decca log-linear graph. Only 4 decades of spectral values are plotted in order to conserve paper. If the spectral data covers more than 4 decades, it is possible to "overlap" decades as shown in the example in the "Procedures" section. Wave energy density is plotted along the "y" axis and wave frequency is plotted linearly along the "x" axis. The frequencies encoded in observations are normally fixed, i.e., 12 points for buoys 46004 or 46005 and 33 points for buoys 46010 or 46002. Frequency values for 12-point buoy data are given in Table 1.

point	1	2	3	4	5	6	7	8	9	10	11	12
frequency (cps)	.05	.06	.07	.08	.09	.10	.12	.16	.20	.24	.28	.33
period (seconds)	20					10			5			3

Table I. Frequencies normally reported in the 12-point ocean wave energy spectral observation.

For 33-point buoy data, frequencies start at .03 cps and are given for each .01 cps thereafter to 135 cps.

As the encoded spectral data may be unfamiliar to the reader, a review of the spectral code is shown in Table II.

The 33-point observations are similar, but start at frequency .03 cps and are given for each .01 thereafter to .35 cps. Further information on how ocean wave spectral data can be applied to forecasting coastal wave height can be obtained from publications listed in "References".

B. Machine Requirements:

The program requires less than 10,000 (10K) words of memory to run. Run time and disk storage requirements are insignificant.

C. Data Base:

Input data are obtained from collectives SXVX20 and SXVX21. The program prompts the user for input information. No special files need be constructed.

TABLE II

12-Point Buoy Ocean Wave Spectral Observation

```
WAVE SPECTRA DATA=
46005  11460  71310  11151  /3505  31006
(buoy,lattitude,longitude,time,wind,sea)

99100  88050  10000  257/0  32202  49881.....99400  88120...57055...
(spectral data)

      99100  frequency interval= .01
      88050  starting frequency= .05
             point  xxx, decimal location = value
      10000    1    000              -      .0
      257/0    2    570              0      .57
      32202    3    220              2    22.0
      49881    4    988              1     9.88
      56271    5    627              1     6.27
      65341    6    534              1     5.34

      99400  frequency interval= .04
      88120  starting frequency= .12
        .
        .
      57055  11     705             -1      .0705
                    note, a 5 in last place means...
                    put decimal one place to left.
```

III. PROCEDURES

A. Initiation of Program

To run the program enter the command:
SP12
or SP33 at the Dasher.

B. Input/Output

The following examples illustrate how input data is entered into the program.

a) Data...Example 1

```
WAVE SPECTRAL DATA=
46005 //460 71310 /3505 31006
99100 88050 10000 257/0 32202 49881 56271 65341 99400 88120
12271 271/0 325/0 414/0 57055 99/// 88330 13215
```

b) Program Input/Output...Example 1

```
SPI2
PROGRAM TO PLOT WAVE SPECTRA
INPUT HEADING
 INPUT BUOY NUMBER
46005
INPUT WAVE GROUP
31006
INPUT WIND GROUP
3505
INPUT DATE
011179
INPUT TIME
1500
INPUT SPECTRA DATA, 99,99 IF END OF DATA
EXAMPLE...I4380... IS INPUT AS 44,0
INPUT: X=VALUE, Y=DECIMAL
          1
0,0
          2
57,0
          3
22,0
          4
99,1
          5
63,1
          6
53,1
          7
23,1
          8
71,0
          9
25,0
         10
14,0
         11
71,5
         12
32,5
IF DATA CORRECT ENTER 0...OTHERWISE 1
1
ENTER LEVEL
3
ENTER VALUES
22,2
IF DATA CORRECT ENTER 0...OTHERWISE 1
0
```

....notes....

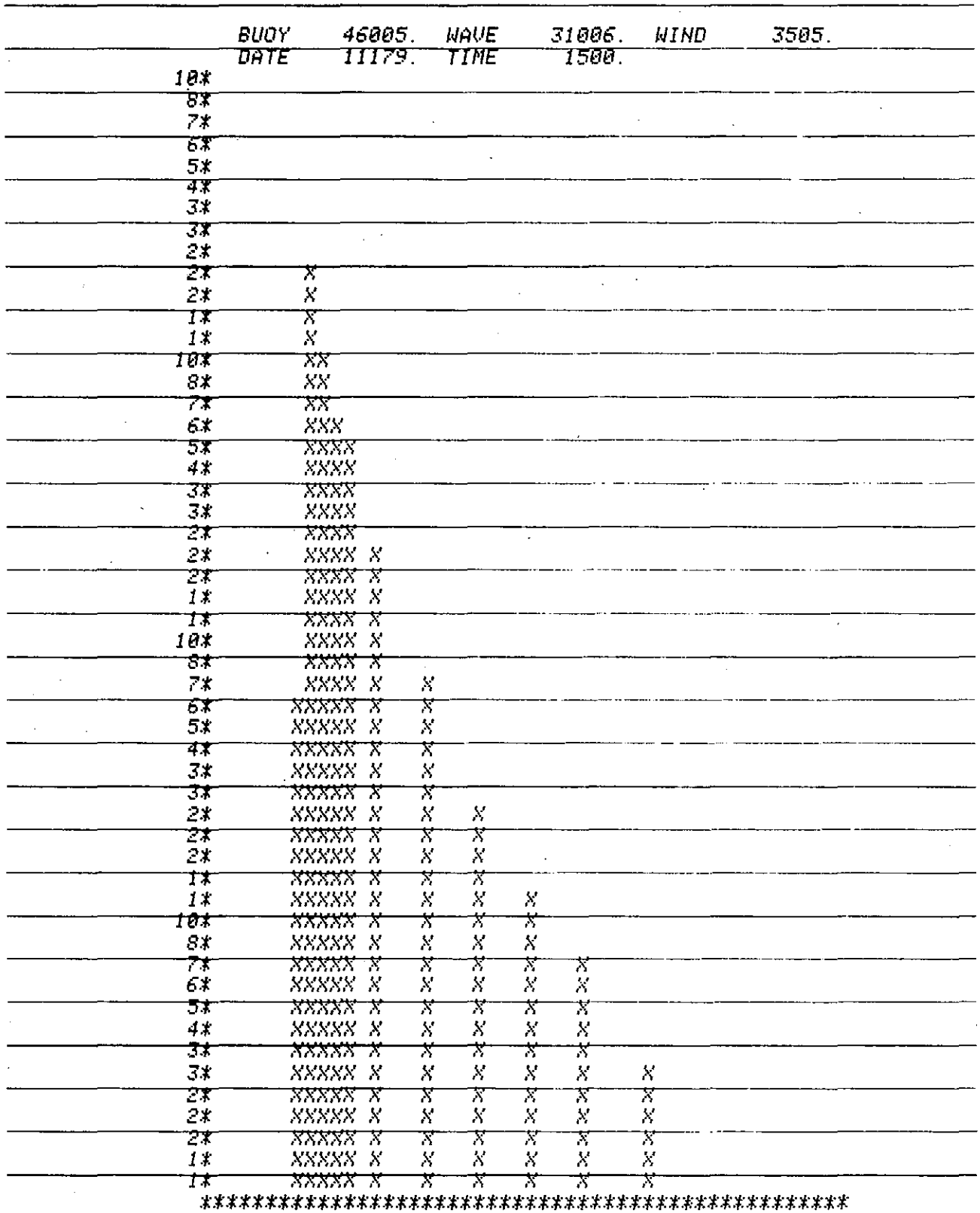
Two pieces of input data are entered for each point separated by a comma. The first is the rounded value of spectral density. The second is the decimal location.

Point 3 was entered incorrectly, and is corrected below.

Point 3 corrected.

Example 1 - Input

Example 1- Output



C) Data . . . Example 2

```
SXVX21 KWBC 101600
46010 //462 71242 10161 /0902 31003
99100 88030 10000 20000 30000 40000 50000 65300 72111 83551
93061 01541 18190 25990 34660 43400 52300 62040 71590 89305
95945 04365 13305 22795 33265 43885 53625 62925 72245 81835
91435 01015 18586 29686 39966
```

D) Input/Output . . . Example 2

```
J201
PROGRAM TO PLOT WAVE SPECTRA
INPUT HEADING
 INPUT BUOY NUMBER
46010
INPUT WAVE GROUP
31003
INPUT WIND GROUP
0902
INPUT DATE
111079
INPUT TIME
1600
INPUT SPECTRA DATA, 99.99 IF END OF DATA
EXAMPLE...14380... IS INPUT AS 44.0
INPUT: X=VALUE, Y=DECIMAL
        1
0.0
        2
0.0
        3
0.0
        4
0.0
        5
0.0
        6
53.0
        7
21.1
        8
36.1
        9
31.1
        10
15.1
        11
82.0
        12
60.0
        13
47.0
        14
34.0
        15
23.0
        16
20.0
        17
16.0
        18
93.5
        19
59.5
        20
44.5
        21
```

Example 2- Input

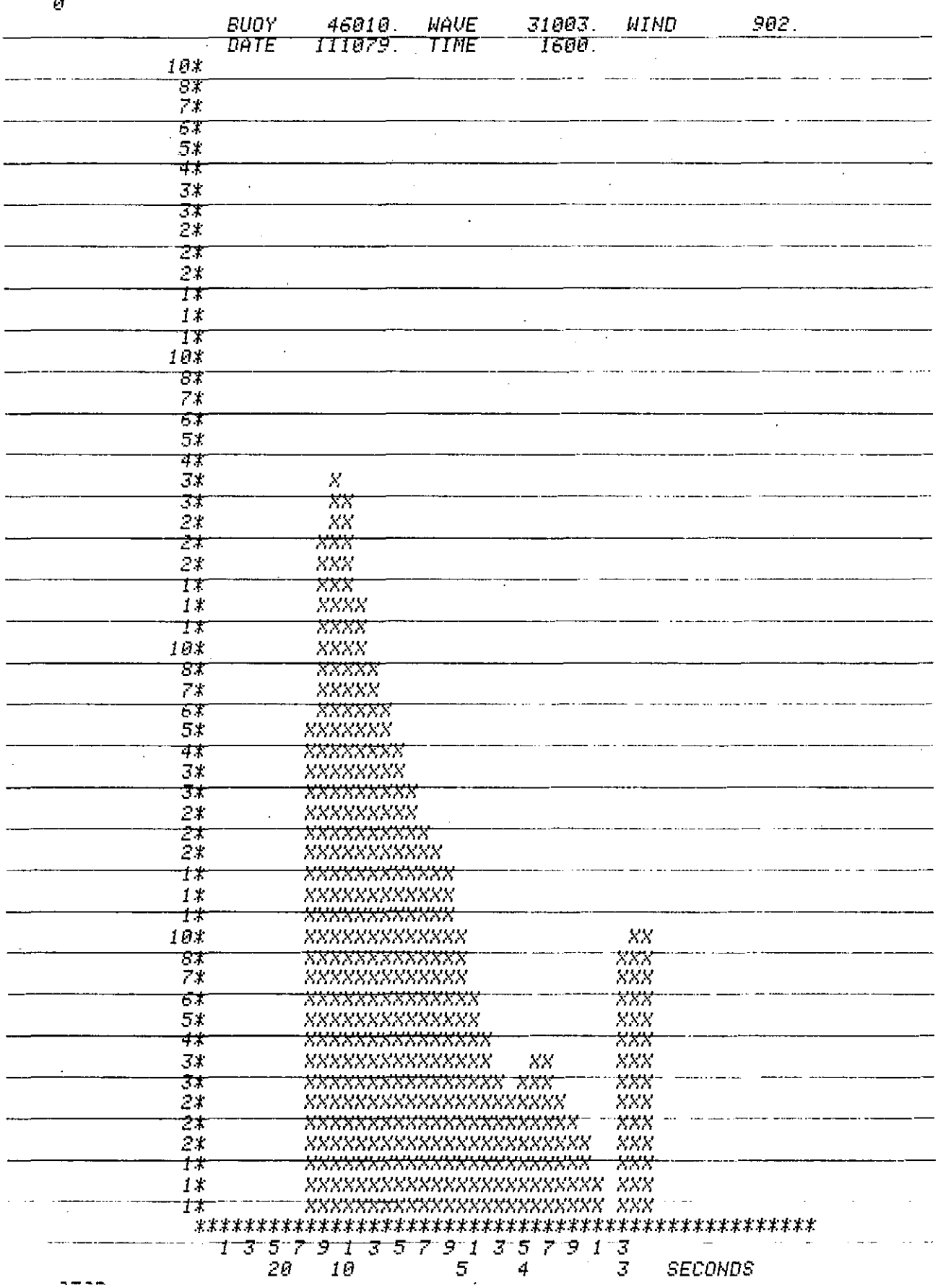
```
33.5
        22
28.5
        23
33.5
        24
39.5
        25
36.5
        26
29.5
        27
22.5
        28
18.5
        29
14.5
        30
10.5
        31                    Data "overlapped" onto last
86.5                          decade.
        32
97.5
        33
99.5
IF DATA CORRECT ENTER 0...OTHERWISE 1
```

NOTE: In the infrequently occuring case when ocean wave energy density is great enough so the decimal "3" appears in an observation, spectral data can be plotted by shifting the plot down one decade i.e.,

decimal code	input	
3	2	
2	1	
1	0	
0	5	
5	0	
6	5	"overlap"

Example 2 - Input (Continued)

Example 2 - Output



Program Listing - SP12

```
      DOUBLE PRECISION BUOY,WAVE,WIND,DATE,TIME
      DIMENSION IK(12),WASP(12,4),IPLOT(12,15),X(12),Y(12)
       IX=" "
      IY="X"
      IZ="*"
      TYPE "PROGRAM TO PLOT WAVE SPECTRA"
      TYPE"INPUT HEADING"
      TYPE" INPUT BUOY NUMBER"
      ACCEPT BUOY
      TYPE"INPUT WAVE GROUP"
      ACCEPT WAVE
      TYPE"INPUT WIND GROUP"
      ACCEPT WIND
      TYPE"INPUT DATE"
      ACCEPT DATE
      TYPE "INPUT TIME"
       ACCEPT TIME
       DO 60 I=1,12
60    IK(I)=0
      DO 4 I=1,12
      X(I)=0
      Y(I)=0
      DO 4 J=1,4
      WASP(I,J)=999
 4    CONTINUE
       DO 7 I=1,12
      DO 7 J=1,15
 7    IPLOT(I,J)=IX
      TYPE"INPUT SPECTRA DATA, 99.99 IF END OF DATA"
       TYPE"EXAMPLE...14380... IS INPUT AS 44.0"
      TYPE"INPUT: X=VALUE, Y=DECIMAL"
       I=0
11    I=I+1
       IF(I.GT.12)GO TO 12
       TYPE I
       ACCEPT X(I),Y(I)
       IF(Y(I).EQ.99)GO TO 12
      GO TO 11
12    CONTINUE
 24    TYPE"IF DATA CORRECT ENTER 0...OTHERWISE 1"
      ACCEPT COR
      IF(COR.EQ.0)GO TO 25
      TYPE"ENTER LEVEL"
      ACCEPT Z
      I=Z
      TYPE"ENTER VALUES"
      ACCEPT X(I),Y(I)
      GO TO 24
 25   CONTINUE
      DO 26 I=1,12
      IF(X(I).EQ.0)GO TO 26
      IF0(Y(I).EQ.99)GO TO 26
```

```
      J=3-Y(I)
       IF(Y(I).EQ.5)J=4
      IF(J.GT.4)GO TO 26
       IF(J.LT.1)GO J=1
      WASP(I,J)=X(I)
   26 CONTINUE
       WRITE(10,505)BUOY,WAVE,WIND
  505 FORMAT(15X,"BUOY",F10.0,"  WAVE",F10.0,"  WIND",F10.0)
      WRITE(10,506)DATE,TIME
  506 FORMAT(15X,"DATE",F10.0,"  TIME",F10.0)
      J=0
    8 J=J+1
       DO 16 K=1,15
      YL=16-K
      DO 16 I=1,12
      IF(WASP(I,J).LT.10.)WASP(I,J)=10
      A=WASP(I,J)
      YT=14.*ALOG(A)/2.3-13
      DY=ABS(YL-YT)
      IF(DY.GT..5)GO TO 16
      IPLOT(I,K)=IY
   16 CONTINUE
       DO 70 I=1,12
      DO 70 K=1,15
      IF(IPLOT(I,K).EQ.IY)IK(I)=1
       IF(IK(I).EQ.1)IPLOT(I,K)=IY
   70 CONTINUE
       DO 30 K=1,13
      B=10+90*(K-1)/15
      KJ=INT((2-ALOG(B)/2.3)*10+.51 )
       IF(KJ.LT.1)GO TO 30
      WRITE(10,400)KJ,12,(IPLOT(I,K),I=1,12)
  400 FORMAT(9X,I3,A1,5X,6A1,1X,A1,4(3X,A1),4X,A1)
   30 CONTINUE
      DO 20 I=1,12
      DO 20 JJ=1,15
      IPLOT(I,JJ)=IX
   20 CONTINUE
      IF(J.LT.4)GO TO 8
      WRITE(10,403)
  403 FORMAT(12X,"************************************************")
      WRITE(10,507)
  507 FORMAT(13X," 1 3 5 7 9 1 3 5 7 9 1 3 5 7 9 1 3")
      WRITE(10,530)
  530 FORMAT(13X,"     20    10         5     4         3    SECONDS")
       STOP
       END
R
```

Program Listing - SP33

```
      DOUBLE PRECISION BUOY,WAVE,WIND,DATE,TIME
      DIMENSION IK(33),WASP(33,4),IPLOT(33,15),X(33),Y(33)
       IX=" "
      IY="X"
      IZ="*"
      TYPE "PROGRAM TO PLOT WAVE SPECTRA"
      TYPE"INPUT HEADING"
      TYPE" INPUT BUOY NUMBER"
      ACCEPT BUOY
      TYPE"INPUT WAVE GROUP"
      ACCEPT WAVE
      TYPE"INPUT WIND GROUP"
      ACCEPT WIND
      TYPE"INPUT DATE"
      ACCEPT DATE
      TYPE "INPUT TIME"
       ACCEPT TIME
       DO 60 I=1,33
   60 IK(I)=0
      DO 4 I=1,33
      X(I)=0
      Y(I)=0
      DO 4 J=1,4
      WASP(I,J)=999
    4 CONTINUE
       DO 7 I=1,33
      DO 7 J=1,15
    7 IPLOT(I,J)=IX
      TYPE"INPUT SPECTRA DATA, 99,99 IF END OF DATA"
       TYPE"EXAMPLE...14380... IS INPUT AS 44,0"
      TYPE"INPUT: X=VALUE, Y=DECIMAL"
       I=0
   11 I=I+1
       IF(I.GT.33)GO TO 33
       TYPE I
       ACCEPT X(I),Y(I)
       IF(Y(I).EQ.99)GO TO 33
      GO TO 11
   33 CONTINUE
    24  TYPE"IF DATA CORRECT ENTER 0...OTHERWISE 1"
      ACCEPT COR
      IF(COR.EQ.0)GO TO 25
      TYPE"ENTER LEVEL"
      ACCEPT Z
      I=Z
      TYPE"ENTER VALUES"
      ACCEPT X(I),Y(I)
      GO TO 24
    25 CONTINUE
      DO 26 I=1,33
      IF(X(I).EQ.0)GO TO 26
      IF(Y(I).EQ.99)GO TO 26
      J=3-Y(I)
       IF(Y(I).EQ.5)J=4
```

```
      IF(J.GT.4)GO TO 26
      IF(J.LT.1)GO J=1
      WASP(I,J)=X(I)
   26 CONTINUE
      WRITE(10,505)BUOY,WAVE,WIND
  505 FORMAT(15X,"BUOY",F10.0,"  WAVE",F10.0,"  WIND",F10.0)
      WRITE(10,506)DATE,TIME
  506 FORMAT(15X,"DATE",F10.0,"  TIME",F10.0)
      J=0
    8 J=J+1
      DO 16 K=1,15
      YL=16-K
      DO 16 I=1,33
      IF(WASP(I,J).LT.10.)WASP(I,J)=10
      A=WASP(I,J)
      YT=14.*ALOG(A)/2.3-13
      DY=ABS(YL-YT)
      IF(DY.GT..5)GO TO 16
      IPLOT(I,K)=IY
   16 CONTINUE
      DO 70 I=1,33
      DO 70 K=1,15
      IF(IPLOT(I,K).EQ.IY)IK(I)=1
      IF(IK(I).EQ.1)IPLOT(I,K)=IY
   70 CONTINUE
      DO 30 K=1,15
      B=10+90*(K-1)/15
      KJ=(2-ALOG(B)/2.3)*10+.51
      IF(KJ.LT.1)GO TO 30
      WRITE(10,400)KJ,I2,(IPLOT(I,K),I=1,33)
  400 FORMAT(9X,I3,A1,3X,33A1)
   30 CONTINUE
      DO 20 I=1,33
      DO 20 JJ=1,15
      IPLOT(I,JJ)=IX
   20 CONTINUE
      IF(J.LT.4)GO TO 8
      WRITE(10,403)
  403 FORMAT(12X,"*************************************************")
      WRITE(10,507)
  507 FORMAT(13X," 1 3 5 7 9 1 3 5 7 9 1 3 5 7 9 1 3")
      WRITE(10,530)
  530 FORMAT(13X,"     20   10        5    4        3   SECONDS")
      END
R
```