UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

HP-85 Computer Program "HYP85"

An Earthquake Location Program

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Open File Report 85-243

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February 1985

HYP85: Introduction

HYP85 is an earthquake-location computer program that runs on an HP-85 computer. HYP85 was adapted from a similar program, HYPOINVERSE written by Klein (1978)*. Because of the change of environment, there have been many changes, most in the way of reduced capability. The purpose of HYP85 is to help users locate the epicenters of earthquakes, based on P- and S-wave arrival times at a series of seismograph stations. HYP85 does not currently calculate magnitudes, but space has been left in the program's data structures for future implementation of magnitude determinations.

The program runs on an HP-85 microcomputer equipped with an extra 16k RAM module. It allows the user to input station locations and related data, velocity models, and arrival times and related data for events. Based on a combination of these data, it locates the event using a simple form of the HYPOINVERSE algorithm. Due to memory constraints, the actual location procedure is in a separate program module called "LOCATE." This means that there is a delay between invoking a locate procedure, and the beginning of the procedure while the LOCATE procedure is loaded into memory.

The following is a brief tour through the program. Included are many examples of what actually appears on the computer screen or on the printer. In general, the program will give the user hints about what kind of input is needed. An important and non-intuitive part of the user interaction is easily understood: the user often specifies an action by striking one of the special function keys K5/K1, K6/K2, K7/K3, or K8/K4. Whenever the user strikes one of these keys, a list of the possible operations will appear on the screen with a short set of key labels just above the special function keys. It is important to remember that each key has two possible associated functions: one function is specified when you press the key without first depressing the shift key (K1, K2, K3, K4); the other function is specified by first depressing the shift key then, while holding the shift, pressing the desired special function key (K5, K6, K7, K8).

The program is started by first loading it. Type

LOAD "HYP85"

followed by the ENDLINE key and, once it is loaded, by striking the RUN key. The computer responds with the following screen:

*Klein, Fred W., Hypocenter location program HYPOINVERSE; Part 1: Users guide to versions 1, 2, 3, and 4, U.S.Geological Survey, Open-file Report 78-694, 113 pp., 1978.

```
HYP85 SERVICE PROGRAM

  STATIONS - ALTER STATION
             RECORD
  MODEL    - ALTER TRAVEL MODEL

  EVENTS   - BUILD AN EVENT
             RECORD
  LOCATE   - CHAIN TO LOCATE
             PROGRAM
  GET PICK - PRINT A DPLOT PICK
             PICK FILE

--------------------------------
GET PICK
STATIONS MODEL   EVENTS  LOCATE
```

The user can now select among five options. The following five sections correspond to these options.

STATIONS (K1 KEY)

When the user selects station management as the option (by pressing the K1 key) the following screen appears:

```
STATION UPDATE

THE CURRENT STATION FILE
HAS 20 STATIONS

ADD    - ADD A NEW STATION
DELETE - REMOVE A STATION
CHANGE - CHANGE STATION INFO
EXIT   - RETURN TO MASTER MENU
SHOWALL- PRINT ALL STATION INFO
SHOW   - PRINT SELECTED STAS


--------------------------------
SHOWALL SHOW
ADD     DELETE  CHANGE  EXIT
```

The six allowable sub-options should be easily understood and used. Example 1 in the appendix shows a sample printed output of the "SHOWALL" option which simply lists all existing station data.

If the user wishes to see the station information on the screen one station at a time, they invoke the "SHOW" option which produces the following display for each station:

```
STATION - LFA
LATITUDE -  37  DEG
            46.36  MIN NORTH
LONGITUDE-  25  DEG
            28.99  MIN WEST
P DELAY -  0  SECS
DURATION ADJ - 0  MAG UNITS
S DELAY -  0  SECS
WEIGHT  -  0
ELEVATION -  693
PERIOD -  .5
MODEL -  2
PRINT
?
```

Respond with an ENDLINE to see the next station's listing.

If the user has the wrong tape in the HP-85, or if there is not yet a "STATNS" file containing station data on the tape the computer will display:

```
TROUBLE OPENING STATNS

CREATE (C), OR TRY AGAIN (T)
?
```

Respond by placing the proper tape in the tape drive and striking "T" or by typing "C" to create a STATNS file. The station file can hold up to 50 different station descriptions at a time.

MODEL UPKEEP (K2 KEY)

When the user has selected the "MODEL" option (by pressing the K2 key) the following screen appears:

```
MODEL UPKEEP
 SHOW    - SHOW VALUES IN MODELS
 SHOWALL- PRINT MODEL VALUES
 CHANGE - CHANGE MODELS
 EXIT    - RETURN TO MASTER MENU


--------------------------------
 SHOW   SHOWALL  CHANGE  EXIT
```

The program allows three different velocity models, each with up to 5 layers (including a half space for the bottom layer) and corresponding velocities. The depth to the top of each layer (km) and the layer P-wave velocity (km/s) are specified.

The sub-options are self explanatory, but note two things. First, changes made in the models are implemented by exiting this portion of the program through the "EXIT" option--exiting any other way may abrogate the changes. Second, as with the STATIONS option, if the wrong data tape or an unintialized data tape is in the drive the following appears:

```
TROUBLE ACCESSING MODEL FILE
CREATE(C) OR TRY AGAIN(T)
?
```

The user must respond with "C" to create a new model file or with "T" after placing the proper tape in the tape drive.

Following is an example of the velocity-model listing produced with the "SHOWALL" option:

```
MODEL  1
DEPTH-    0.00 SPEED-    5.50
DEPTH-    2.50 SPEED-    6.40
DEPTH-    8.00 SPEED-    7.20
DEPTH-   14.00 SPEED-    8.00
DEPTH-    0.00 SPEED-    0.00

MODEL  2
DEPTH-    0.00 SPEED-    4.50
DEPTH-    3.80 SPEED-    6.80
DEPTH-    8.00 SPEED-    7.50
DEPTH-    0.00 SPEED-    0.00
DEPTH-    0.00 SPEED-    0.00

MODEL  3
DEPTH-    0.00 SPEED-    0.00
DEPTH-    0.00 SPEED-    0.00
DEPTH-    0.00 SPEED-    0.00
DEPTH-    0.00 SPEED-    0.00
DEPTH-    0.00 SPEED-    0.00
```

EVENT-FILE MANAGEMENT (K3 KEY)

When one invokes the "EVENTS" option of the main menu the following query appears on the screen:

```
ARRIVAL FILE MANAGEMENT
FILE NAME?
?
```

The user must type the name of a file containing phase data (arrival times, pick qualities, etc.). If the user wishes to start a new file, s/he should type the new file name, and the following message will appear:

```
TROUBLE WITH FILE
TRY AGAIN (T) OR CREATE(C)
?
```

Respond with "C" to make a new file.

The program will then ask the user to specify center coordinates for the array of stations that are to be specified for this file. Press the ENDLINE key for the next three prompts because this "center" has no function in the current implementation; it may one day be used to specify the location of a contact between two velocity models.

Once the file is properly opened, the following screen appears:

```
ARRIVAL UPDATE

THE CURRENT ARRIVAL FILE
HAS 0 ARRIVALS

ADD    - ADD AN ARRIVAL
DELETE - REMOVE AN ARRIVAL
CHANGE - CHANGE ARRIVAL INFO
EXIT   - RETURN TO MASTER MENU
SHOWALL- PRINT ALL ARRIVAL INFO
SHOW   - PRINT SELECTED ARRIVALS
CENTER - CHANGE CENTER COORDS

--------------------------------
SHOWALL SHOW    CENTER
ADD     DELETE  CHANGE  EXIT
```

The event files allow up to 15 different stations to be used for an earthquake location.

Example 2 (appendix) is the printed output of the "SHOWALL" option that lists phase data for the earthquake.

Note that permanent changes to the event file are accomplished only by exiting from this menu with the EXIT (K4) option. This means one may lose data even though s/he was able to produce a printed list of the data changes and additions.

The station names may not be changed once given, due to a bug in the present implementation. One must delete and recreate the whole station entry to change its name.

GET PICK (K5 KEY)

This option is included to allow easy access to Sprengnether DR-100 data that was sampled and that had arrivals picked using DPLOT software on the HP-85. If the user invokes this option the following message appears:

```
GET PICK
LOAD IN HP 85 TAPE WHICH HOLDS
 THE PICK FILE YOU WISH TO LIST
 STRIKE THE 'CONT' KEY WHEN YOU
 HAVE THE NEW TAPE PROPERLY
 LOADED
```

Subsequently, the user must specify a file name. It is important to remember to return the proper tape into the tape drive before exiting the "GET PICK" option. Example 3 in the appendix is a sample "GET PICK" printout.

LOCATE AN EVENT (K4 KEY)

When one invokes the "LOCATE" option, a separate program is loaded into the computer (this takes some time) and the following message appears on the screen:

```
NON STANDARD ORIGIN (Y/N)
?
```

The user must type "Y" if s/he wishes to specify the starting location for the interative hypocenter-location procedure. Any other input will cause the default starting location (a point near the earliest station) to be used.

Next the computer will query:

```
P LEV(0-2)     2
?
```

There are three printer output levels--level 0 is the most terse, level 2 the most complete. Examples 4A and 4B show parts of a level-2 output, example 5 shows a level-1 output, and example 6 shows a level-0 output

Finally the computer asks for the name of the event file (referred to here as the arrival file) previously created with the "EVENTS" option:

```
SPECIFY ARRIVAL FILE
?
```

Respond by typing the name of the event file for the earthquake you want located.

When the program converges to a solution or gives up, the selected printout (level 0, 1, or 2)will be ready at the printer and the following query will appear on the screen:

```
CHAIN TO HYP85
?
```

Typing "Y" takes the user back to the main program (this takes some time). Any other input causes the program to ask for information for another location computation.

PROGRAM STORAGE

The program resides in two program files, "HYP85" and "LOCATE." When a different program is needed it is automatically read into the computer, or the user may explicitly load them. It is advantagous (speed) to put both programs at the beginning of the tape and run HYP85 at least enough to create the files STATNS and MODEL before adding other files to the tape.

APPENDIX

EXAMPLE 1: STATION LIST

```
STATION - LGD
LAT     37  D  45.27  M NORTH
LONG    25  D  24.37  M WEST
P DELAY -  0  SECS
DURATION ADJ - 0  MAG UNITS
S DELAY -  0  SECS
WEIGHT  -  0
ELEVATION -  454
PERIOD -  1
MODEL -  2
**********************************

STATION - CRA
LAT     37  D  45.19  M NORTH
LONG    25  D  28.13  M WEST
P DELAY -  0  SECS
DURATION ADJ - 0  MAG UNITS
S DELAY -  0  SECS
WEIGHT  -  0
ELEVATION -  667
PERIOD -  1
MODEL -  2
**********************************

STATION - MTS
LAT     37  D  46.86  M NORTH
LONG    25  D  26.31  M WEST
P DELAY -  0  SECS
DURATION ADJ - 0  MAG UNITS
S DELAY -  0  SECS
WEIGHT  -  0
ELEVATION -  826
PERIOD -  .5
MODEL -  2
**********************************

STATION - ADB
LAT     37  D  43.98  M NORTH
LONG    25  D  28.62  M WEST
P DELAY -  0  SECS
DURATION ADJ - 0  MAG UNITS
S DELAY -  0  SECS
WEIGHT  -  0
ELEVATION -  200
PERIOD -  1
MODEL -  2
**********************************
```

EXAMPLE 2: EVENT LIST

```
**********************************
CENTER
LAT     0  D  0  M NORTH
LONG    0  D  0  M WEST
**********************************
STATION - RIB
P ARRIVAL DAY-249  23:10:52.850
P WEIGHT  0
S ARRIVAL DAY-249  23:10:54.200
S WEIGHT  3
DURATION  33
DESCRIPTOR - ID
**********************************

STATION - VIF
P ARRIVAL DAY-249  23:10:52.800
P WEIGHT  1
S ARRIVAL DAY-249  23:10:54.350
S WEIGHT  3
DURATION  35
DESCRIPTOR - IU
**********************************

STATION - MTS
P ARRIVAL DAY-249  23:10:52.300
P WEIGHT  1
S ARRIVAL DAY-  0  00:00:00.000
S WEIGHT  9
DURATION  37
DESCRIPTOR - I-
**********************************

STATION - LFA
P ARRIVAL DAY-249  23:10:53.300
P WEIGHT  0
S ARRIVAL DAY-249  23:10:54.000
S WEIGHT  4
DURATION  41
DESCRIPTOR - ID
**********************************

STATION - FRA
P ARRIVAL DAY-249  23:10:53.450
P WEIGHT  2
S ARRIVAL DAY-249  23:10:55.450
S WEIGHT  4
DURATION  28
DESCRIPTOR - I+
**********************************
```

EXAMPLE 3: GET-PICK OUTPUT

```
FILE - POINTS

 2  SETS OF PICKED POINTS


SET # 1
POINT 1   VALUE=   .903
DAY-157   00:21:46.943

POINT 2   VALUE=   .820
DAY-157   00:21:46.913

POINT 3   VALUE=   .879
DAY-157   00:21:46.993

POINT 4   VALUE=   .869
DAY-157   00:21:47.013

DESCRIPTOR - TEST RECORD
DR100 # 202


SET # 2
POINT 1   VALUE=   .034
DAY-157   00:21:46.125

POINT 2   VALUE= -.356
DAY-157   00:21:46.504

POINT 3   VALUE=   .903
DAY-157   00:21:46.863

POINT 4   VALUE= -.542
DAY-157   00:21:49.313

DESCRIPTOR -
CHANNEL ONE EXAMPLE PICK
DR100 # 202
```

EXAMPLE 4A: BEGINNING (ITERATIONS) OF LOCATE OUTPUT (LEVEL 2)

```
EVENT FILE E24923

**********************************
ITERATION 1
DAY-249  23:10:50.300
LAT     37 D 47.16 M NORTH
LONG    25 D 26.61 M WEST
DEPTH -   7.000
  DELTA T=   1.114
  LAT       0 D  0.51 M NORTH
  LONG      0 D  2.15 M EAST
  DELTA DEPTH =00.000
    RMW   = 13
    RMS   = 1.52037666025
    RR    = 3.28927699901
    NFREE= 3
FOCAL DEPTH FREED
**********************************
AIRQUAKE PREVENTED
ITERATION 2
DAY-249  23:10:51.414
LAT     37 D 47.67 M NORTH
LONG    25 D 24.46 M WEST
DEPTH -   7.000
  DELTA T=    .371
  LAT       0 D  0.27 M SOUTH
  LONG      0 D  0.13 M WEST
  DELTA DEPTH =-3.500
    RMW   = 13
    RMS   = .308403886894
    RR    = 3.54144577533
    NFREE= 4
**********************************
ITERATION 3
DAY-249  23:10:51.785
LAT     37 D 47.39 M NORTH
LONG    25 D 24.58 M WEST
DEPTH -   3.500
  DELTA T=   -.038
  LAT       0 D  0.26 M SOUTH
  LONG      0 D  0.31 M WEST
  DELTA DEPTH =-0.550
    RMW   = 13
    RMS   = .182791193002
    RR    = .8614166851
    NFREE= 4
**********************************
```

EXAMPLE 4: ENDING LOCATE OUTPUT (LEVEL 2)

```
**********************************
END OF LOCATION

DAY-249  23:10:51.753
LAT     37 D 46.94 M NORTH
LONG    25 D 24.90 M WEST
DEPTH -   2.719

EIGENVALUES
  3.762
   .500
   .467
   .245


EIGENVECTORS OF ADJUSTMENT
     .99      .05     -.12     -.04
     .03     -.16     -.08      .98
    -.13      .52     -.84      .02
     .03      .84      .52      .17

COVARIANCE
     .01     -.05      .05     -.02
    -.05     1.34      .03      .18
     .05       03      .36     -.02
    -.02      .18     -.02      .37

        #ERROR ELLIPSE
ERRORS #  SERR AZ DIP
   .118 #  1.17 359 10
 1.158 #    .61  95 34
  .598 #    .57 255 54
  .610 #

*****
RIB ****************************
*****
DIST AZM  AN P/S W
 4.5 295 121 IPD 0

(TOBS -TCAL -DLY  =RES) WT
 1.10  1.16 0.00  -.07 1.42

*****
RIB ****************************
*****
DIST AZM  AN P/S W
 4.5 295 121  S  3

(TOBS -TCAL -DLY  =RES) WT
 2.45  1.16 0.00   .41  .01

*****
WIF ****************************
*****
DIST AZM  AN P/S W
 4.7 207 120 IPU 1

(TOBS -TCAL -DLY  =RES) WT
 1.05  1.21 0.00  -.16 1.06
```

EXAMPLE 5: PARTIAL LOCATE OUTPUT (LEVEL 1)

```
**********************************

EVENT FILE E24923

**********************************
ITERATION 1
**********************************
ITERATION 2
**********************************
ITERATION 3
**********************************
ITERATION 4
**********************************
ITERATION 5
**********************************
ITERATION 6
**********************************
END OF LOCATION

DAY-249  23:10:51.753
LAT     37 D 46.94 M NORTH
LONG    25 D 24.90 M WEST
DEPTH -  2.719

EIGENVALUES
  3.762
   .500
   .467
   .245


EIGENVECTORS OF ADJUSTMENT
    .99      .05     -.12     -.04
    .03     -.16     -.08      .98
   -.13      .52     -.84      .02
    .03      .84      .52      .17

COVARIANCE
    .01     -.05      .05     -.02
   -.05     1.34      .03      .18
    .05      .03      .36     -.02
   -.02      .18     -.02      .37

        #ERROR ELLIPSE
ERRORS #  SERR AZ DIP
  .118 #  1.17 359 10
 1.158 #   .61  95 34
  .598 #   .57 255 54
  .610 #

*****
RIB ******************************
*****
DIST AZM  AN P/S W
 4.5 295 121 IPD 0

(TOBS -TCAL -DLY  =RES) WT
 1.10  1.16 0.00  -.07 1.42
```

EXAMPLE 6: LOCATE OUTPUT (LEVEL 0)

```
**********************************

EVENT FILE E24923

**********************************
ITERATION 1
**********************************
ITERATION 2
**********************************
ITERATION 3
**********************************
ITERATION 4
**********************************
ITERATION 5
**********************************
ITERATION 6
**********************************
END OF LOCATION

DAY-249  23:10:51.753
LAT     37 D 46.94 M NORTH
LONG    25 D 24.90 M WEST
DEPTH -  2.719

**********************************
 417.434     '
```

BASIC-LANGUAGE LISTING OF "HYP85"

```
 10 OPTION BASE 1
 20 W9=15
 30 W5=W9*4
 40 DIM A(15,4),B(4,15),C(20,4),
    Z(4),Y(15),X(4)
 50 DIM A9(15,6)
 60 DIM A8(15,9)
 70 DIM A2$[60]
 80 DIM K(15,6)
 90 DIM W(30)
 95 DIM K5$[64]
100 DIM I(30)
110 W6=1
120 W7=3
130 W8=50
140 S=-1
150 DIM S$[200]
160 DEF FNS$(I)
170 IF S=-1 THEN S=FNS1(0)
180 FNS$="    "
190 IF I>S THEN 220
200 IF I<1 THEN 220
210 FNS$=S$[I*4-3,I*4]
220 FN END
230 DEF FNS2(I)
240 S$[I*4-3,I*4]=S1$
250 FNS2=1
260 FN END
270 DIM S(31)
280 FOR I=1 TO 31 @ S(I)=0 @ NEX
    T I
290 DEF FNS1(I)
300 IF I=0 THEN 410
310 IF I>S THEN 390
320 ON ERROR GOTO 380
330 READ# 1,I+1 ; S()
340 OFF ERROR
350 S1$=FNS$(I)
360 FNS1=1
370 GOTO 640
380 OFF ERROR
390 FNS1=0
400 GOTO 640
410 IF S<>-1 THEN 460
420 ON ERROR GOTO 480
430 ASSIGN# 1 TO "STATNS"
440 READ# 1 ; S,S$
450 OFF ERROR
460 FNS1=S
470 GOTO 640
480 OFF ERROR
490 CLEAR @ DISP "TROUBLE OPENIN
    G STATNS"
500 DISP @ DISP "CREATE (C), OR
    TRY AGAIN (T)"
510 INPUT Y$
520 IF Y$="T" THEN 420
530 IF Y$<>"C" THEN 490
540 ON ERROR GOTO 630
550 CREATE "STATNS",51
```

```
560 OFF ERROR
570 S=0
580 S$=""
590 S$[200,200]=" "
600 ASSIGN# 1 TO "STATNS"
610 PRINT# 1,1 ; S,S$
620 GOTO 460
630 OFF ERROR
640 FN END
650 DEF FNS0(I)
660 IF I>50 THEN 750
670 IF I>S+1 THEN 750
680 IF I<1 THEN 770
690 A=FNS2(I)
700 PRINT# 1,I+1 ; S()
710 IF I<>S+1 THEN 730
720 S=S+1
730 PRINT# 1,1 ; S,S$
740 FNS0=1 @ GOTO 820
750 FNS0=0 @ GOTO 820
760 FNS0=1
770 S=-1
780 ON ERROR GOTO 800
790 ASSIGN# 1 TO *
800 OFF ERROR
810 FNS0=1
820 FN END
830 DEF FNS3(I)
840 IF I>S OR I<1 THEN 900
850 IF I=S THEN 880
860 IF NOT FNS1(S) THEN 870
870 IF NOT FNS0(I) THEN 880
880 S=S-1
890 PRINT# 1,1 ; S,S$
900 FNS3=1
910 FN END
920 DEF FNS4(I)
930 IF I<1 OR I>S+1 THEN 1240
940 IF I<=S THEN 990
950 S1$="    "
960 FOR A=1 TO 31 @ S(A)=0 @ NEX
    T A
970 S(9)=1
980 GOTO 1000
990 A=FNS1(I)
1000 CLEAR
1010 DISP "STATION NAME - ";S1$
1020 DISP "NEW?" @ INPUT Y$
1030 IF LEN(Y$)=0 THEN 1090
1040 IF LEN(Y$)>=4 THEN 1070
1050 Y$=Y$&" "
1060 GOTO 1040
1070 Y$[5,5]=" " @ IF I<>FNS7(Y$
    [1,4]) THEN 1000
1080 S1$=Y$[1,4] @ GOTO 1000
1090 S(1)=FNL9(S(1))
1100 S(2)=FNL8(S(2))
1110 A=S(3) @ S(3)=FNZ("P DELAY
     (SEC)")
1120 A=S(4) @ S(4)=FNZ("DURATION
      ADJ.")
1130 A=S(5) @ S(5)=FNZ("S DELAY
     (SEC)")
1140 A=S(6) @ S4=FNZ("STATION WE
     IGHT")
1150 IF S4>9 OR S4<0 THEN 1140
1160 S(6)=S4
1170 A=S(7) @ S(7)=FNZ("ELEVATIO
     N (M)")
1180 A=S(8) @ S(8)=FNZ("PERIOD (
     SECS)")
1190 A=S(9) @ S4=FNZ("MODEL (1 T
     O 3)")
1200 IF S4>3 OR S4<1 THEN 1190
1210 S(9)=S4
1220 FNS4=1
1230 A=FNS0(I)
1240 FN END
1250 DEF FNS5(I)
1260 S5=FNS1(I) @ FNS5=S5 @ IF S
     5=0 THEN 1470
1270 DISP "STATION - ";S1$
1280 S4=S(1) @ IF S4<0 THEN S4=-
     S4
1290 S5=S4 DIV 60 @ S6=S4-S5*60
1300 DISP "LATITUDE - ";S5;" DEG
     "
1310 DISP "            ";S6;" MIN
      ";
1330 IF S(1)>=0 THEN DISP "NORTH
     " ELSE DISP "SOUTH"
1340 S4=S(2) @ IF S4<0 THEN S4=-
     S4
1350 S5=S4 DIV 60 @ S6=S4-S5*60
1360 DISP "LONGITUDE- ";S5;" DEG
     "
1370 DISP "            ";S6;" MIN
      ";
1390 IF S(2)>=0 THEN DISP "WEST"
      ELSE DISP "EAST"
1400 DISP "P DELAY - ";S(3);" SE
     CS"
1410 DISP "DURATION ADJ -";S(4);
     " MAG UNITS"
1420 DISP "S DELAY - ";S(5);" SE
     CS"
1430 DISP "WEIGHT  - ";S(6)
1440 DISP "ELEVATION - ";S(7)
1450 DISP "PERIOD - ";S(8)
1460 DISP "MODEL - ";S(9)
1470 FN END
1480 DEF FNS6(I)
1490 S5=FNS1(I) @ FNS6=S5 @ IF S
     5=0 THEN 1610
1500 PRINT "STATION - ";S1$
1510 S4=FNL6(S(1))
1520 S4=FNL5(S(2))
1530 PRINT "P DELAY - ";S(3);" S
     ECS"
1540 PRINT "DURATION ADJ -";S(4)
     ;" MAG UNITS"
```

```
1550 PRINT "S DELAY - ";S(5);" S
     ECS"
1560 PRINT "WEIGHT  - ";S(6)
1570 PRINT "ELEVATION - ";S(7)
1580 PRINT "PERIOD - ";S(8)
1590 PRINT "MODEL - ";S(9)
1600 GOSUB 6820
1610 FN END
1620 DEF FNS7(A$)
1630 S7=1
1640 IF S7>S THEN 1670
1650 IF FNS$(S7)=A$ THEN 1670
1660 S7=S7+1 @ GOTO 1640
1670 FNS7=S7
1680 FN END
1690 DEF FNN(A)
1700 INPUT Q$
1710 IF LEN(Q$)=0 THEN 1760
1720 E1=VAL(Q$)
1730 FNN=E1
1740 E1=0
1750 GOTO 1780
1760 E1=1
1770 FNN=0
1780 FN END
1790 DEF FNZ(A$)
1800 CLEAR @ DISP A$;"    ";A
1810 B=FNN(A)
1820 IF E1=1 THEN 1850
1830 A=B
1840 GOTO 1800
1850 FNZ=A
1860 FN END
1870 DEF FND1(I)
1880 D9=I/60
1890 D8=INT(D9)
1900 D9=INT((D9-D8)*60000+.5)/10
     00
1910 D8=D8/60
1920 D7=INT(D8)
1930 D8=INT(.5+(D8-D7)*60)
1940 D7=D7/24
1950 D6=INT(D7)
1960 D7=INT(.5+(D7-D6)*24)
1970 FND1=I
1980 FN END
1990 DEF FND2(I)
2000 I=FND1(I)
2010 DISP USING 2020 ; D6,D7,D8,
     D9
2020 IMAGE "DAY-",DDD,XX,ZZ,":",
     ZZ,":",ZZ.DDD
2030 FND2=I
2040 FN END
2050 DEF FND3(I)
2060 I=FND1(I)
2070 PRINT USING 2020 ; D6,D7,D8
     ,D9
2080 FND3=I
2090 FN END
2100 DEF FND(A$)
2110 CLEAR @ DISP "TIME OF ";A$
2120 D5=FND2(A)
2130 DISP "CHANGE (Y/N)" @ INPUT
      Y$
2140 IF Y$<>"Y" THEN 2210
2150 DISP "DAY",D6 @ D5=FNN(1) @
      IF E1=0 THEN D6=D5
2160 DISP "HOUR",D7 @ D5=FNN(1)
     @ IF E1=0 THEN D7=D5
2170 DISP "MIN",D8 @ D5=FNN(1) @
      IF E1=0 THEN D8=D5
2180 DISP "SEC",D9 @ D5=FNN(1) @
      IF E1=0 THEN D9=D5
2190 A=((D6*24+D7)*60+D8)*60+D9
2200 GOTO 2110
2210 FND=A
2220 E1=1
2230 FN END
2240 DEF FNL9(I)
2250 GOSUB 6830
2260 FNL9=FNL7(I)
2270 FN END
2280 DEF FNL8(I)
2290 GOSUB 6870
2300 FNL8=FNL7(I)
2310 FN END
2320 DEF FNL3(I)
2330 IF I>=0 THEN L9=1 ELSE L9=-
     1
2340 L8=I*L9
2350 L7=L8 DIV 60
2360 L8=L8-L7*60
2370 PRINT L9$;" ";L7;" D ";L8;"
      M ";
2380 IF L9=1 THEN PRINT L8$ ELSE
      PRINT L7$
2390 FNL3=I
2400 FN END
2410 DEF FNL6(I)
2420 GOSUB 6830
2430 FNL6=FNL3(I)
2440 FN END
2450 DEF FNL5(I)
2460 GOSUB 6870
2470 FNL5=FNL3(I)
2480 FN END
2490 DEF FNL4(I)
2500 IF I>=0 THEN L9=1 ELSE L9=-
     1
2510 L8=I*L9
2520 L7=L8 DIV 60
2530 L8=L8-L7*60
2540 DISP L9$;" ";L7;" D ";L8;"
     M ";
2550 IF L9=1 THEN DISP L8$ ELSE
     DISP L7$
2560 FNL4=I
2570 FN END
2580 DEF FNL7(I)
```

```
2590 CLEAR @ I=FNL4(I)
2600 DISP "ALTER (Y/N)" @ INPUT
     Y$
2610 IF Y$<>"Y" THEN 2710
2620 CLEAR @ DISP L9$&" DEGREES"
     ;L7;@ L6=FNN(L7) @ IF E1=0
     THEN L7=L6
2630 CLEAR @ DISP L9$&" MINS";L8
     ;@ L6=FNN(L8) @ IF E1=0 THE
     N L8=L6
2640 CLEAR @ DISP L8$&" OR "&L7$
     ;" - ";
2650 IF L9=1 THEN DISP L8$ ELSE
     DISP L7$
2660 INPUT Y$
2670 IF LEN(Y$)<1 THEN 2690
2680 IF Y$[1,1]=L8$[1,1] THEN L9
     =1 ELSE L9=-1
2690 I=L9*(L7*60+L8)
2700 GOTO 2590
2710 FNL7=I
2720 FN END
2730 A=0
2740 DIM A$[32]
2750 N=4 @ M=15
2760 T9=.000000001
2770 ! V9() AND D9() ARE TRAVEL
2780 !  MODEL ARRAYS
2790 DIM V9(3,5),D9(3,5)
2800 DIM H1(3,5),H2(3,5),H3(6),H
     4(6),H5(5)
2810 DEF FNM1(I)
2820 FOR M1=1 TO 3
2830 FOR M2=1 TO 5
2840 V9(M1,M2)=0
2850 D9(M1,M2)=0
2860 NEXT M2
2870 NEXT M1
2880 FNM1=1
2890 FN END
2900 DEF FNM2(I)
2910 IF I>3 OR I<0 THEN 2980
2920 DISP "MODEL ";I
2930 FOR M2=1 TO 5
2940 IMAGE "DEPTH- ",DDD.DD," SP
     EED- ",DDD.DD
2950 DISP USING 2940 ; D9(I,M2),
     V9(I,M2)
2960 IMAGE "DEPTH- ",DDD.DD," VE
     LOCITY- ",DDD.DD
2970 NEXT M2
2980 FNM2=1
2990 FN END
3000 DEF FNM3(I)
3010 IF I>3 OR I<0 THEN 3070
3020 PRINT "MODEL ";I
3030 FOR M2=1 TO 5
3040 PRINT USING 2940 ; D9(I,M2)
     ,V9(I,M2)
3050 NEXT M2
3060 PRINT
3070 FNM3=1
3080 FN END
3090 DEF FNM4(I)
3100 IF I>3 OR I<1 THEN 3230
3110 CLEAR @ DISP "CHANGE MODEL
     ";I
3120 A=D9(I,1) @ D9(I,1)=FNZ("FI
     RST DEPTH")
3130 A=V9(I,1) @ V9(I,1)=FNZ("FI
     RST SPEED")
3140 A=D9(I,2) @ D9(I,2)=FNZ("SE
     COND DEPTH")
3150 A=V9(I,2) @ V9(I,2)=FNZ("SE
     COND SPEED")
3160 A=D9(I,3) @ D9(I,3)=FNZ("TH
     IRD DEPTH")
3170 A=V9(I,3) @ V9(I,3)=FNZ("TH
     IRD SPEED")
3180 A=D9(I,4) @ D9(I,4)=FNZ("FO
     URTH DEPTH")
3190 A=V9(I,4) @ V9(I,4)=FNZ("FO
     URTH SPEED")
3200 A=D9(I,5) @ D9(I,5)=FNZ("FI
     FTH DEPTH")
3210 A=V9(I,5) @ V9(I,5)=FNZ("FI
     FTH SPEED")
3220 FNM4=FNM2(I)
3230 FNM4=1
3240 FN END
3250 DEF FNH1(I)
3260 M1=0
3270 IF I=1 THEN 3330
3280 FOR M2=1 TO I-1
3290 M3=SQR(H2(G3,I)-H2(G3,M2))
3300 M4=H1(G3,M2)*M3/(V9(G3,M2)*
     V9(G3,I))
3310 IF M2>=G7 THEN M1=M1+2*M4 E
     LSE M1=M1+M4
3320 NEXT M2
3330 FNH1=M1
3340 FN END
3350 DEF FNH2(I)
3360 M1=0
3370 IF I=1 THEN 3430
3380 FOR M2=1 TO I-1
3390 M3=SQR(H2(G3,I)-H2(G3,M2))
3400 M4=H1(G3,M2)*V9(G3,M2)/M3
3410 IF M2>=G7 THEN M1=M1+2*M4 E
     LSE M1=M1+M4
3420 NEXT M2
3430 FNH2=M1
3440 FN END
3450 !
3460 DEF FNA$(I)
3470 FNA$="    "
3480 IF I>A7 THEN 3510
3490 IF I<1 THEN 3510
3500 FNA$=A2$[I*4-3,I*4]
3510 FN END
```

```
3520 DEF FNA1(A$)
3530 ON ERROR GOTO 3650
3540 ASSIGN# 3 TO A$
3550 READ# 3,1 ; A7,A8,A9
3560 READ# 3,2 ; A2$
3570 READ# 3,3
3580 FOR A1=1 TO W9
3590 FOR A2=1 TO 6
3600 READ# 3 ; A9(A1,A2)
3610 NEXT A2
3620 NEXT A1
3630 OFF ERROR
3640 GOTO 3910
3650 OFF ERROR
3660 CLEAR @ DISP "TROUBLE WITH
     FILE"
3670 DISP "TRY AGAIN (T) OR CREA
     TE(C)" @ INPUT Y$
3680 IF Y$="T" THEN 3530
3690 IF Y$<>"C" THEN 3890
3700 ON ERROR GOTO 3880
3710 CREATE A$,12
3720 A7=0 @ A8=0 @ A9=0 @ A2$=""
      @ A2$[W5,W5]=" "
3730 OFF ERROR
3740 DISP "SUPPLY CENTER COORDIN
     ATES"
3750 DISP " ENDLINE TO CONTINUE"
      @ INPUT Y$
3760 A8=FNL9(A8)
3770 A9=FNL8(A9)
3780 ON ERROR GOTO 3880
3790 FOR A1=1 TO W9
3800 FOR A2=1 TO 6
3810 A9(A1,A2)=0
3820 NEXT A2
3830 NEXT A1
3840 ASSIGN# 3 TO A$
3850 A=FNA0(1)
3860 OFF ERROR
3870 GOTO 3910
3880 CLEAR @ DISP "FATAL ERROR"
     @ BEEP @ STOP
3890 FNA1=0
3900 GOTO 3920
3910 FNA1=1
3920 FN END
3930 DEF FNA0(I)
3940 PRINT# 3,1 ; A7,A8,A9
3950 PRINT# 3,2 ; A2$
3960 PRINT# 3,3
3970 FOR A1=1 TO W9
3980 FOR A2=1 TO 6
3990 PRINT# 3 ; A9(A1,A2)
4000 NEXT A2
4010 NEXT A1
4020 IF I<>0 THEN 4040
4030 ASSIGN# 3 TO *
4040 FNA0=1
4050 FN END
4060 DEF FNA7(A$)
4070 A6=1
4080 IF A6>A7 THEN 4120
4090 IF FNA$(A6)=A$[1,4] THEN 41
     20
4100 A6=A6+1
4110 GOTO 4080
4120 FNA7=A6
4130 FN END
4140 DEF FNA3(I)
4150 IF I>A7 THEN 4230
4160 IF I<1 THEN 4230
4170 IF I=A7 THEN 4220
4180 A2$[I*4-3,I*4]=FNA$(A7)
4190 FOR A3=1 TO 6
4200 A9(I,A3)=A9(A7,A3)
4210 NEXT A3
4220 A7=A7-1
4230 FNA3=I
4240 FN END
4250 DEF FNA4(I)
4260 IF I>A7+1 OR I<1 THEN 4520
4270 IF I>W9 THEN 4520
4280 IF I<>A7+1 THEN 4350
4290 A2$[I*4-3,I*4]="    "
4300 FOR A3=1 TO 5
4310 A9(I,A3)=0
4320 NEXT A3
4330 A9(I,6)=FNA9("    ")
4340 A7=A7+1
4350 CLEAR @ DISP "STATION NAME
     - ";FNA$(I) @ INPUT Y$
4360 IF LEN(Y$)=0 THEN 4420
4370 IF LEN(Y$)>=4 THEN 4390
4380 Y$=Y$&" " @ GOTO 4370
4390 IF FNA7(Y$[1,4])<>A7+1 THEN
      4350
4400 A2$[I*4-3,I*4]=Y$[1,4]
4410 GOTO 4350
4420 A=A9(I,1) @ A9(I,1)=FND("P
     ARRIVAL")
4430 A=A9(I,2) @ A9(I,2)=FNZ("P
     WEIGHT")
4440 A=A9(I,3) @ A9(I,3)=FND("S
     ARRIVAL")
4450 A=A9(I,4) @ A9(I,4)=FNZ("S
     WEIGHT")
4460 A=A9(I,5) @ A9(I,5)=FNZ("DU
     RATION")
4470 CLEAR @ DISP "DESCRIPTOR -
     ";FNA9$(A9(I,6))
4480 INPUT Y$
4490 IF LEN(Y$)=0 THEN 4510
4500 A9(I,6)=FNA9(Y$) @ GOTO 447
     0
4510 GOTO 4530
4520 FNA4=0 @ GOTO 4540
4530 FNA4=I
4540 FN END
4550 DEF FNA9(A$)
```

```
4560 IF LEN(A$)>=4 THEN 4580
4570 A$=A$&" " @ GOTO 4560
4580 FNA9=((NUM(A$[1,1])*256+NUM
     (A$[2,2]))*256+NUM(A$[3,3])
     )*256+NUM(A$[4,4])
4590 FN END
4600 DEF FNA9$(I)
4610 FNA9$=CHR$(I DIV 16777216)&
     CHR$(I DIV 65536 MOD 256)&C
     HR$(I DIV 256 MOD 256)&CHR$
     (I MOD 256)
4620 FN END
4630 DEF FNA5(I)
4640 DISP "STATION - ";FNA$(I)
4650 DISP "P ARRIVAL ";
4660 A=FND2(A9(I,1))
4670 DISP "P WEIGHT ";A9(I,2)
4680 DISP "S ARRIVAL ";
4690 A=FND2(A9(I,3))
4700 DISP "S WEIGHT ";A9(I,4)
4710 DISP "DURATION ";A9(I,5)
4720 DISP "DESCRIPTOR - ";FNA9$(
     A9(I,6))
4730 FNA5=1
4740 FN END
4750 DEF FNA6(I)
4760 PRINT "STATION - ";FNA$(I)
4770 PRINT "P ARRIVAL ";
4780 A=FND3(A9(I,1))
4790 PRINT "P WEIGHT ";A9(I,2)
4800 PRINT "S ARRIVAL ";
4810 A=FND3(A9(I,3))
4820 PRINT "S WEIGHT ";A9(I,4)
4830 PRINT "DURATION ";A9(I,5)
4840 PRINT "DESCRIPTOR - ";FNA9$
     (A9(I,6))
4850 GOSUB 6820
4860 PRINT
4870 FNA6=1
4880 FN END
4890 CLEAR
4900 DISP "HYP85 SERVICE PROGRAM
     "
4910 DISP @ DISP "  STATIONS - A
     LTER STATION"
4920 DISP "                RECORD"
4930 DISP "  MODEL     - ALTER TR
     AVEL MODEL"
4940 DISP
4950 DISP "  EVENTS    - BUILD AN
      EVENT"
4960 DISP "                RECORD"
4970 DISP "  LOCATE    - CHAIN TO
      LOCATE"
4980 DISP "                PROGRAM"
4985 DISP "  GET PICK - PRINT A
     DPLOT PICK"
4986 DISP "                PICK FIL
     E"
4990 ON KEY# 1,"STATIONS" GOTO 5
     060
5000 ON KEY# 2," MODEL" GOTO 567
     0
5010 ON KEY# 3," EVENTS" GOTO 61
     70
5020 ON KEY# 4," LOCATE" GOTO 68
     10
5025 ON KEY# 5,"GET PICK" GOTO 8
     000
5030 OFF KEY# 6 @ OFF KEY# 7 @ O
     FF KEY# 8
5040 KEY LABEL
5050 GOTO 5050
5060 CLEAR @ DISP "STATION UPDAT
     E"
5070 A=FNS1(0)
5080 DISP @ DISP "THE CURRENT ST
     ATION FILE" @ DISP "HAS";S;
     "STATIONS"
5090 DISP @ DISP "ADD     - ADD A
      NEW STATION"
5100 DISP "DELETE - REMOVE A STA
     TION"
5110 DISP "CHANGE - CHANGE STATI
     ON INFO"
5120 DISP "EXIT   - RETURN TO MA
     STER MENU"
5130 DISP "SHOWALL- PRINT ALL ST
     ATION INFO"
5140 DISP "SHOW   - PRINT SELECT
     ED STAS"
5150 ON KEY# 1,"ADD" GOTO 5260
5160 ON KEY# 2,"DELETE" GOTO 534
     0
5170 ON KEY# 3,"CHANGE" GOTO 545
     0
5180 ON KEY# 4,"EXIT" GOTO 5240
5190 ON KEY# 5,"SHOWALL" GOTO 52
     80
5200 ON KEY# 6,"SHOW" GOTO 5590
5210 OFF KEY# 7 @ OFF KEY# 8
5220 KEY LABEL
5230 GOTO 5230
5240 A=FNS0(0)
5250 GOTO 4890
5260 A=FNS4(S+1)
5270 GOTO 5060
5280 GOSUB 6820
5290 FOR I=1 TO S
5300 A=FNS6(I)
5310 PRINT
5320 NEXT I
5330 GOTO 5060
5340 CLEAR @ DISP "NAME OF STATI
     ON TO DELETE"
5350 INPUT Y$
5360 IF LEN(Y$)>=4 THEN 5380
5370 Y$=Y$&" " @ GOTO 5360
5380 DISP "ARE YOU SURE (Y/N)" @
      INPUT Y1$
5382 IF Y1$[1,1]<>"Y" THEN 5060
```

```
5385 A=FNS7(Y$)
5390 IF A>S THEN 5420
5400 A=FNS3(A)
5410 GOTO 5060
5420 DISP "NO SUCH STATION"
5430 DISP "PRESS ENDLINE TO CONT
     INUE" @ INPUT Y$
5440 GOTO 5060
5450 CLEAR @ DISP "NAME OF STATI
     ON TO UPDATE"
5460 INPUT Y$
5470 IF LEN(Y$)>=4 THEN 5490
5480 Y$=Y$&" " @ GOTO 5470
5490 A=FNS7(Y$)
5500 IF A>S THEN 5420
5510 A=FNS4(A)
5520 GOTO 5060
5530 DISP "NO SUCH STATION"
5540 GOTO 5060
5550 DISP "CONTINUE(Y/N)" @ INPU
     T Y$
5560 DISP "CONTINUE(Y/N)" @ INPU
     T Y$
5570 IF Y$<>"Y" THEN 5060
5580 GOTO 5600
5590 J=1
5600 CLEAR @ A=FNS5(J)
5610 DISP "PRINT" @ INPUT Y$
5620 IF Y$<>"Y" THEN 5640
5630 A=FNS6(J)
5640 J=J+1
5650 IF J>S THEN 5060
5660 GOTO 5560
5670 CLEAR
5680 ON ERROR GOTO 5730
5690 ASSIGN# 2 TO "MODEL"
5700 READ# 2 ; D9(),V9()
5710 OFF ERROR
5720 GOTO 5860
5730 OFF ERROR
5740 CLEAR @ DISP "TROUBLE ACCES
     SING MODEL FILE"
5750 DISP "CREATE(C) OR TRY AGAI
     N(T)"
5760 INPUT Y$@ IF Y$="T" THEN 56
     70
5770 IF Y$<>"C" THEN 4890
5780 ON ERROR GOTO 5780
5790 CREATE "MODEL",2
5800 A=FNM1(A)
5810 ASSIGN# 2 TO "MODEL"
5820 PRINT# 2,1 ; D9(),V9()
5830 OFF ERROR
5840 GOTO 5860
5850 DISP "FATAL FILE ERROR" @ S
     TOP
5860 CLEAR @ DISP "MODEL UPKEEP"
5870 DISP @ DISP " SHOW    - SHOW
      VALUES IN MODELS"
5880 DISP @ DISP " SHOWALL- PRIN
     T MODEL VALUES"
5890 DISP @ DISP " CHANGE - CHAN
     GE MODELS"
5900 DISP @ DISP " EXIT    - RETU
     RN TO MASTER MENU"
5910 ON KEY# 1," SHOW" GOTO 6000
5920 ON KEY# 2,"SHOWALL" GOTO 60
     60
5930 ON KEY# 3," CHANGE" GOTO 61
     00
5940 ON KEY# 4," EXIT" GOTO 5980
5950 OFF KEY# 5 @ OFF KEY# 6 @ O
     FF KEY# 7 @ OFF KEY# 8
5960 KEY LABEL
5970 GOTO 5970
5980 ASSIGN# 2 TO *
5990 GOTO 4890
6000 CLEAR @ DISP "MODEL NUMBER
     (1 TO 3)"
6010 INPUT I
6020 A=FNM2(I)
6030 DISP "MORE (Y/N)" @ INPUT Y
     $
6040 IF Y$="Y" THEN 6000
6050 GOTO 5860
6060 FOR I=1 TO 3
6070 A=FNM3(I)
6080 NEXT I
6090 GOTO 5860
6100 CLEAR @ DISP "MODEL NUMBER
     (1 TO 3)"
6110 INPUT I
6120 A=FNM4(I)
6130 PRINT# 2,1 ; D9(),V9()
6140 DISP "MORE (Y/N)" @ INPUT Y
     $
6150 IF Y$="Y" THEN 6100
6160 GOTO 5860
6170 CLEAR @ DISP "ARRIVAL FILE
     MANAGEMENT"
6180 DISP "FILE NAME?"
6190 INPUT F$
6200 A=FNA1(F$)
6210 CLEAR @ DISP "ARRIVAL UPDAT
     E"
6220 DISP @ DISP "THE CURRENT AR
     RIVAL FILE" @ DISP "HAS";A7
     ;"ARRIVALS"
6230 DISP @ DISP "ADD     - ADD A
     N ARRIVAL"
6240 DISP "DELETE - REMOVE AN AR
     RIVAL"
6250 DISP "CHANGE - CHANGE ARRIV
     AL INFO"
6260 DISP "EXIT    - RETURN TO MA
     STER MENU"
6270 DISP "SHOWALL- PRINT ALL AR
     RIVAL INFO"
6280 DISP "SHOW    - PRINT SELECT
     ED ARRIVALS"
6290 DISP "CENTER - CHANGE CENTE
     R COORDS"
```

```
6300 ON KEY# 1,"ADD" GOTO 6430
6310 ON KEY# 2,"DELETE" GOTO 646
     0
6320 ON KEY# 3,"CHANGE" GOTO 655
     0
6330 ON KEY# 4,"EXIT" GOTO 6610
6340 ON KEY# 2,"DELETE" GOTO 646
     0
6350 ON KEY# 3,"CHANGE" GOTO 655
     0
6360 ON KEY# 4,"EXIT" GOTO 6610
6370 ON KEY# 5,"SHOWALL" GOTO 66
     20
6380 ON KEY# 6,"SHOW" GOTO 6710
6390 ON KEY# 7,"CENTER" GOTO 675
     0
6400 OFF KEY# 8
6410 KEY LABEL
6420 GOTO 6420
6430 IF A7=W9 THEN 6210
6440 A=FNA4(A7+1)
6450 GOTO 6210
6460 CLEAR @ DISP "ARRIVAL STATI
     ON NAME" @ INPUT Y$
6470 IF LEN(Y$)>=4 THEN 6490
6480 Y$=Y$&" " @ GOTO 6470
6490 A=FNA7(Y$)
6500 IF A=A7+1 THEN 6520
6505 DISP "ARE YOU SURE (Y/N)" @
      INPUT Y1$
6506 IF Y1$[1,1]<>"Y" THEN 6210
6510 A=FNA3(A) @ GOTO 6210
6520 DISP "NO SUCH STATION"
6530 DISP "ENDLINE TO CONTINUE"
     @ INPUT Y$
6540 GOTO 6210
6550 CLEAR @ DISP "ARRIVAL STATI
     ON NAME" @ INPUT Y$
6560 IF LEN(Y$)>=4 THEN 6580
6570 Y$=Y$&" " @ GOTO 6560
6580 A=FNA7(Y$)
6590 IF A=A7+1 THEN 6520
6600 A=FNA4(A) @ GOTO 6210
6610 A=FNA0(0) @ GOTO 4890
6620 GOSUB 6820
6630 PRINT "CENTER"
6640 A8=FNL6(A8)
6650 A9=FNL5(A9)
6660 GOSUB 6820
6670 FOR I=1 TO A7
6680 A=FNA6(I)
6690 NEXT I
6700 GOTO 6210
6710 CLEAR @ DISP "ARRIVAL STATI
     ON NAME" @ INPUT Y$
6715 IF LEN(Y$)>=4 THEN 6720
6716 Y$=Y$&"    "
6720 A=FNA7(Y$)
6730 IF A=A7+1 THEN 6520
6740 CLEAR @ A=FNA5(A) @ GOTO 65
     30
6750 CLEAR @ DISP "SUPPLY CENTER
      COORDINATES"
6760 DISP " ENDLINE TO CONTINUE"
      @ INPUT Y$
6770 A8=FNL9(A8)
6780 A9=FNL8(A9)
6790 GOTO 6530
6800 ! LOCATION ROUTINE
6810 CHAIN "LOCATE"
6820 PRINT "**********************
     ***********" @ RETURN
6830 L9$="LAT  "
6840 L8$="NORTH"
6850 L7$="SOUTH"
6860 RETURN
6870 L9$="LONG "
6880 L8$="WEST "
6890 L7$="EAST "
6900 RETURN
8000 CLEAR @ DISP @ DISP @ DISP
     "GET PICK"
8010 IF S=-1 THEN 8040
8020 ASSIGN# 1 TO *
8030 S=-1
8040 DISP "LOAD IN HP 85 TAPE WH
     ICH HOLDS"
8050 DISP " THE PICK FILE YOU WI
     SH TO LIST"
8060 DISP " STRIKE THE 'CONT' KE
     Y WHEN YOU"
8070 DISP " HAVE THE NEW TAPE PR
     OPERLY"
8080 DISP " LOADED"
8090 PAUSE
8094 OFF ERROR
8095 GOTO 8100
8097 CAT
8098 DISP "FILE SPEC ERROR"
8099 DISP "TRY AGAIN"
8100 DISP "PICK FILE NAME" @ INP
     UT Y$
8110 ON ERROR GOTO 8094
8120 ASSIGN# 1 TO Y$
8130 OFF ERROR
8135 PRINT "FILE - ";Y$ @ PRINT
8140 READ# 1,1 ; K0,K2
8150 PRINT K0;" SETS OF PICKED P
     OINTS"
8160 PRINT
8170 FOR I=1 TO K0
8175 PRINT @ PRINT @ PRINT "SET
     #";I
8180 READ# 1,I+1 ; K9
8190 READ# 1 ; K1,K5,K1$
8200 READ# 1 ; K2,K6,K2$
8210 READ# 1 ; K3,K7,K3$
8220 READ# 1 ; K4,K8,K4$
8230 READ# 1 ; K5$,O1,O2
8240 PRINT USING 8245 ; "POINT 1
     ",K5
```

```
8245 IMAGE K,2X,"VALUE=",DD.DDD
8250 A=FND3(K1+86400) @ PRINT
8260 PRINT USING 8245 ; "POINT 2
     ",K6
8265 A=FND3(K2+86400) @ PRINT
8270 PRINT USING 8245 ; "POINT 3
     ",K7
8275 A=FND3(K3+86400) @ PRINT
8280 PRINT USING 8245 ; "POINT 4
     ",K8
8285 A=FND3(K4+86400) @ PRINT
8290 PRINT "DESCRIPTOR - ";K5$
8295 PRINT "DR100 #";01
8300 NEXT I
8310 PRINT @ PRINT
8320 ASSIGN# 1 TO *
8330 CLEAR @ DISP @ DISP "MORE (
     Y/N)" @ INPUT Y$
8340 IF Y$="Y" THEN 8040
8350 DISP "PLEASE INSERT THE ORI
     GINAL" @ DISP " HYP85-LOCAT
     E TAPE AND STRIKE"
8360 DISP " 'CONT' WHEN THE TAPE
      IS READY"
8370 PAUSE
9000 GOTO 4890
```

BASIC-LANGUAGE LISTING OF "LOCATE"

```
 10 OPTION BASE 1
 20 W9=15
 30 W5=W9*4
 40 DIM A(25,5),Z(5),Y(25),V(5,5
    )
 50 DIM I9(25) ! IMPORT
 60 DIM C2(3),C3(3),C1(4,4)
 70 DIM A9(15,6)
 80 DIM A8(15,9)
 90 DIM A2$[60]
100 DIM K(25,5)
110 DIM W(25)
115 DIM I(30)
120 P9=1.75 ! POS
130 R0=.16 ! RMSCUT
140 R1=1.5 ! RMSW1
150 R2=3 ! RMSW2
160 R4=2 ! NRES
170 ! R5 RMSMIN
180 ! R6 OLD RMS
190 ! R7 IS RMS
200 ! R8 IS RR
210 ! R9=JBAC
220 ! F1 IS NFREE
230 F2=.012 ! EIGTOL
240 W6=1 ! DISW1
250 W7=3 ! DISW2
260 W8=50 ! DISCUT
270 B0=20 ! ITRLIM
280 B1=.04 ! DQUIT
290 B2=7 ! DXFIX
300 B3=12 ! DZMAX
310 B4=.5 ! DZAIR
320 B5=1 ! SWT
330 B6=.9 ! DAMP
340 B7=.001 ! DRQT
350 B8=-5 ! FMA1
360 B9=3.89 ! FMB1
370 C0=0 ! FMZ1
380 C1=0 ! FMD1
390 C2=210 ! FMBRK
400 C3=-.705 ! FMA2
410 C4=2.026 ! FMB2
420 C5=0 ! FMZ2
430 C6=0 ! FMD2
440 C7=7 ! ZTR
450 C8=.25 ! RDERR
460 C9=1 ! ERCOF
470 E0=1 ! KINFO
480 E5=.02 ! RBACK
490 E2=.6 ! BACFAC
500 E3=25 ! MAX M
510 T9=.00000001 ! ZERO THRESHOL
    D
520 ! Q9 IS ITERATION COUNT
530 ! E4 IS KDFIX
540 ! N9 IS NLAST
550 ! D0 IS DONE
560 ! G0 IS FIRST ARRIVAL
570 ! Q0 IS SECOND ARRIVAL
580 ! V9() AND D9() ARE TRAVEL
590 !  MODEL ARRAYS
600 DIM V9(3,5),D9(3,5)
610 DIM H1(3,5),H2(3,5),H3(6),H4
    (6),H5(5)
620 ! H1(MODNUM,LEV)=WIDTH
630 ! H2(MODNUM,LEV)=VS0
640 ! V9(MODNUM,LEV)=VELOCITY
650 ! D9(MODNUM,LEV)=DEPTH
660 !
670 !
680 !
690 !
700 S=-1
710 DIM S$[200]
720 DEF FNS$(I)
730 IF S=-1 THEN S=FNS1(0)
740 FNS$="    "
750 IF I>S THEN 780
760 IF I<1 THEN 780
770 FNS$=S$[I*4-3,I*4]
780 FN END
790 DIM S(31)
800 FOR I=1 TO 31 @ S(I)=0 @ NEX
    T I
810 DEF FNS1(I)
820 IF I=0 THEN 920
830 ON ERROR GOTO 890
840 READ# 1,I+1 ; S()
850 OFF ERROR
860 S1$=FNS$(I)
870 FNS1=I
880 GOTO 970
890 OFF ERROR
900 FNS1=0
910 GOTO 970
920 ON ERROR GOTO 890
930 ASSIGN# 1 TO "STATNS"
940 READ# 1 ; S,S$
950 OFF ERROR
960 FNS1=S
970 FN END
980 DEF FNS7(A$)
990 S7=1
1000 IF S7>S THEN 1030
1010 IF FNS$(S7)=A$ THEN 1030
1020 S7=S7+1 @ GOTO 1000
1030 FNS7=S7
1040 FN END
1050 DEF FNN(A)
1060 INPUT Q$
1070 IF LEN(Q$)=0 THEN 1120
1080 E1=VAL(Q$)
1090 FNN=E1
1100 E1=0
1110 GOTO 1140
1120 E1=1
1130 FNN=0
1140 FN END
1150 DEF FNZ(A$)
```

```
1160 CLEAR @ DISP A$;"    ";A
1170 U1=FNN(A)
1180 IF E1=1 THEN 1210
1190 A=U1
1200 GOTO 1160
1210 FNZ=A
1220 FN END
1230 DEF FND1(I)
1240 D9=I/60
1250 D8=INT(D9)
1260 D9=INT((D9-D8)*60000+.5)/10
     00
1270 D8=D8/60
1280 D7=INT(D8)
1290 D8=INT(.5+(D8-D7)*60)
1300 D7=D7/24
1310 D6=INT(D7)
1320 D7=INT(.5+(D7-D6)*24)
1330 FND1=I
1340 FN END
1350 DEF FND2(I)
1360 I=FND1(I)
1370 DISP USING 1380 ; D6,D7,D8,
     D9
1380 IMAGE "DAY-",DDD,XX,ZZ,":",
     ZZ,":",ZZ.DDD
1390 FND2=I
1400 FN END
1410 DEF FND3(I)
1420 I=FND1(I)
1430 PRINT USING 1380 , D6,D7,D8
     ,D9
1440 FND3=I
1450 FN END
1460 DEF FND(A$)
1470 CLEAR @ DISP "TIME OF ";A$
1480 D5=FND2(A)
1490 DISP "CHANGE (Y/N)" @ INPUT
      Y$
1500 IF Y$<>"Y" THEN 1570
1510 DISP "DAY",D6 @ D5=FNN(1) @
      IF E1=0 THEN D6=D5
1520 DISP "HOUR",D7 @ D5=FNN(1)
     @ IF E1=0 THEN D7=D5
1530 DISP "MIN",D8 @ D5=FNN(1) @
      IF E1=0 THEN D8=D5
1540 DISP "SEC",D9 @ D5=FNN(1) @
      IF E1=0 THEN D9=D5
1550 A=((D6*24+D7)*60+D8)*60+D9
1560 GOTO 1470
1570 FND=A
1580 E1=1
1590 FN END
1600 DEF FNL9(I)
1610 GOSUB 8410
1620 FNL9=FNL7(I)
1630 FN END
1640 DEF FNL8(I)
1650 GOSUB 8450
1660 FNL8=FNL7(I)
1670 FN END
1680 DEF FNL3(I)
1690 IF I>=0 THEN L9=1 ELSE L9=-
     1
1700 L8=I*L9
1710 L7=L8 DIV 60
1720 L8=L8-L7*60
1730 IF L9=1 THEN L6$=L8$ ELSE L
     6$=L7$
1740 PRINT USING 1750 ; L9$,L7,L
     8,L6$
1750 IMAGE AAAAA,X,DDZ," D ",DZ.
     DD," M ",AAAAA
1760 FNL3=I
1770 FN END
1780 DEF FNL6(I)
1790 GOSUB 8410
1800 FNL6=FNL3(I)
1810 FN END
1820 DEF FNL5(I)
1830 GOSUB 8450
1840 FNL5=FNL3(I)
1850 FN END
1860 DEF FNL4(I)
1870 IF I>=0 THEN L9=1 ELSE L9=-
     1
1880 L8=I*L9
1890 L7=L8 DIV 60
1900 L8=L8-L7*60
1910 DISP L9$;" ";L7;" D ";L8;"
     M ";
1920 IF L9=1 THEN DISP L8$ ELSE
     DISP L7$
1930 FNL4=I
1940 FN END
1950 DEF FNL7(I)
1960 CLEAR @ I=FNL4(I)
1970 DISP "ALTER (Y/N)" @ INPUT
     Y$
1980 IF Y$<>"Y" THEN 2080
1990 CLEAR @ DISP L9$&" DEGREES"
     ;L7;@ L6=FNN(L7) @ IF E1=0
     THEN L7=L6
2000 CLEAR @ DISP L9$&" MINS";L8
     ;@ L6=FNN(L8) @ IF E1=0 THE
     N L8=L6
2010 CLEAR @ DISP L8$&" OR "&L7$
     ;" - ";
2020 IF L9=1 THEN DISP L8$ ELSE
     DISP L7$
2030 INPUT Y$
2040 IF LEN(Y$)<1 THEN 2060
2050 IF Y$[1,1]=L8$[1,1] THEN L9
     =1 ELSE L9=-1
2060 I=L9*(L7*60+L8)
2070 GOTO 1960
2080 FNL7=I
2090 FN END
2100 A=0
2110 DIM A$[32]
```

```
2120 DEF FNH1(I)
2130 M1=0
2140 IF I=1 THEN 2200
2150 FOR M2=1 TO I-1
2160 M3=SQR(H2(G3,I)-H2(G3,M2))
2170 M4=H1(G3,M2)*M3/(V9(G3,M2)*
     V9(G3,I))
2180 IF M2>=G7 THEN M1=M1+2*M4 E
     LSE M1=M1+M4
2190 NEXT M2
2200 FNH1=M1
2210 FN END
2220 DEF FNH2(I)
2230 M1=0
2240 IF I=1 THEN 2300
2250 FOR M2=1 TO I-1
2260 M3=SQR(H2(G3,I)-H2(G3,M2))
2270 M4=H1(G3,M2)*V9(G3,M2)/M3
2280 IF M2>=G7 THEN M1=M1+2*M4 E
     LSE M1=M1+M4
2290 NEXT M2
2300 FNH2=M1
2310 FN END
2320 !
2330 DEF FNA$(I)
2340 FNA$="    "
2350 IF I>A7 THEN 2380
2360 IF I<1 THEN 2380
2370 FNA$=A2$[I*4-3,I*4]
2380 FN END
2390 DEF FNA1(A$)
2400 ON ERROR GOTO 2520
2410 ASSIGN# 3 TO A$
2420 READ# 3,1 ; A7,A8,A9
2430 READ# 3,2 ; A2$
2440 READ# 3,3
2450 FOR A1=1 TO W9
2460 FOR A2=1 TO 6
2470 READ# 3 ; A9(A1,A2)
2480 NEXT A2
2490 NEXT A1
2500 OFF ERROR
2510 GOTO 2550
2520 OFF ERROR
2530 FNA1=0
2540 GOTO 2560
2550 FNA1=1
2560 FN END
2570 DEF FNA6(I)
2580 PRINT "STATION - ";FNA$(I)
2590 PRINT "P ARRIVAL ";
2600 A=FND3(A9(I,1))
2610 PRINT "P WEIGHT ";A9(I,2)
2620 PRINT "S ARRIVAL ";
2630 A=FND3(A9(I,3))
2640 PRINT "S WEIGHT ";A9(I,4)
2650 PRINT "DURATION ";A9(I,5)
2660 PRINT "YEAR ";A9(I,6)
2670 GOSUB 8400
2680 PRINT
2690 FNA6=1
2700 FN END
2710 CLEAR
2720 ! LOCATION ROUTINE
2730 !
2740 !
2750 BEEP @ CLEAR @ DISP "NON ST
     ANDARD ORIGIN (Y/N)" @ INPU
     T Y5$
2760 P5=2 @ A=P5 @ P5=FNZ("P LEV
     (0-2)")
2770 CLEAR @ DISP "SPECIFY ARRIV
     AL FILE" @ INPUT Y6$
2780 T5=TIME
2790 IF FNA1(Y6$)=0 THEN 7910
2800 G0=1
2810 FOR I=2 TO A7 @ IF A9(I,1)<
     A9(G0,1) AND A9(I,2)<4 THEN
      G0=I
2820 NEXT I
2830 IF G0<>1 THEN Q0=1 ELSE Q0=
     2
2840 FOR I=1 TO A7
2850 IF I=G0 THEN 2870
2860 IF A9(I,1)<A9(Q0,1) AND A9(
     I,2)<4 THEN Q0=I
2870 NEXT I
2880 I=0
2890 I=I+1
2900 IF A9(I,1)-A9(G0,1)>240 THE
     N 7870
2910 IF I<A7 THEN 2890
2920 IF FNS1(0)<>0 THEN 2940
2930 PRINT "BAD STATION FILE" @
     GOTO 7920
2940 ASSIGN# 3 TO *
2950 ASSIGN# 2 TO "MODEL"
2960 READ# 2 ; D9(),V9()
2970 ASSIGN# 2 TO *
2980 FOR M1=1 TO 3
2990 FOR M2=1 TO 5
3000 IF M2<5 THEN H1(M1,M2)=D9(M
     1,M2+1)-D9(M1,M2)
3010 H2(M1,M2)=V9(M1,M2)*V9(M1,M
     2)
3020 NEXT M2
3030 NEXT M1
3040 I=0
3050 I=I+1
3060 A1$=FNA$(I)
3070 A=FNS7(A1$)
3080 IF A>S THEN 7880
3090 A=FNS1(A)
3100 FOR J=1 TO 9 @ A8(I,J)=S(J)
      @ NEXT J
3110 IF I<A7 THEN 3050
3120 ASSIGN# 1 TO *
3130 T1=A9(G0,1)-2
3140 Z1=C7
3150 Q1=A8(G0,1)+.3
```

```
3160 Q2=A8(G0,2)+.3
3170 IF Y5$<>"Y" THEN 3240
3180 T5=TIME
3190 Q1=FNL9(Q1)
3200 Q2=FNL8(Q2)
3210 T1=A9(G0,1)
3220 A=T1 @ T1=FND("EVENT")
3230 A=Z1 @ Z1=FNZ("START DEPTH
     (KM)")
3240 IF Z1<0 THEN E4=1 ELSE E4=0
3250 Z1=ABS(Z1)
3260 Q1=Q1/60
3270 Q2=Q2/60
3280 Q9=0
3290 D0=0
3300 N=3
3310 N9=3
3320 R5=10000
3330 R6=10000
3340 DEG
3350 GOSUB 8400
3360 PRINT @ PRINT "EVENT FILE "
     ;Y6$ @ PRINT
3370 ! BEGIN ITERATION
3380 Q9=Q9+1
3390 W=0
3400 M=0
3410 FOR I=1 TO A7
3420 G1=A8(I,1)/60-Q1
3430 G2=A8(I,2)/60-Q2
3440 G3=COS(Q1+G1/2)
3480 K(I,1)=ATN2(-G2*G3,G1)
3490 IF K(I,1)<0 THEN K(I,1)=K(I
     ,1)+360
3500 K(I,2)=111.195*SQR(G1*G1+G2
     *G2*G3*G3)
3510 NEXT I
3520 G3=K(Q0,2)
3530 IF G3<W8 THEN G3=W8
3540 G1=W6*G3
3550 G2=W7*G3
3560 FOR I=1 TO A7
3570 G4=K(I,2)
3580 G5=0
3590 IF A8(I,6)>0 THEN 3640
3600 IF G4>G2 THEN 3640
3610 G5=1
3620 IF G4<G1 THEN 3640
3630 G5=.5*COS(180*(G4-G1)/(G2-G
     1))+.5
3640 IF A9(I,2)>3 AND (A9(I,5)=0
      OR A9(I,4)<4) THEN 3700
3650 M=M+1
3660 W(M)=0
3670 IF A9(I,2)<4 THEN W(M)=G5/4
     *(4-A9(I,2))
3680 IF W(M)>0 THEN W=W+1
3690 I(M)=I
3700 IF A9(I,4)>3 THEN 3760
3710 M=M+1
3720 W(M)=0
3730 IF A9(I,4)<4 THEN W(M)=G5/4
     *(4-A9(I,4))
3740 IF W(M)>0 THEN W=W+1
3750 I(M)=I+10000
3760 NEXT I
3770 IF M<4 THEN 7840
3780 IF M>E3 THEN M=E3
3790 ! HYTRV
3800 FOR I=1 TO M
3810 G1=I(I)
3820 G2=G1 DIV 10000
3830 G1=G1-G2*10000
3840 G3=A8(G1,9)
3850 G4=K(G1,2)
3860 G5=1
3870 IF D9(G3,G5)>=D9(G3,G5+1) T
     HEN 3900
3880 G5=G5+1
3890 IF G5<5 THEN 3870
3900 G6=0
3910 G6=G6+1
3920 IF D9(G3,G6)>Z1 THEN 3950
3930 IF G6<G5 THEN 3910
3940 G7=G6 @ GOTO 3960
3950 G7=G6-1
3960 G8=Z1-D9(G3,G7)
3970 G9=G8*G8+.000001
3980 IF G7=G5 THEN 4300
3990 FOR J=G6 TO G5
4000 K1=SQR(H2(G3,J)-H2(G3,G7))
4010 H3(J)=FNH1(J)-K1*G8/(V9(G3,
     J)*V9(G3,G7))
4020 H4(J)=FNH2(J)-G8*V9(G3,G7)/
     K1
4030 NEXT J
4040 K1=V9(G3,G6)*V9(G3,G7)*(H3(
     G6)-FNH1(G7))/(V9(G3,G6)-V9
     (G3,G7))
4050 FOR J=G6 TO G5
4060 H5(J)=H3(J)+G4/V9(G3,J)
4070 NEXT J
4080 X2=999.99
4090 FOR J=G6 TO G5
4100 IF H5(J)>X2 THEN 4140
4110 IF H4(J)>G4 THEN 4140
4120 X2=H5(J)
4130 K=J
4140 NEXT J
4150 IF G4<K1 THEN 4210
4160 A(I,2)=H5(K)
4170 A(I,3)=1/V9(G3,K)
4180 A(I,4)=-SQR(H2(G3,K)-H2(G3,
     G7))/(V9(G3,K)*V9(G3,G7))
4190 A(I,1)=-V9(G3,G7)/V9(G3,K)
4200 GOTO 4950
4210 IF G7<>1 THEN 4300
4220 K1=SQR(Z1*Z1+G4*G4)
4230 K3=K1/V9(G3,1)
4240 IF K3>=X2 THEN 4160
```

```
4250 A(I,2)=K3
4260 A(I,3)=G4/(V9(G3,1)*K1)
4270 A(I,4)=Z1/(V9(G3,1)*K1)
4280 A(I,1)=G4/K1
4290 GOTO 4950
4300 K1=G4
4310 K2=G4*G8/Z1
4320 K3=K1/SQR(K1*K1+G9)
4330 K4=K2/SQR(K2*K2+G9)
4340 K5=K3*K3
4350 K6=K4*K4
4360 K7=G8*K3/SQR(1.000001-K5)
4370 K8=G8*K4/SQR(1.000001-K6)
4380 FOR J=1 TO G7-1
4390 K7=K7+H1(G3,J)*K3/SQR(H2(G3
     ,G7)/H2(G3,J)-K5)
4400 K8=K8+H1(G3,J)*K4/SQR(H2(G3
     ,G7)/H2(G3,J)-K6)
4410 NEXT J
4420 J1=0
4430 J1=J1+1
4440 IF K7-K8<.02 THEN 4620
4450 M1=K2+(G4-K8)*(K1-K2)/(K7-K
     8)
4460 M2=M1/SQR(M1*M1+G9)
4470 M3=M2*M2
4480 M4=G8*M2/SQR(1.000001-M3)
4490 FOR J=1 TO G7-1
4500 M4=M4+H1(G3,J)*M2/SQR(H2(G3
     ,G7)/H2(G3,J)-M3) @ NEXT J
4510 M5=G4-M4
4520 IF ABS(M5)<.02 THEN 4650
4530 IF M5>0 THEN 4570
4540 K1=M1
4550 K7=M4
4560 GOTO 4590
4570 K2=M1
4580 K8=M4
4590 IF J1<10 THEN 4610
4600 IF 1-M2<.0002 THEN 4650
4610 IF J1<25 THEN 4430
4620 M1=(K1+K2)/2
4630 M2=M1/SQR(M1*M1+G9)
4640 M3=M2*M2
4650 IF 1-M2>.0002 THEN 4740
4660 M5=FNH1(G7)+G4/V9(G3,G7)
4670 IF G7=G5 THEN 4690
4680 IF M5>=X2 THEN 4160
4690 A(I,2)=M5
4700 A(I,3)=1/V9(G3,G7)
4710 A(I,4)=0
4720 A(I,1)=.9999999
4730 GOTO 4950
4740 M5=G8/(V9(G3,G7)*SQR(1-M3))
4750 FOR J=1 TO G7-1
4760 M5=M5+H1(G3,J)*V9(G3,G7)/(H
     2(G3,J)*SQR(H2(G3,G7)/H2(G3
     ,J)-M3))
4770 NEXT J
4780 IF G7=G5 THEN 4800
4790 IF M5>=X2 THEN 4160
4800 A(I,2)=M5
4810 K1=SQR(1-M3)
4820 K2=K1*K1*K1
4830 K3=G8/K2
4840 K4=G8*M2/(V9(G3,G7)*K2)
4850 FOR J=1 TO G7-1
4860 K5=SQR(H2(G3,G7)/H2(G3,J)-M
     3)
4870 K5=K5*K5*K5
4880 K6=H1(G3,J)/(H2(G3,J)*K5)
4890 K3=K3+K6*H2(G3,G7)
4900 K4=K4+K6*V9(G3,G7)*M2
4910 NEXT J
4920 A(I,3)=K4/K3
4930 A(I,4)=(1-V9(G3,G7)*M2*A(I,
     3))/(V9(G3,G7)*K1)
4940 A(I,1)=M2
4950 A(I,1)=ASN(A(I,1))
4960 IF A(I,1)<0 THEN A(I,1)=A(I
     ,1)+180
4970 A(I,1)=180-A(I,1)
4980 NEXT I
4990 ! GET EMERGENCE ANGLES
5000 !  RESIDUALS, ETC.
5010 FOR I=1 TO M
5020 K=I(I) MOD 10000
5030 G3=A8(K,9)
5040 K2=I(I) DIV 10000
5050 K(I,5)=A(I,1)
5060 K(I,3)=A(I,2)
5070 IF K2=1 THEN 5120
5080 K1=A8(K,3)
5090 K3=1
5100 K(I,4)=A9(K,1)
5110 GOTO 5150
5120 K1=A8(K,5)
5130 K3=P9
5140 K(I,4)=A9(K,3)
5150 K(I,4)=K(I,4)-K(I,3)*K3-K1-
     T1
5160 A(I,1)=1
5170 K4=A(I,3)*K3
5180 A(I,2)=-K4*COS(K(K,1))
5190 A(I,3)=K4*SIN(K(K,1))
5200 A(I,4)=K3*A(I,4)
5210 NEXT I
5220 FOR I=1 TO R4
5230 K1=0
5240 K2=0
5250 FOR J=1 TO M
5260 K2=K2+W(J)*W(J)
5270 K1=K1+W(J)*W(J)*K(J,4)*K(J,
     4)
5280 NEXT J
5290 IF K2=0 THEN 7840
5300 K1=SQR(K1/K2)
5310 K3=K1
5320 IF K3<R0 THEN K3=R0
5330 K4=K3*(R2-R1)
```

```
5340 W=0
5350 K2=0
5360 FOR J=1 TO M
5370 IF W(J)=0 THEN 5470
5380 K5=ABS(K(J,4))
5390 K5=(K5-K3*R1)/K4
5400 IF K5>1 THEN 5460
5410 IF K5<0 THEN 5430
5420 W(J)=W(J)*(.5+.5*COS(180*K5
     ))
5430 K2=K2+W(J)
5440 W=W+1
5450 GOTO 5470
5460 W(J)=0
5470 NEXT J
5480 NEXT I
5490 K1=W/K2
5500 K2=0
5510 R7=0
5520 K4=0
5530 W=0
5540 FOR I=1 TO M
5550 W(I)=W(I)*K1
5560 K2=K2+W(I)*W(I)
5570 R7=R7+W(I)*W(I)*K(I,4)*K(I,
     4)
5580 IF W(I)<.1 THEN 5630
5590 W=W+1
5600 K=I(I)
5610 K=K DIV 10000
5620 IF K<>0 THEN K4=K4+1
5630 FOR J=1 TO N
5640 A(I,J)=A(I,J)*W(I)
5650 NEXT J
5660 A(I,N+1)=K(I,4)*W(I)
5670 NEXT I
5680 R7=SQR(R7/K2)
5690 GOSUB 8400
5700 IF W<4 THEN 7840
5710 IF (N+N9=8 OR E4=1) AND ABS
     (R6-R7)<B7 OR Q9>B0 AND R7<
     R5+E5 THEN D0=1
5720 IF R7>R5+E5 AND NOT D0 THEN
      6310
5730 GOSUB 7980
5740 FOR I=1 TO N
5750 K1=0
5760 FOR J=1 TO M
5770 K1=K1+A(J,I)*A(J,N+1)
5780 NEXT J
5790 Y(I)=K1
5800 NEXT I
5810 FOR I=1 TO N
5820 A(I,N+1)=Y(I)
5830 NEXT I
5840 F1=0
5850 FOR I=1 TO N
5860 IF Z(I)>F2 THEN F1=F1+1
5870 NEXT I
5880 FOR I=1 TO 4
5890 Y(I)=0
5900 IF I>N THEN 5940
5910 FOR J=1 TO F1
5920 Y(I)=Y(I)+V(I,J)*A(J,N+1)/Z
     (J)
5930 NEXT J
5940 NEXT I
5950 K1=B0*.6
5960 K2=B6
5970 IF Q9>K1 THEN K2=B6/2
5980 FOR I=1 TO 4
5990 Y(I)=Y(I)*K2
6000 NEXT I
6010 FOR I=1 TO M
6020 K2=0
6030 FOR J=1 TO N
6040 K2=K2+A(I,J)*A(I,J)
6050 NEXT J
6060 I9(I)=K2
6070 NEXT I
6080 R8=0
6090 FOR I=2 TO N
6100 R8=R8+Y(I)*Y(I)
6110 NEXT I
6120 R8=SQR(R8)
6130 IF (N+N9=8 OR E4=1) AND R8<
     B1 THEN D0=1
6140 ! FINISH HYSOL HERE
6150 IF Z1+Y(4)>0 THEN 6190
6160 IF P5>=2 THEN PRINT "AIRQUA
     KE PREVENTED"
6170 Y(4)=-B4*Z1
6180 FOR I=1 TO 3 @ Y(I)=Y(I)*B4
      @ NEXT I
6190 IF ABS(Y(4))<B3 THEN 6220
6200 IF P5>=2 THEN PRINT "DEPTH
     VARIATION DAMPED"
6210 Y(4)=Y(4)*B3/(ABS(Y(4))+B3)
6220 R6=R7
6230 IF R7<R5 THEN R5=R7
6240 R9=0
6250 R8=0
6260 FOR I=2 TO 4
6270 R8=R8+Y(I)*Y(I)
6280 NEXT I
6290 R8=SQR(R8)
6300 GOTO 6420
6310 R9=R9+1
6320 R6=R7
6330 IF R5>R7 THEN R5=R7
6340 IF R9=1 THEN 6380
6350 FOR I=1 TO 4 @ Y(I)=Y(I)*(1
     -E2) @ NEXT I
6360 R8=R8*(1-E2)
6370 GOTO 6400
6380 FOR I=1 TO 4 @ Y(I)=-E2*Y(I
     ) @ NEXT I
6390 R8=R8*E2
6400 IF P5>=2 THEN PRINT USING 6
     410 ; E2
```

```
6410 IMAGE "RMS INCREASE - RESET
     HYPO ", D.D
6420 PRINT "ITERATION";Q9
6430 D2=Y(2)/111.19
6440 D3=Y(3)/(111.19*COS(D2+Q1))
6450 IF P5<2 THEN 6570
6460 GOSUB 8490
6470 PRINT USING 6480 ; Y(1)
6480 IMAGE "  DELTA T=",X,DD.DDD
6490 PRINT "  ";@ A=FNL6(D2*60)
6500 PRINT "  ";@ A=FNL5(D3*60)
6510 PRINT USING 6520 ; Y(4)
6520 IMAGE "  DELTA DEPTH =",ZZ.
     DDD
6530 PRINT "     RMW  =";W
6540 PRINT "     RMS  =";R7
6550 PRINT "     RR   =";R8
6560 PRINT "     NFREE=";F1
6570 IF D0 THEN 6680
6580 T1=T1+Y(1)
6590 Q1=Q1+D2
6600 Q2=Q2+D3
6610 Z1=Z1+Y(4)
6620 N9=N
6630 IF N=4 OR R8>B2 OR E4=1 THE
     N 3380
6640 N=4
6650 IF P5>=2 THEN PRINT "FOCAL
     DEPTH FREED"
6660 GOTO 3380
6670 PAUSE
6680 GOSUB 8400
6690 PRINT "END OF LOCATION"
6700 PRINT
6710 GOSUB 8490
6720 PRINT
6730 IF P5<1 THEN 7920
6740 PRINT "EIGENVALUES"
6750 FOR I=1 TO N
6760 PRINT USING "DDD.DDD" ; Z(I
     )
6770 NEXT I
6780 PRINT @ PRINT
6790 PRINT "EIGENVECTORS OF ADJU
     STMENT"
6800 FOR I=1 TO 4
6810 PRINT USING 7010 ; V(I,1),V
     (I,2),V(I,3),V(I,4)
6820 NEXT I
6830 PRINT
6840 K1=C8*C8+R7*R7*C9
6850 FOR I=1 TO 4
6860 FOR J=1 TO I
6870 C1(I,J)=0
6880 IF I<=N AND J<=N THEN 6910
6890 IF I=J THEN C1(I,J)=999
6900 GOTO 6960
6910 FOR L=1 TO N
6920 IF Z(L)=0 THEN C1(I,J)=C1(I
     ,J)+999 ELSE C1(I,J)=C1(I,J
     )+V(I,L)*V(J,L)/(Z(L)*Z(L))
6930 NEXT L
6940 C1(I,J)=K1*C1(I,J)
6950 C1(J,I)=C1(I,J)
6960 NEXT J
6970 NEXT I
6980 PRINT "COVARIANCE"
6990 FOR I=1 TO 4
7000 PRINT USING 7010 ; C1(I,1),
     C1(I,2),C1(I,3),C1(I,4)
7010 IMAGE 4(DDDD.DD,X)
7020 NEXT I
7030 PRINT
7050 FOR I=1 TO 3
7060 FOR J=1 TO 3 @ A(I,J)=C1(I+
     1,J+1) @ NEXT J
7070 NEXT I
7080 M1=M
7090 M=3 @ N=3
7100 GOSUB 7980
7110 FOR I=1 TO 3
7120 Z(I)=SQR(Z(I))
7130 IF Z(I)>99 THEN Z(I)=99
7140 NEXT I
7150 K1=0 @ K2=0
7160 FOR I=1 TO 3
7170 K3=Z(I)*SQR(V(1,I)*V(1,I)+V
     (2,I)*V(2,I))
7180 IF K3>K1 THEN K1=K3
7190 K4=Z(I)*ABS(V(3,I))
7200 IF K4>K2 THEN K2=K4
7210 NEXT I
7220 IF K1>99 THEN K1=99
7230 IF K2>99 THEN K2=99
7240 FOR J=1 TO 3
7250 C2(J)=0 @ C3(J)=0
7260 K3=SQR(V(1,J)*V(1,J)+V(2,J)
     *V(2,J))
7270 IF K3=0 THEN 7340
7280 C2(J)=ATN2(-V(2,J),V(1,J))
7290 C3(J)=ATN2(V(3,J),K3)
7300 IF C3(J)>-1 THEN 7330
7310 C3(J)=-C3(J)
7320 C2(J)=C2(J)+180
7330 IF C2(J)<0 THEN C2(J)=C2(J)
     +360
7340 NEXT J
7350 PRINT "        #ERROR ELLIPS
     E"
7360 PRINT "ERRORS #  SERR AZ DI
     P"
7370 FOR I=1 TO 3
7380 K1=SQR(C1(I,I))
7390 PRINT USING 7400 ; K1,Z(I),
     C2(I),C3(I)
7400 IMAGE DD.DDD," #",DDD.DD,X,
     DDD,X,DD
7410 NEXT I
7420 K1=SQR(C1(4,4))
7430 PRINT USING "DD.DDD,X,A" ;
     K1,"#"
```

```
7440 PRINT
7450 FOR I=1 TO M1
7460 K=I(I) MOD 10000
7470 K1=I(I) DIV 10000
7480 PRINT "*****" @ PRINT FNA$(
     K);"**********************
     *****" @ PRINT "*****"
7490 IF K1=0 THEN 7570
7500 Z$="S"
7510 K5=A9(K,3)
7520 K6=A8(K,5)
7530 K4=A9(K,4)
7540 K2=(A9(K,3)-T1)/P9+T1
7550 K3=A9(K,6) MOD 65536
7560 GOTO 7630
7570 Z$="P"
7580 K5=A9(K,1)
7590 K6=A8(K,3)
7600 K4=A9(K,2)
7610 K2=A9(K,1)
7620 K3=A9(K,6) DIV 65536
7630 Z1$=CHR$(K3 DIV 256)
7640 Z2$=CHR$(K3 MOD 256)
7650 PRINT "DIST AZM  AN P/S W"
7660 PRINT USING 7670 ; K(K,2),K
     (K,1),K(I,5),Z1$,Z$,Z2$,K4
7670 IMAGE DD.D,X,DDD,X,DDD,X,A,
     A,A,X,D
7680 PRINT @ PRINT "(TOBS -TCAL
     -DLY  =RES) WT"
7690 !
7700 PRINT USING 7710 ; K5-T1,K(
     I,3),K6,K(I,4),W(I)
7710 IMAGE DD.DD,X,DD.DD,X,D.DD,
     X,DD.DD,X,D.DD
7720 !
7730 !
7740 PRINT
7750 !
7760 !
7770 !
7780 !
7790 !
7800 !
7810 !
7820 NEXT I
7830 GOTO 7920
7840 PRINT "ERROR EXIT" @ PRINT
     "WEIGHTED PHASES ARE INSUFF
     ICIENT"
7850 PRINT " FOR A SOLUTION"
7860 GOTO 7920
7870 PRINT "ARRIVAL AT ";FNA$(I)
     ;" IS TOO LATE" @ GOTO 7920
7880 PRINT "STATION ";A1$;" OF T
     HE ARRIVAL LIST"
7890 PRINT " DOES NOT APPEAR ON
     THE STATION"
7900 PRINT " LIST" @ GOTO 7920
7910 PRINT "TROUBLE OPENING ARRI
     VAL FILE"
7920 GOSUB 8400
7930 PRINT TIME-T5 @ PRINT @ PRI
     NT @ PRINT @ PRINT
7940 CLEAR @ DISP @ DISP @ DISP
     "CHAIN TO HYP85" @ INPUT Y$
7950 IF Y$<>"Y" THEN 2710
7960 CHAIN "HYP85"
7970 ! SUBROUTINES
7980 ! T5=TIME
7990 FOR I=1 TO N
8000 FOR J=1 TO N @ V(I,J)=0 @ N
     EXT J
8010 V(I,I)=1
8020 NEXT I
8030 U8=0
8040 U9=N*(N-1)/2
8050 U8=U8+1
8060 FOR J=1 TO N-1
8070 FOR K=J+1 TO N
8080 U1=0 @ U3=0 @ U2=0
8090 FOR I=1 TO M
8100 U1=U1+A(I,J)*A(I,K)
8110 U2=U2+A(I,J)*A(I,J)
8120 U3=U3+A(I,K)*A(I,K)
8130 NEXT I
8140 IF U2>=U3 THEN 8170
8150 U=0 @ U4=1
8160 GOTO 8210
8170 IF U2*U3<=T9 THEN 8280
8180 IF U1/U2*(U1/U3)<=T9 THEN 8
     280
8190 U2=U2-U3 @ U5=SQR(4*U1*U1+U
     2*U2)
8200 U=SQR((U5+U2)/(2*U5)) @ U4=
     U1/(U5*U)
8210 FOR I=1 TO M
8220 U3=A(I,J) @ A(I,J)=U*U3+U4*
     A(I,K) @ A(I,K)=-U3*U4+U*A(
     I,K)
8230 NEXT I
8240 FOR I=1 TO N
8250 U3=V(I,J) @ V(I,J)=U*U3+U4*
     V(I,K) @ V(I,K)=-U3*U4+U*V(
     I,K)
8260 NEXT I
8270 GOTO 8290
8280 U9=U9-1
8290 NEXT K
8300 NEXT J
8310 IF U9>0 THEN 8040
8320 FOR J=1 TO N
8330 U2=0
8340 FOR I=1 TO M @ U2=U2+A(I,J)
     *A(I,J) @ NEXT I
8350 Z(J)=SQR(U2)
8360 IF U2<=T9 THEN 8380
8370 FOR I=1 TO M @ A(I,J)=A(I,J
     )/Z(J) @ NEXT I
8380 NEXT J
8390 RETURN
```

```
8400 PRINT "**********************
     ************" @ RETURN
8410 L9$="LAT   "
8420 L8$="NORTH"
8430 L7$="SOUTH"
8440 RETURN
8450 L9$="LONG "
8460 L8$="WEST "
8470 L7$="EAST "
8480 RETURN
8490 A=FND3(T1)
8500 A=FNL6(Q1*60)
8510 A=FNL5(Q2*60)
8520 PRINT USING 8530 ; Z1
8530 IMAGE "DEPTH - ",DD.DDD
8540 RETURN
*********************************
```