NRL Report 7881

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A Fortran Computer Program for Computing the Great Circle Acoustic Path in the Ocean from a Signal Source to a Hydrophone Site and Plotting it on a Mercator Chart

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NAVAL RESEARCH LABORATORY
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FRACZONE is a Fortran program designed to compute the spherical triangular acoustic reception zones based on empirical data and plot these zones on one or more Mercator charts.

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FOREWORD

The documentation of computer programs requires a careful explanation of the various aspects of each program. The Research Computation Center of NRL has a desirable and recommended format for reporting computer programs, and this report follows that format.

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A FORTRAN COMPUTER PROGRAM FOR COMPUTING THE GREAT CIRCLE ACOUSTIC PATH IN THE OCEAN FROM A SIGNAL SOURCE TO A HYDROPHONE SITE AND PLOTTING IT ON A MERCATOR CHART

1.0 IDENTIFICATION

1.1 Title

Great Circle Acoustic Reception Zone from a Signal Source to a Hydrophone Receiver.

1.2 Identification Name

T3-NRL-FRACZONE.

1.3 Classification Code

T3-Applications and Application-Oriented Programs, Other Physical Sciences.

1.4 NRL Research Computation Center Identification Number

T3004O00.

1.5 Entry Points

FRACZONE.

1.6 Programming Language

Language: 3600/3800 Fortran

Routine Type: Main Program

Operating System: DRUM SCOPE 2.0

1.7 Computer and Configuration

CDC 3800.

1.8 Contributor or Programmer

Leon P. LaLumiere, Jr., Code 8174, Environmental Sciences Section, Propagation Branch, Acoustics Division.

Note: Manuscript submitted March 5, 1975.

1.9 Contributing Organization

Naval Research Laboratory (NRL), Washington, D.C. 20375.

1.10 Program Availability

1.10.1 Submittal: Program write-up, Fortran source deck, and the source listing.

1.10.2 On File: Program library of the NRL Research Computation Center.

1.11 Verification

This program has been used and tested as discussed in Section 7.

1.12 Date

1 November 1974.

2.0 PURPOSE

2.1 Description of the Routine

FRACZONE computes the bearing and distance from a hydrophone site to a signal source location, both recorded as latitudes and longitudes, then computes new latitudes and longitudes along the great circle path from the hydrophone site to the signal source location in small increments, converts these latitudes and longitudes into X-Y coordinates, and plots the resulting curve on a Mercator projection chart. If the hydrophone site is within the chart grid, the great circle path starts there and is plotted up to the signal source location. If the hydrophone site is outside the grid, the great circle is plotted up to the point where it leaves the grid.

2.2 Problem Background

Long-range acoustic propagation in the oceans is affected by the topographic features of the ocean floor. Signal reception from a source behind a mountain peak, say along the Mid-Atlantic Ridge, often is effectively blocked by that topographic feature. Surveys by oceanographic vessels have revealed many of these features and their locations.

As an example, suppose a hydrophone site is fixed at some point in an ocean. A ship towing a continuous wave (CW) signal source follows a certain course while records are kept of the navigation fixes and the times when the projector is turned on and off. At the listening post records are kept of the times when signal reception occurs and when reception fades or ceases. When the travel time of sound from ship to post is taken into account, analysis of the records reveals regions of the ocean where reception occurs and where it does not occur.

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If a second listening post is fixed elsewhere and records are kept there, then by crossfixing, the localization of geographic features is established.

The data for this program include data cards, the first of which contains location and time determined from analysis indicating start of reception followed by a second card with location and time indicating loss of reception. In this program great circle paths are plotted on a chart. A line joins the point where reception starts to the point where reception ends. The spherical triangle plotted is a zone of reception. Gaps between successive spherical triangles are zones of no reception. See Figs. 1 and 2.

3.0 USAGE

3.1 Calling Sequence or Operational Procedure

Since FRACZONE is a complete program, the insertion of data cards along with the necessary control cards is the only requirement. The data cards control the program.

3.2 Arguments, Parameters, and Initial Conditions

The following parameters must be punched on data cards (Section 3.9 gives the formats):

Card No. 1 = Magnetic tape skipfile card (Fig. 3)

MTSKF = number of files to be skipped on the plotting tape (blank or zero for none).

Card No. 2 = Title card (Fig. 4)

LT = number of alphanumeric characters to be read

ITITLE (L) = title for the chart to be plotted $\leqslant$ 78 characters

Card No. 3 = Chart Parameter card (Fig. 5)

IBC = bathymetric chart number

RS = chart southernmost latitude in whole degrees

RN = chart northernmost latitude in whole degrees

RL = chart westernmost longitude in whole degrees

RR = chart easternmost longitude in whole degrees

SCALE = chart longitude scale in inches per degree

IBYE = degree increment between tic marks for annotating the chart

JOG = indicator for reading a site card, thusly: $\gtrless 0$ — read a new site card
= 0— skip reading a new site card

JUG = indicator for reading on/off fixes, thusly: $\gtrless 0$ — read new on/off fixes
= 0 — skip reading new on/off fixes

Card No. 4 = Site Location Card (Fig. 6)

ISITE (NS) = listening post or site number

ALAD (NS) = latitude in degrees of the site

ALAM (NS) = latitude in minutes to the nearest hundredth

ALOD (NS) = longitude in degrees of the site

ALOM (NS) = longitude in minutes to the nearest hundredth

Card No. 5, etc = two or multiple of two On/Off Fix cards (Figs. 7, 8, and 9).

ISN (NP) = ship number. ISN (NP) < 0 indicates end of data deck of On/Off fixes

ISD (NP) = ship day (not used by this program)

IY (NP) = year

JUDY (NP) = julian day

IT (NP) = time zulu (0000 to 2359)

IFN (NP) = consecutive fix number (not used by this program)

XLAD (NP) = latitude in degrees of the skip fix

XLAM (NP) = latitude in minutes to the nearest hundredth

XLOD (NP) = longitude in degrees of the ship fix

XLOM (NP) = longitude in minutes to the nearest hundredth

IFIXTY (NP) = type of navigation fix (not used by this program)

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IST (NP) = signal transmission indicator, thusly: =1 — signal transmission
= 0 — no signal transmission

ISR (NP) = signal reception indicator, thusly: = 1 — signal reception
= 0 — no signal reception

Card No. 6 = Option Card (Figs. 10 through 14). This may be a bathymetric chart (B.C.) card or series of B.C. cards using the same site and On/Off fix data cards or using a different site and different On/Off fix data cards. It may also be a control card, thusly:

IBC = NEXT — indicates read a new title card thus restarting the read cycle of card Nos. 2 through 7.

= FINIS — indicates the end of the program execution.

3.3 Space Required (Decimal and Octal)

3.3.1 Unique Storage

67535 octal or 28509 decimal locations

3.3.2 Common Blocks

COMMON/1000/ISN(2500), ISD(2500), IY(2500), JUDY(2500), IT(2500), IFN(2500), SLAT(2500), SLON(2500)

3.3.3 Temporary Storage

Plotting commands for the Calcomp Model 563 are stored on magnetic tape for off-line plotting.

3.4 Messages and Instructions to the Operator

None.

3.5 Error Returns, Messages, and Codes

If an end-of-file card is mistakenly read, the following message is printed: "Data deck improperly organized. Run aborted," and the execution of the program ceases.

If the number of sites exceeds 99 or the number of On/Off fixes exceeds 2500, the following message is printed: "Data storage capacity exceeded. Run aborted," and the execution of the program ceases.

If the computed Y-axis of the chart plot exceeds 29.25 in., the following message is printed: "Plotter Y-axis limit exceeds 29.25 in. Y-LENGTH = XX.XX. Run aborted," and execution of the program ceases.

3.6 Informative Messages to the User

The following are listed (Figs. 15, 16, and 17).

- Chart parameters taken from Card No. 3, the title taken from Card No. 2, and the date on which the data were processed.
- A listing of each On/Off fix actually plotted giving the date, time, latitude, longitude, bearing from site, bearing from fix, distance, and travel time for the signal.
- A message stating plotting completed for site number and number of fixes plotted and the file number on the magnetic tape in which the plotting commands are stored.
- At the conclusion of the program execution, a message lists the number of sites used and the total number of On/Off fixes used.

3.7 Input

The input consists of data cards containing the parameters listed in Section 3.2 and illustrated in Section 3.9.

3.8 Output

The output is given in Section 3.6. All plotting commands are placed on a magnetic tape for off-line plotting. An end-of-file mark separates each chart plot and a double end-of-file mark follows the last chart plot on the tape.

3.9 Formats

The listing shown in Table 1 is an example of an Input Data Deck. Figures 3 through 14 are examples of the data cards used in FRACZONE.

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Table 1

```
   0
43PROGRAM FRACZONE TEST CASE TO SITE NO. 1234
0606N  29.    35.    60.    50.    2.0    1 1 1
 1234  25.       30.00     59      45.00
99 01  71  359 0001   1  29  54.  49  30.  50  11
99 01  71  359 0100   2  30  12.  50  12.  50  10
99 01  71  359 0200   3  30  18.  50  18.  50  11
99 01  71  359 0400   4  31  00.  50  54.  50  10
99 01  71  359 0600   5  31  18.  51  12.  50  11
99 01  71  359 0800   6  31  54.  51  54.  50  10
99 01  71  359 1000   7  32  12.  52  06.  50  11
99 01  71  359 1200   8  32  48.  52  48.  50  10
99 01  71  359 1400   9  33  06.  53  00.  50  11
99 01  71  359 1600  10  33  48.  53  42.  50  10
99 01  71  359 1800  11  34  00.  54  00.  50  11
99 01  71  359 2000  12  34  48.  54  18.  50  10
99 01  71  359 2100  13  34  54.  54  24.  50  11
99 01  71  359 2300  14  35  18.  55  06.  50  10
—3
0605N  23.    29.    60.    50.    2.0    1
NEXT
43PROGRAM FRACZONE TEST CASE TO SITE NO. 5678
0606N  29.    35.    60.    50.    2.0    1    1
 5678  30.       15.00     65.      30.00
0706N  29.    35.  70.     60.    2.0    1
FINIS
```

3.10 External Routines and Symbols

SKIPFILE
PLOTS
PLOT
MRGRD2
MERED
XYIIN
DATE
TICTACTO
NAVIGATE
GEODIS
OUTANDIN
LOCATE
NUMBER
GCPATH
JOINER

JULIAN
SPACEOO
STOPPLOT
MINIF
MAXIF
ALOGIO
SINF
COSF
ACOSF
SQRTF
ATAN2
TANF
ATANF
ASINF
XMODF

3.11 Timing

The compile time is 120 seconds; execution time is extremely variable. The example presented herein required an execution time of approximately 90 sec.

3.12 Accuracy

The accuracy is variable, depending on the input data, but is limited by the accuracy of the plotter: 0.01 in.

3.13 Cautions to Users

In this program north latitudes and west longitudes are positive while south latitudes and east longitudes are negative.

In the computation of a great circle path that enters and leaves the chart very close to one of the corners of the chart the program will sometimes fall into an endless loop because of incremental limitations. The solution is to add an extra degree of latitude or longitude to the chart at the corner where the problem arises.

For off-line plotting at the RCC plotting tape(s) must be recorded at low density (200 bits per in.).

3.14 Program Deck Structure

7/9 JOB card

7/9 EQUIP, 8=**, RW, LO, DA card

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$^{7}_{9}$ FTN card

Program FRACZONE
Subroutines MRGRD2
MERED
XYITN
DATE
TICTACTO
NAVIGATE
GEODIS
OUTANDIN
LOCATE
GCPATH
JOINER
JULIAN
SCOPE card

$^{7}_{9}$ LOAD card

$^{7}_{9}$ RUN card

Data cards

$^{77}_{88}$ EOF card

3.15 References — Literature

David Chang, "A Fortran Subroutine for the Great Circle Distance Between Two Points and Bearings at the Points," NRL Computer Note 32, Sept. 1, 1969.

David Chang, "A Fortran Subroutine for Locations and Bearings at Given Distances from a Starting Point along a Great Circle Path," NRL Computer Note 33, Sept. 1, 1969.

Edward L. Wright and Janet P. Mason, "GEODIST, A New Fortran Subroutine in the RCC Program Library," NRL Computer Note 51, Dec. 31, 1970.

4.0 METHOD OR ALGORITHM

After the program has read cards 1, 2, and 3 the plot package is initialized and the plot origin is defined. Subroutine MRGRD2 is called. This subroutine in turn calls subroutines MERED and XYIIN. MERED converts latitudes into meridional parts.

After the longitude is scaled XYIIN converts the scaled latitudes and longitudes into X-Y coordinates for use in the plotting of the chart. The chart is also annotated and labeled. Control is then returned to the main program.

The main program then establishes the limits beyond which plotting the great circle path will not occur. After reading card 4, the site position, it calls TICTACTO. This subroutine is used throughout the program to determine whether or not a fix is within the chart grid. If it is the X-Y coordinates of the fix are computed and stored. If the fix is outside the grid, the bearings from the site to the four corners of the chart are computed, then tested for the maximum and minimum, and these last are stored.

The On/Off fixes are then read into an array. At this point the program enters a long iterative loop that processes each fix, determines if the great circle path between the site and the fix passes through the chart, and if it does, plots it on the chart. First the program calls TICTACTO to determine if the fix is inside the chart grid. If not, it calls NAVIGATE. This subroutine takes the site position and the fix and computes the forward azimuth from the site and the back azimuth from the fix and the distance between them. The program tests the forward azimuth against the maximum and the minimum bearings of the chart grid corners. If this bearing lies between them the great circle path passes through the grid. Next, the program calls OUTANDIN, a subroutine that determines where the great circle path enters the chart grid. After this point has been determined, subroutine GCPATH is called repeatedly. This subroutine, given the site position, a bearing, and a distance, computes the latitude and longitude at that bearing and distance. The latitude and longitude are converted to X-Y coordinates. The distance is repeatedly incremented for a series of fixes along the great circle path and these are continuously plotted. At the same time a series of tests determine if the great circle path has reached the fix at which point plotting stops, or if the great circle path has passed outside the grid at which point plotting stops. After this a series of tests determines if the fix is an On or Off fix. If Off, a series of tests determines if a straight line joining the two fixes should be drawn or partially drawn as shown in Fig. 1. If one fix is inside and the other is outside the grid, a partial line is drawn. The program calls JOINER, a subroutine that determines where the partial line enters or leaves the chart grid. After this the do-loop is continued until all data have been processed.

5.0 SOURCE LANGUAGE LISTING

A listing of the program in the Fortran language is reproduced on the following pages.

6.0 COMPARISON

As far as known, no comparable program exists.

7.0 TEST METHOD AND RESULTS

The input data deck illustrated in Section 3.9 was used in the program to produce the plots shown in Figs. 1 and 2. In Fig. 2, S is the location of a listening post. In Fig.

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1, point C is the fix at which sound reception begins and point D is the fix at which sound reception ceases. The spherical triangle SCD is a zone of reception. The gap between triangles SCD and SEF is a zone of no reception. The line BA stops at A and indicates a fix just outside the grid. Below A, the number 246.7 is the bearing from the ship fix to the site, while the number 61.9 (above the numeral 52) is the bearing from the site to the ship fix.

8.0 ACKNOWLEDGMENTS

The author thanks his coworkers in the Environmental Sciences Section, Propagation Branch, Acoustics Division for their encouragement, cooperation, suggestions, and advice.

```
      PROGRAM FRACZONE                                                  A   1
C     IDENT NUMBER - T3004000                                           A   2
C     TITLE - GREAT CIRCLE SPHERICAL TRIANGULAR ACOUSTIC RECEPTION ZONE. A   3
C     IDENT NAME - T3-NRL-FRACZONE                                      A   4
C     LANGUAGE - FORTRAN                                                A   5
C     COMPUTER - CDC-3800                                               A   6.
C     CONTRIBUTOR - LEON P. LA LUMIERE JR., CODE 8174                   A   7
C                   PROPAGATION BRANCH, ACOUSTICS DIVISION              A   8
C     ORGANIZATION - NRL - NAVAL RESEARCH LABORATORY                    A   9
C                          WASHINGTON, D.C. 20375                       A  10
C     DATE - 1 NOVEMBER 1974                                            A  11
C     PURPOSE - TO COMPUTE AND PLOT A GREAT CIRCLE SPHERICAL TRIANGLE   A  12
C               DISPLAYING ACOUSTIC RECEPTION ZONES ON A CHART.         A  13
C                                                                       A  14
C     *** INPUT DATA DECK *** DATA CARDS MAY BE LEFT BLANK AS DESIRED.  A  15
C     *** CARD 1 - MAGNETIC TAPE SKIPFILE OPTION - FORMAT 6             A  16
C     MTSKF = NUMBER OF FILES TO BE SKIPPED ON THE PLOTTING TAPE, IF ANY A  17
C     *** CARD 2 - TITLE CARD - FORMAT 7                                A  18
C     LT = NUMBER OF ALPHANUMERIC CHARACTERS IN THE TITLE.              A  19
C     ITITLE(L) = TITLE .LE. 78 CHARACTERS.                             A  20
C     *** CARD 3 - CHART PARAMETER CARD - FORMAT 3                      A  21
C     IBC = BATHYMERIC CHART NUMBER.                                    A  22
C     RS = CHART SOUTHMOST LATITUDE IN WHOLE DEGREES.                   A  23
C     RN = CHART NORTHMOST LATITUDE IN WHOLE DEGREES.                   A  24
C     RL = CHART WESTMOST LONGITUDE IN WHOLE DEGREES.                   A  25
C     RR = CHART EASTMOST LONGITUDE IN WHOLE DEGREES.                   A  26
C     SCALE = CHART LONGITUDE SCALE IN INCHES PER DEGREE.               A  27
C     IBYE = CHART ANNOTATION INCREMENT IN WHOLE DEGREES.               A  28
C     JOG = OPTION TO READ OR NOT READ A SITE LOCATION CARD, THUSLY -   A  29
C         .GT. 0 - READ A NEW SITE LOCATION CARD.                       A  30
C         = 0 - SKIP READING A NEW SITE LOCATION CARD.                  A  31
C     JUG = OPTION TO READ OR NOT READ A NEW DATA DECK OF ON/OFF FIXES, A  32
C         .GT. 0 - READ A NEW DATA DECK OF ON/OFF FIXES.                A  33
C         = 0 - SKIP READING A NEW DATA DECK OF ON/OFF FIXES.           A  34
C     *** CARD 4 - SITE LOCATION CARD - FORMAT 4                        A  35
C     ISITE(NS) = SITE NUMBER.                                          A  36
C     ALAD(NS) = SITE LATITUDE IN WHOLE DEGREES.                        A  37
C     ALAM(NS) = SITE LATITUDE IN MINUTES TO THE NEAREST HUNDREDTH.     A  38
C     ALOD(NS) = SITE LONGITUDE IN WHOLE DEGREES.                       A  39
C     ALOM(NS) = SITE LONGITUDE IN MINUTES TO THE NEAREST HUNDREDTH.    A  40
C     *** CARD 5, ETC. - TWO OR MULTIPLE OF TWO ON/OFF FIXES - FORMAT 5 A  41
C     ISN(NP) = SHIP NUMBER. ALSO AN INTEGER OPTION, THUSLY -           A  42
C             .LT. 0 - INDICATES END OF DATA DECK OF ON/OFF FIXES.      A  43
C             = -1 - READ NEW SITE LOCATION FOR PLOTTING ON SAME CHART. A  44
C             = -2 - READ NEW ON/OFF FIXES FOR PLOTTING ON SAME CHART.  A  45
C             = -3 - READ NEW CHART PARAMETER CARD FOR NEW CHART.       A  46
C             = -4 - READ NEW TITLE CARD.                               A  47
C             = -9 - END PROGRAM AFTER PROCESSING ON/OFF FIXES.         A  48
C     ISD(NP) = SHIP DAY (NOT USED IN THIS PROGRAM).                    A  49
C     IY(NP) = YEAR OF PROJECT.                                         A  50
C     JUDY(NP) = JULIAN DAY.                                            A  51
C     IT(NP) = TIME ZULU (0000 TO 2359).                                A  52
C     IFN(NP) = CONSECUTIVE FIX NUMBER (NOT USED IN THIS PROGRAM).      A  53
C     XLAD(NP) = FIX LATITUDE IN WHOLE DEGREES.                         A  54
C     XLAM(NP) = FIX LATITUDE IN MINUTES TO THE NEAREST HUNDREDTH.      A  55
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```
C     XLOD(NP) = FIX LONGITUDE IN WHOLE DEGREES.                          A  56
C     XLOM(NP) = FIX LONGITUDE IN MINUTES TO THE NEAREST HUNDREDTH.       A  57
C     IFIXTY(NP) = TYPE OF FIX (NOT USED IN THIS PROGRAM).                A  58
C     IST(NP) = SIGNAL TRANSMISSION INDICATOR, THUSLY -                   A  59
C             = 1 - SIGNAL TRANSMISSION.                                  A  60
C             = 0 - NO SIGNAL TRANSMISSION.                               A  61
C     ISR(NP) = SIGNAL RECEPTION INDICATOR, THUSLY -                      A  62
C             = 1 - SIGNAL RECEPTION.                                     A  63
C             = 0 - NO SIGNAL RECEPTION.                                  A  64
C     *** CARD 6 - ALPHANUMERIC OPTION. THIS MAY BE ONE OR MORE CHART     A  65
C                  PARAMETER CARDS USING THE SAME SITE AND ON/OFF DATA    A  66
C                  OR USING A DIFFERENT SITE AND ON/OFF DATA. IT MAY      A  67
C                  ALSO BE A CONTROL CARD, THUSLY -                       A  68
C     IBC = NEXT - READ A NEW TITLE CARD THIS RESTARTING THE READ CYCLE   A  69
C                  OF CARDS 2 THRU 6.                                     A  70
C         = FINIS - INDICATES END OF PROGRAM EXECUTION.                  A  71
C     *** IN THIS PROGRAM NORTH LATITUDES AND WEST LONGITUDES ARE         A  72
C         POSITIVE WHILE SOUTH LATITUDES AND WEST LONGITUDES ARE          A  73
C         NEGATIVE.                                                       A  74
C                                                                         A  75
C     THE FOLLOWING SUBROUTINES ARE REQUIRED BY THIS PROGRAM              A  76
C     CALL MRGRD2(IBC,RS,RN,RL,RR,SCALE,IBYF,CHT,NNN,AMPI,RPI,ITITLE,LT,  A  77
C     1YO,XR,YLENG)                                                       A  78
C     CALL MERED (0,YIMM,YIMO)                                            A  79
C     CALL XYIIN(NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)                  A  80
C     CALL DATE (MONTH,IDAY,IYEAR,JUL) USED IN MRGRD                      A  81
C     CALL TICTACTO (RS,RN,RL,RR,SLAT(J),SLON(J),MAPS,IFX,IFY)            A  82
C     CALL NAVIGATE (Y,Z,DSA,DSO,BR1,BR2,TEST)                            A  83
C     CALL GEODIS (DSA, DSO, DFA, DFO, AZ, BAZ, DISTKM, DEG)              A  84
C     CALL OUTANDIN (RS,RN,RL,RR,ALAT(NS),ALON(NS),BS,Y,X,DIST)           A  85
C     CALL LOCATE (XPT,YPT,XXL,XXR,YYL,YYU,BX,BY,ISR(J),CHT,AHT)          A  86
C     CALL GCPATH (DFA,DFO,BS,IST,1,Y,X,FB)                               A  87
C     CALL JOINER (RS,RN,RL,RR,SLAT(J),SLON(J),SLAT(K),SLON(K),Y,X)       A  88
C     CALL JULIAN (IY(J), JUDY(J), ID, IM, LPYR)                          A  89
C                                                                         A  90
      DIMENSION ISITE(30), ALAD(30), ALAM(30), ALOD(30), ALOM(30), ALAT(  A  91
     130), ALON(30), XA(30), YA(30), XLAD(2500), XLAM(2500), XLOD(2500),  A  92
     2 XLOM(2500), IFIXTY(2500), XN(2500), YN(2500), IST(2500), ISR(2500  A  93
     3), IBUF(254), ITITLE(78)                                            A  94
      COMMON /1000/ ISN(2500),ISD(2500),IY(2500),JUDY(2500),IT(2500),IFN  A  95
     1(2500),SLAT(2500),SLON(2500)                                        A  96
      DIMENSION MONTH(12)                                                 A  97
      DATA (MONTH=5H JAN ,5H FEB ,5H MAR ,5H APR ,5H MAY ,5H JUN ,5H JUL  A  98
     1 ,5H AUG ,5H SEP ,5H OCT ,5H NOV ,5H DEC )                          A  99
C                                                                         A 100
    1 FORMAT (1H1)                                                        A 101
    2 FORMAT (1H0)                                                        A 102
    3 FORMAT (A5,4F5.0,3X,F7.4,9I5)                                       A 103
    4 FORMAT (I5,F5.0,5X,F5.2,F5.0,5X,F5.2)                               A 104
    5 FORMAT (I2,I3,I3,I4,I5,I5,F3,F6.2,F4,F6.2,I3,25X,I1,I1)             A 105
    6 FORMAT (16I5)                                                       A 106
    7 FORMAT (I2,78A1)                                                    A 107
    8 FORMAT (5X,78A1)                                                    A 108
    9 FORMAT (5X,*CHART PARAMETERS*//5X,*B.C. NO. = *,A5//5X,*SOUTHMOST   A 109
     1LATITUDE = *,F4,3X,*NORTHMOST LATITUDE = *,F4//5X,*WESTMOST LONGIT  A 110
```

```
     2UDE = *,F4,3X,*EASTMOST LONGITUDE = *,F4//5X,*SCALE = *,F7.4,* INC
     3HES / DEGREE *,2X,*DEGREE INCREMENT = *,I2//5X,*CHARACTER HEIGHT =
     4 *,F5.3//5X,*DATA PROCESSED ON *,I2,A5,I2)
   10 FORMAT (5X,*FOR SITE NO. *,I4,* AND SOUND SPEED = *,F4,* FEET / SE
     1COND*//8X,*DATE*,4X,*TIME*,5X,*SHIP POSITION*,6X,*SHIP*,5X,*SITE*,
     24X,*DISTANCE*,4X,*TRAVEL*/22X,*LATITUDE*,2X,*LONGITUDE*,2X,*BEARIN
     3G*,2X,*BEARING*,3X,*(NMS)*,4X,*TIME (MIN)*/)
   11 FORMAT (5X,I2,1X,I2,1X,I2,3X,I4,2X,F2.1X,F5.2,2X,F3,1X,F5.2,3X,F6.
     12,3X,F6.2,3X,F5.0,5X,F6.1,7X,I1,I1)
   12 FORMAT (5X,*PLOTTING COMPLETED FOR SITE NO. *,I4,*  NUMBER OF SHIP
     1 POSITIONS = *,I4,//5X,*Y-LENGTH = *,F5.2,* INCHES*)
   13 FORMAT (/5X,*PLOTTING COMMANDS ARE STORED IN FILE NO. *,I3)
   14 FORMAT (5X,*PLOTTING COMPLETED FOR NUMBER OF SITES = *,I2,* AND NU
     1MBER OF SHIP POSITIONS = *,I4)
   15 FORMAT (//5X,*DATA STORAGE CAPACITY EXCEEDED, RUN ABORTED*)
   16 FORMAT (//5X,3H***,* PLOTTER Y- AXIS LIMIT EXCEEDS 29.25 INCHES.
     1Y-LENGTH = *,F5.2,*  RUN ABORTED *,3H***)
   17 FORMAT (//5X,*DATA DECK IMPROPERLY ORGANIZED, RUN ABORTED*)
C
      CALL Q8QERSTP (1000)
      SNDSPD=4910.
      SPDKTS=SNDSPD/6076.115
      XRAD=0.01745329
C     XRAD IS THE CONSTANT FOR CHANGING ANGULAR DEGREES INTO RADIANS
      X0=0.
      Y0=1.250
      NE=0
      NB=0
      NM=0
      PI=3.141592653
      PINEG=-3.141592653
      LC=50
      LK=0
      IPAGE=1
      YNEW=0.
      LPYR=1
      NS=0
      NQ=0
      MINUS=4000000000000000B
      CHT=0.280
      AHT=0.105
      NEXT=4525676360606060B
      IFINIS=2631453162606060B
C
C     READ A MAGNETIC TAPE SKIPFILE CARD WITH NO. OF FILES TO SKIP.
C
      READ 6, MTSKF
      IFILE=MTSKF
      IF (MTSKF) 20,20,18
   18 DO 19 M=1,MTSKF
   19 CALL SKIPFILE (8)
C
C     READ A TITLE CARD.
C
   20 READ 7, LT,(ITITLE(I),I=1,LT)
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      IF ( EOF,60) 71,21
C
C     READ A CHART PARAMETER CARD (OR AN ALPHANUMERIC CONTROL CARD).
C
   21 READ 3, IBC,RS,RN,RL,RR,SCALE,IBYE,JOG,JUG
C     JUG = 1 - READ NEW SITE CARD.
C     JOG = 0 - SKIP READ NEW SITE CARD.
C     JUG = 1 - READ NEW FIX CARDS.
C     JUG = 0 - SKIP READ NEW FIX CARDS.
      IF ( EOF,60) 71,22
   22 IF (IBC.EQ.IFINIS) GO TO 68
      IF (IBC.EQ.NEXT) GO TO 20
      CALL PLOTS (IBUF,254,8,29)
      CALL PLOT (XO,YO,-3)
      CALL MRGRD2 (IBC,RS,RN,RL,RR,SCALE,IBYE,CHT,NNN,AMPI,RPI,ITITLE,LT
     1,YO,XR,YLENG)
      IF (YLENG.GT.29.25) GO TO 69
      YTEST=YLENG-YO
      XIRO=RL*XRAD
      YIMM=RS*XRAD
      CALL MERED (0,YIMM,YIMO)
C     THE FOLLOWING SETS THE LIMITS OF THE GREAT CIRCLE PLOT.
      XIR=RL*XRAD
      YMM=RS*XRAD
      CALL MERED (0,YMM,YIM)
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)
      XXL=XPT
      YYL=YPT
      XIR=RR*XRAD
      YMM=RN*XRAD
      CALL MERED (0,YMM,YIM)
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)
      XXR=XPT
      YYU=YPT
      IF (NNN) 24,24,23
   23 XIRO=(360.+RL)*XRAD
      NEG=NNN
      NNN=0
   24 CONTINUE
      MARK=MAPS=LAST=LK=LOCK=0
      CALL DATE (M,ID,KY,JY)
      PRINT 9, IBC,RS,RN,RL,RR,SCALE,IBYE,CHT,ID,MONTH(M),KY
      PRINT 2
      PRINT 8, (ITITLE(I),I=1,LT)
      PRINT 1
      IF (JOG) 25,33,25
   25 NS=NS+1
C
C     READ A SITE POSITION CARD.
C
      READ 4, ISITE(NS),ALAD(NS),ALAM(NS),ALOD(NS),ALOM(NS)
      IF ( EOF,60) 71,26
   26 IF (NS.GT.99) GO TO 70
      ALAM(NS)=ABSF(ALAM(NS))
      ALOM(NS)=ABSF(ALOM(NS))
```

```
      KOY=ALAD(NS).AND.MINUS                                            A 221
      IF (KOY.EQ.MINUS) 27,28                                           A 222
   27 ALAT(NS)=ALAD(NS)-ALAM(NS)/60.                                    A 223
      GO TO 29                                                          A 224
   28 ALAT(NS)=ALAD(NS)+ALAM(NS)/60.                                    A 225
   29 KEY=ALOD(NS).AND.MINUS                                            A 226
      IF (KEY.EQ.MINUS) 30,31                                           A 227
   30 ALON(NS)=ALOD(NS)-ALOM(NS)/60.                                    A 228
      GO TO 32                                                          A 229
   31 ALON(NS)=ALOD(NS)+ALOM(NS)/60.                                    A 230
   32 DFA=ALAT(NS)                                                      A 231
      DFO=-ALON(NS)                                                     A 232
C     MARK = 5 - INDICATES THE SITE LIES INSIDE THE CHART GRID.         A 233
   33 CALL TICTACTO (RS,RN,RL,RR,ALAT(NS),ALON(NS),MARK,ISX,ISY,NEG)    A 234
      IF (MARK-5) 35,34,35                                              A 235
   34 XIR=ALON(NS)*XRAD                                                 A 236
      IF ((NEG.GT.0).AND.(ALON(NS).LT.0.)) XIR=(360.+ALON(NS))*XRAD     A 237
      YMM=ALAT(NS)*XRAD                                                 A 238
      CALL MERED (0,YMM,YIM)                                            A 239
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 240
      XA(NS)=XPT                                                        A 241
      YA(NS)=YPT                                                        A 242
      CALL PLOT (XPT,YPT,3)                                             A 243
   35 XW=-RL                                                            A 244
      XE=-RR                                                            A 245
      IF (MARK.EQ.5) GO TO 38                                           A 246
      CALL NAVIGATE (DFA,DFO,RS,XW,A1,BAZ,D1)                           A 247
      CALL NAVIGATE (DFA,DFO,RN,XW,A2,BAZ,D2)                           A 248
      CALL NAVIGATE (DFA,DFO,RN,XE,A3,BAZ,D3)                           A 249
      CALL NAVIGATE (DFA,DFO,RS,XE,A4,BAZ,D4)                           A 250
      IF (MARK.EQ.8) 36,37                                              A 251
   36 A3=A3+360.                                                        A 252
      A4=A4+360.                                                        A 253
   37 B2=MAX1F(A1,A2,A3,A4)                                             A 254
      B1=MIN1F(A1,A2,A3,A4)                                             A 255
      TEMP=MIN1F(D1,D2,D3,D4)                                           A 256
   38 CONTINUE                                                          A 257
C                                                                       A 258
      PRINT 8, (ITITLE(L),L=1,LT)                                       A 259
      PRINT 2                                                           A 260
      PRINT 10, ISITE(NS),SNDSPD                                        A 261
      NF=0                                                              A 262
C                                                                       A 263
      IF (JUG.EQ.1) NP=0                                                A 264
      IF (JUG) 39,43,39                                                 A 265
   39 NQ=NP+1                                                           A 266
   40 NP=NP+1                                                           A 267
      IF (NP.GT.2500) GO TO 70                                          A 268
C                                                                       A 269
C     READ TWO OR MORE ON/OFF FIX CARDS (LAST CARD IS A CONTROL CARD).  A 270
C                                                                       A 271
      READ 5, ISN(NP),ISD(NP),IY(NP),JUDY(NP),IT(NP),IFN(NP),XLAD(NP),XL A 272
     1AM(NP),XLOD(NP),XLOM(NP),IFIXTY(NP),IST(NP),ISR(NP)               A 273
C     IST(NP) IS IN COLUMN 70.  ISR(NP) IS IN COLUMN 71.                A 274
C     IST(NP) = 1 - TRANSMISSION                                        A 275
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C     IST(NP) = 0 - NO TRANSMISSION                                    A 276
C     ISR(NP) = 1 - RECEPTION                                          A 277
C     ISR(NP) = 0 - NO RECEPTION                                       A 278
      IF ( EOF,60) 71,41                                               A 279
   41 IF (ISN(NP)) 42,40,40                                            A 280
   42 NB=NP                                                            A 281
      NP=NP-1                                                          A 282
C                                                                      A 283
C     DO LOOP FOR PLOTTING A GREAT CIRCLE BETWEEN TWO POINTS           A 284
C                                                                      A 285
   43 DO 66 J=NQ,NP                                                    A 286
      K=J-1                                                            A 287
      XLAM(J)=ABSF(XLAM(J))                                            A 288
      XLOM(J)=ABSF(XLOM(J))                                            A 289
      LUCK=LOCK                                                        A 290
      LOCK=XLOD(J).AND.MINUS                                           A 291
      IF (LOCK.EQ.MINUS) 44,45                                         A 292
   44 SLON(J)=XLOD(J)-XLOM(J)/60.                                      A 293
      GO TO 46                                                         A 294
   45 SLON(J)=XLOD(J)+XLOM(J)/60.                                      A 295
   46 LLA=XLAD(J).AND.MINUS                                            A 296
      IF (LLA.EQ.MINUS) 47,48                                          A 297
   47 SLAT(J)=XLAD(J)-XLAM(J)/60.                                      A 298
      GO TO 49                                                         A 299
   48 SLAT(J)=XLAD(J)+XLAM(J)/60.                                      A 300
   49 DSA=SLAT(J)                                                      A 301
      DSO=-SLON(J)                                                     A 302
      LAST=MAPS                                                        A 303
      DIST=TEMP                                                        A 304
      IF (MARK.EQ.5) DIST=0.0                                          A 305
      DELDIS=1.5                                                       A 306
C                                                                      A 307
C     FOR COMPOSITE OR WHOLE OCEAN CHARTS SET DELDIS = 15.0            A 308
C     FOR B. C. SIZE CHARTS SET DELDIS = 1.5                           A 309
C                                                                      A 310
      IF (SCALE.LT.1.0) DELDIS=15.0                                    A 311
      DELP=DELDIS*2.2                                                  A 312
      JUMP=1                                                           A 313
      KICK=0                                                           A 314
C     FAZ IS THE BEARING FROM THE SHIP TO THE SITE.                    A 315
C     BAZ IS THE BEARING FROM THE SITE TO THE SHIP.                    A 316
      CALL GEODIS (DSA,DSO,DFA,DFO,FAZ,BAZ,DISTKM,DEG)                 A 317
C     MAPS = 5 - INDICATES THE FIX LIES INSIDE THE CH RT GRID.         A 318
      CALL TICTACTO (RS,RN,RL,RR,SLAT(J),SLON(J),MAPS,IFX,IFY,NEG)     A 319
      CALL NAVIGATE (DFA,DFO,DSA,DSO,BS,BAY,DTEST)                     A 320
C     BS IS THE BEARING FROM THE SITE TO THE SHIP FIX.                 A 321
C     IF BOTH FIXES ARE OUTSIDE THE GRID CHECK IF PATH PASSES THRU THE A 322
C     GRID.  IF NOT SKIP.                                              A 323
      IF ((MAPS.NE.5).AND.(MARK.NE.5)) 50,51                           A 324
   50 IF (MARK.EQ.8) BS=BS+360.                                        A 325
      IF ((BS.LT.B1).OR.(BS.GT.B2)) 66,51                              A 326
   51 IF ((MARK.EQ.8).AND.(BS.GE.360.0)) BS=BS-360.0                   A 327
      KICK=1                                                           A 328
      LEAP=1                                                           A 329
      YMM=SLAT(J)*XRAD                                                 A 330
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      XIR=SLON(J)*XRAD                                                  A 331
      CALL MERED (0,YMM,YIM)                                            A 332
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 333
C     STORAGE OF PLOTTING DATA FOR LATER USAGE IN OTHER PLOTS.          A 334
      XN(J)=XPT                                                         A 335
      YN(J)=YPT                                                         A 336
C     THIS VERSION PLOTS A GREAT CIRCLE UP TO THE FIX ONLY              A 337
      IF (MARK-5) 52,53,52                                              A 338
C                                                                       A 339
C     THE GREAT CIRCLE PATH ENTERS THE CHART GRID AT THIS POINT.        A 340
C                                                                       A 341
   52 CALL OUTANDIN (RS,RN,RL,RR,ALAT(NS),ALON(NS),BS,Y,X,DIST)         A 342
      IF (DIST.GE.DTEST) GO TO 66                                       A 343
      XIR=X*XRAD                                                        A 344
      YMM=Y*XRAD                                                        A 345
      CALL MERED (0,YMM,YIM)                                            A 346
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 347
      CALL LOCATE (XPT,YPT,XXL,XXR,YYL,YYU,BX,BY,ISR(J),CHT,AHT)        A 348
      CALL NUMBER (BX,BY,AHT,B.Z,0.0,4HF5.1)                            A 349
      CALL NUMBER (BX,BY,AHT,BAZ,0.0,4HF5.1)                            A 350
      CALL PLOT (XPT,YPT,3)                                             A 351
   53 IF (MARK.NE.5) GO TO 54                                           A 352
      CALL PLOT (XA(NS),YA(NS),3)                                       A 353
C                                                                       A 354
C     THE GREAT CIRCLE PATH IS COMPUTED FROM STATEMENT 54 TO 59.        A 355
C                                                                       A 356
   54 DIST=DIST+DELDIS                                                  A 357
      IF (DIST.GT.DTEST) GO TO 61                                       A 358
      CALL GCPATH (DFA,DFO,BS,DIST,1,Y,Z,FB)                            A 359
      X=-Z                                                              A 360
      IF ((Y.LT.RS).OR.(Y.GT.RN).OR.(X.GT.RL).OR.(X.LT.RR)) 58,55       A 361
   55 XIR=X*XRAD                                                        A 362
      YMM=Y*XRAD                                                        A 363
      CALL MERED (0,YMM,YIM)                                            A 364
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 365
      CALL PLOT (XPT,YPT,2)                                             A 366
      CALL NAVIGATE (Y,Z,DSA,DSO,BR1,BR2,TEST)                          A 367
      IF (TEST.LE.DELP) 56,54                                           A 368
   56 DIST=DIST-DELDIS                                                  A 369
      GO TO (57,57,61), JUMP                                            A 370
   57 DELP=DELP*0.1                                                     A 371
      DELDIS=DELDIS*0.1                                                 A 372
      JUMP=JUMP+1                                                       A 373
      GO TO 54                                                          A 374
C                                                                       A 375
C     THE GREAT CIRCLE PATH LEAVES THE CHART GRID AT THIS POINT.        A 376
C                                                                       A 377
   58 DIST=DIST-DELDIS                                                  A 378
      GO TO (59,60), LEAP                                               A 379
   59 DELDIS=DELDIS*0.1                                                 A 380
      DELP=DELP*0.1                                                     A 381
      LEAP=2                                                            A 382
      GO TO 54                                                          A 383
   60 CALL GCPATH (DFA,DFO,BS,DIST,1,Y,Z,FB)                            A 384
      X=-Z                                                              A 385
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      XIR=X*XRAD                                                        A 386
      YMM=Y*XRAD                                                        A 387
      CALL MERED (0,YMM,YIM)                                            A 388
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 389
      CALL PLOT (XPT,YPT,2)                                             A 390
      CALL PLOT (XPT,YPT,3)                                             A 391
      CALL LOCATE (XPT,YPT,XXL,XXR,YYL,YYU,BX,BY,ISR(J),CHT,AHT)        A 392
      CALL NUMBER (BX,BY,AHT,FAZ,0.0,4HF5.1)                            A 393
      CALL NUMBER (BX,BY,AHT,FAZ,0.0,4HF5.1)                            A 394
      CALL PLOT (XPT,YPT,3)                                             A 395
   61 CONTINUE                                                          A 396
      IF ((MAPS.EQ.5).AND.(LAST.EQ.0).AND.(ISR(J).EQ.1)) GO TO 64       A 397
      IF ((MAPS.EQ.5).AND.(LAST.EQ.5)) GO TO 64                         A 398
      IF ((MAPS.EQ.5).AND.(LAST.NE.5).AND.(ISR(J).EQ.1)) GO TO 64       A 399
      IF ((MAPS.EQ.5).AND.(LAST.NE.5).AND.(ISR(J).EQ.0)) GO TO 63       A 400
      IF ((MAPS.NE.5).AND.(LAST.EQ.5).AND.(ISR(J).EQ.1)) GO TO 65       A 401
      IF ((MAPS.NE.5).AND.(LAST.EQ.5).AND.(ISR(J).EQ.0)) 62,65          A 402
C                                                                       A 403
C     THE LAST FIX IS OUTSIDE THE GRID BUT THE PREVIOUS FIX IS INSIDE.  A 404
C                                                                       A 405
   62 CALL JOINER (RS,RN,RL,RR,SLAT(K),SLON(K),SLAT(J),SLON(J),Y,X)     A 406
      XIR=X*XRAD                                                        A 407
      YMM=Y*XRAD                                                        A 408
      CALL MERED (0,YMM,YIM)                                            A 409
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 410
      CALL PLOT (XPT,YPT,3)                                             A 411
      CALL PLOT (XPT,YPT,2)                                             A 412
      CALL PLOT (XN(K),YN(K),2)                                         A 413
      CALL PLOT (XN(K),YN(K),3)                                         A 414
      GO TO 65                                                          A 415
C                                                                       A 416
C     THE LAST FIX IS INSIDE THE GRID BUT THE PREVIOUS FIX IS OUTSIDE.  A 417
C                                                                       A 418
   63 CALL JOINER (RS,RN,RL,RR,SLAT(J),SLON(J),SLAT(K),SLON(K),Y,X)     A 419
      XIR=X*XRAD                                                        A 420
      YMM=Y*XRAD                                                        A 421
      CALL MERED (0,YMM,YIM)                                            A 422
      CALL XYIIN (NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)               A 423
      CALL PLOT (XPT,YPT,3)                                             A 424
      CALL PLOT (XPT,YPT,2)                                             A 425
      CALL PLOT (XN(J),YN(J),2)                                         A 426
      CALL PLOT (XN(J),YN(J),3)                                         A 427
      GO TO 65                                                          A 428
C                                                                       A 429
C     THE CURRENT FIX LIES WITHIN THE CHART GRID.                       A 430
C                                                                       A 431
   64 CALL PLOT (XN(J),YN(J),2)                                         A 432
      CALL PLOT (XN(J),YN(J),3)                                         A 433
      IF (K.EQ.0) GO TO 65                                              A 434
      IF (ISR(K).NE.1) GO TO 65                                         A 435
C                                                                       A 436
C     THE PREVIOUS FIX LIES WITHIN THE CHART GRID.                      A 437
C                                                                       A 438
      CALL PLOT (XN(K),YN(K),2)                                         A 439
      CALL PLOT (XN(K),YN(K),3)                                         A 440
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   65 NF=NF+1                                                           A 441
C                                                                       A 442
      IF (KICK.EQ.0) GO TO 66                                           A 443
      CALL JULIAN (IY(J),JUDY(J),ID,IM,LPYR)                            A 444
      DIST=DISTKM/1.852                                                 A 445
      TRAVEL=DIST/SPDKTS/60.                                            A 446
      PRINT 11, ID,IM,IY(J),IT(J),XLAD(J),XLAM(J),XLOD(J),XLOM(J),FAZ,BA A 447
     1Z,DIST,TRAVEL,IST(J),ISR(J)                                       A 448
      LK=LK+1                                                           A 449
      IF (LK.LT.LC) GO TO 66                                            A 450
      PRINT 1                                                           A 451
      PRINT 8, (ITITLE(L),L=1,LT)                                       A 452
      PRINT 2                                                           A 453
      PRINT 10, ISITE(NS),SNDSPD                                        A 454
      LK=0                                                              A 455
   66 CONTINUE                                                          A 456
C                                                                       A 457
      PRINT 1                                                           A 458
      PRINT 8, (ITITLE(L),L=1,LT)                                       A 459
      PRINT 2                                                           A 460
      NT=NP-NQ+1                                                        A 461
      NM=NM+NT                                                          A 462
      PRINT 12, ISITE(NS),NF,YLENG                                      A 463
      IF ((ISN(NB).EQ.-1).OR.(ISN(NB).EQ.-2)) GO TO 67                  A 464
      IFILE=IFILE+1                                                     A 465
      PRINT 13, IFILE                                                   A 466
   67 PRINT 1                                                           A 467
C                                                                       A 468
C     ISN(NB) = -1 - READ NEW SITE INFO FOR PLOTTING ON SAME CHART      A 469
C     ISN(NB) = -2 - READ NEW SHIP INFO FOR PLOTTING ON SAME CHART      A 470
C     ISN(NB) = -3 - USE SAME SITE INFO FOR PLOTTING ON NEW CHART       A 471
C     ISN(NB) = -4 - READ NEW TITLE, SITE INFO FOR PLOTTING NEW CHART   A 472
C     ISN(NB) = -9 - END OF DATA TO BE PROCESSED                        A 473
C                                                                       A 474
      IF (ISN(NB).EQ.-1) GO TO 25                                       A 475
      IF (ISN(NB).EQ.-2) GO TO 40                                       A 476
      XNEW=XR+6.0                                                       A 477
      CALL PLOT (XNEW,YNEW,-3)                                          A 478
      CALL SPACE00                                                      A 479
      LK=0                                                              A 480
      IF (ISN(NB).EQ.-3) GO TO 21                                       A 481
      IF (ISN(NB).EQ.-4) GO TO 20                                       A 482
C                                                                       A 483
   68 XNEW=XR+15.                                                       A 484
      CALL PLOT (XNEW,YNEW,3)                                           A 485
      CALL SPACE00                                                      A 486
      CALL STOPPLOT                                                     A 487
      PRINT 14, NS,NM                                                   A 488
      STOP                                                              A 489
C                                                                       A 490
   69 PRINT 16, YLENG                                                   A 491
      CALL SKIPFILE (60)                                                A 492
      STOP                                                              A 493
C                                                                       A 494
   70 PRINT 15                                                          A 495
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      CALL SKIPFILE (60)                                                A 496
      STOP                                                              A 497
C                                                                       A 498
   71 PRINT 17                                                          A 499
      CALL SKIPFILE (60)                                                A 500
      STOP                                                              A 501
C                                                                       A 502
      END                                                               A 503


      SUBROUTINE MRGRD2(IBC,RS,RN,RE,RW,SCALE,IBYE,XHT,NNN,AMPI,RPI,ITIT  B   1
     1LE,LT,YO,XR,YLENG)                                                 B   2
C     MODIFIED FOR CDC 3800 BY LEON LA LUMIERE - CODE 8178 - 17 NOV 1971 B   3
C     MBGRD2 HAS BEEN MODIFIED ESPECIALLY FOR PROGRAM BEAMPATH 8 DEC 72  B   4
C     PLOTS A MERCATOR GRID WITH LONGITUDE ANNOTATED ALONG BOTTOM        B   5
C        AND LATITUDE ALONG RIGHT SIDE                                   B   6
C     INPUT...                                                           B   7
C        IBC,SN....B.C. NUMBER AND DIRECTION (CAN BE LEFT BLANK)         B   8
C        RS,RN...SOUTHERN AND NORTHERN LATITUDE LIMITS                   B   9
C        RE,RW...LEFT SIDE AND RIGHT SIDE LONGITUDE LIMITS               B  10
C                ABOVE SHOULD HAVE NEGATIVES FOR EAST AND SOUTH          B  11
C        SCALE...INCHES PER DEGREE                                       B  12
C        IBYE...TICK MARK SPACING IN DEGREES                             B  13
C        XHT...HEIGHT OF LAT-LONG PLOTTED VALUES                         B  14
C       ITITLE...CHART CAPTION TO THE LEFT OF CHART (CAN BE LEFT BLANK)  B  15
C       LT...NUMBER OF ALPHANUMERIC CHARACTERS IN CAPTION .LE. 78        B  16
C       YO...Y-AXIS ORIGIN IN INCHES (PREFERABLY 1.25 INCHES)            B  17
C     OUTPUT...                                                          B  18
C        NNN...EQUALS ONE IF DATELINE CROSSED                            B  19
C        AMPI...LATITUDE SCALE (MERIDIANAL PARTS PER INCH)               B  20
C        RPI...LONGITUDE SCALE (RADIANS PER INCH)                        B  21
C       XR...RIGHTMOST LONGITUDE X-COORDINATE IN INCHES                  B  22
C       YLENG...LATITUDE LENGTH (Y-AXIS) IN INCHES .LE. 29.25            B  23
      DIMENSION RAD(4),L(4),X(361),Y(181),ITITLE(78)                     B  24
      DIMENSION MONTH(12)                                                B  25
      DATA (MONTH = 5H JAN ,5H FEB ,5H MAR ,5H APR ,5H MAY ,5H JUN ,5H J B  26
     1UL ,5H AUG ,5H SEP ,5H OCT ,5H NOV ,5H DEC )                       B  27
      XRAD=0.01745329$JBC=60606060606060608                              B  28
      RAD(1)=RS                                                          B  29
      RAD(2)=RN                                                          B  30
      RAD(3)=RE                                                          B  31
      RAD(4)=RW                                                          B  32
      DO 1 I=1,4                                                         B  33
      L(I)=RAD(I)                                                        B  34
    1 RAD(I)=RAD(I)*XRAD                                                 B  35
C     DETERMINATION OF MEREDIANAL PARTS FOR BOUNDARY LIMITS              B  36
      LATDL=IABS(L(2)-L(1))+1                                            B  37
      CALL MERED (0,RAD(1),YS)                                           B  38
      CALL MERED (0,RAD(2),YN)                                           B  39
C     DETERMINATION OF INTERNATIONAL DATELINE CROSSING                   B  40
      KA=L(3)-L(4)                                                       B  41
      IF (KA.GT.0) GO TO 2                                               B  42
      IDLO=KA+361                                                        B  43
      NNN=1                                                              B  44
      GO TO 3                                                            B  45
```

```
    2 IDLO=KA+1                                                         B  46
      NNN=0                                                             B  47
C     DETERMINATION OF MERIDIANAL PARTS PER INCH FOR Y-AXIS             B  48
    3 AMPI=60./SCALE                                                    B  49
C     DETERMINATION OF RADIANS PER INCH FOR X-AXIS                      B  50
      RPI=XRAD/SCALE                                                    B  51
      YLENG=(YN-YS)/AMPI+YO                                             B  52
      IF (YLENG.GT.29.25) GO TO 12                                      B  53
C     INITIALIZATION OF PLOTTING                                        B  54
      CALL PLOT (0.,0.,3)                                               B  55
C     PLOTS B. C. CHART NUMBER AT LOWER LEFT, IF DESIRED                B  56
      IF(IBC.EQ.JBC) GO TO 13                                           B  57
      XIBC=-XHT*6.0                                                     B  58
      CALL SYMBOL (XIBC,0.,XHT,IBC,90.,5)                               B  59
      CALL PLOT (0.,0.,3)                                               B  60
C     PLOTS BOTTOM OF GRID, ANNOTATING LONGITUDE                        B  61
   13 K=0                                                               B  62
      YY=-XHT*3.0                                                       B  63
      DO 5 I=1,IDLO,IBYE                                                B  64
      LONG=L(3)-I+1                                                     B  65
      IF (LONG.GT.-180) GO TO 4                                         B  66
      LONG=LONG+360                                                     B  67
    4 FAC=I-1                                                           B  68
      K=K+1                                                             B  69
      X(K)=FAC*SCALE                                                    B  70
      CALL SYMBOL (X(K),0.,XHT,3,0.,-1)                                 B  71
      XX=X(K)-XHT*15./7.                                                B  72
      CALL NUMBER (XX,YY,XHT,LONG,0.,2HI4)                              B  73
    5 CONTINUE                                                          B  74
      A=X(K)+XHT*6.0                                                    B  75
      XR=X(K)                                                           B  76
      N=K                                                               B  77
      K=0                                                               B  78
      DO 6 I=1,LATDL,IBYE                                               B  79
      K=K+1                                                             B  80
      LAT=L(1)+I-1                                                      B  81
      XLAT=LAT                                                          B  82
      XLAT=XLAT*XRAD                                                    B  83
      CALL MERED (0,XLAT,YPT)                                           B  84
      Y(K)=(YPT-YS)/AMPI                                                B  85
    6 CONTINUE                                                          B  86
      YY=Y(1)-(XHT/2.)                                                  B  87
      LATT=L(1)                                                         B  88
      CALL NUMBER (A,YY,XHT,LATT,0.,2HI3)                               B  89
      DO 10 J=2,K                                                       B  90
      LATT=L(1)+(IBYE*(J-1))                                            B  91
      YY=Y(J)-(XHT/2.)                                                  B  92
      XX=J                                                              B  93
      JJ=J/2*10                                                         B  94
      JK=XX/2.*10.                                                      B  95
      IF (JJ.NE.JK) GO TO 8                                             B  96
      CALL NUMBER (A,YY,XHT,LATT,0.,2HI3)                               B  97
      DO 7 I=1,N                                                        B  98
      JJ=N-I+1                                                          B  99
    7 CALL SYMBOL (X(JJ),Y(J),XHT,3,0.,-1)                              B 100
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      GO TO 10                                                          B 101
    8 DO 9 I=1,N                                                        B 102
    9 CALL SYMBOL (X(I),Y(J),XHT,3,0.,-1)                               B 103
      CALL NUMBER (A,YY,XHT,LATT,0.,2HI3)                               B 104
   10 CONTINUE                                                          B 105
      XX=-XHT*7.5                                                       B 106
      YY=Y(1)                                                           B 107
      IF (LT .EQ. 0) GO TO 14                                           B 108
      DO 11 I=1,LT                                                      B 109
      CALL SYMBOL (XX,YY,XHT,ITITLE(I),90.,1)                           B 110
   11 YY=YY+XHT*4./7.*1.5                                               B 111
   14 XX=0.0$YY=-YO + 0.1                                               B 112
      CALL SYMBOL (XX,YY,0.140,103HNAVAL RESEARCH LABORATORY - ACOUSTICS B 113
     1 DIVISION - PROPAGATION BRANCH - ENVIRONMENTAL SCIENCES SECTION - B 114
     2,0.0,103)                                                         B 115
C     THE FOLLOWING CALLS CAN ONLY BE USED ON THE CDC 3800 AT NRL       B 116
      CALL DATE (M,ID,IY,JY)                                            B 117
      XX=XX+0.140*4./7.*1.5*103.                                        B 118
      XINC=0.140*4./7.*1.5                                              B 119
      CALL NUMBER (XX,YY,0.140,ID,0.0,2HI2)                             B 120
      XX=XX+XINC*2.                                                     B 121
      CALL SYMBOL (XX,YY,0.140,MONTH(M),0.0,5)                          B 122
      XX=XX+XINC*5.                                                     B 123
      CALL NUMBER (XX,YY,0.140,IY,0.0,2HI2)                             B 124
      CALL PLOT (0.,0.,3)                                               B 125
   12 RETURN                                                            B 126
      END                                                               B 127


      SUBROUTINE MERED(NA,XRLD,XMP)                                     C   1
C*****SUBROUTINE MERED(III)                                             C   2
C             XRLD = INPUT LATITUDE IN RADIANS                          C   3
C             XMP = OUTPUT LATITUDE IN MERIDIANAL PARTS                 C   4
C             IGNORE VARIABLE NA IN THIS VERSION AS SPHEROID ASSUMED    C   5
C         CONSTANT.                                                     C   6
      SINL=SIN(XRLD)                                                    C   7
      X=((((.000213*SINL*SINL)+.0525)*SINL*SINL)+23.268932)*SINL        C   8
      XMP=(SINL+1.)/(1.-SINL)                                           C   9
      XMP=ALOG10(XMP)                                                   C  10
      XMP=(3957.852234*XMP)-X                                           C  11
      RETURN                                                            C  12
      END                                                               C  13


      SUBROUTINE XYIIN(NNN,XIRO,YIMO,RPI,AMPI,XIR,YIM,XPT,YPT)          D   1
C******CONVERTS LAT-LONG INTO X-Y COORDINATES IN INCH-S                 D   2
C     INPUT...                                                          D   3
C        NNN...EQUALS ONE IF DATELINE CROSSED                           D   4
C        XIRO,YIMO...ORIGIN(LOWER LEFT) OF CHART IN RADIANS OF          D   5
C      LONGITUDE AND MERIDIANAL PARTS OF LATITUDE                       D   6
C        RPI...LONGITUDE SCALE IN RADIANS PER INCH                      D   7
C        AMPI...LATITUDE SCALE IN MERIDIANAL PARTS PER INCH             D   8
C        XIR...LONGITUDE IN RADIANS                                     D   9
C      OUTPUT...                                                        D  10
C        XPT,YPT...LAT-LONG IN CHART INCHES                             D  11
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```
      DATA(TWOPI=6.283184)                                              D  12
      IF(NNN.EQ.0) GO TO 10                                             D  13
      IF(XIR.LE.XIRO) GO TO 20                                          D  14
   10 XPT=(XIRO-XIR)/RPI                                                D  15
      GO TO 30                                                          D  16
   20 XPT=(TWOPI+XIRO-XIR)/RPI                                          D  17
   30 YPT=(YIM-YIMO)/AMPI                                               D  18
      RETURN                                                            D  19
      END                                                               D  20


      SUBROUTINE JULIAN (IY,JUDY,ID,IM,LPYR)                            F   1
C     ONVERTS JULIAN DATE INTO DAY, MONTH, YEAR FOR ANNOTATION IN TANTRK F   2
C     IY = YEAR, JUDY = JULIAN DAY, ID = CALENDER DAY, IM = CALENDER MON F   3
C     OMPLIMENTS OF BOB FEDEN - CODE 8174 - 17 NOV 1971                 F   4
C     MODIFIED BY LEON LA LUMIERE - CODE 8178 - 17 NOV 1971             F   5
C                                                                       F   6
      DIMENSION JJ(13), AA(12)                                          F   7
      TYPE INTEGER AA                                                   F   8
      DATA ((JJ(I), I = 1, 13) = 0, 31, 59, 90, 120, 151, 181, 212, 243, F   9
     1273, 304, 334, 365)                                               F  10
      DATA ((AA(I), I = 1, 12) = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12) F  11
      LL=IY                                                             F  12
      MM=JUDY                                                           F  13
      IF (LL.LT.0) GO TO 10                                             F  14
      IF (LL.EQ.0) GO TO 1                                              F  15
      IF (MOD(LL,4).EQ.0) GO TO 4                                       F  16
    1 IF (MM.LE.0.OR.MM.GT.365) GO TO 4                                 F  17
    2 DO 3 K=2,13                                                       F  18
      IF (MM.LE.JJ(K)) GO TO 6                                          F  19
    3 CONTINUE                                                          F  20
    4 LPYR=2                                                            F  21
      IF (MM.LE.0.OR.MM.GT.366) GO TO 10                                F  22
      IF (MM.LE.59) GO TO 2                                             F  23
      IF (MM.EQ.60) GO TO 5                                             F  24
      MM=MM-1                                                           F  25
      GO TO 2                                                           F  26
    5 II=29                                                             F  27
      K=3                                                               F  28
      GO TO 7                                                           F  29
    6 II=MM-JJ(K-1)                                                     F  30
      IF (LL.EQ.0) GO TO 8                                              F  31
      IF (MOD(LL,4).NE.0) GO TO 8                                       F  32
      IF (MOD(LL,4).EQ.0.AND.MM.LE.59) GO TO 8                          F  33
      MM=MM+1                                                           F  34
    7 IF (LL.GE.10) GO TO 8                                             F  35
    8 ID=II                                                             F  36
      IM=AA(K-1)                                                        F  37
    9 RETURN                                                            F  38
   10 CONTINUE                                                          F  39
      GO TO 9                                                           F  40
C                                                                       F  41
   11 FORMAT (1X,*YEAR = *,I2,1X,*JULIAN DAY = *,I3,1X,*ARE BAD DATES*) F  42
      END                                                               F  43
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      SUBROUTINE JOINER (RS,RN,RL,RR,FLAT,FLON,SLAT,SLON,Y,X)
C     COMPUTES THE LATITUDE Y AND LONGITUDE X AT WHICH A SHIP PATH
C     BETWEEN TWO NAVIGATION FIXES ENTERS OR LEAVES A CHART GRID.
C     FLAT AND FLON ARE THE LATITUDE AND LONGITUDE OF THE FIX INSIDE THE
C     GRID.
C     SLAT AND SLON ARE THE LATITUDE AND LONGITUDE OF THE FIX OUTSIDE
C     THE GRID.
C     PROGRAMMER - LEON LA LUMIERE - CODE 8174 - 12 FEB 1974
C
      DIMENSION Y(1), X(1), FB(1)
C
      DIST = 0.0
      DELDIS = 1.5
      JUMP = 1
C
      Y1 = FLAT
      X1 = -FLON
      Y2 = SLAT
      X2 = -SLON
      CALL NAVIGATE (Y1,X1,Y2,X2,FAZ,BAZ,D)
C
    1 DIST = DIST + DELDIS
      CALL GCPATH (Y1,X1,FAZ,DIST,1,Y,X,FB)
      X = -X
      IF ((Y.LT.RS).OR.(Y.GT.RN).OR.(X.GT.RL).OR.(X.LT.RR))2, 1
    2 GO TO (3,4) JUMP
    3 DIST = DIST - DELDIS
      DELDIS = DELDIS * 0.1
      JUMP = 2
      GO TO 1
C
    4 DIST = DIST - DELDIS
      CALL GCPATH (Y1,X1,FAZ,DIST,1,Y,X,FB)
      X = -X
      RETURN
      END


      SUBROUTINE NAVIGATE (LATT1,LONG1,LATT2,LONG2,AZIMUTH,BACKAZ,
     *DISTANCE)
C     COMPUTES THE FORWARD AND BACK AZIMUTHS BETWEEN TWO FIXES.
C     LATT1 AND LONG1 ARE THE INITIAL LATITUDE AND LONGITUDE.
C     LATT2 AND LONG2 ARE THE FINAL LATITUDE AND LONGITUDE.
C     AZIMUTH IS THE BEARING AT THE FIRST FIX TO THE SECOND FIX.
C     BACKAZ IS THE BEARING AT THE SECOND FIX TO THE FIRST FIX.
C     DISTANCE IS THE DISTANCE BETWEEN THE FIXES IN NAUTICAL MILES.
C     PROGRAMMER - LEON LA LUMIERE - CODE 8144 - 31 JAN 1970
C
      TYPE REAL LATT1, LONG1, LATT2, LONG2, NORM12SQ, NORM1PSQ, NORM12,
     1NORM1P
      DATA (RADIUS = 3437.746771)
      CONVERT =3.141592653/180.
      ALPHA1 =LATT1*CONVERT
      BETA1 = LONG1*CONVERT
      ALPHA2 =LATT2*CONVERT
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      BETA2 = LONG2*CONVERT                                             N  18
      X1 = COS(ALPHA1)*COS(BETA1)                                       N  19
      Y1 = COS(ALPHA1)*SIN(BETA1)                                       N  20
      Z1 = SIN(ALPHA1)                                                  N  21
      X2 = COS(ALPHA2)*COS(BETA2)                                       N  22
      Y2 = COS(ALPHA2)*SIN(BETA2)                                       N  23
      Z2 = SIN(ALPHA2)                                                  N  24
      PRODUCT=(Y1*Z2-Z1*Y2)*Y1 + (X1*Z2-Z1*X2)*( X1)                    N  25
      NORM12SQ=(Y1*Z2-Z1*Y2)**2+(X1*Z2-Z1*X2)**2+(X1*Y2-Y1*X2)**2       N  26
      NORM1PSQ=(Y1)**2+( X1)**2                                         N  27
      NORM12 = SQRT(NORM12SQ)                                           N  28
      NORM1P = SQRT(NORM1PSQ)                                           N  29
      DELTA = ACOS(PRODUCT/(NORM12*NORM1P))                             N  30
      ADOTB = X1*X2 + Y1*Y2 + Z1*Z2                                     N  31
      AMAGSQ = (X1)*(X1) + (Y1)*(Y1) + (Z1)*(Z1)                        N  32
      BMAGSQ = (X2)*(X2) + (Y2)*(Y2) + (Z2)*(Z2)                        N  33
      AMAG = SQRT(AMAGSQ)                                               N  34
      BMAG = SQRT(BMAGSQ)                                               N  35
      PHI = ACOS(ADOTB/(AMAG*BMAG))                                     N  36
      DISTANCE = RADIUS * PHI                                           N  37
      ZNAB = X1*Y2 - Y1*X2                                              N  38
      IF (ZNAB) 9,9,10                                                  N  39
    9 DELTA = 360.*CONVERT - DELTA                                      N  40
   10 AZIMUTH = DELTA/CONVERT                                           N  41
      IF (AZIMUTH .EQ. 360.) AZIMUTH = 0.0                              N  42
      PRODUCT=(Y2*Z1-Z2*Y1)*Y2 + (X2*Z1-Z2*X1)*X2                       N  43
      NORM12SQ=(Y2*Z1-Z2*Y1)**2+(X2*Z1-Z2*X1)**2+(X2*Y1-Y2*X1)**2       N  44
      NORM1PSQ=(Y2)**2+(X2)**2                                          N  45
      NORM12 = SQRT(NORM12SQ)                                           N  46
      NORM1P = SQRT(NORM1PSQ)                                           N  47
      DELTA = ACOS(PRODUCT/(NORM12*NORM1P))                             N  48
      ZNAB=X2*Y1-Y2*X1                                                  N  49
      IF (ZNAB) 11,11,12                                                N  50
   11 DELTA = 360.*CONVERT - DELTA                                      N  51
   12 BACKAZ = DELTA/CONVERT                                            N  52
      IF (BACKAZ .EQ. 360.) BACKAZ = 0.0                                N  53
      RETURN                                                            N  54
      END                                                               N  55


      SUBROUTINE LOCATE (TX,TY,XXL,XXR,YYL,YYU,BX,BY,ISR,CHT,AHT)       S   1
C     GIVEN A SET OF X-Y COORDINATES  THIS ALGORITHM DETERMINES WHERE AN S   2
C     ANNOTATION OUTSIDE THE GRID SHOULD BE PLACED WITH RESPECT TO THE  S   3
C     STARTING POINT OF A PLOTTED CURVE, IN THIS CASE, BEARINGS.        S   4
C     PROGRAMMER - LEON LA LUMIERE - CODE 8174 - 5 DEC 1972             S   5
C                                                                       S   6
C     TX IS THE X-COORDINATE OF THE POINT.                              S   7
C     TY IS THE Y-COORDINATE OF THE POINT.                              S   8
C     XXL IS THE WESTMOST LONGITUDE X-COORDINATE.                       S   9
C     XXR IS THE EASTMOST LONGITUDE X-COORDINATE.                       S  10
C     YYL IS THE SOUTHMOST LATITUDE Y-COORDINATE.                       S  11
C     YYU IS THE NORTHMOST LATITUDE Y-COORDINATE.                       S  12
C     BX IS THE STARTING X-COORDINATE OF THE ANNOTATION.                S  13
C     BY IS THE STARTING Y-COORDINATE OF THE ANNOTATION.                S  14
C     ISR DETERMINES THE OFFSET OF THE STARTING POINT.                  S  15
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C     CHT IS THE GRID CHARACTER HEIGHT.                                S  16
C     AHT IS THE ANNOTATION CHARACTER HEIGHT.                          S  17
C                                                                      S  18
      TX1 = (XXR - TX)/(XXR - XXL)                                     S  19
      TX2 = (TX - XXL)/(XXR - XXL)                                     S  20
      TY1 = (YYU - TY)/(YYU - YYL)                                     S  21
      TY2 = (TY - YYL)/(YYU - YYL)                                     S  22
      IF (TX1 - TX2) 1,1,2                                             S  23
    1 INDEXX = 1                                                       S  24
      GO TO 3                                                          S  25
    2 INDEXX = 2                                                       S  26
    3 IF (TY1 - TY2) 4,4,5                                             S  27
    4 INDEXY = 1                                                       S  28
      GO TO 6                                                          S  29
    5 INDEXY = 2                                                       S  30
    6 IF (INDEXX - INDEXY) 7,8,9                                       S  31
C     THE POINT IS IN THE LOWER RIGHT QUADRANT.                        S  32
    7 IF (TX1 - TY2) 10,10,11                                          S  33
   10 BY = TY - AHT * 0.5                                              S  34
      IF (ISR) 22,22,21                                                S  35
   21 BX = XXR + CHT * 0.7                                             S  36
      GO TO 20                                                         S  37
   22 BX = XXR + CHT * 0.7 + AHT * 36./7.                              S  38
      GO TO 20                                                         S  39
   11 BX = TX - AHT * 6./7. * 3.33                                     S  40
      IF (ISR) 24,24,23                                                S  41
   23 BY = YYL - CHT * 0.7 - AHT                                       S  42
      GO TO 20                                                         S  43
   24 BY = YYL - CHT * 0.7 - AHT * 2.2                                 S  44
      GO TO 20                                                         S  45
C     THE POINT IS IN THE UPPER LEFT QUADRANT.                         S  46
    9 IF (TX2 - TY1) 12,12,13                                          S  47
   12 BY = TY - AHT * 0.5                                              S  48
      IF (ISR) 26,26,25                                                S  49
   25 BX = XXL - CHT * 0.7 - AHT * 36./7.                              S  50
      GO TO 20                                                         S  51
   26 BX = XXL - CHT * 0.7 - AHT * 72./7.                              S  52
      GO TO 20                                                         S  53
   13 BX = TX - AHT * 6./7. * 3.33                                     S  54
      IF (ISR) 28,28,27                                                S  55
   27 BY = YYU + CHT * 0.7                                             S  56
      GO TO 20                                                         S  57
   28 BY = YYU + CHT * 0.7 + AHT * 2.2                                 S  58
      GO TO 20                                                         S  59
C     THE POINT IS IN THE UPPER RIGHT QUADRANT.                        S  60
    8 IF (INDEXX - 1) 14,14,15                                         S  61
   14 IF (TX1 - TY1) 16,16,17                                          S  62
   16 BY = TY - AHT * 0.5                                              S  63
      IF (ISR) 30,30,29                                                S  64
   29 BX = XXR + CHT * 0.7                                             S  65
      GO TO 20                                                         S  66
   30 BX = XXR + CHT * 0.7 + AHT * 36./7.                              S  67
      GO TO 20                                                         S  68
   17 BX = TX - AHT * 6./7. * 3.33                                     S  69
      IF (ISR) 32,32,31                                                S  70
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   31 BY = YYU + CHT * 0.7                                              S  71
      GO TO 20                                                          S  72
   32 BY = YYU + CHT * 0.7 + AHT * 2.2                                  S  73
      GO TO 20                                                          S  74
C     THE POINT IS IN THE LOWER LEFT QUADRANT.                           S  75
   15 IF (TX2 - TY2) 18,18,19                                           S  76
   18 BY = TY - AHT * 0.5                                               S  77
      IF (ISR) 34,34,33                                                 S  78
   33 BX = XXL - CHT * 0.7 - AHT * 36./7.                               S  79
      GO TO 20                                                          S  80
   34 BX = XXL - CHT * 0.7 - AHT * 72./7.                               S  81
      GO TO 20                                                          S  82
   19 BX = TX - AHT * 6./7. * 3.33                                      S  83
      IF (ISR) 36,36,35                                                 S  84
   35 BY = YYL - CHT * 0.7 - AHT                                        S  85
      GO TO 20                                                          S  86
   36 BY = YYL - CHT * 0.7 - AHT * 2.2                                  S  87
   20 RETURN                                                            S  88
      END                                                               S  89


      SUBROUTINE TICTACTO (RS,RN,RL,RR,Y,X,IGRID,INX,INY,NNN)           T   1
C     GIVEN A POINT DEFINED BY A LATITUDE AND A LONGITUDE LOCATE THE    T   2
C     POINT WITH RESPECT TO A CHART GRID.                               T   3
C     NORTH LATITUDES AND WEST LONGITUDES ARE GIVEN IN POSITIVE DEGREES. T   4
C     SOUTH LATITUDES AND EAST LONGITUDES ARE GIVEN IN NEGATIVE DEGREES. T   5
C     RS = SOUTHMOST LATITUDE.                                          T   6
C     RN = NORTHMOST LATITUDE.                                          T   7
C     RL = WESTMOST LONGITUDE.                                          T   8
C     RR = EASTMOST LONGITUDE.                                          T   9
C     Y = LATITUDE OF THE POINT.                                        T  10
C     X = LONGITUDE OF THE POINT.                                       T  11
C     IGRID = GRID NUMBER (1 THRU 9)                                    T  12
C     INX = COLUMN INDEX                                                T  13
C     INY = ROW INDEX                                                   T  14
C     PROGRAMMER - LEON LA LUMIERE - CODE 8174 - 27 DEC 1972            T  15
C                                                                       T  16
C     THE POINT IS INITIALLY ASSUMED TO LIE WITHIN THE GRID.            T  17
      WEST = RL                                                         T  18
      EAST = RR                                                         T  19
      TEST = X                                                          T  20
      IGRID = 5     $INX = 2        $INY = 2                            T  21
C     THE FOLLOWING TESTS DETERMINE IF THE POINT IS OUTSIDE THE GRID.   T  22
C     IF SO, WHERE IT IS.                                               T  23
      IF (Y - RS) 1, 2, 2                                               T  24
C     THE POINT IS BELOW THE GRID.                                      T  25
    1 IGRID = IGRID + 3       $INY = 3                                  T  26
      GO TO 4                                                           T  27
    2 IF (Y - RN) 4, 4, 3                                               T  28
C     THE POINT IS ABOVE THE GRID.                                      T  29
    3 IGRID = IGRID - 3       $INY = 1                                  T  30
    4 IF (NNN .GT. 0) WEST = 360. + WEST                                T  31
      IF ((NNN .GT. 0) .AND. (TEST .LT. 0.0)) TEST = 360. + TEST        T  32
      IF (TEST - WEST) 6, 6, 5                                          T  33
C     THE POINT IS LEFT OF THE GRID.                                    T  34
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    5 IGRID = IGRID - 1        $INX = 1                                T  35
      GO TO 8                                                          T  36
    6 IF (TEST - EAST) 7, 8, 8                                         T  37
C     THE POINT IS RIGHT OF THE GRID.                                  T  38
    7 IGRID = IGRID + 1        $INX = 3                                T  39
    8 RETURN                                                           T  40
      END                                                              T  41


      SUBROUTINE OUTANDIN (RS,RN,RL,RR,ALAT,ALON,BS,Y,X,DIST)          U   1
C     COMPUTES THE LATITUDE Y AND THE LONGITUDE X AT WHICH A GREAT     U   2
C     CIRCLE PATH ENTERS A CHART GRID.                                 U   3
C     PROGRAMMER - LEON LA LUMIERE - CODE 8174 - 6 FEB 1974            U   4
C                                                                      U   5
      DIMENSION Y(1), X(1), FB(1)                                      U   6
C                                                                      U   7
      SLAT = ALAT                                                      U   8
      SLON = -ALON                                                     U   9
      DIST = 0.0                                                       U  10
      DELDIS = 15.                                                     U  11
      JUMP = 1                                                         U  12
C                                                                      U  13
    1 DIST = DIST + DELDIS                                             U  14
      CALL GCPATH (SLAT,SLON,BS,DIST,1,Y,X,FB)                         U  15
      X = -X                                                           U  16
      IF ((Y.GE.RS).AND.(Y.LE.RN).AND.(X.LE.RL).AND.(X.GE.RR)) 2, 1    U  17
    2 GO TO (3, 3, 4) JUMP                                             U  18
    3 DIST = DIST - DELDIS                                             U  19
      DELDIS = DELDIS * 0.1                                            U  20
      JUMP = JUMP + 1                                                  U  21
      GO TO 1                                                          U  22
    4 RETURN                                                           U  23
      END                                                              U  24


      SUBROUTINE GEODIS (EPLAT,EPLON,STLAT,STLON,AZ,BAZ,DIST,DEG)      00000100
C INPUT                                                                00000200
C EPLAT AND EPLON=INITIAL LATITUDE AND LONGITUDE    POSITIVE FOR NORTH AND EAST
C STLAT AND STLON=END POINT (IN DEGREES)            NEGATIVE FOR SOUTH AND WEST
C OUTPUT                                                               00000500
C SUBROUTINE GENERATES THE FOLLOWING$ AZ=INITIAL AZIMUTH (DEG) BAZ=BACK AZIMUTH
C (DEG) DIST=RANGE IN KILOMETERS  DEG= RANGE IN DEGREES                00000700
      COMMON/GEODISTC/AL,BL,D2R,PI2                                    00000800
      TYPE REAL L1R,L2R,KL,KK,L                                        00000900
      DATA (AL=6378206.4),(BL=6356583.8),(D2R=.017453292519),          00001000
     1(PI2=6.28318530716)                                              00001100
      BOA=BL/AL                                                        00001200
      F=1.0-BOA                                                        00001300
      P1R=EPLAT*D2R                                                    00001400
      P2R=STLAT*D2R                                                    00001500
      L1R=EPLON*D2R                                                    00001600
      L2R=STLON*D2R                                                    00001700
      DLR=L2R-L1R                                                      00001800
      T1R=ATAN(BOA*TANF(P1R))                                          00001900
      T2R=ATAN(BOA*TANF(P2R))                                          00002000
```

```
      TM=(T1R+T2R)/2.0                                                  00002100
      DTM=(T2R-T1R)/2.0                                                 00002200
      STM=SIN(TM)                                                       00002300
      CTM=COS(TM)                                                       00002400
      SDTM=SIN(DTM)                                                     00002500
      CDTM=COS(DTM)                                                     00002600
      KL=STM*CDTM                                                       00002700
      KK=SDTM*CTM                                                       00002800
      SDLMR=SIN(DLR/2.0)                                                00002900
      L=SDTM*SDTM+SDLMR*SDLMR*(CDTM*CDTM-STM*STM)                       00003000
      CD=1.0-2.0*L                                                      00003100
      DL=2*ASIN(SQRT(L))                                                00003200
      SD=SIN(DL)                                                        00003300
      T=DL/SD                                                           00003400
      U=2.0*KL*KL/(1.0-L)                                               00003500
      V=2.0*KK*KK/L                                                     00003600
      D=4.0*T*T                                                         00003700
      X=U+V                                                             00003800
      E=-2.0*CD                                                         00003900
      Y=U-V                                                             00004000
      A=-D*E                                                            00004100
      FF64=F*F/64.0                                                     00004200
      DIST=AL*SD*(T-(F/4.0)*(T*X-Y)+FF64*(X*(A+(T-(A+E)/2.0)*X)+Y*(-2.0*00004300
     1D+E*Y)+D*X*Y))/1000.0                                             00004400
      DEG = DIST/111.195                                                00004500
      TDLPM=TANF((DLR+(-((E*(4.0-X)+2.0*Y)*((F/2.0)*T+FF64*(32.0*T+(A-2000004600
     1.0*T)*X-2.0*(D+2.0)*Y))/4.0)*TANF(DLR)))/2.0)                     00004700
      HAPBR=ATAN2(SDTM,(CTM*TDLPM))                                     00004800
      HAMBR=ATAN2(CDTM,(STM*TDLPM))                                     00004900
      A1M2=PI2+HAMBR-HAPBR                                              00005000
      A2M1=PI2-HAMBR-HAPBR                                              00005100
    1 IF((A1M2.GE.0.0).AND.(A1M2.LT.PI2)) 5,2                           00005200
    2 IF(A1M2.GE.PI2) 3,4                                               00005300
    3 A1M2=A1M2-PI2                                                     00005400
      GO TO 1                                                           00005500
    4 A1M2=A1M2+PI2                                                     00005600
      GO TO 1                                                           00005700
    5 IF((A2M1.GE.0.0).AND.(A2M1.LT.PI2)) 9,6                           00005800
    6 IF(A2M1.GE.PI2) 7,8                                               00005900
    7 A2M1=A2M1-PI2                                                     00006000
      GO TO 5                                                           00006100
    8 A2M1=A2M1+PI2                                                     00006200
      GO TO 5                                                           00006300
    9 AZ=A1M2/D2R                                                       00006400
      BAZ=A2M1/D2R                                                      00006500
      RETURN                                                            00006600
      END                                                               00006700

      SUBROUTINE GCPATH(PAS,POS,BS,DIST,N,FINLAT,FINLON,FINBER)         GCP   10
C     IDENT NUMBER - T0002000                                           GCP   20
C     TITLE - GREAT CIRCLE PATH FROM A POINT                            GCP   30
C     IDENT NAME - TO-NRL-GCPATH                                        GCP   40
C     LANGUAGE - FORTRAN                                                GCP   50
C     COMPUTER - CDC-3800                                               GCP   60
```

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C     CONTRIBUTOR - DAVID CHANG, CODE 8170, PROPAGATION BRANCH,
C                                ACOUSTICS DIVISION
C     ORGANIZATION - NRL - NAVAL RESEARCH LABORATORY -
C                                WASHINGTON, D.C.   20390
C     DATE - 22 JULY 1969
C     PURPOSE - GIVEN A GREAT CIRCLE PATH SPECIFIED BY AN INITIAL
C     POINT AND BEARING, THIS SUBROUTINE FINDS THE LOCATIONS AND
C     BEARINGS OF POINTS AT A GIVEN ARRAY OF DISTANCES IN NAUTICAL
C     MILES ALONG THAT PATH.
C
C     THE EARTH IS A SPHERE WITH CIRCUMFERENCE 21,600. MILES
C
C     ALL ANGLES ARE IN FLOATING POINT DEGREES.
C     LATITUDES .GE. 90. ARE AT THE NORTH POLE
C     LATITUDES .LE.-90. ARE AT THE SOUTH POLE
C     ALL LONGITUDES MUST BE BETWEEN -180. (180 W) AND +180. (180 E).
C     ALL BEARINGS NOT AT POLES ARE BETWEEN 0. AND 360. DEGREES,
C     MEASURED CLOCKWISE FROM DUE NORTH.
C     ALL BEARINGS AT THE POLES ARE LONGITUDE LINES.
C     FOR DISTANCES .LE. 0. OR .GE. CIRCUMFERENCE, THE FINAL POINT IS
C     THE INITIAL POINT.
C
C     PAS = INITIAL LATITUDE
C     POS = INITIAL LONGITUDE
C     BS  = INITIAL BEARING
C     DIST   = ARRAY OF N DESIRED DISTANCES IN NAUTICAL MILES
C     N      = DIMENSION OF FOUR ARRAYS
C     FINLAT = ARRAY OF FINAL LATITUDES
C     FINLON = ARRAY OF FINAL LONGITUEDS
C     FINBER = ARRAY OF FINAL BEARINGS
C
      DIMENSION DIST(N),FINLAT(N),FINLON(N),FINBER(N)
      DATA(DTOR=1772435750650451B)
      DATA(RTOD=2006712273406462B)
      DATA(RADEARTH=20146555576261378)
      DATA(AMILPDEG=60.)
      IF(PAS .GE. 90.)  GO TO 101
      IF(PAS .LE.-90.)  GO TO 151
C  INITIAL POINT NOT AT POLES.
      IF(BS. EQ.0.)  GO TO 201
      IF(BS. EQ.180.)  GO TO 251
C  GREAT CIRCLE USED DOES NOT PASS THROUGH POLES
      DUMMY=BS*DTOR
      CBS=COS(DUMMY)
      LEFT=0
      IF(BS.GT.180.)  LEFT=1
      DUMMY=PAS*DTOR
      CS=SIN(DUMMY)
      SS=COS(DUMMY)
      DO 60  I=1,N
      DA=DIST(I)/AMILPDEG
      IF(DA.NE.180.)  GO TO 20
      FINLAT(I)=-PAS
      FINLON(I)=POS+180.
      IF(FINLON(I).GT.180.)  FINLON(I)=FINLON(I)-360.
```

```
      FINBER(I)=180.-BS                                                 GCP  620
      IF(LEFT)  FINBER(I)=FINBER(I)+360.                                GCP  630
      GO TO 60                                                          GCP  640
20    IF(DA.LT.360. .AND. DA.GT.0.)  GO TO 30                           GCP  650
      FINLAT(I)=PAS                                                     GCP  660
      FINLON(I)=POS                                                     GCP  670
      FINBER(I)=BS                                                      GCP  680
      GO TO 60                                                          GCP  690
30    D=DIST(I)/RADEARTH                                                GCP  700
      CD=COS(D)                                                         GCP  710
      SD=SIN(D)                                                         GCP  720
      CF=CS*CD+SS*SD*CBS                                                GCP  730
      PAF=ASIN(CF)                                                      GCP  740
      SF=COS(PAF)                                                       GCP  750
      CBF=(CF*CD-CS)/SF/SD                                              GCP  760
      CAP=(CD-CS*CF)/SS/SF                                              GCP  770
      BF=ACOS(CBF)*RTOD                                                 GCP  780
      APO=ACOS(CAP)*RTOD                                                GCP  790
      IF(SD.LT.0.)  APO=360.-APO                                        GCP  800
      IF(LEFT)  GO TO 40                                                GCP  810
      DUMMY=POS+APO                                                     GCP  820
      IF(DUMMY.GT. 180.)  DUMMY=DUMMY-360.                              GCP  830
      GO TO 50                                                          GCP  840
40    DUMMY=POS-APO                                                     GCP  850
      IF(DUMMY.LT.-180.)  DUMMY=DUMMY+360.                              GCP  860
      BF=360.-BF                                                        GCP  870
50    FINLON(I)=DUMMY                                                   GCP  880
      FINBER(I)=BF                                                      GCP  890
      FINLAT(I)=PAF*RTOD                                                GCP  900
60    CONTINUE                                                          GCP  910
      RETURN                                                            GCP  920
101   DO 120  I=1,N                                                     GCP  930
C  INITIAL POINT AT NORTH POLE                                          GCP  940
      D=DIST(I)/AMILPDEG                                                GCP  950
      IF(D-180.)  105,115,111                                           GCP  960
105   FINLAT(I)=90.-D                                                   GCP  970
      FINLON(I)=BS                                                      GCP  980
      FINBER(I)=180.                                                    GCP  990
      GO TO 120                                                         GCP 1000
111   FINLAT(I)=D-270.                                                  GCP 1010
      FINLON(I)=BS+180.                                                 GCP 1020
      IF(FINLON(I).GT.180.)  FINLON(I)=FINLON(I)-360.                   GCP 1030
      FINBER(I)=0.                                                      GCP 1040
      GO TO 120                                                         GCP 1050
115   FINLAT(I)=-90.                                                    GCP 1060
      FINBER(I)=BS+180.                                                 GCP 1070
      IF(FINBER(I).GT.180.)  FINBER(I)=FINBER(I)-360.                   GCP 1080
      FINLON(I)=FINBER(I)                                               GCP 1090
120   CONTINUE                                                          GCP 1100
      RETURN                                                            GCP 1110
151   DO 170  I=1,N                                                     GCP 1120
C  INITIAL POINT AT SOUTH POLE                                          GCP 1130
      D=DIST(I)/AMILPDEG                                                GCP 1140
      IF(D-180.)  155,165,161                                           GCP 1150
155   FINLAT(I)=D-90.                                                   GCP 1160
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      FINLON(I)=BS                                                      GCP 1170
      FINBER(I)=0.                                                      GCP 1180
      GO TO 170                                                         GCP 1190
161   FINLAT(I)=270.-D                                                  GCP 1200
      FINLON(I)=BS+180.                                                 GCP 1210
      IF(FINLON(I).GT.180.)  FINLON(I)=FINLON(I)-360.                   GCP 1220
      FINBER(I)=18 .                                                    GCP 1230
      GO TO 170                                                         GCP 1240
165   FINLAT(I)= 90.                                                    GCP 1250
      FINBER(I)=BS+180.                                                 GCP 1260
      IF(FINBER(I).GT.180.)  FINBER(I)=FINBER(I)-360.                   GCP 1270
      FINLON(I)=FINBER(I)                                               GCP 1280
170   CONTINUE                                                          GCP 1290
      RETURN                                                            GCP 1300
201   DNP=90.-PAS                                                       GCP 1310
C  GREAT CIRCLE PASSES THROUGH NORTH POLE, AND THEN SOUTH POLE          GCP 1320
      DSP=180.+DNP                                                      GCP 1330
      DO 230  I=1,N                                                     GCP 1340
      D=DIST(I)/AMILPDEG                                                GCP 1350
      IF(D-DNP)  211,203,208                                            GCP 1360
203   FINLAT(I)=90.                                                     GCP 1370
      FINBER(I)=POS+180.                                                GCP 1380
      IF(FINBER(I).GT.180.)  FINBER(I)=FINBER(I)-360.                   GCP 1390
      FINLON(I)=FINBER(I)                                               GCP 1400
      GO TO 230                                                         GCP 1410
205   FINLAT(I)=-90.                                                    GCP 1420
      FINLON(I)=FINBER(I)=POS                                           GCP 1430
      GO TO 230                                                         GCP 1440
208   IF(D-DSP)  221,205,209                                            GCP 1450
209   D=D-360.                                                          GCP 1460
211   FINLAT(I)=PAS+D                                                   GCP 1470
      FINLON(I)=POS                                                     GCP 1480
      FINBER(I)=0.                                                      GCP 1490
      GO TO 230                                                         GCP 1500
221   FINLAT(I)=180.-PAS-D                                              GCP 1510
      FINLON(I)=POS+180.                                                GCP 1520
      IF(FINLON(I).GT.180.)  FINLON(I)=FINLON(I)-360.                   GCP 1530
      FINBER(I)=180.                                                    GCP 1540
230   CONTINUE                                                          GCP 1550
      RETURN                                                            GCP 1560
251   DSP=90.+PAS                                                       GCP 1570
C  GREAT CIRCLE PASSES THROUGH SOUTH POLE, AND THEN NORTH POLE          GCP 1580
      DNP=180.+DSP                                                      GCP 1590
      DO 280  I=1,N                                                     GCP 1600
      D=DIST(I)/AMILPDEG                                                GCP 1610
      IF(D-DSP)  261,253,258                                            GCP 1620
253   FINLAT(I)=-90.                                                    GCP 1630
      FINBER(I)=POS+180.                                                GCP 1640
      IF(FINBER(I).GT.180.)  FINBER(I)=FINBER(I)-360.                   GCP 1650
      FINLON(I)=FINBER(I)                                               GCP 1660
      GO TO 280                                                         GCP 1670
255   FINLAT(I)= 90.                                                    GCP 1680
      FINLON(I)=FINBER(I)=POS                                           GCP 1690
      GO TO 280                                                         GCP 1700
258   IF(D-DNP)  271,255,259                                            GCP 1710
```

```
259     D=D-360.                                                        GCP 1720
261     FINLAT(I)=PAS-D                                                 GCP 1730
        FINLON(I)=POS                                                   GCP 1740
        FINBER(I)=180.                                                  GCP 1750
        GO TO 280                                                       GCP 1760
271     FINLAT(I)=D-180.-PAS                                            GCP 1770
        FINLON(I)=POS+180.                                              GCP 1780
        IF(FINLON(I).GT.180.)  FINLON(I)=FINLON(I)-360.                 GCP 1790
        FINBER(I)=0.                                                    GCP 1800
280     CONTINUE                                                        GCP 1810
        RETURN                                                          GCP 1820
        END                                                             GCP 1830
           IDENT     DATE                                               00001600
           ENTRY     DATE                                               00001700
           REM                      IDENTIFICATION NO.  M1002R00
           REM                      TITLE  SYSTEM DATE REQUEST
           REM                             INFORMATION
           REM                      IDENTIFICATION NAME  M1-NRL-DATE
           REM                      LANGUAGE  COMPASS
           REM                      COMPUTER  CDC-3800
           REM                      CONTRIBUTOR  JOHN H. HOUSTON
           REM                                   CODE 7817JH
           REM                      ORGANIZATION  MATHEMATICS AND
           REM                                       INFORMATION SCIENCES
           REM                                         DIVISION
           REM                                    RESEARCH COMPUTATION
           REM                                        CENTER
           REM                                    CODE 7817JH
           REM                      DATE  17 JANUARY 1969
           REM                      PURPOSE  THIS ROUTINE GIVES THE USER
           REM                               THE SYSTEM DATE REQUEST
           REM                               INFORMATION IN INTEGER FORM.
           REM                      FORTRAN CALLING SEQUENCE
           REM                           CALL DATE(MONTH,IDAY,IYEAR,JUL)
           REM                             MONTH,IDAY,IYEAR,AND JUL ARE
           REM                             OUTPUT PARAMETERS IN INTEGER
           REM                             FORM.
SAVEARIT   BSS       2                                                  00001800
VAR        BSS       4                                                  00001900
BANK1ST    BSS       4                                                  00002000
LOCN       BSS       3                                                  00002100
JULDAY     BSS       1                                                  00002200
UNITS      BSS       1                                                  00002300
TENS       BSS       1                                                  00002400
DATE       UNJP      **                                                 00002500
           DSTA      (*)SAVEARIT          SAVE A AND Q REGISTERS        00002600
           RXT       D,A                                                00002700
           STA       =SLOCND                                            00002800
           SIU       NDX,1                                              00002900
           SIL       NDX,2                SAVE INDEX REGISTERS          00003000
           SIU       NDX+1,3                                            00003100
           SIL       NDX+1,4                                            00003200
           SIU       NDX+2,5                                            00003300
           SIL       NDX+2,6                                            00003400
           LDA       DATE                 UBJP INTO A-REGISTER          00003500
```

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        RXT       A,B6                  TRANSMIT RETURN ADDRESS TO B6   00003600
        ARS       15                                                    00003700
        RXT       A,OB                  BANK DESIGNATOR OF RETURN       00003800
        RXT       OB,D                  ADDRESS TO OB                   00003900
        LDQ       2,6                   LOAD Q WITH (RETURN+2)          00004000
        STQ       (*)VAR+3              ADDR. OF FOURTH PARAM TO VAR+3  00004100
        QRS       15                                                    00004200
        SBYT,Q0,E3 BANK1ST+3            STORE INDICATOR                 00004300
        QRS       9                                                     00004400
        STQ       VAR+2                 ADDR. OF THIRD PARAMETER TO
        QRS       15                                                    00004600
        SBYT,Q0,E3 BANK1ST+2            STORE BANK INDICATOR            00004700
        RXT       D,OB                                                  00004800
        LDA       1,6                   LOAD A WITH (RETURN+1)          00004900
        STA       (*)VAR+1                                              00005000
        ARS       15                                                    00005100
        SBYT,A0,E3 BANK1ST+1                                            00005200
        ARS       9                                                     00005300
        STA       VAR                   ADDR. OF 1ST PARAM TO VAR.      00005400
        ARS       15                                                    00005500
        SBYT,A0,E3 BANK1ST                                              00005600
        DATE                                                            00005800
        ENQ       0                                                     00005900
* GET DATE IN BCD---- CALENDAR AND JULIAN                               00006000
* PROCEED TO CONVERT TO INTEGER                                         00006100
        SBYT,A36,E12 LOCN               MONTH                           00006200
        SBYT,A18,E12 LOCN+1             DAY                             00006300
        SBYT,A0,E12 LOCN+2              YEAR                            00006400
        ENI       0,1                                                   00006500
BACKUP  LDA       LOCN,1                                                00006600
        LRS       6                                                     00006700
        QRS       42                                                    00006800
        RXT       Q,D                                                   00006900
        MUI       =D10                                                  00007000
        ROP,+     A,D,A                                                 00007100
        STA       LOCN,1                INTEGER FORM                    00007200
        ISK       2,1                                                   00007300
        SLJ       BACKUP                                                00007400
* AT THIS PT. LOCN,LOCN+1,LOCN+2 CONTAIN  MONTH,DAY,YEAR IN  INTEGER    00007500
* FORM.  WHEN DATE REQUEST IS ISSUED BCD CALENDAR DATE IS RETURNED IN   00007600
* A-REGISTER, AND BCD JULIAN DATE IS RETURNED IN Q-REGISTER.            00007700
        DATE                                                            00007800
        ENA       0                     DAY ,E.G.,  030206              00007900
        QLS,E0    30                                                    00008000
        SBYT,Q30,E6 UNITS                                               00008100
        SBYT,Q36,E6 TENS                                                00008200
        LLS       6                                                     00008300
        MUI       =D10                                                  00008400
        LDQ       TENS                                                  00008500
        ROP,<     A,Q,A                 CONVERSION                      00008600
        MUI       =D10                                                  00008700
        LDQ       UNITS                                                 00008800
        ROP,+     A,Q,A                                                 00008900
        STA       JULDAY                INTEGER FORM                    00009000
        ENI       0,2                                                   00009100
```

```
BACK     ENI       15,1                                                  00009200
* STORE BANK INDICATORS AND ADDRESSES IN TRANSMIT INSTRUCTIONS.          00009300
         LDQ       BANK1ST,2                                             00009400
         SBYT,Q0,E3 XMIT,2,1                                             00009500
         INI       -15,1                                                 00009600
         LDQ       VAR,2                                                 00009700
         SBYT,Q0,E15 XMIT,2,1                                            00009800
         ISK       3,2                                                   00009900
         SLJ       BACK                                                  00010000
XMIT     XMIT      ($)LOCN,($)**                                         00010100
         XMIT      ($)LOCN+1,($)**                                       00010200
         XMIT      ($)LOCN+2,($)**                                       00010300
         XMIT      ($)JULDAY,($)**                                       00010400
NDX      ENI       **,1                                                  00010500
         ENI       **,2                    RESTORE REGISTERS             00010600
         ENI       **,3                                                  00010700
         ENI       **,4                                                  00010800
         ENI       **,5                                                  00010900
         ENI       **,6                                                  00011000
         LDA       LOCND                                                 00011200
         RXT       A,D                                                   00011300
         DLDA      SAVEARIT                                              00011100
         SLJ       DATE                                                  00011400
         END                                                             00011500
```

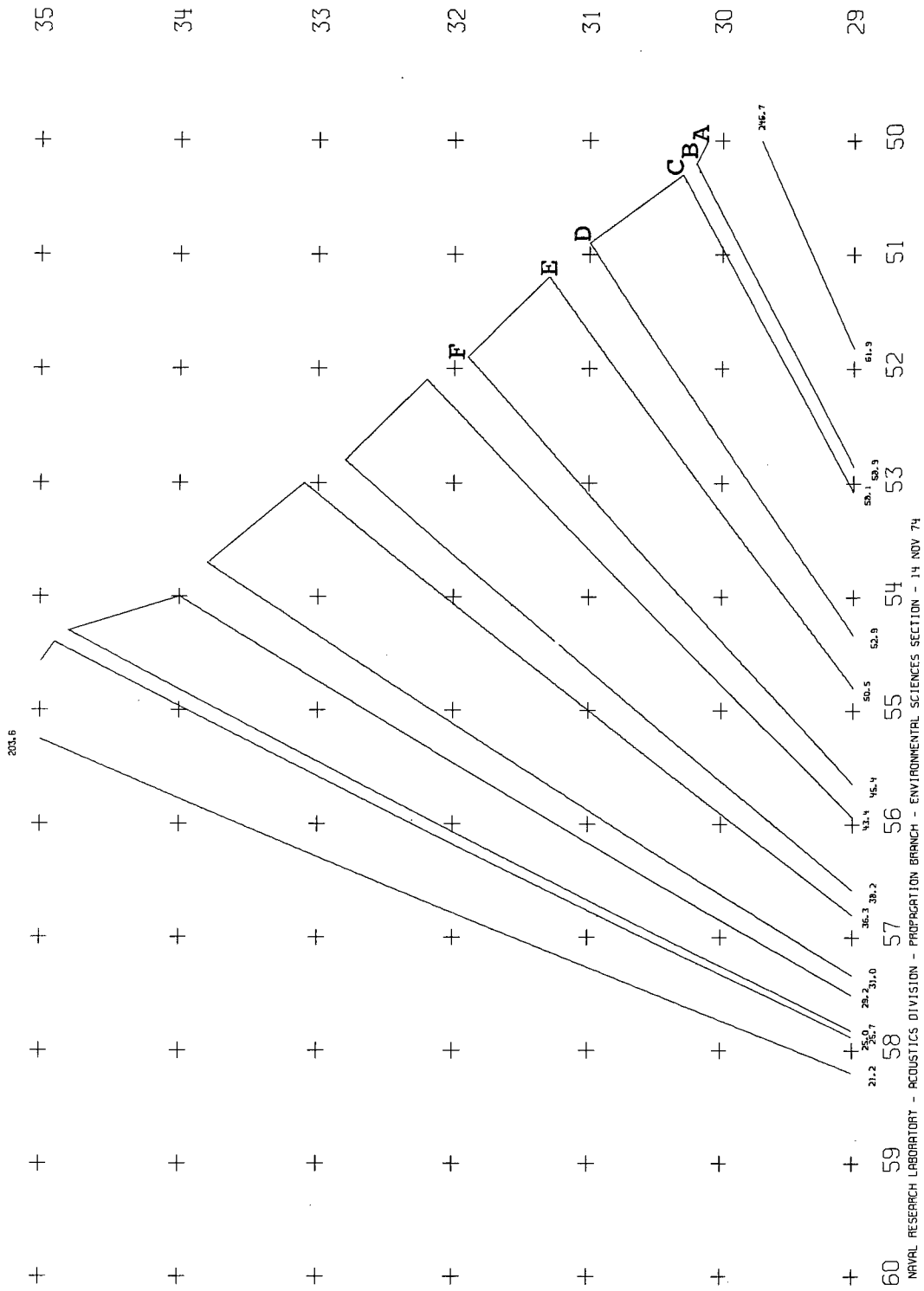
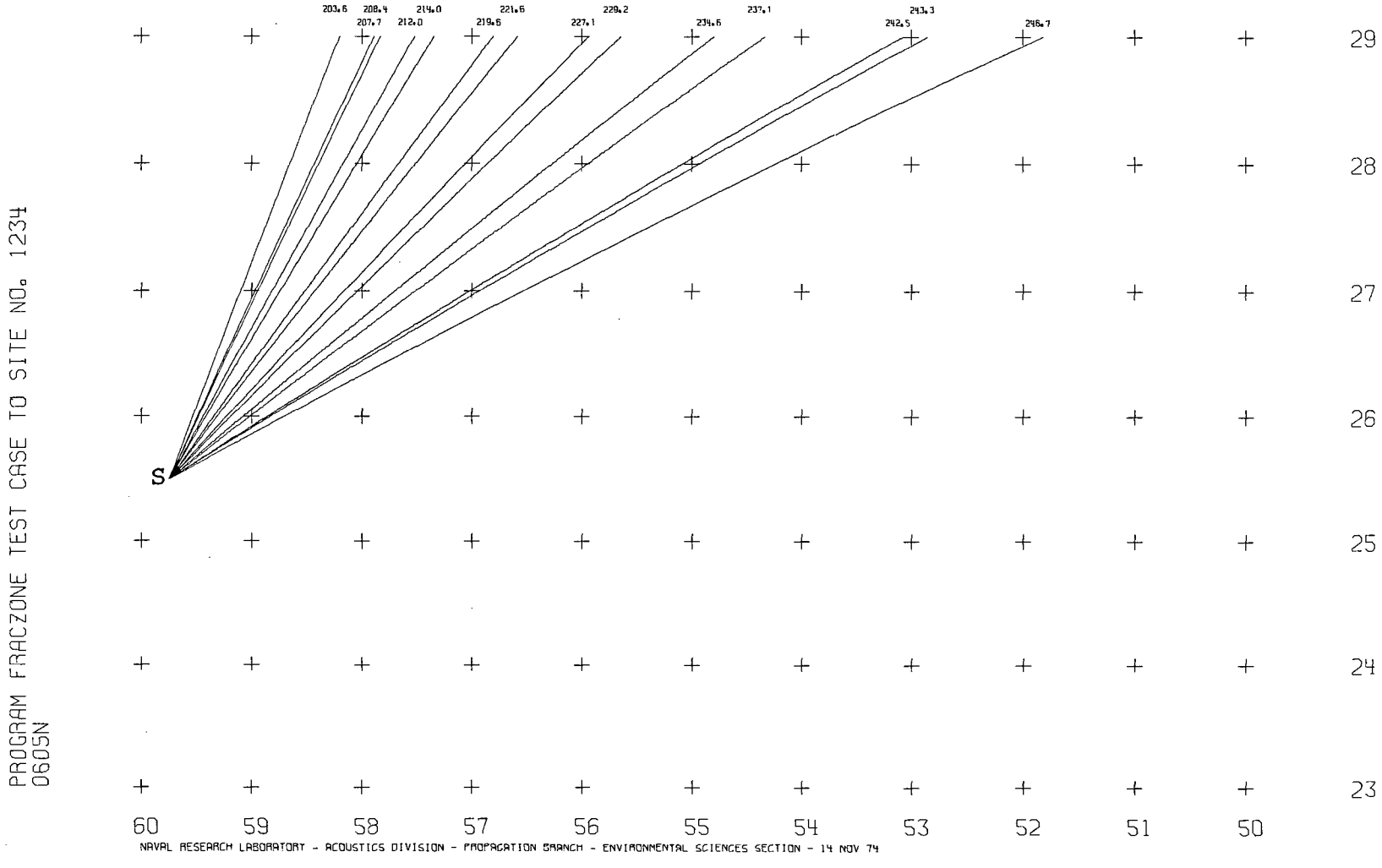


Figure 1

PROGRAM FRACZONE TEST CASE TO SITE NO. 1234
060GN


PROGRAM FRACZONE TEST CASE TO SITE NO. 1234
0605N
203.6
208.4
207.7
214.0
212.0
221.6
219.6
229.2
227.1
237.1
234.6
243.3
242.5
246.7
S
29
28
27
26
25
24
23
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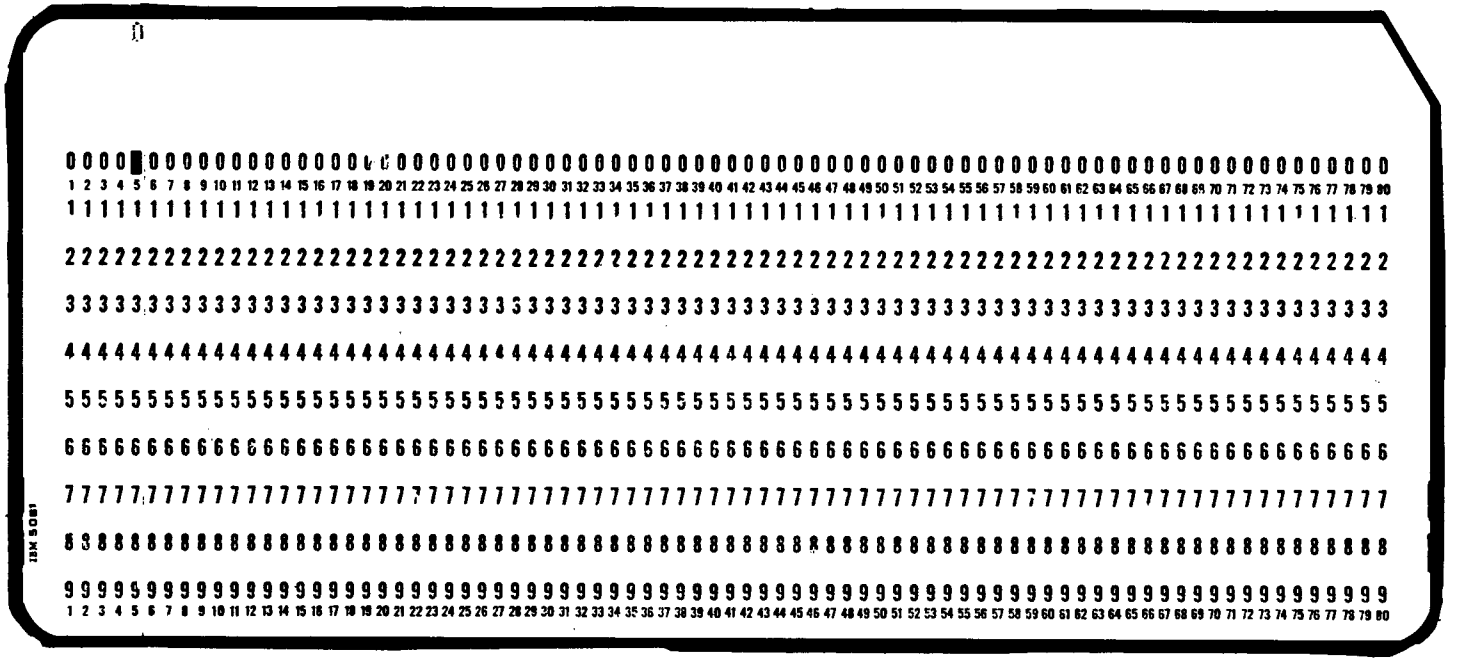
50
NAVAL RESEARCH LABORATORY - ACOUSTICS DIVISION - PROPAGATION BRANCH - ENVIRONMENTAL SCIENCES SECTION - 14 NOV 74

Figure 2

Card No. 1 - Magnetic Tape Skipfile Card

MTSKF



```
READ 6, MTSKF

6 FORMAT (16I5)
```

Figure 3

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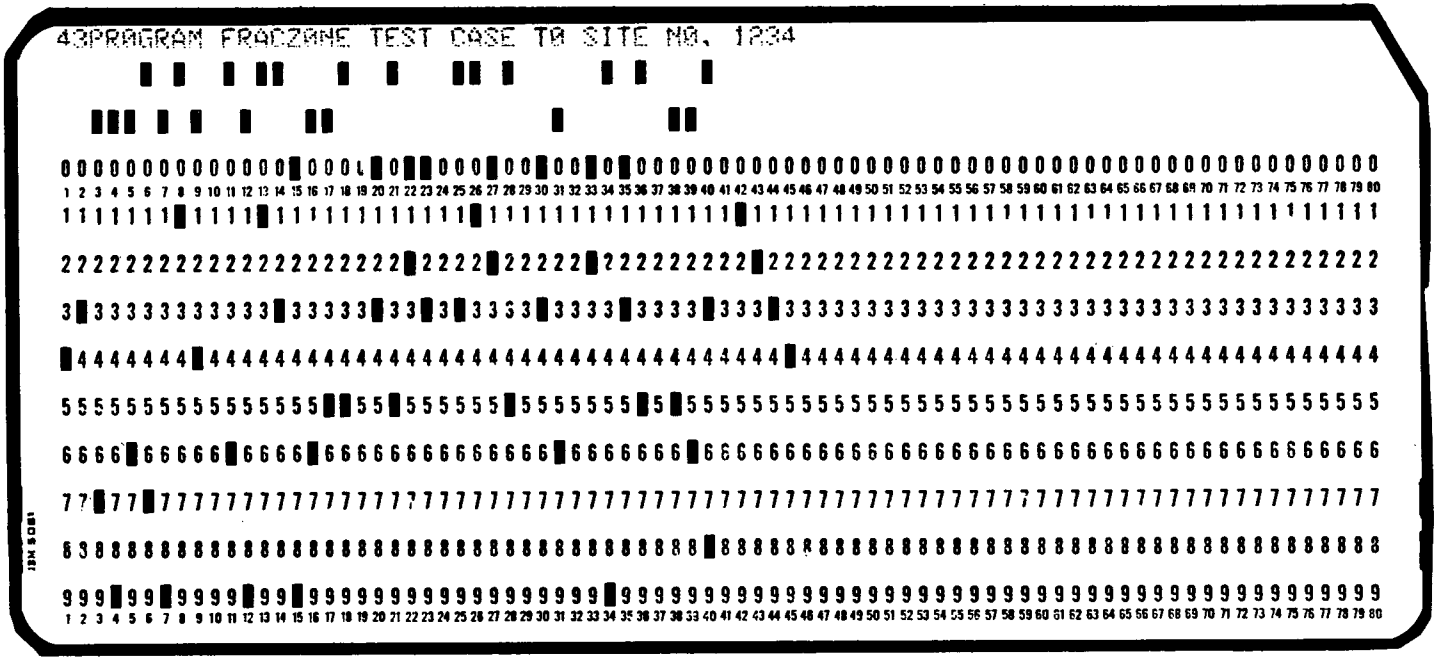
Card No. 2 - Title Card

LT ITITLE(L)

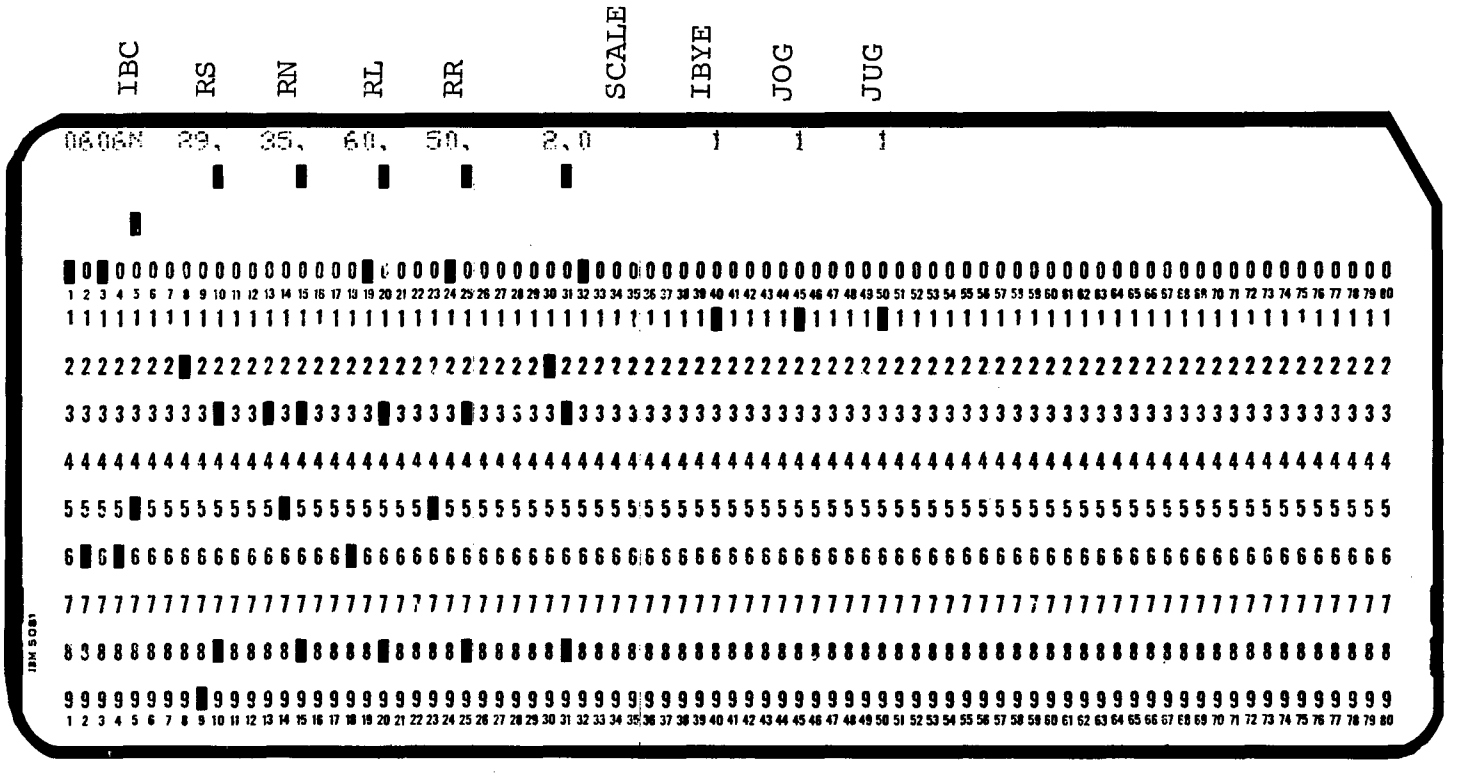



```
READ 7, LT, (ITITLE(L), L = 1, LT)

7 FORMAT (I2,78A1)
```

Figure 4

Card No. 3 - Chart Parameter Card




```
READ 3, IBC,RS,RN,RL,RR,SCALE,IBYE,JOG,JUG

3 FORMAT (A5,4F5.0,3X,F7.4,9I5)
```

Figure 5

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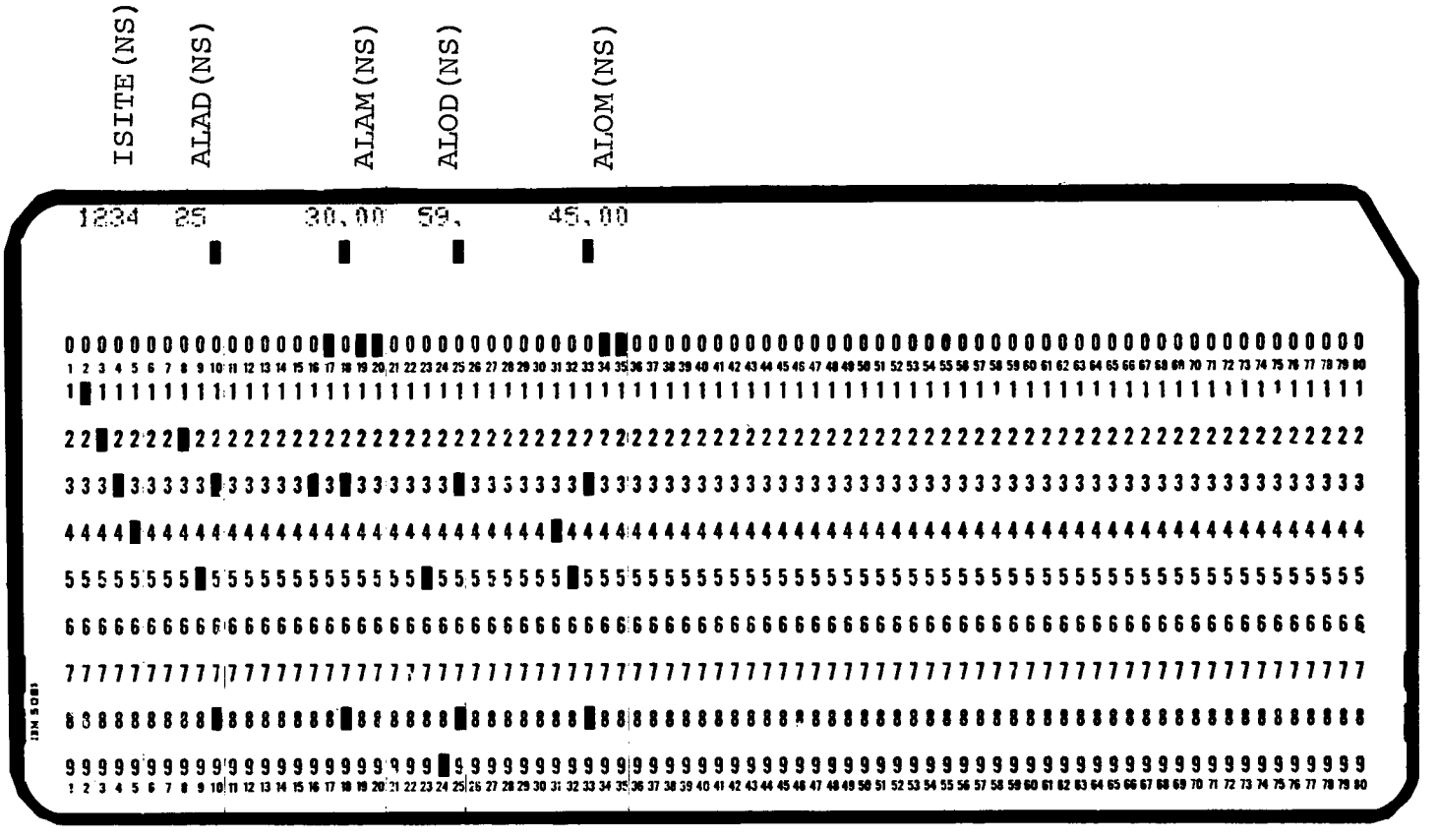
Card No. 4 - Site Position

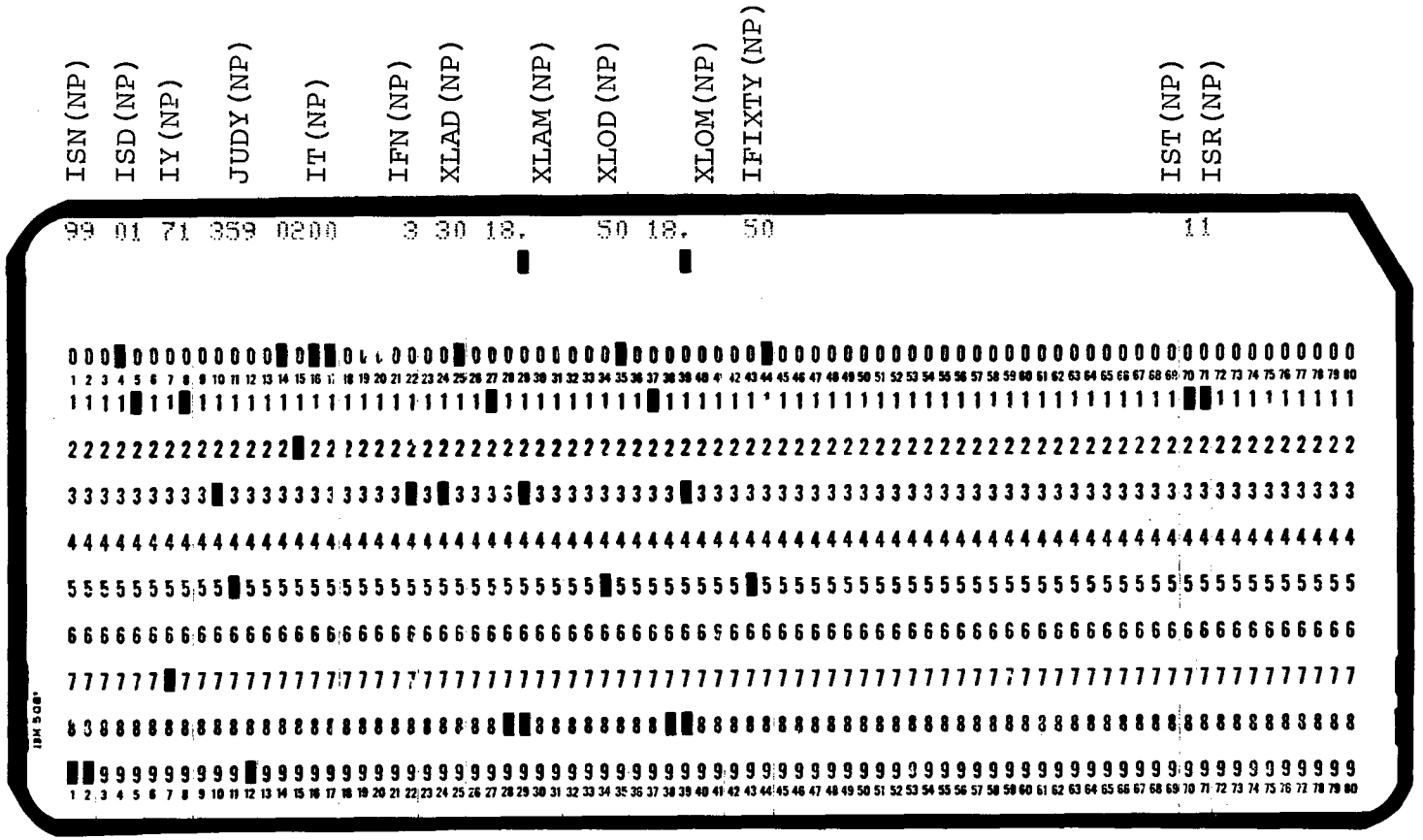



```
READ 4,ISITE(NS),ALAD(NS),ALAM(NS),ALOD(NS),ALOM(NS)

4 FORMAT (I5,F5.0,5X,F5.2,F5.0,5X,F5.2)
```

Figure 6

Card No. 5, etc. - Navigation Fix Card with On/Off Indicator; in this case ON.

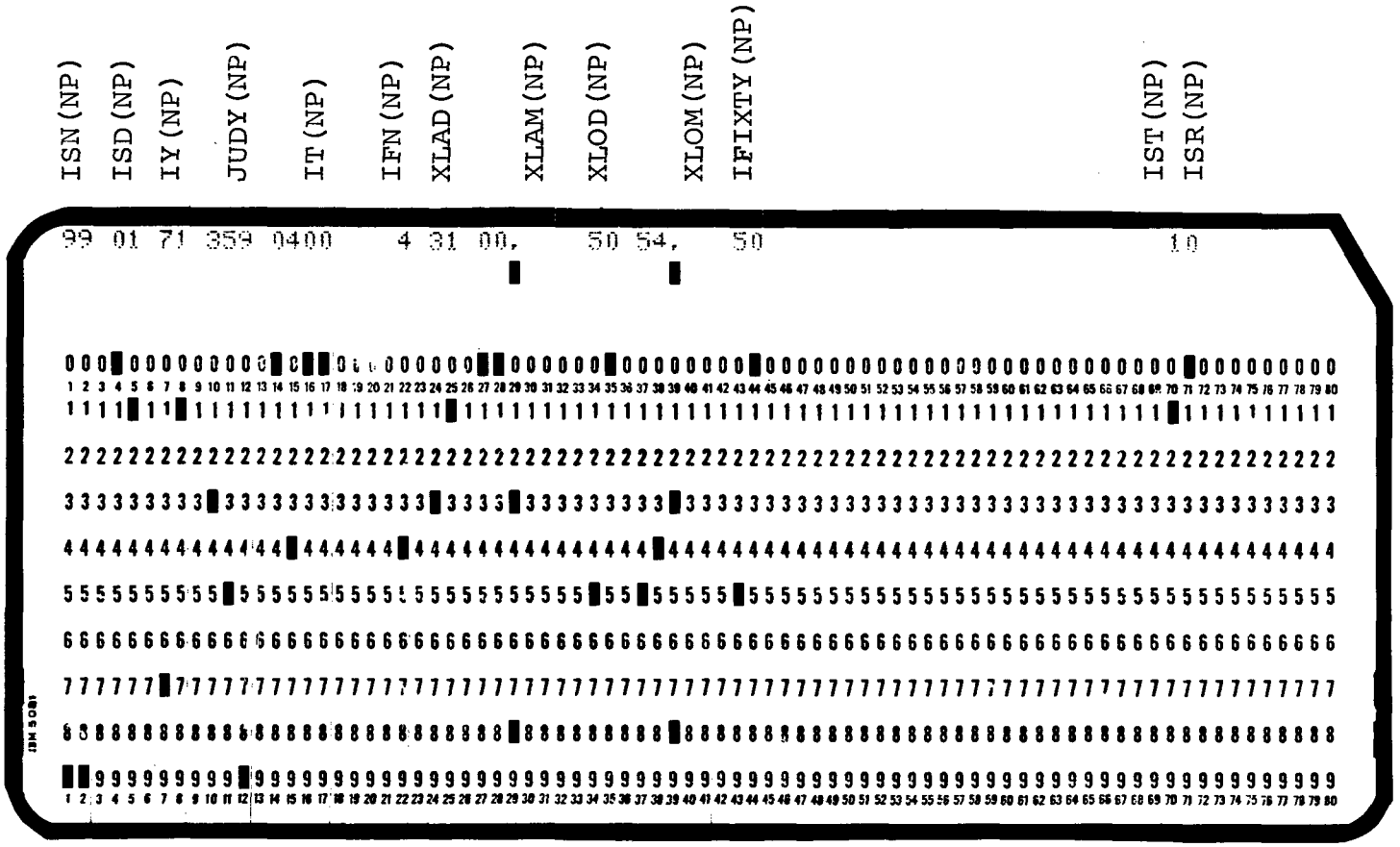



```
READ 5,ISN(NP),ISD(NP),IY(NP),JUDY(NP),IT(NP),IFN(NP),XLAD(NP),
XLAM(NP),XLOD(NP),XLOM(NP),IFIXTY(NP),IST(NP),ISR(NP)
5 FORMAT (I2,I3,I3,I4,I5,I5,F3,F6.2,F4,F6.2,I3,2X,I1,I1)
```

Figure 7

UNCLASSIFIED

Card No. 6, etc. - Navigation Fix Card with On/Off Indicator; in this case OFF.

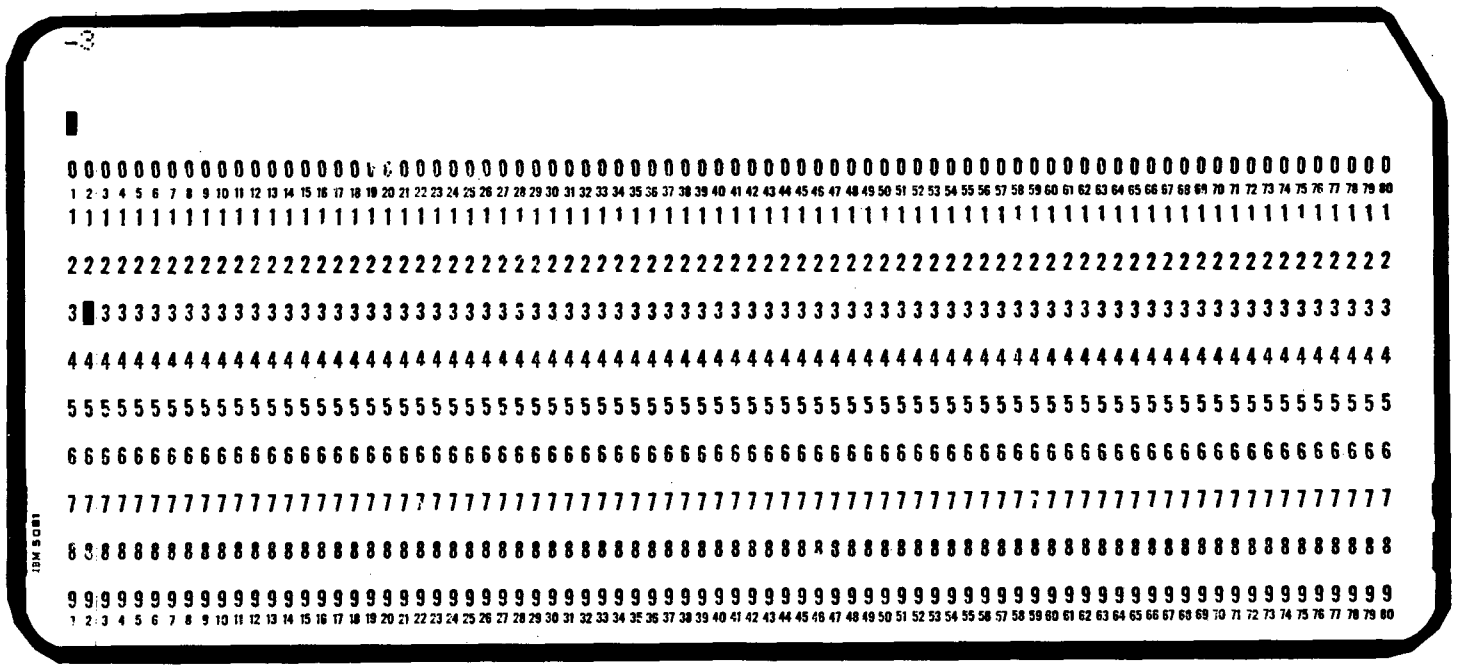



```
READ 5,ISN(NP),ISD(NP),IY(NP),JUDY(NP),IT(NP),IFN(NP),XLAD(NP),
XLAM(NP),XLOD(NP),XLOM(NP),IFIXTY(NP),IST(NP),ISR(NP)
5 FORMAT (I2,I3,I3,I4,I5,I5,F3,F6.2,F4,F6.2,I3,2X,I1,I1)
```

Figure 8

Card No. 7 - Integer Control Card

ISN(NP)



```
READ 5,ISN(NP),ISD(NP),IY(NP),JUDY(NP),IT(NP),IFN(NP),XLAD(NP),
XLAM(NP),XLOD(NP),XLOM(NP),IFIXTY(NP),IST(NP),ISR(NP)
5 FORMAT (I2,I3,I3,I4,I5,I5,F3,F6.2,F4,F6.2,I3,2X,I1,I1)
```

Figure 9

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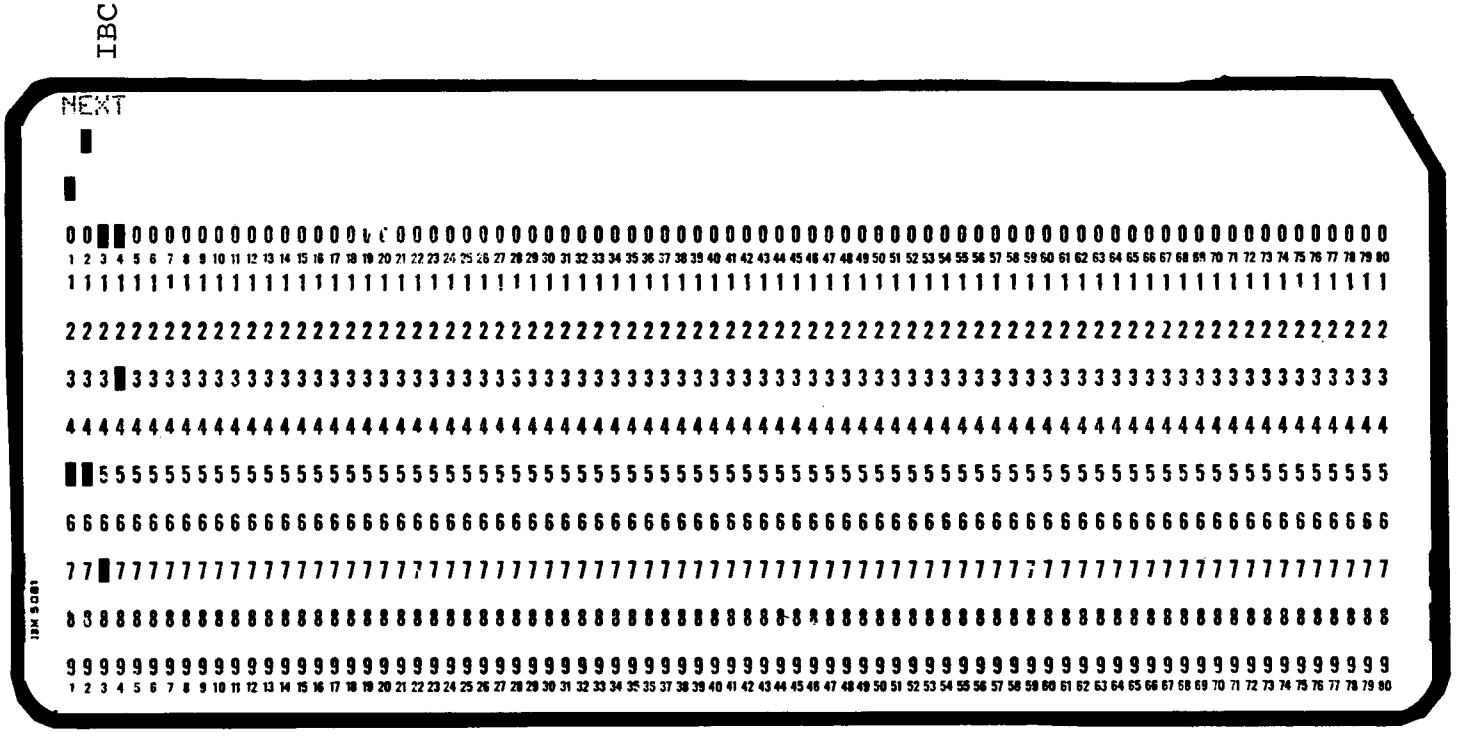
Card No. 8 - Alphanumeric Control Card

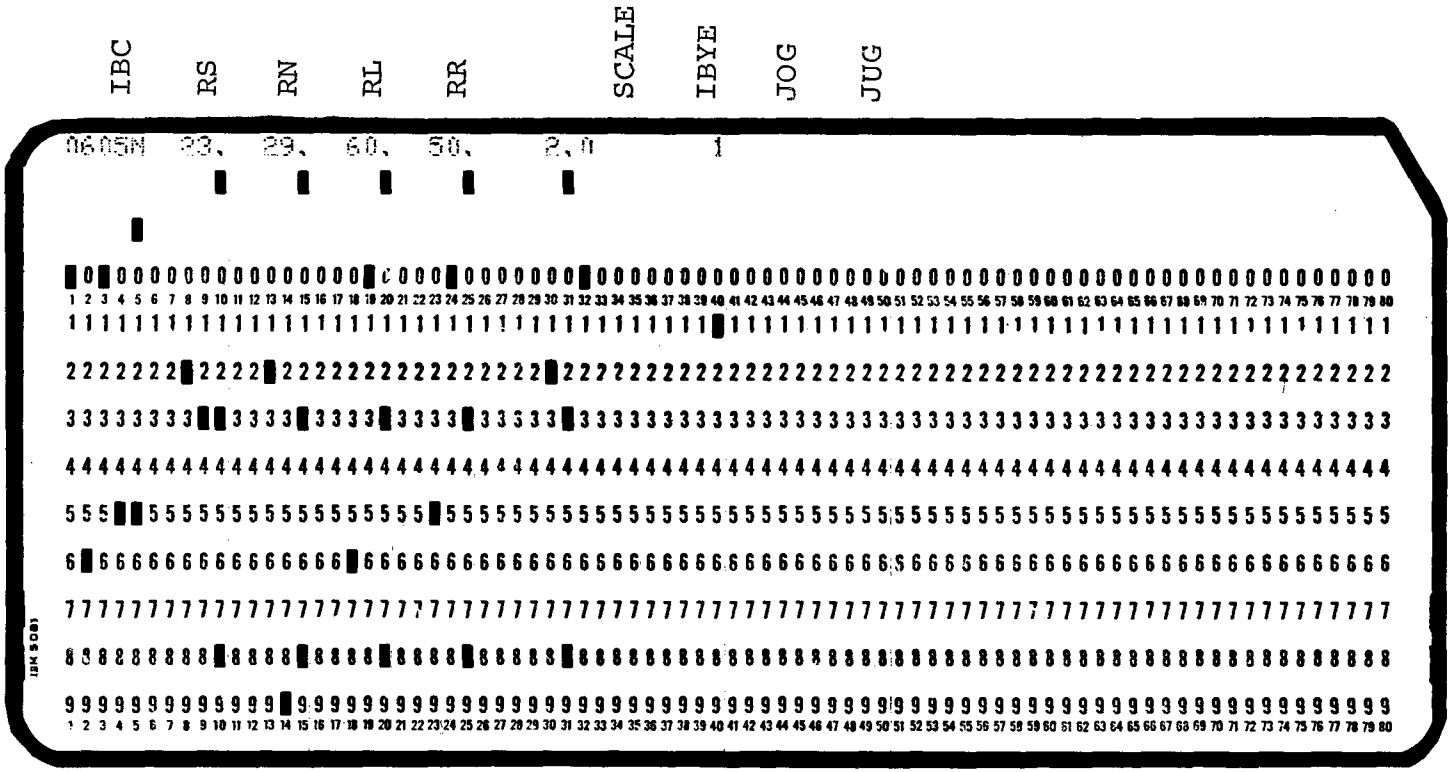



```
READ 4,ISITE(NS),ALAD(NS),ALAM(NS),ALOD(NS),ALOM(NS)

4 FORMAT (I5,F5.0,5X,F5.2,F5.0,5X,F5.2)
```

Figure 10

Card No. 9 - Chart Parameter Card with JOG and JUG zero or blank



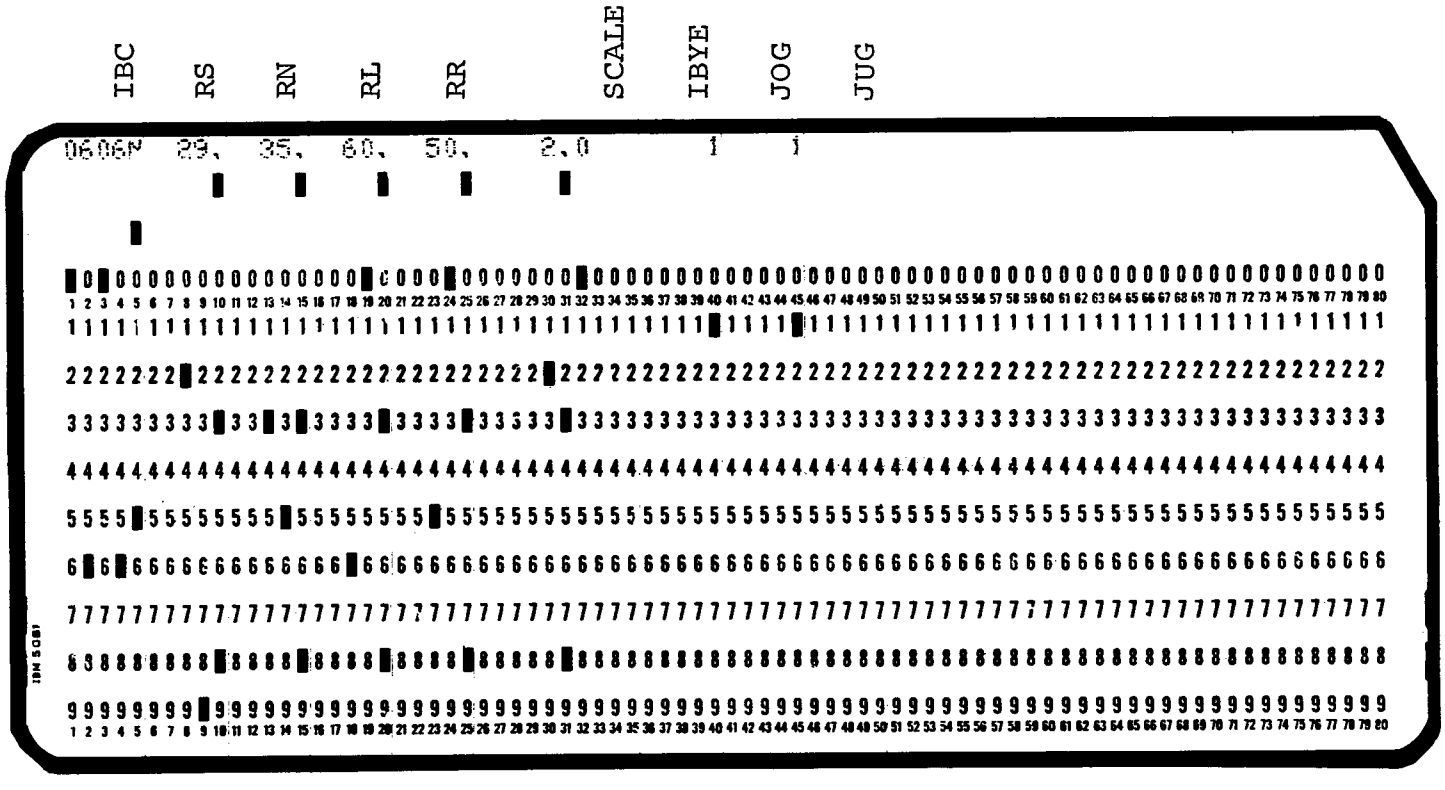

```
READ 4,ISITE(NS),ALAD(NS),ALAM(NS),ALOD(NS),ALOM(NS)

4 FORMAT (I5,F5.0,5X,F5.2,F5.0,5X,F5.2)
```

Figure 11

UNCLASSIFIED

Card No. 10 - Chart Parameter Card with JUG zero or blank

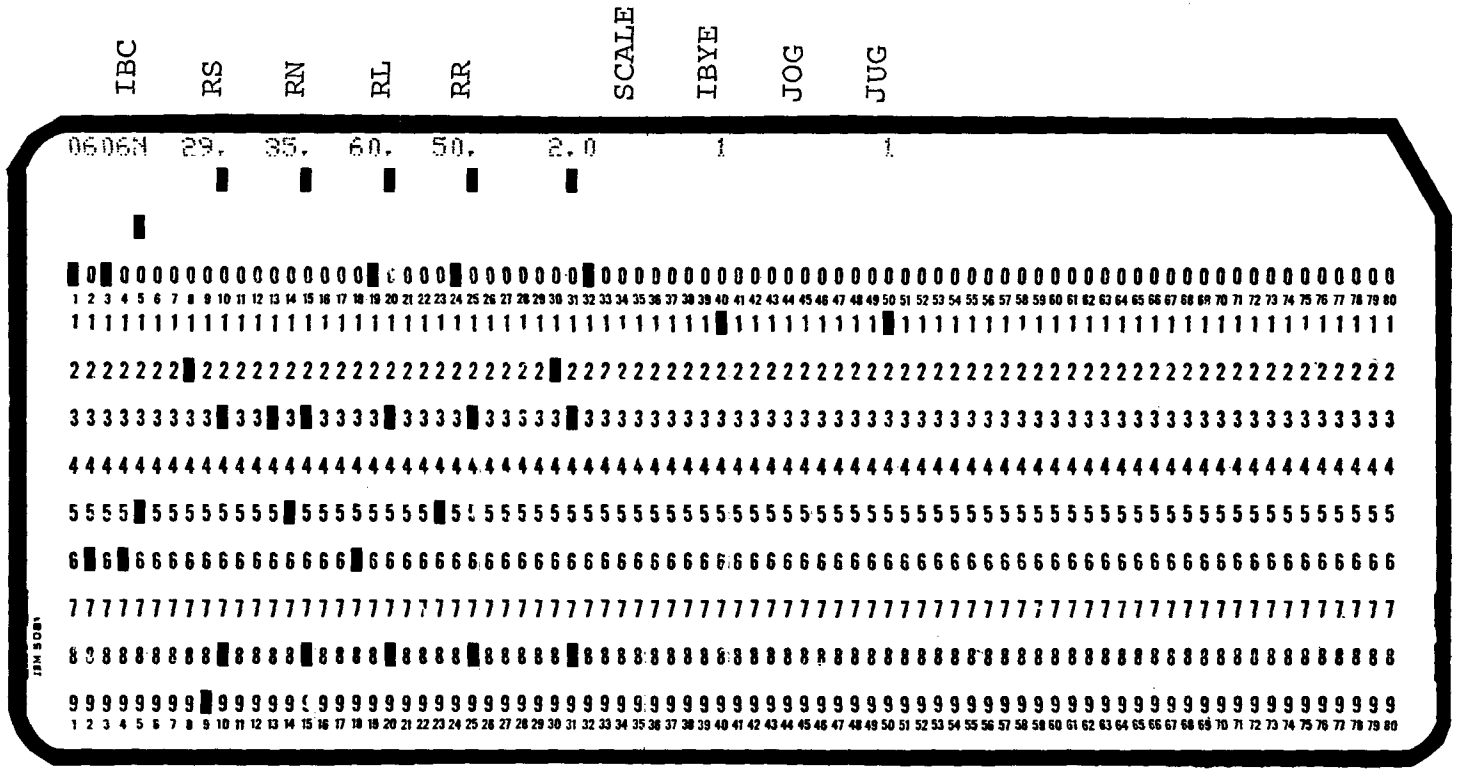



```
READ 3, IBC,RS,RN,RL,RR,SCALE,IBYE,JOG,JUG

3 FORMAT (A5,4F5.0,3X,F7.4,9I5)
```

Figure 12

Card No. 11 - Chart Parameter Card with JOG zero or blank




```
READ 3, IBC,RS,RN,RL,RR,SCALE,IBYE,JOG,JUG
3 FORMAT (A5,4F5.0,3X,F7.4,9I5)
```

Figure 13

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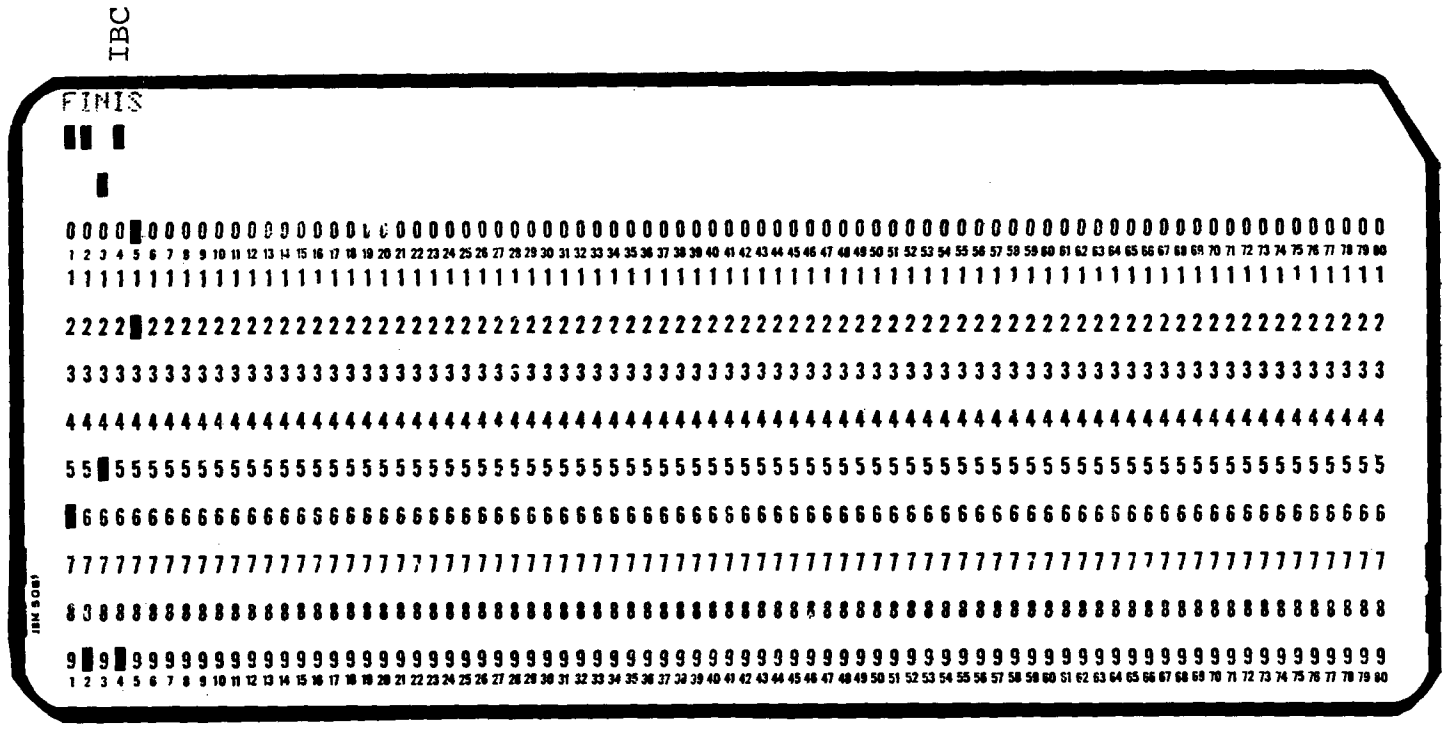
Card No. 12 - Alphanumeric Control Card




```
READ 3, IBC,RS,RN,RL,RR,SCALE,IBYE,JOG,JUG

3 FORMAT (A5,4F5.0,3X,F7.4,9I5)
```

Figure 14

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```
CHART PARAMETERS

E.C. NO. = 0606N

SOUTHMOST LATITUDE =   29   NORTHMOST LATITUDE =   35

WESTMOST LONGITUDE =   60   EASTMOST LONGITUDE =   50

SCALE =  2.0000 INCHES / DEGREE   DEGREE INCREMENT =  1

CHARACTER HEIGHT = 0.280

DATA PROCESSED ON 28 MAR 75

PROGRAM FRACZONE TEST CASE TO SITE NO. 1234
```

Figure 15

PROGRAM FRACZONE TEST CASE TO SITE NO. 1234

FOR SITE NO. 1234 AND SOUND SPEED = 4910 FEET / SECOND

DATE	TIME	SHIP POSITION LATITUDE	SHIP POSITION LONGITUDE	SHIP BEARING	SITE BEARING	DISTANCE (NMS)	TRAVEL TIME (MIN)	
25 12 71	100	30 12,00	50 12,00	243,33	58,85	580	12,0	10
25 12 71	200	30 18,00	50 18,00	242,52	58,09	578	11,9	11
25 12 71	400	31 0,00	50 54,00	237.10	52,90	573	11,8	10
25 12 71	600	31 18,00	51 12,00	234,61	50,53	570	11,8	11
25 12 71	800	31 54,00	51 54,00	229,19	45,41	564	11,6	10
25 12 71	1000	32 12,00	52 6,00	227,06	43,36	568	11,7	11
25 12 71	1200	32 48,00	52 48,00	221,64	38,24	569	11,7	10
25 12 71	1400	33 6,00	53 0,00	219,61	36,30	576	11,9	11
25 12 71	1600	33 48,00	53 42,00	214,03	31,03	589	12,1	10
25 12 71	1800	34 0,00	54 0,00	212,03	29,17	590	12,2	11
25 12 71	2000	34 48,00	54 18,00	208,41	25,66	624	12,9	10
25 12 71	2100	34 54,00	54 24,00	207,70	25,00	627	12,9	11

Figure 16

```
PROGRAM FRACZONE TEST CASE TO SITE NO, 1234

PLOTTING COMPLETED FOR SITE NO, 1234  NUMBER OF SHIP POSITIONS =   13

Y-LENGTH = 15,34 INCHES

PLOTTING COMMANDS ARE STORED IN FILE NO,   1
```

Figure 17

UNCLASSIFIED