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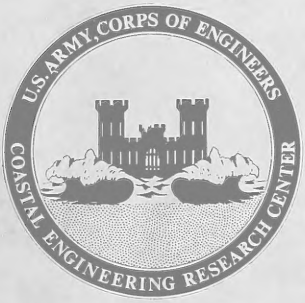
MAY 1970



U. S. ARMY, CORPS OF ENGINEERS

COASTAL ENGINEERING
RESEARCH CENTER

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ABSTRACT

RAPLOT II is a computer program for processing radiation and navigation data from field surveys of the Radioisotopic Sand Tracer (RIST) study, but is applicable to any survey type operation on the nearshore Continental Shelf. Collected data are punched onto paper tape by the data collection computer on the research vessel. The data are later transferred to magnetic tape which provides the input for the RAPLOT II Program. Program control parameters are on punched cards. The navigation data, which consists of ranges to two shore-based radar beacons, are first edited for spurious data, and then converted to rectangular coordinates (in this case the California Lambert Coordinate System). Radiation data are converted to count rate as counts per second. Background count rate is computed and subtracted from the observed count rate, and any radiation counts that are significantly above the background count rate are corrected for time of decay since the isotope was injected. Output from the program is in three forms - printed output, graphical output, and magnetic tape record. The processed data are transferred to magnetic tape and made available for further processing such as the generation of contour maps.

FOREWORD

CERC Miscellaneous Paper 2-69, Radioisotopic Sand Tracer Study, Point Conception, California, reported the early results of the RIST study. This study is part of Contract AT(49-11)-2988 between the Atomic Energy Commission and CERC. Other participants in this continuing multi-agency study are the Oak Ridge National Laboratories of the Atomic Energy Commission; U. S. Navy Pacific Missile Range; U. S. Air Force (Western Test Range, First Strategic Aerospace Division); U. S. Army Corps of Engineers Los Angeles District office; NASA (Nuclear Systems and Space Power Division), the State of California (Department of Water Resources) and U. S. Army Mobility Equipment Command. The study involves the collection and analysis of an enormous amount of data. Computer processing is the only means by which these data could be handled.

Philip A. Turner, a geologist, developed the original RAPLOT program and prepared this report. The work was done under the general supervision of David B. Duane, Chief, Geology Branch, and George M. Watts, Chief, Engineering Development Division. CERC continues to refine data processing and improve the printed and graphic output which consists of maps drawn by an incremental plotter.

At the time of publication, Lieutenant Colonel Edward M. Willis was the Director of CERC; Joseph M. Caldwell was Technical Director.

NOTE: Comments on this publication are invited. Discussion will be published in the next issue of the CERC Bulletin.

This report is published under authority of Public Law 166, 79th Congress, approved July 31, 1945, as supplemented by Public Law 172, 88th Congress, approved November 7, 1963.

CONTENTS

ILLUSTRATIONS

Section A. INTRODUCTION

In 1966 the Coastal Engineering Research Center (CERC), in cooperation with the Atomic Energy Commission, initiated a 3-year radioisotopic sand tracer study of littoral transport around Point Conception, California. The purpose was to develop and use radioactive tracers for research in sand movement and littoral processes. The objectives included determination of suitable radioactive isotopes, development of handling and survey procedures, and development of computer programs for editing, processing and graphical display of the data. At the same time, studies of sediment transport around the Point Conception headland and of the mechanics of littoral transport were conducted. Methods developed by this program have direct application to engineering design of harbor development and beach erosion prevention, and quasi-military application such as the location of radioactive and other toxic materials.

Sand grains indigenous to the study area are labeled with a radioisotope that does not adversely affect their hydraulic properties. A mobile detector system, using cesium iodide crystals and housed in a "ball" towed behind an amphibious vehicle, detects the location and intensity of the radiation. Concurrently, additional field data are collected on sediment size and composition, isotope distribution, beach and nearshore bottom topography, weather, and sea and swell conditions.

During a sand-tracer field investigation, radiation measurements are made continuously as the mobile detector system is towed along a beach, through the surf, and over the offshore bottom. With a time selection mode for data acquisition available in increments from 0.1 to 10.0 seconds, a large mass of data is accumulated in a few hours. During a field test, surveying may go on several hours a day for several weeks. Computer processing is necessary to study and evaluate the great volume of collected data. Plotting and posting of the survey data is also useful for monitoring field operation.

The initial field investigations at Surf, California, relied on manual preparation of maps and subjective interpretation of data printed by the teletype of the onboard data acquisition system. It immediately became evident that computer processing and plotting must be employed in future operations, and CERC undertook development of computer programs to generate plots useful to continuing field operations. This specific program is called RAPLOT. The first version of the program was used to process the data collected in the December 1967 field test at Point Conception, California, and is documented in Appendix D of CERC report, M.P. 2-69, by Duane and Judge (1969). RAPLOT was originally compiled and made operational on the UNIVAC 1108 at the National Bureau of Standards, with graphic display on a Benson-Lehner incremental plotter at CERC. Later, the program was adapted to the IBM 7094 Computer and Milgo plotter at the Western Test Range of Vandenberg Air Force Base. This version of the program was used to support later field tests at Point Conception and Surf, California, in September and October 1968 and in February and June 1969.

Improvement and modification of program data acquisition systems created changes in the collection format which required a new version of the RAPLOT program. At the same time, experience gained from running the RAPLOT program was incorporated to provide an improved and more sophisticated data processing capability for the RIST project. The new program is called RAPLOT II and was used at CERC for processing field data for all tests after December 1968. Subsequently, the program was modified to run on an IBM 7094 computer to produce plots on a Stromberg-Carlson 4020 cathode ray tube. This version is called RAPLOT III (See Appendix B, page 47).

Section B. SUMMARY OF RAPLOT II PROGRAM

1. Hardware Requirements

RAPLOT II was written in FORTRAN V for the UNIVAC 1108 Computer and EXEC II operating system at the National Bureau of Standards (NBS) in Gaithersburg, Maryland. CERC is connected to NBS by a leased telephone line and has a UNIVAC 1004 for its remote terminal. The NBS UNIVAC 1108 has 65,000 words of core memory of which 38,400 are required for the RAPLOT II Program. FORTRAN V employs advanced features not found in standard FORTRAN IV. They are the NTRAN subroutine for executing binary input-output commands, and the FLD function, a bit manipulation routine.

For field program use, RAPLOT II has been modified and written in FORTRAN IV to run on an IBM 7094 computer at the Pacific Missile Range data processing center at Point Mugu, California. The size of the program had to be reduced considerably to fit into the 32,000 word memory. Consequently, the processing of the data is less thorough, and the writing out of the processed data on magnetic tape was eliminated. This version was used to support a RIST field test near Point Mugu where the primary requirement was for quick printout and graphic display of the processed survey data.

2. Program Description and Logic

A flow chart of the program is given in Figure 1; an outline description of the main steps in the program follows:

a. Read in two program control cards and a file legend card. Additional control parameters are computed from these input parameters.

b. Read in from magnetic tape a data file from a radioisotopic tracer survey.

c. Check radar beacon ranges for errors. If distance-time ratio for successive ranges indicates a ship speed greater than 6 knots, or 3.09 meters per second, correct the ranges by linear interpolation. Experience has indicated that these beacon ranges may be erroneous (as much as an order of magnitude) as often as 5 percent of the time.

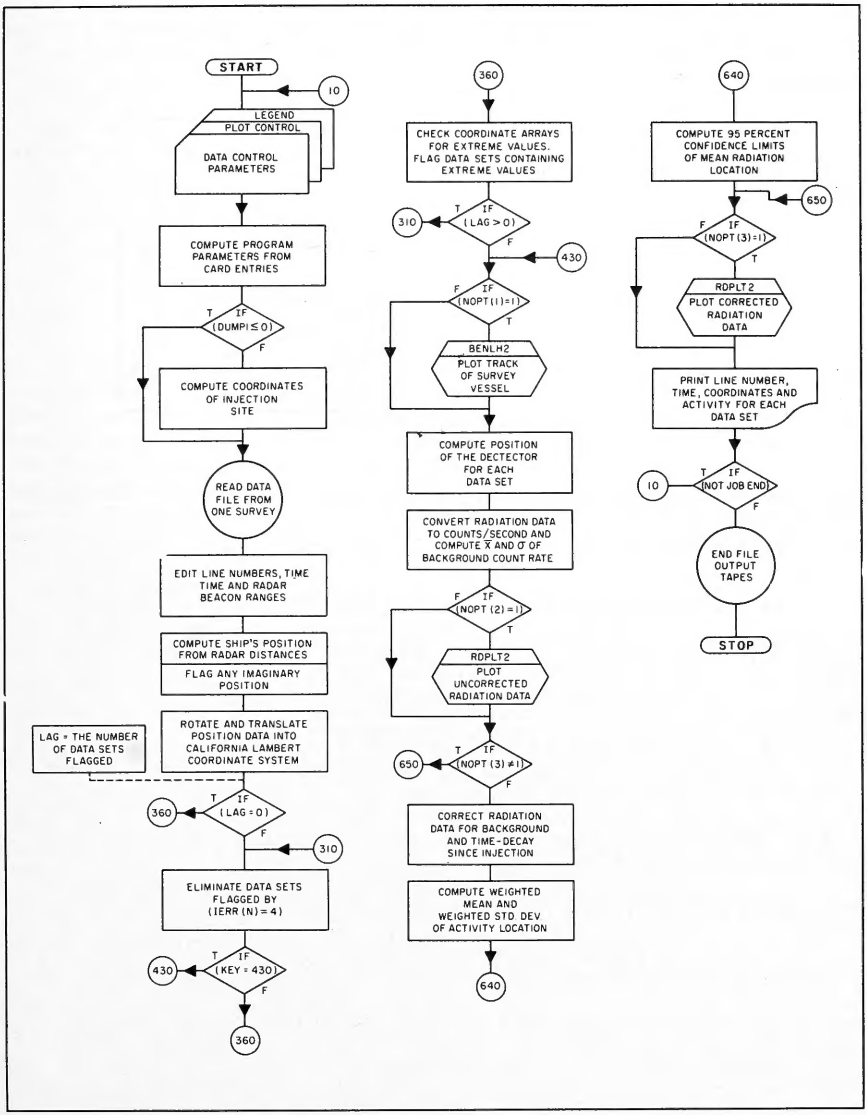
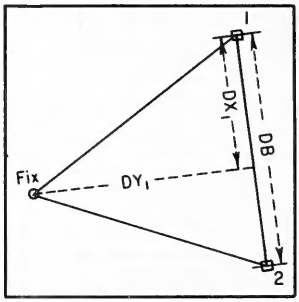


Figure 1. Flow Chart of RAPLOT II Program

d. Compute the position of the survey vessel at each fix. The program control cards provide the California Lambert Coordinates of the shore beacon, and the data input tapes provide the beacon ranges. By the cosine law this can be translated into distance in terms of a rectangular coordinate system:

$$DX_1 = (DB^2 + D_1^2 - D_2^2)/(2 \cdot DB)$$

$$DY_1 = (D_1^2 - DX_1^2)^{\frac{1}{2}}$$



Where D_1 = the distance of survey vessel from the upcoast radar beacon

D_2 = the distance from the downcoast beacon

DB = the distance between the two beacons

DX_1 = the distance of the fix position of survey vessel from the upcoast beacon in a direction parallel to a line intersecting the two beacons

DY_1 = the distance of the fix from an upcoast beacon in a direction normal to a line intersecting the two beacons.

These distances may be translated and rotated to give the Lambert Coordinates for each fix

$$NORTH_f = DX_1 \sin\theta + DY_1 \cos\theta + NORTH_b$$

$$EAST_f = DX_1 \cos\theta - DY_1 \sin\theta + EAST_b$$

Where θ = the angle of rotation of the coordinate system

$NORTH_b$ and $EAST_b$ = the Lambert coordinates of the upcoast radar beacon

$NORTH_f$ and $EAST_f$ = the coordinates of the fix.

Occasionally the two radar beacon ranges will produce an imaginary position. When this occurs, one of the coordinates of the radar fix is defined by the square root of a negative number. When such an imaginary fix occurs, the line of data producing the imaginary fix is eliminated from the file being processed.

e. The north and east coordinate arrays are searched for extreme values by Chauvenet's criterion and any data set containing extreme values is eliminated. Chauvenet's criterion is based on the normal distribution, and a value is rejected if the probability of occurrence of such a deviation from the mean of the n measurements is less than 1/2 n (P. R. Rider, 1933).

f. Plot the track of the survey vessel by a call to subroutine BENLH2.

g. Compute the position of the mobile underwater detector for each fix by correcting for the distance the detector is towed astern of the survey vessel. Cable length, mean water depth, and length of survey vessel, are all input on the program control card. Assuming a position for the detector vehicle at the beginning of the survey, the position of the detector for each fix is computed by linear interpolation from the present position of the vessel to the last interpolated position of the detector.

$$YD_n = YV_n - \frac{CABLE\ (YV_n - YD_{n-1})}{\sqrt{(YV_n - YD_{n-1})^2 + (XV_n - XD_{n-1})^2}}$$

$$XD_n = XV_n - \frac{CABLE\ (YV_n - YD_{n-1})}{\sqrt{(YV_n - YD_{n-1})^2 + (XV_n - XD_{n-1})^2}}$$

where XD and YD are the coordinates of the detector and XV and YV are coordinates of the vessel. CABLE is the horizontal distance from the detector to the survey vessel.

h. Radiation data are converted to counts per second, and the mean and standard deviation of the background count rate is computed. An estimated background count rate is entered on the data control card for each channel. This estimated background count rate is used to compute the extreme values of the range of the background radiation level, again by means of Chauvenet's criterion. All counts between these extreme ranges are averaged to obtain the mean background count rate for each channel.

i. Plot uncorrected radiation values by a call to BENLH2 through RDPLT2 entry.

j. Correct the radiation data by subtracting the mean background count rate. Then correct the remainder, if it is significantly higher than background, for the time of the decay since the isotope was injected.

$$CCR = (NCR - 3\sigma)e^{\Lambda t} + 3\sigma$$

where $$\Lambda = \frac{\log_e(2)}{T_{\frac{1}{2}}} \quad , \quad \text{and}$$

where CCR = the corrected count rate

NCR = the net (observed radiation value less mean background) count rate

σ = the standard deviation of the background count rate

$\underline{t}$ = the elapsed time from the injection to the time of the fix

$T_{\frac{1}{2}}$ = the isotope halflife in hours.

Only radiation count rates that are significantly greater than background are corrected for time of decay. Otherwise, in a survey made one or more halflives after the injection, the correction would inflate background radiation readings to such a degree that they would appear to be significant.

k. Compute the weighted mean and weighted standard deviation of the coordinate location of the radioactivity. Compute the 95 percent confidence limits of the mean radiation location.

$$\overline{XD} = \frac{\sum_{i=1}^{n} XD_i \cdot CCR_i}{\sum_{i=1}^{n} CCR_i}$$

$$\overline{YD} = \frac{\sum_{i=1}^{n} YD_i \cdot CCR_i}{\sum_{i=1}^{n} CCR_i}$$

l. Print out the sequence number, time, radar beacon ranges, coordinates, and activity for each line of data.

m. Return to the beginning of the program to read in more data control cards, and process another file of data unless it is the end of job, in which case processing ends.

Section C. SUBROUTINES USED IN THE PROGRAM

1. BENLH2 - Plotting Subroutine

Subroutine BENLH2 performs the operations necessary to produce a plot of the trackline and of the radiation data on the Benson-Lehner incremental plotter. BENLH2 does this by calling the several subroutines of the Benson-Lehner plot package which translates the data given to the subroutines by BENLH2 into plot commands that are written out onto magnetic tape. The tape is used to drive a Benson-Lehner model 305 incremental plotter off-line. Figure 2 is a flow chart of this subroutine.

Subroutine TRACK is substituted for subroutine BENLH2 to produce the RAPLOT III program. TRACK interfaces the RAPLOT program with the plot subroutines for the Stromberg-Carlson 4060 cathode ray tube. Otherwise, it functions essentially like subroutine BENLH2. Both subroutines plot the trackline followed by the survey vessel, and both will also plot the uncorrected or corrected radiation values for each survey. These are symbol plots in which the count rate is represented by a symbol indicating a value between arbitrarily fixed limits. For uncorrected radiation, the limits are established in terms of standard deviation from the mean background count rate. For corrected radiation count rate, the internal limits for each symbol are established on a power of 2 scale. Also, a special symbol is used to indicate background if the count rate is less than 3 standard deviations from the background count rate. If the count rate is more than 3 standard deviations below background, the value is not plotted at all. The reason for this is that an abnormally low count rate may indicate that the detector was "flying" meaning that it was not in contact with the ocean bottom at the time of the fix. Both BENLH2 and TRACK will plot the location of the mean radiation position referred to as RADBAR. They may also plot the location of the injection site, if this is desired.

2. Statistical Subroutines

The subroutines described below are used to perform certain statistical computations required by the RAPLOT II program. To reduce the time necessary to prepare the program, these subroutines were taken from the STAT-PACK, a library of statistical subroutines available on the UNIVAC 1108 system. Further details may be obtained from the STAT-PACK Programmers' Reference Manual.

Subroutine STDEV computes the standard deviation of an array by the following formula:

$$\sigma = \left(\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n} \right)^{1/2}$$

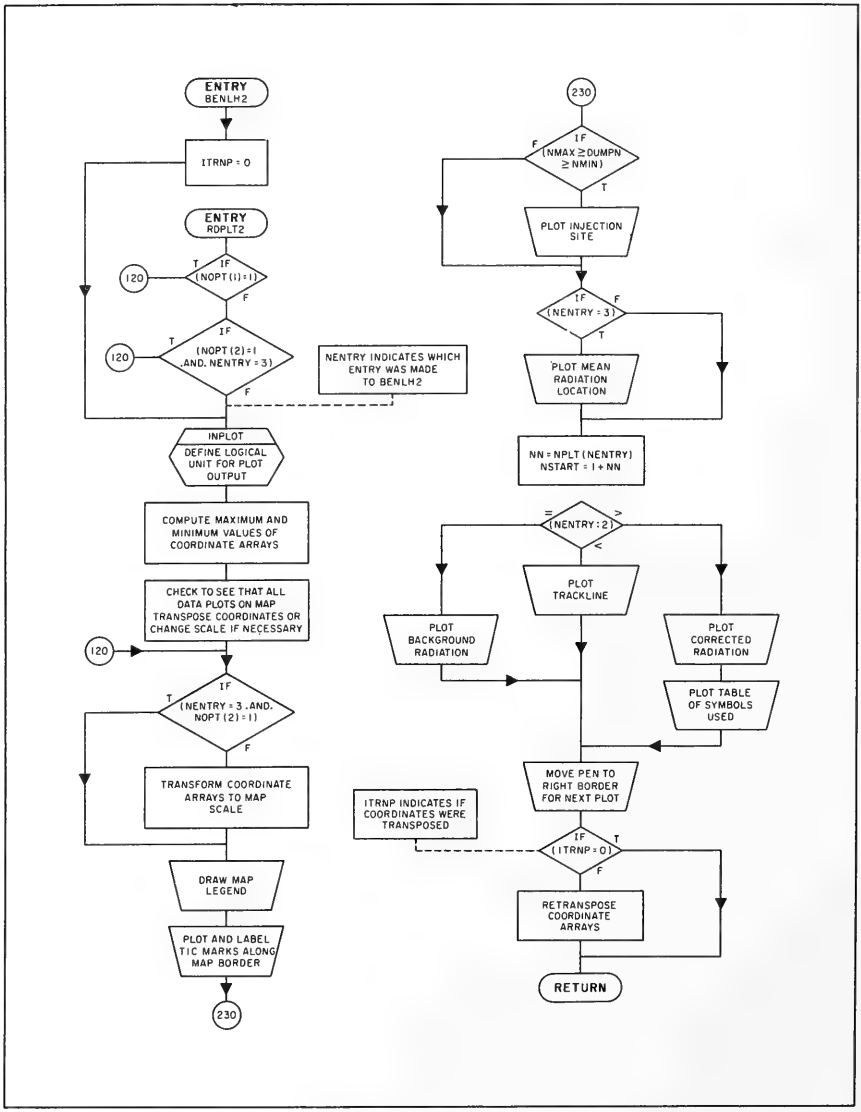


Figure 2. Flow Chart of BENLH2 Program

where X = the array of values

$\overline{X}$ = the arithmetic mean of the X array

n = the number of elements in the X array

σ = the standard deviation

Subroutine AMEAN is called to compute the arithmetic mean of the X array.

Subroutine TINORM computes the value of the inverse of the normal distribution by a rational approximation. The inverse normal distribution is defined by the solution for X of the following integral equation

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{X} e^{-t^2/2} \, dt = \alpha$$

where α is the probability for which the ordinate is to be calculated. The rational approximation itself may be ascertained from the FORTRAN statements in the subroutine.

3. Input-Output Subroutines

The binary input-output statements in FORTRAN, although convenient to use, cannot make efficient use of magnetic tapes because the language does not permit total parallel processing. Furthermore, a considerable amount of time is used in processing a list because of its generality. More efficient use is attained by buffering the input or output in parallel with computing. On the UNIVAC 1108 system the NTRAN subroutine provides a means of buffering through a call statement in FORTRAN:

CALL NTRAN (UNIT, sequence of operations)

in which UNIT is an integer constant or variable designating the logical unit. If the unit is not busy, NTRAN initiates the first operation and stacks the remainder in a waiting list. If the unit is already busy, then the entire sequence is stacked in a waiting list and chained to the previously stacked sequence. Control is then returned to the program following the call NTRAN statement. When an interrupt occurs, NTRAN records the transmission status, initiates the next operation in the chain and returns control to the interrupted program.

The NTRAN subroutine is used to write out on magnetic tape the arrays containing the legend, sequence number, underwater detector coordinates and corrected count rate for both radiation channels for each file of survey data being processed. The information thus stored on

magnetic tape may be used for further processing such as drawing contour maps. No provision is made for outputting the processed data in RAPLOT III because no further processing was planned for any of the field test sites. Also deletion of the output statements reduces the running time of the program.

Call NTRAN statements are also used in RAPLOT II to position the input tape by end of file marks.

Section D. PROGRAM INPUT

1. Card Input

Input for the RAPLOT II program comes from punched cards and from magnetic tape. Three program control cards are read in for each file of survey data processed. Formats, and descriptions of the variables written onto the cards are given in Table I; names given to the variables in this table are the ones employed by the program. Figure 3 shows a data sheet that is used for filling out the control cards. It is useful not only for filling in the parameters on the cards, but also for keeping track of the data files when large numbers of files are being processed.

The last 12 characters of the legend (Card 3, spaces 66-78) are used for file identification. Before a file of survey data is read in, a 7-word identification array called SENTNL is read in from the beginning of the tape file. The first two words in SENTNL are compared with the last two words in LEGEND. If a match is not found, the tape is positioned at the beginning of the next file and a new SENTNL array is read in. This procedure is in lines 48 through 52 of the source language listing of RAPLOT II in Appendix A. It has been deleted from RAPLOT III.

2. Tape Input

When a RIST survey is underway in the field, data from various sensors are assembled by the onboard detector system, and punched on 8-channel paper tape in American Standard Code for Information Interchange (ASCII) code. At present, there are seven data fields for each line of record. A brief description of the variables and the tape record format is given in Table II; Figure 4 is a sample listing from a paper-tape data file.

In the actual processing of the RIST data files, it has been found necessary to edit the data files prior to putting them through the RAPLOT II program. The edited data are written out in unformatted magnetic tape files. This is why the READ statement in line 58 of the listing in Appendix A is an unformatted FORTRAN READ statement. Unformatted (or binary) input-output statements are much more efficient for the computer to execute than formatted statements. For that reason, they are employed wherever possible. RAPLOT III employs a formatted READ statement (line 51, Appendix B) for inputting a data file, since the need for short turn-around time is greater than the need to edit data files when supporting a field test.

TABLE I

Format of Program Control Cards

I Data Control Card (3F3.0,2F7.0,1X,2F2.0,F3.0,F5.2,3F2.0,4(1X,F7.0),I3)

Column	Variable	Description
1-3	CABLE	Length of cable, in feet, on which the detector is towed.
4-6	DEPTH	Average water depth plus freeboard, in feet.
7-9	BOAT	Distance from radar mast to cable stanchion in feet.
10-16	BKG(1)	Estimated background count rate (counts per second) for radiation channel 1.
17-23	BKG(2)	Same for radiation channel 2.
25-28	ZHR,ZMIN	The time of injection in hours and minutes (24-hour clock).
29-31	DAYS	The number of days that have elapsed since the injection.
32-36	HLIFE	The halflife of the radioisotope in days.
37-40	SETIME, RMIN	The time when the survey was started, in hours and minutes (24-hour clock).
41-42	SEC	The time, in seconds, between successive fixes.
44-50	BEACIN	California Lambert Coordinates of the radar beacons. BEACON 1 is always the upcoast beacon.
52-58	BEACIE	
60-66	BEAC2N	
68-74	BEAC2E	
75-77	ISKIP	The number of lines to skip at the beginning of a data set in order to avoid reading in some bad data.

TABLE I (Continued)

Format of Program Control Cards

II Plot Control Card (4I1,F10.0,1X,3I2,1X,F10.0,2(1X,F10.0),1X,A6)

Column	Variable	Description
1-4	NOPT	Plot option controls. A numeral 1 in the column indicated causes the various options to be executed.
1		Plot trackline followed by survey vessel.
2		Plot uncorrected radiation values.
3		Plot radiation values corrected for background and for decay since injection.
4		Unused.
5-14	SCALE	Map scale in feet per inch.
16-17	NPLT(1)	Options used for spotting data points for each plot option. User can specify that every Nth point be plotted. If left blank, every point will be plotted.
18-19	NPLT(2)	
20-21	NPLT(3)	
23-32	GRID	Intervals on the coordinate grid at which Lambert Coordinates will be posted. If GRID=0, tick marks are not plotted.
34-43	DUMP 1	Distance in meters from the injection site to the upcoast and downcoast beacon, respectively. If the fields are blank, then the injection site is not plotted.
45-54	DUMP 2	
56-61	INDATE	Day, month and year that the radioactive sand was injected.

III Plot legend card (13A6,L2)

1-78	LEGEND	A descriptive legend that is included on the printed output, and is also written on the lower margin of the map.
79-80	JOBEND	The letter 'T' is entered here if the data file being processed is the last one in the job. Otherwise the field is left blank.

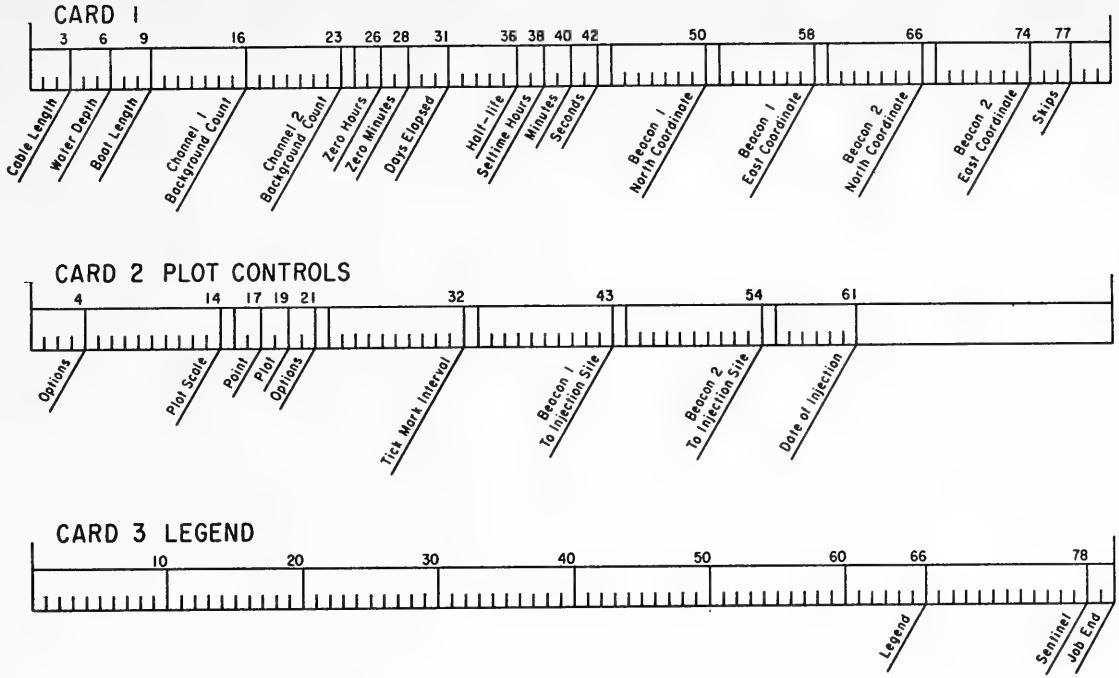


Figure 3. Data Sheet for RAPLOT II Control Cards

TABLE II

Format of Paper-tape Record on Which RIST Survey Data is Collected
Paper-Tape Format (I6,3F7.1,3F7.0)

Column	Array	Description
1-6	NMBR	A line (record) number which is incremented with each line of data unless manually reset.
8-13	TIME	Cumulative time, in tenths of seconds, since the beginning of the survey. Time is reset to zero at the beginning of each survey.
15-20	D_1	Distance, in tenths of meters, from the upcoast radar responder beacon.
22-27	D_2	Distance, in tenths of meters, from the downcoast radar responder beacon.
29-34	RAD_1	Radiation Channel 1: pulses from differential discriminator accumulated for time between successive records. It is automatically reset to zero at the writing of each record.
36-41	RAD_2	Radiation Channel 2: same description.
43-48	FATH	Depth of water recorded by fathometer. This is not presently in operation.

```
000061 001240 001763 004900 000236 000201 000000
000062 001260 001793 004916 000175 000142 000000
000063 001280 001814 004919 000155 000132 000000
000064 001300 001846 004924 000150 000130 000000
000065 001320 001861 004929 000142 000119 000000
000066 001340 001878 004930 000152 000136 000000
000067 001360 001920 004920 000149 000124 000000
000068 001380 001925 004825 000152 000116 000000
000069 001400 001958 004947 000136 000114 000000
000070 001420 001980 004975 000130 000110 000000
000071 001440 001022 004932 000130 000101 000000
000072 001460 002027 004932 000127 000104 000000
000073 001480 002043 004945 000144 000117 000000
000074 001500 002092 004977 000145 000123 000000
000075 001520 002120 004966 000108 000089 000000
000076 001540 002143 004970 000140 000115 000000
000077 001560 002157 004970 000143 000117 000000
000078 001580 002189 004979 000174 000136 000000
000079 001600 002206 004981 000142 000114 000000
000080 001620 002234 004999 000138 000122 000000
000081 001640 002265 004996 000133 000108 000000
000082 001660 002286 004998 000188 000155 000000
000083 001680 002315 004016 000122 000101 000000
000084 001700 002327 005048 000164 000131 000000
000085 001720 002365 005011 000166 000133 000000
000086 001740 002386 005021 000178 000151 000000
000087 001760 002403 005039 000152 000120 000000
000088 001780 002448 005075 000133 000105 000000
000089 001800 002471 005073 000154 000131 000000
000090 001820 002497 005077 000169 000143 000000
000091 001840 002509 005089 000151 000128 000000
000092 001860 002549 005109 000174 000153 000000
000093 001880 002580 005135 000153 000130 000000
000094 001900 002611 005138 000158 000126 000000
000095 001920 002629 005156 000154 000124 000000
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000097 001960 002693 005191 000170 000141 000000
000098 001980 002719 005207 000189 000151 000000
000099 002000 002757 005211 000167 000137 000000
000100 002020 000774 005219 000147 000120 000000
000101 002040 000808 005238 000170 000133 000000
000102 002060 002836 005266 000173 000129 000000
000103 002080 002868 005272 000149 000126 000000
000104 002100 002902 005280 000146 000126 000000
000105 002120 002916 005302 000192 999149 000000
000106 002140 002958 005322 000140 000114 000000
000107 002160 002997 005342 000170 000136 000000
000108 002180 002028 005355 000163 000133 000000
000109 002200 003044 005363 000142 000121 000000
```

Figure 4. Sample Listing of Input Data File for RAPLOT II

Section E. PROGRAM OUTPUT

1. Printed Output

Three forms of output are generated by the RAPLOT II program - printed output, graphical output, and magnetic tape output.

The printed output for one data file consists of one page listing the program control parameters and summary statistics (Figure 5) followed by a complete listing of the unprocessed and processed data arrays (Figure 6).

The printout of program parameters and summary statistics for RAPLOT III (Figure 7) is virtually the same. However, the radar-range data and uncorrected radiation data are deleted from the printed listing (Figure 8). Also, only one channel of corrected radiation data is included.

Because of the large volume of data files that may be processed by the RAPLOT II program, it is usually necessary to keep track of the number of pages of output. Fifty lines are printed to a page of output; one page is required for program control parameters and another page for summary statistics. Therefore, the number of pages per data file = 2 + (number of lines of data/50.)

2. Graphical Output

Graphical output from RAPLOT II is in the form of plot commands that are either written out on magnetic tape or punched onto cards to be used to drive a Benson-Lehner plotter off-line. Under the present setup, the plot commands are written out on logical tape unit 9; therefore, this same unit cannot be used for other tape input or output without first making changes. On the UNIVAC 1108 system, the plot commands are blocked and written out in card image length records at 556 bits per inch in even parity, BCD. Experience has shown that one full tape will hold approximately 20 separate plots. Assuming that 2 plots are generated per file of data, this means that 10 files of radiation survey data will generate a full tape of plot commands.

RAPLOT II graphical output consists of three types of plots - plots of the trackline followed by the survey vehicle, plots of uncorrected radiation data (for plotting background radiation), and plots of corrected radiation data. Selection of the various plots is controlled by the variable NOPT in Table I. The plot selection options are independent of each other. Any one of the three plot types may be selected, or all three if it is desired. Normally, the trackline plot is selected and then, depending on whether the data is from a background or a radiation survey, either the plot of uncorrected radiation or corrected radiation data is selected. Plots of the survey vehicle trackline and the corrected radiation data are shown in Figures 9 and 10.

```
·REAL TIME CLOCK INTERROGATED AT 17:30.15
      SURF  600 FT S  R-158 O/S  RADIATION SURVEY  AU-198          1451  10/04/1968 5            F

   BEACON 1   451655.N  1217236.E     BEACON 2   445357.N  1218250.E


   SQUARE DIST BETWEEN =     .40693000+08     DISTANCE BETWEEN =     6379.
   SINE =    -.98728560-00     COSINE =     .15895643-00
   INJECTION TIME =11.13.          CLOCK SET AT14.51.     DIGITIZING INTERVAL = 2.SECONDS
   DAYS ELAPSED SINCE INJECTION = 0.
   HALF-LIFE OF ISOTOPE =   3.00DAYS     DECAY FACTOR =     .96270442-02     TIME-DELAY FACTOR =   3.63HOURS
      CABLE LENGTH = 75.          MEAN WATER DEPTH = 10.          BOAT LENGTH = 12.
      DISTANCE FROM RADAR MAST TO DETECTOR =  86.3FEET.


                                    PLOTS GENERATED
      TRACKLINE    1          BACKGROUND RADIATION    0          CORRECTED RADIATION    1

                10/04/1968 5


                SUMMARY STATISTICS OF BACKGROUND RADIATION COUNT RATE
                          RAD CHANNEL 1      RAD CHANNEL 2
      EST. BKG. COUNTS/SEC.       310.               250.
      MEAN BKG. COUNTS/SEC.       317.               254.
      STD. DEV. COUNTS/SEC.        20.                18.


                SUM OF CORRECTED RADIATION COUNTS
                     RADIATION CHANNEL 1     .40784094+07
                     RADIATION CHANNEL 2     .24124798+07


                SUMMARY STATISTICS OF RADIATION LOCATION.
                        NORTH COORD          EAST COORD
                MEAN        445611.            1217433.
             STD. DEV.          47.                 89.
          CONFIDENCE
        LIMIT OF MEAN            1.                  2.


        MAXIMUM COORD      446198.N           1218147.E


        MINIMUM COORD      444978.N           1216821.E
```

Figure 5. Printed Output of RAPLOT II Program Control Parameters and Summary Statistics for One Data File

SURF 600 FT S R=158 O/S RADIATION SURVEY AU-198 1451 10/04/1968 5

LINE	TIME SEC	DISTANCE TO BEACON 1	2	RADIATION COUNT RAD1	RAD2	BOAT COORDINATES N	E	BALL COORDINATES N	E	CORRECTED RADIATION RAD1	RAD2
54	110.	1843.1	239.7	8065.	6066.	445604.	1217494.	445587.	1217578.	3848.	2879.
55	112.	1842.5	241.9	1860.	1502.	445606.	1217487.	445588.	1217571.	635.	515.
56	114.	1841.9	243.1	8107.	6305.	445608.	1217483.	445589.	1217567.	3870.	3003.
57	116.	1840.9	245.2	958.	762.	445611.	1217477.	445591.	1217561.	167.	132.
58	118.	1840.3	247.1	2725.	2215.	445612.	1217471.	445592.	1217555.	1083.	884.
59	120.	1840.7	248.8	17401.	12640.	445611.	1217465.	445593.	1217549.	8684.	6284.
60	122.	1839.4	251.8	10481.	8538.	445615.	1217455.	445595.	1217540.	5100.	4159.
61	124.	1838.8	254.7	60955.	45884.	445616.	1217446.	445598.	1217530.	31244.	23503.
62	126.	1839.2	255.7	45464.	34421.	445615.	1217442.	445598.	1217527.	23220.	17566.
63	128.	1837.9	257.9	94671.	51929.	445619.	1217436.	445600.	1217520.	48708.	26635.
64	130.	1837.1	260.6	77135.	35455.	445621.	1217427.	445602.	1217511.	39625.	18102.
65	132.	1836.5	262.7	99527.	52681.	445623.	1217421.	445603.	1217505.	51224.	27025.
66	134.	1837.2	264.2	93090.	48696.	445621.	1217415.	445604.	1217499.	47890.	24961.
67	136.	1835.1	266.0	97057.	46751.	445627.	1217411.	445606.	1217494.	49945.	23953.
68	138.	1836.4	267.7	90077.	55047.	445623.	1217403.	445607.	1217488.	46330.	28251.
69	140.	1835.1	270.0	102924.	54563.	445627.	1217397.	445608.	1217481.	52985.	28000.
70	142.	1834.6	271.7	103271.	52168.	445628.	1217391.	445610.	1217476.	53165.	26760.
71	144.	1834.1	273.1	101177.	50189.	445630.	1217387.	445611.	1217471.	52081.	25735.
72	146.	1833.2	275.2	105781.	56877.	445633.	1217381.	445612.	1217465.	54466.	29199.
73	148.	1833.1	277.2	105325.	57838.	445633.	1217374.	445614.	1217458.	54230.	29697.
74	150.	1832.3	279.5	98000.	47192.	445635.	1217367.	445615.	1217451.	50436.	24183.
75	152.	1831.9	281.2	90976.	42361.	445637.	1217361.	445617.	1217445.	46797.	21680.
76	154.	1830.6	282.6	99412.	50021.	445641.	1217358.	445618.	1217441.	51168.	25648.
77	156.	1829.9	285.2	100796.	66012.	445643.	1217349.	445620.	1217433.	51885.	33932.
78	158.	1831.5	287.4	94070.	65442.	445638.	1217340.	445622.	1217425.	48401.	33637.
79	160.	1830.4	289.3	99616.	66481.	445641.	1217335.	445623.	1217419.	51274.	34175.
80	162.	1828.1	291.1	104735.	56326.	445649.	1217331.	445624.	1217414.	53926.	28915.
81	164.	1828.5	293.1	93753.	64126.	445646.	1217323.	445626.	1217407.	48238.	32956.
82	166.	1828.7	295.2	97060.	63602.	445646.	1217316.	445628.	1217400.	49951.	32685.
83	168.	1827.2	297.5	93157.	43312.	445651.	1217310.	445629.	1217393.	47929.	22174.
84	170.	1828.2	299.7	83310.	54378.	445648.	1217301.	445631.	1217386.	42828.	27907.
85	172.	1826.4	301.6*	62522.	47361.	445654.	1217296.	445632.	1217380.	32060.	24272.
86	174.	1825.2	303.5	105403.	57939.	445658.	1217291.	445634.	1217374.	54274.	29752.
87	176.	1825.7	305.3	90326.	44991.	445656.	1217284.	445635.	1217368.	46464.	23044.
88	178.	1825.0	307.5	92640.	48754.	445658.	1217277.	445637.	1217361.	47663.	24994.
89	180.	1824.5	309.4	93799.	52621.	445660.	1217271.	445639.	1217355.	48263.	26997.
90	182.	1825.2	311.4	90736.	45406.	445657.	1217264.	445640.	1217349.	46677.	23259.
91	184.	1823.9	313.4	86256.	38661.	445662.	1217258.	445642.	1217342.	44356.	19765.
92	186.	1823.1	315.9	93013.	44196.	445664.	1217251.	445644.	1217334.	47857.	22633.
93	188.	1821.8	318.1	101368.	54468.	445668.	1217244.	445645.	1217327.	52186.	27954.
94	190.	1822.0	320.0	104634.	67960.	445668.	1217235.	445648.	1217319.	53878.	34944.
95	192.	1820.8	323.3	85960.	62040.	445672.	1217228.	445650.	1217311.	44204.	31878.
96	194.	1820.0	326.2	75456.	55731.	445674.	1217218.	445652.	1217302.	38762.	28609.
97	196.	1820.2	328.9	55074.	41312.	445674.	1217209.	445654.	1217293.	28203.	21139.
98	198.	1818.5	331.8	56601.	43581.	445679.	1217201.	445657.	1217284.	28994.	22315.
99	200.	1817.1	334.8	41716.	32880.	445684.	1217192.	445659.	1217275.	21283.	16771.
100	202.	1816.3	337.5	43710.	33666.	445687.	1217183.	445662.	1217266.	22316.	17178.
101	204.	1814.1	340.5	25112.	19875.	445694.	1217175.	445665.	1217257.	12681.	10034.
102	206.	1812.2	343.7	20933.	16963.	445700.	1217166.	445669.	1217247.	10516.	8525.
103	208.	1812.5	346.8	21475.	17336.	445700.	1217155.	445672.	1217237.	10797.	8718.

Figure 6. Sample of Printed Output of RAPLOT II Processed Data for One RIST Data File

```
     PT MUGU GROIN SITE  BACKGROUNT SURVEY 1  23/09/69  1445                                        F

BEACON 1   228153.N  1648821.E      BEACON 2   227348.N  1649710.E

SQUARE DIST BETWEEN =  0.14383460E 07      DISTANCE BETWEEN =      1199.
SINE = -0.67121892E 00      COSINE =  0.74125916E 00
INJECTION TIME =10. 0.           CLOCK SET AT14.45.      DIGITIZING INTERVAL = 2.SECONDS
DAYS ELAPSED SINCE INJECTION = 0.
HALF-LIFE OF ISOTOPE =    3.00DAYS      DECAY FACTOR =  0.96270442E-02      TIME-DELAY FACTOR =    4.75HOURS
    CABLE LENGTH = 75.           MEAN WATER DEPTH = 12.           BOAT LENGTH = 12.
    DISTANCE FROM RADAR MAST TO DETECTOR =  86.0FEET.


                                PLOTS GENERATED
    TRACKLINE    1          BACKGROUND RADIATION    1          CORRECTED RADIATION   -0

            SUMMARY STATISTICS OF BACKGROUND RADIATION COUNT RATE
    EST. BKG. COUNTS/SEC.        75.
    MEAN BKG. COUNTS/SEC.        78.
    STD. DEV. COUNTS/SEC.         9.


 MAXIMUM COORD          228192.N           1649201.E


 MINIMUM COORD          226291.N           1647486.E
```

Figure 7. Printed Output of RAPLOT III Program Control Parameters and Summary Statistics for One Data File

PT MUGU GROIN SITE BACKGROUNT SURVEY 1 23/09/69 1445

LINE	TIME SEC	DISTANCE TO BEACON 1	2	BOAT COORDTNATES NORTH	EAST	BALL COORDINATES NORTH	EAST	UNCORRECTED RADIATION	CORRECTED COUNTS/SEC	DEPTH FEET
0	2.			228177.	1648434.	228092.	1648429.		75.	0.
1	4.			228192.	1648435.	228106.	1648430.		92.	0.
2	6.			228182.	1648427.	228106.	1648430.		106.	0.
3	8.			228181.	1648424.	228106.	1648430.		88.	0.
4	10.			228171.	1648419.	228106.	1648430.		102.	0.
5	12.			228168.	1648416.	228106.	1648430.		97.	0.
6	14.			228160.	1648408.	228106.	1648430.		106.	0.
7	16.			228145.	1648406.	228106.	1648430.		104.	0.
8	18.			228145.	1648402.	228106.	1648430.		96.	0.
9	20.			228141.	1648398.	228106.	1648430.		92.	0.
10	22.			228130.	1648394.	228106.	1648430.		101.	0.
11	24.			228118.	1648392.	228106.	1648430.		100.	0.
12	26.			228119.	1648385.	228106.	1648430.		92.	0.
13	28.			228124.	1648379.	228106.	1648430.		113.	0.
14	30.			228108.	1648373.	228106.	1648430.		96.	0.
15	32.			228105.	1648361.	228106.	1648430.		100.	0.
16	34.			228101.	1648354.	228106.	1648430.		71.	0.
18	38.			228072.	1648336.	228101.	1648416.		70.	0.
19	40.			228063.	1648325.	228096.	1648404.		74.	0.
20	42.			228050.	1648316.	228090.	1648392.		59.	0.
21	44.			228040.	1648308.	228084.	1648382.		57.	0.
22	46.			228023.	1648301.	228075.	1648370.		72.	0.
23	48.			228015.	1648295.	228069.	1648362.		79.	0.
24	50.			228011.	1648288.	228063.	1648355.		63.	0.
25	52.			228005.	1648278.	228057.	1648347.		60.	0.
26	54.			227994.	1648273.	228050.	1648339.		76.	0.
27	56.			227989.	1648266.	228044.	1648332.		74.	0.
28	58.			227992.	1648254.	228040.	1648325.		66.	0.
29	60.			227970.	1648251.	228029.	1648314.		71.	0.
30	62.			227970.	1648241.	228024.	1648307.		76.	0.
31	64.			227960.	1648232.	228015.	1648298.		81.	0.
32	66.			227957.	1648220.	228009.	1648288.		75.	0.
33	68.			227942.	1648214.	227999.	1648278.		63.	0.
34	70.			227935.	1648204.	227992.	1648269.		66.	0.
35	72.			227919.	1648205.	227983.	1648262.		80.	0.
36	74.			227921.	1648199.	227982.	1648260.		80.	0.
37	76.			227913.	1648197.	227976.	1648255.		78.	0.
38	78.			227914.	1648192.	227974.	1648253.		64.	0.
39	80.			227906.	1648185.	227967.	1648246.		48.	0.
40	82.			227895.	1648179.	227958.	1648237.		52.	0.
41	84.			227894.	1648173.	227955.	1648234.		68.	0.
42	86.			227881.	1648173.	227947.	1648228.		64.	0.
43	88.			227886.	1648164.	227945.	1648226.		82.	0.
44	90.			227875.	1648157.	227936.	1648217.		59.	0.
45	92.			227862.	1648152.	227927.	1648208.		56.	0.
46	94.			227854.	1648147.	227920.	1648203.		64.	0.
47	96.			227856.	1648141.	227918.	1648201.		74.	0.
48	98.			227845.	1648138.	227910.	1648194.		75.	0.
49	100.			227833.	1648134.	227901.	1648187.		57.	0.
50	102.			227825.	1648128.	227893.	1648181.		55.	0.

Figure 8. Sample of Printed Output of RAPLOT III Processed Data for One RIST Data File

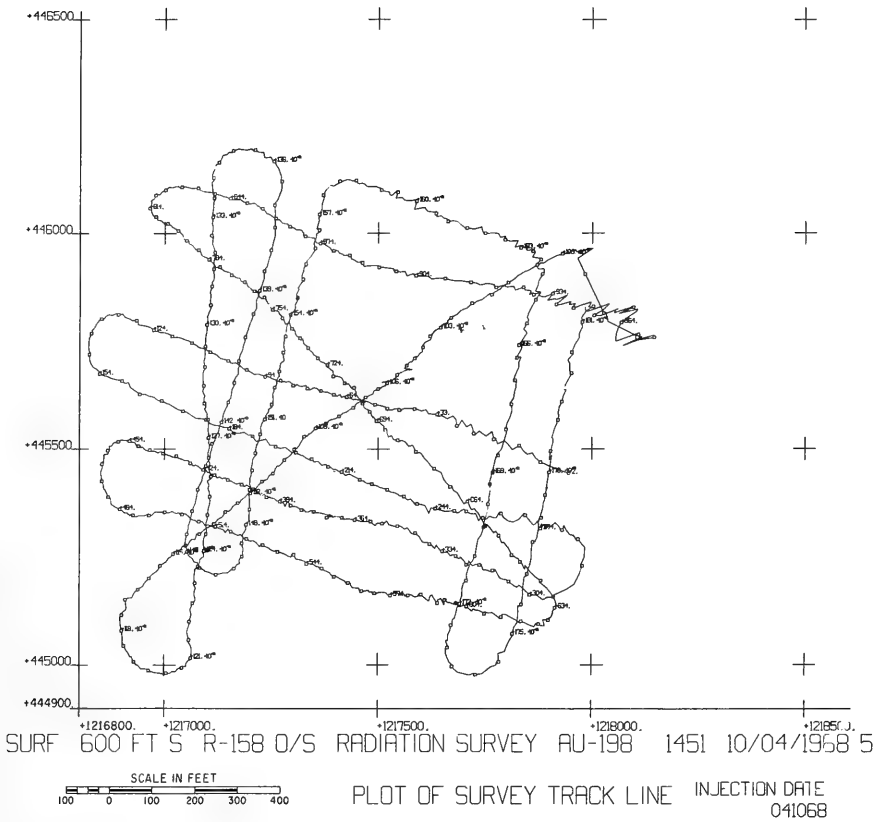

Figure 9. Trackline Plot Produced on Benson-Lehner Plotter by Subroutine BENLH2 of RAPLOT II

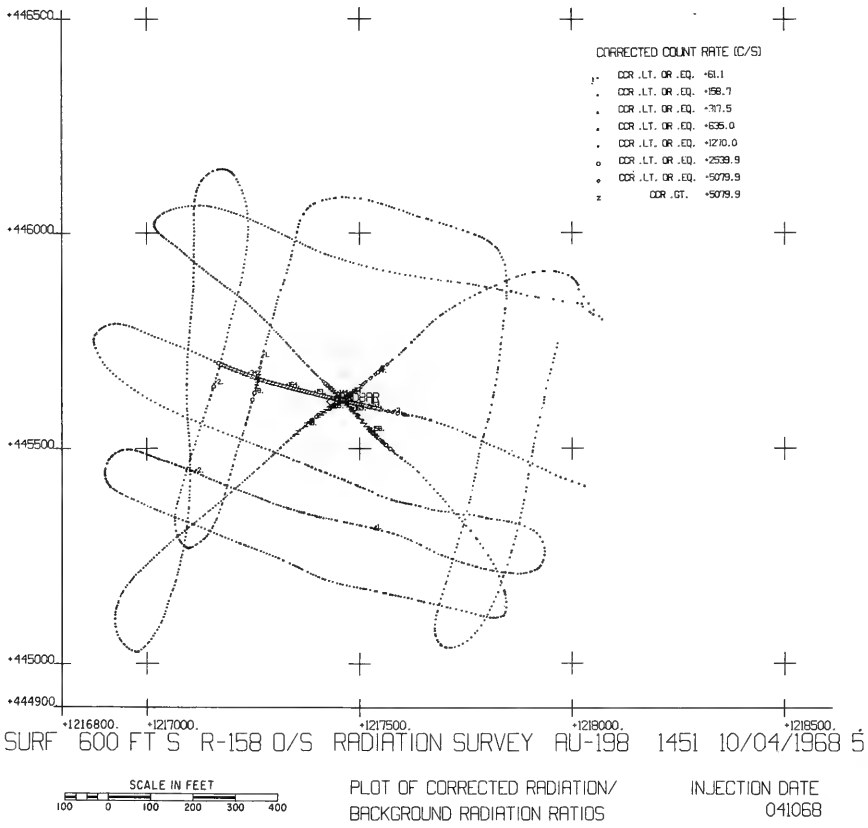

Figure 10. Plot of Corrected Radiation Data Produced on Benson-Lehner Plotter by Subroutine BENLH2 of RAPLOT II

The graphical output from RAPLOT III is produced on the Stromberg-Carlson 4020 computer recorder. The technique for getting the plots is somewhat the same as the Benson-Lehner plotter in that the plot commands are written out on magnetic tape and are then used off-line to generate the plots. There is a highly developed software package that goes with the S-C 4020 and if it is planned to use this method of generating plots, the Programmers' Reference Manual for the S-C 4020 should be used. Figure 11 is a trackline plot produced on the computer recorder at the Pacific Missile Range data processing center at Point Mugu. Figure 12 is a plot of uncorrected radiation data that was also produced there.

3. Magnetic Tape Output

The processed data is stored on magnetic tape for future reference by the calls to the NTRAN subroutine. The arrays written out are: LEGEND, sequence number (NMBR), coordinates of radiation location (NCORD and ECORD), and corrected radiation data (CCR). This procedure has been eliminated from RAPLOT III.

Section F. INSTRUCTIONS FOR RUNNING PROGRAM

An example of a job deck setup for running RAPLOT II is shown in Figure 13. Further instructions on running jobs are in the 1108 EXEC II Programmers' Reference Manual. Running time depends on the number of files being processed and the number of records in each file. Figure 14 shows a graph of UNIVAC 1108 central processing unit time to process one file versus the number of records in the file.

For running version III on the IBM 7094, consult the IBM reference manuals for FORTRAN IV and the system monitor (IBSYS). It may also be useful to have a copy of the Programmers' Reference Manual for the S-C 4020 Computer Recorder.

Section G. RADIATION CONTOURING PROGRAM

Present programming effort is directed toward completing RADCON, a FORTRAN V program for drawing contour maps of radiation data. The input for this program will be the files of processed data on magnetic tape that have been generated by RAPLOT II. If necessary, two or more data files may be combined to provide the input for one contour map. The radiation data are first smoothed by a moving average (LINAVE) procedure and then interpolated over a uniform grid by a weighted least-squares numerical approximation (NUPRX). The resulting grid is then contoured at equally spaced intervals of the gridded values. There are also options for transforming the radiation data, although the number of options and types of transformation is still undecided.

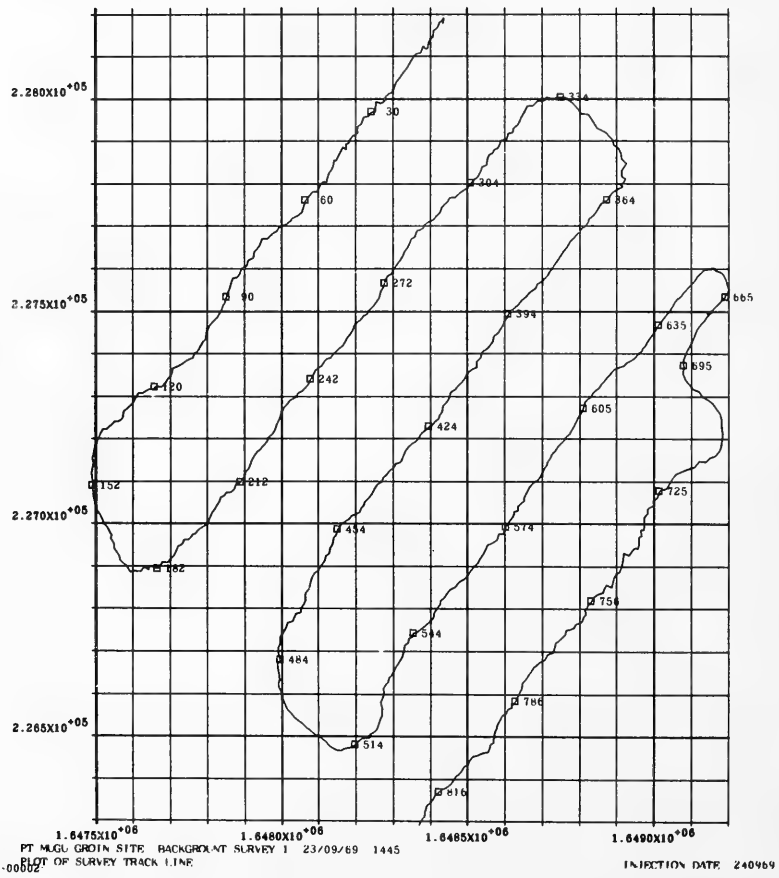

Figure 11. Trackline Plot Produced on S-C 4060 Computer Recorder by Subroutine TRACK of RAPLOT III

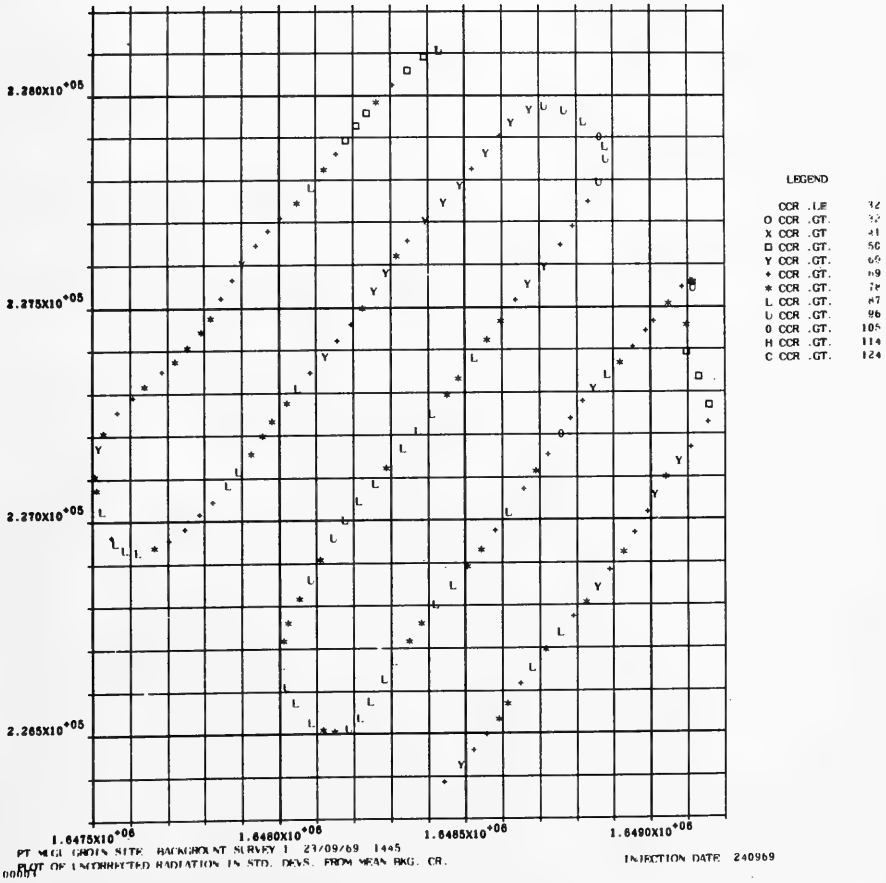

Figure 12. Plot of Uncorrected Radiation Data Produced on S-C 4060 Computer Records by Subroutine TRACK of RAPLOT III

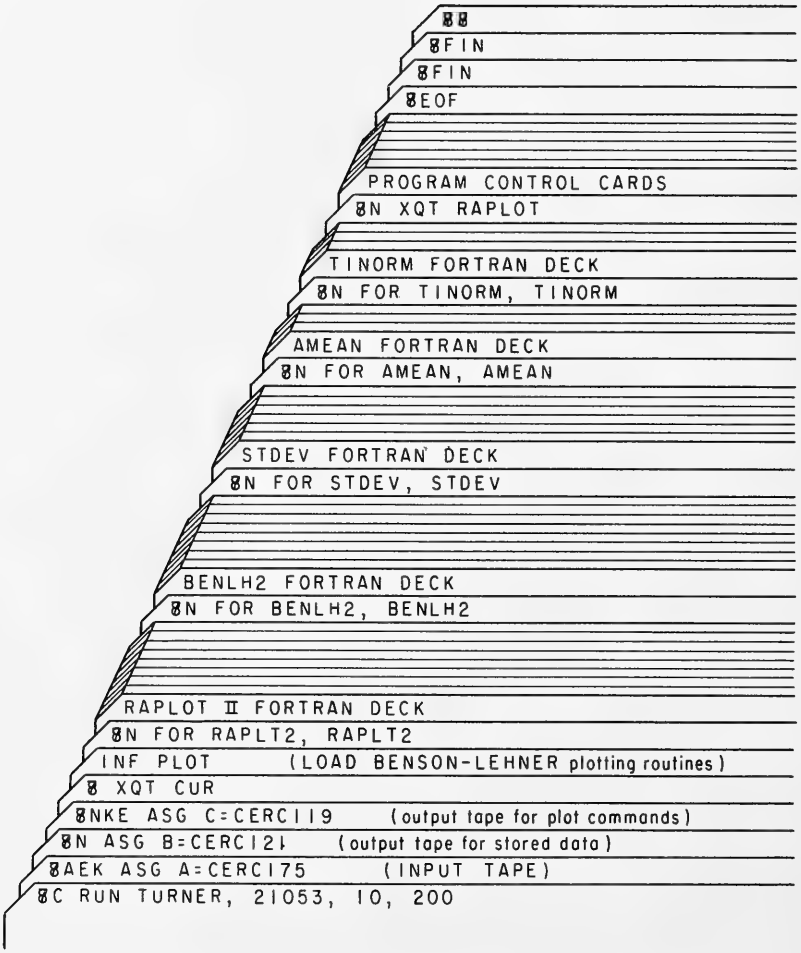

Figure 13. Example of a RAPLOT II Job Deck Setup for UNIVAC 1108 Running under EXEC II

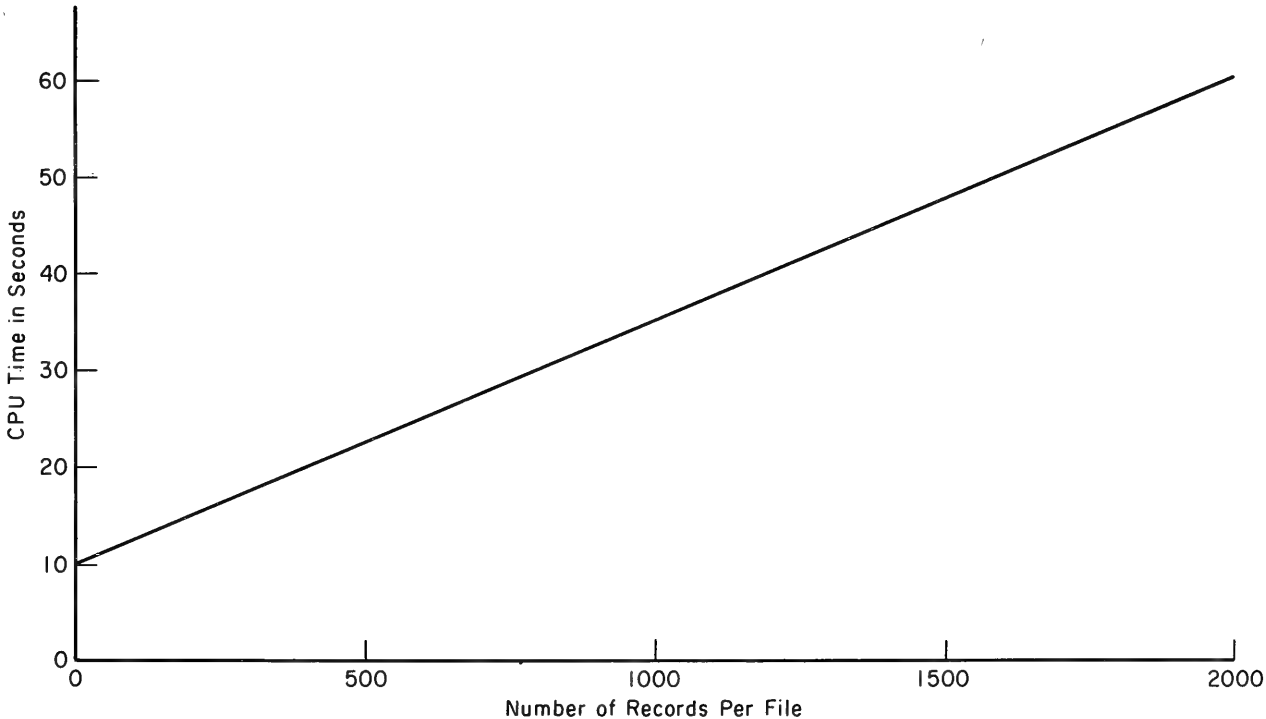

Figure 14. Graph of CPU Time Required to Plot One Data File Versus the Number of Records in the File.

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APPENDIX A

LISTING AND INDEX OF RAPLOT II PROGRAM

The source deck has been analyzed routine-by-routine and a directory of all statement numbers and variable names used in the source deck. The symbols are listed numerically and alphabetically. Beside each symbol appears line numbers followed by a code which designates where and how the symbol was referenced. The codes used are as follows:

Code	Meaning
Blank	A simple reference, such as the use of a statement number in an IF statement or a variable used in an arithmetic statement.
=	Arithmetic definition of a variable which appears on the left of an = sign.
*	Statement number defined at this line.
AG	Variable appears as an argument in a subroutine or function statement or as an argument in a CALL statement.
CO	Variable appears in a COMMON statement.
CX	Variable appears in a COMPLEX statement.
DA	Variable appears in a DATA statement.
DB	Variable appears in a DOUBLE PRECISION statement.
DI	Variable appears in a DIMENSION statement.
EQ	Variable appears in an EQUIVALENCE statement.
EX	Function name appears in an EXTERNAL statement.
IN	Variable appears in an INTEGER statement.
LG	Variable appears in a LOGICAL statement.
NM	Variable appears in a NAMELIST statement.
PR	Variable or FORMAT number appears in a PRINT statement.
PU	Variable or FORMAT number appears in a PUNCH statement.
RD	Variable or FORMAT number appears in a READ statement.
RL	Variable appears in a REAL statement.
WR	Variable or FORMAT number appears in a WRITE statement.

PROGRAM -- RAPLOT II

```
C              PROGRAM --  RAPLOT II                                          1
C      THE PURPOSE OF THIS PROGRAM IS TO REDUCE THE RADIOACTIVITY SURVEY      2
C      DATA FROM THE RIST PROJECT AND PLOT THE SURVEY ON A BENSON-LEHNER      3
C      INCREMENTAL PLOTTER.  THE FOLLOWING PLOTS ARE THE OUTPUT:             4
C         TRACKLINE FOLLOWED BY SURVEY VESSEL                                5
C         PLOT OF UNCORRECTED RADIATION VALUES (BACKGROUND SURVEY)           6
C         SYMBOL PLOT OF RADIATION VALUES CORRECTED FOR BACKGROUND AND       7
C                  DECAY SINCE INJECTION TIME.                               8
C         PROGRAMMER:  PHILIP A. TURNER                                      9
C                      GEOLOGY BRANCH                                        10
C                      U S ARMY COASTAL ENGINEERING RESEARCH CENTER           11
C                      5201 LITTLE FALLS ROAD                                12
C                      WASHINGTON, D. C.   20016                             13
C         COMPLETED IN JANUARY  1969                                         14
C                                                                            15
C      FORMAT AND ENTRIES ON DATA CONTROL CARD                               16
C          COL  1- 3  CABLE LENGTH IN FEET TO THE NEAREST FOOT.              17
C          COL  4- 6  WATER DEPTH PLUS FREEBOARD TO THE NEAREST FOOT.        18
C          COL  7- 9  DISTANCE FROM RADAR MAST TO CABLE STANCHION IN FEET    19
C                     TO THE NEAREST FOOT.                                   20
C          COL 10-16  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR      21
C                     CHANNEL 1.                                             22
C          COL 17-23  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR      23
C                     CHANNEL 2.                                             24
C          COL 25-28  TIME OF INJECTION IN HOURS AND MINUTES.                25
C          COL 29-31  THE NUMBER OF DAYS SINCE THE INJECTION                 26
C          COL 32-36  THE HALF LIFE OF THE RADIOISOTOPE IN DAYS.             27
C                        THE DECIMAL POINT MUST BE PUNCHED IN.               28
C          COL 37-40  THE TIME WHEN THE SURVEY WAS STARTED, IN HOURS AND     29
C                        MINUTES.                                            30
C          COL 41-42  TIME (IN SECONDS) BETWEEN SUCCESSIVE FIXES             305
C          COL 44-50  BEACON1 NORTH COORD/ LAMBERT COORDINATES OF RADAR      31
C          COL 52-58  BEACON1  EAST COORD/ BEACONS TO THE NEAREST FOOT.      32
C          COL 60-66  BEACON2 NORTH COORD/ BEACON1 IS ALWAYS UPCOAST.        33
C          COL 68-74  BEACON2  EAST COORD/                                   34
C          COL 75-77  THE NUMBER OF LINES OF DATA TO BE SKIPPED AT THE       35
C                        BEGINNING OF A DATA SET IN ORDER TO AVOID           36
C                        READING IN SOME BAD DATA.                           37
C      FORMAT AND ENTRIES ON PLOT CONTROL CARD                               38
C          COL  1- 3  PLOT OPTION CONTROL.  TO USE, PUNCH THE NUMERAL 1      39
C                     IN THE COLUMN INDICATED.                               40
C                     1 = PLOT TRACKLINE FOLLOWED BY SURVEY VESSEL.          41
C                     2 = PLOT UNCORRECTED RADIATION VALUES.                 42
C                     3 = PLOT RADIATION VALUES CORRECTED FOR BACKGROUND     43
C                        AND DECAY SINCE TIME ZERO.                          44
C                     4 = UNUSED. LEAVE BLANK.                               45
C          COL  5-14  MAP SCALE EXPRESSED IN FEET PER INCH                   46
C          COL 16-17  OPTION 1 / USE WHEN SPOTTING DATA FOR EACH PLOT        47
C          COL 18-19     )    2 / OPTION.  USER CAN SPECIFY THAT EVERY NTH   48
C          COL 20-21     )    4 / POINT BE PLOTTED.  IF LEFT BLANK, THE      49
C                           PROGRAM ASSUMES EVERY POINT IS TO BE             50
C                           PLOTTED.                                         51
C          COL 23-32  INTERVALS ON THE COORDINATE GRID AT WHICH TICK         52
C                     MARKS WITH THE LAMBERT COORDINATES WILL BE POSTED.     53
C                     IF FIELD IS LEFT BLANK, PROGRAM WILL ASSUME THAT       54
C                     NO TICK MARKS ARE TO BE PLOTTED AND POSTED.            55
C          COL 34-43  BEACON 1 / INJECTION SITE. DISTANCE IN METERS TO       56
C          COL 45 54  BEACON 2 / THE NAMED BEACONS. IF FIELDS ARE LEFT       57
C                           BLANK, SITE IS NOT PLOTTED.                      58
C          COL 56-61  DAY,MONTH AND YEAR THE SAND WAS INJECTED               59
C      FORMAT AND ENTRIES ON PLOT IDENTIFICATION CARD                        60
C          COL  1-78  THIS FIELD WILL BE PLOTTED ON THE LOWER MARGIN OF      61
C                     THE MAP.                                               62
C          COL 80     PUNCH 'T' HERE ON THE LAST DATA SET.                   63
1           COMMON NOPT(4),SCALE,NPLT(3),GRID,SITEN,SITEE,INDATE,LEGEND(13),BE  64
           1AC1N,BEAC1E,BEAC2N,BEAC2E,LINE,BGCR(2),SIGMA(2),NBAR,EBAR,NENTRY,N  65
           2MAX,NMIN,EMAX,EMIN                                                 66
2           REAL NORTH(2200),NCORD(2200),NBAR,NMAX,NMIN                        67
3           DIMENSION NMBR(2200), TIME(2200), D(2,2200), EAST(2200), ECORD(220  68
           10), RAD(2,2200), CCR(2,2200), L(4), IERR(2200), BKG(2), FATH(2200  69
           2), ISIGN(3)                                                        70
4           INTEGER SENTNL(7),WORD1,WORD2,BLANK,AS                             71
5           LOGICAL JOBEND                                                     72
C                                                                              73
C      NTAPE IS THE NUMBER FOR THE INPUT TAPE CONTAINING THE SURVEY DATA       74
C      ITAPE IS THE UNIT ON WHICH THE PROCESSED DATA IS WRITTEN OUT            75
C                                                                              76
6           DATA WORD1,WORD2,NTAPE,ITAPE,COR1,COR2,BLANK,AS/6HEND OF,6H DATA ,  77
           17,8,2,9,2,8,6H      ,1H*/                                         78
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```
      C                                                                      79
      C     READ IN DATA CONTROL CARD                                        80
      C                                                                      81
    7 10    IF (L(1).NE.-1) GO TO 20                                         82
    8       GO TO 10                                                         83
    9 20    IF (L(1).LT.-1) GO TO 770                                        84
   10       READ (5,780) CABLE,DEPTH,BOAT,BKG,ZHR,ZMIN,DAYS,HLIFE,SETIME,RMIN,  85
     1SEC,BEAC1N,BEAC1E,BEAC2N,BEAC2E,ISKIP                                  86
      C                                                                      87
      C     READ IN PLOT CONTROL PARAMETERS                                  88
      C                                                                      89
   11       READ (5,790) NOPT,SCALE,(NPLT(I),I=1,3),GRID,DUMP1,DUMP2,INDATE  90
   12       DO 40 I=1,3                                                      91
   13       IF (NPLT(I)) 30,30,40                                            92
   14 30    NPLT(I)=1                                                        93
   15 40    CONTINUE                                                         94
      C                                                                      95
      C     READ IN PLOT LEGEND                                              96
      C                                                                      97
   16       READ (5,800) LEGEND,JOBEND                                       98
   17       WRITE (6,810) LEGEND,JOBEND                                      99
   18       WRITE (6,820) BEAC1N,BEAC1E,BEAC2N,BEAC2E                       100
      C                                                                     101
      C     COMPUTE PROGRAM PARAMETERS FROM DATA CONTROL CARD ENTRIES       102
      C                                                                     103
   19       SQDSTB=(BEAC2N-BEAC1N)**2+(BEAC2E-BEAC1E)**2                    104
   20       DISTB=SQRT(SQDSTB)                                              105
   21       WRITE (6,830) SQDSTB,DISTB                                      106
   22       SINE=(BEAC2N-BEAC1N)/DISTB                                      107
   23       COSINE=(BEAC2E-BEAC1E)/DISTB                                    108
   24       WRITE (6,840) SINE,COSINE                                       109
   25       WRITE (6,850) ZHR,ZMIN,SETIME,RMIN,SEC,DAYS                     110
   26       ZHR=ZHR+ZMIN/60.                                                111
   27       SETIME=SETIME+RMIN/60.                                          112
   28       DELAY=SETIME+DAYS*24.-ZHR                                       113
   29       IF (HLIFE.GT.0.0) DECAY=ALOG(2.)/(HLIFE*24.)                    114
   30       WRITE (6,860) HLIFE,DECAY,DELAY                                 115
   31       WRITE (6,870) CABLE,DEPTH,BOAT                                  116
   32       CABLE=BOAT+SQRT(CABLE**2-DEPTH**2)                              117
   33       WRITE (6,880) CABLE                                             118
   34       WRITE (6,890) (NOPT(I),I=1,3)                                   119
      C                                                                     120
      C     COMPUTE COORDINATES OF THE INJECTION SITE FROM THE DISTANCES FROM  121
      C     THE BEACONS                                                     122
      C                                                                     123
   35       IF (DUMP1) 80,80,50                                             124
   36 50    DUMP1=(DUMP1+COR1)*3.28083                                      125
   37       DUMP2=(DUMP2+COR2)*3.28083                                      126
   38       DX1=(SQDSTB+DUMP1*DUMP1-DUMP2*DUMP2)/(DISTB*2.)                 127
   39       DY1=DUMP1*DUMP1-DX1*DX1                                         128
   40       IF (DY1) 60,60,70                                               129
   41 60    SITEN=-999999.                                                  130
   42       WRITE (6,900)                                                   131
   43       GO TO 80                                                        132
   44 70    DY1=-SQRT(DY1)                                                  133
   45       SITEE=DX1*COSINE-DY1*SINE+BEAC1E                                134
   46       SITEN=DX1*SINE+DY1*COSINE+BEAC1N                                135
   47       WRITE (6,910) SITEN,SITEE                                       136
      C                                                                     137
      C     TEST FILE SENTINEL TO BE SURE THAT THE CORRECT DATA FILE IS BEING  138
      C     READ IN                                                         139
      C                                                                     140
   48 80    READ (NTAPE) SENTNL                                             141
   49       IF (SENTNL(1).EQ.WORD1.AND.SENTNL(2).EQ.WORD2) GO TO 730        142
   50       IF (SENTNL(1).EQ.LEGEND(12).AND.SENTNL(2).EQ.LEGEND(13)) GO TO 90  143
   51       CALL NTRAN (NTAPE,8,1)                                          144
   52       GO TO 80                                                        145
   53 90    WRITE (6,920) SENTNL                                            146
      C                                                                     147
      C     READ IN THE DATA FILE FROM ONE RIST SURVEY                      148
      C                                                                     149
   54 100   IF (L(2).NE.-1) GO TO 110                                       150
   55       GO TO 100                                                       151
   56 110   IF (L(2).LT.-1) GO TO 770                                       152
   57       CALL NTRAN (ITAPE,1,13,LEGEND,L(1))                            153
   58       READ (NTAPE) LINE,(NMBR(N),TIME(N),D(1,N),D(2,N),RAD(1,N),RAD(2,N)  154
     1,FATH(N),N=1,LINE)                                                   155
   59       CALL NTRAN (NTAPE,8,1)                                          156
   60       IERR(1)=0                                                       157
   61       DO 130 N=2,LINE                                                 158
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```
62              IERR(N)=0                                                       159
        C                                                                       160
        C       CHECK TO SEE THAT LINE NUMBERS AND TIMES OF FIXES ARE IN MONOTONIC 161
        C       ASCENDING SEQUENCE.                                             162
        C                                                                       163
63              IF (NMBR(N).LE.NMBR(N-1)) NMBR(N)=NMBR(N-1)+1                   164
64              IF (TIME(N)-TIME(N-1)) 120,120,130                              165
65      120     TIME(N)=TIME(N-1)+SEC                                           166
66      130     CONTINUE                                                        167
67              IF (ISKIP.LE.0) GO TO 160                                       168
        C                                                                       169
        C       SKIP LEADING CARD IMAGES THAT CONTAIN BAD DATA.                 170
        C                                                                       171
68              NSTART=ISKIP+1                                                  172
69              DO 150 N=NSTART,LINE                                            173
70              NMBR(N-ISKIP)=NMBR(N)                                           174
71              TIME(N-ISKIP)=TIME(N)                                           175
72              DO 140 I=1,2                                                    176
73              D(I,N-ISKIP)=D(I,N)                                             177
74      140     RAD(I,N-ISKIP)=RAD(I,N)                                         178
75      150     FATH(N-ISKIP)=FATH(N)                                           179
76              LINE=LINE-ISKIP                                                 180
77      160     MSTOP=LINE-1                                                    181
        C                                                                       182
        C       CHECK DISTANCES TO RADAR BEACONS FOR ERRORS.  IF DISTANCE/TIME   183
        C       FOR SUCCESSIVE BEACON RANGES INDICATE A SHIP SPEED .GT. 6 KNOTS 184
        C       (3.09 METERS/SEC),RANGE IS IN ERROR.                            185
        C                                                                       186
78              DO 270 I=1,2                                                    187
79              DO 200 M=1,MSTOP                                                188
80              IF (D(I,M)) 200,200,170                                         189
81      170     NSTART=M+1                                                      190
82              DO 190 N=NSTART,LINE                                            191
83              IF (ABS(D(I,N)-D(I,M))-(TIME(N)-TIME(M))*3.08865) 200,200,180   192
84      180     D(I,N)=-1.                                                      193
85              IERR(N)=IERR(N)+1                                               194
86      190     CONTINUE                                                        195
87      200     CONTINUE                                                        196
88              DO 260 M=1,MSTOP                                                197
89              IF (D(I,M)) 210,210,260                                         198
90      210     NSTART=M                                                        199
        C                                                                       200
        C       CORRECT ERRONEOUS BEACON RANGES BY LINEAR INTERPOLATION (ON TIME) 201
        C       BETWEEN NON-ERRONEOUS RANGES.                                   202
        C                                                                       203
91              DO 230 N=NSTART,LINE                                            204
92              IF (D(I,N)) 230,230,220                                         205
93      220     NSTOP=N                                                         206
94              GO TO 240                                                       207
95      230     CONTINUE                                                        208
96      240     DTIME=TIME(NSTOP)-TIME(NSTART-1)                                209
97              DD1=D(I,NSTOP)-D(I,NSTART-1)                                    210
98              N=NSTART                                                        211
99      250     D(I,N)=D(I,NSTART-1)+DD1*(TIME(N)-TIME(NSTART-1))/DTIME         212
100             N=N+1                                                           213
101             IF (N-NSTOP) 250,260,260                                        214
102     260     CONTINUE                                                        215
103     270     CONTINUE                                                        216
        C                                                                       217
        C       COMPUTE POSITION OF SHIP FROM DISTANCES FROM THE TWO BEACONS    218
        C                                                                       219
104             LAG=0                                                           220
105             DO 300 N=1,LINE                                                 221
        C                                                                       222
        C       MAKE CONSTANT CORRECTION FOR CUBIC AUTOTAPE INTERROGATOR        223
        C       AND CONVERT TO FEET                                             224
        C                                                                       225
106             DFT1=(D(1,N)+COR1)*3.28083                                      226
107             DFT2=(D(2,N)+COR2)*3.28083                                      227
108             DX1=(SQDSTB+DFT1*DFT1-DFT2*DFT2)/(2.*DISTB)                     228
109             DY1=DFT1*DFT1-DX1*DX1                                           229
        C                                                                       230
        C       CHECK FOR IMAGINARY ROOT.                                       231
        C                                                                       232
110             IF (DY1) 280,280,290                                            233
111     280     IERR(N)=IERR(N)+4                                               234
112             LAG=LAG+1                                                       235
113             GO TO 300                                                       236
114     290     DY1=-SQRT(DY1)                                                  237
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      C                                                                       238
      C     ROTATE COORDINATES AND TRANSLATE INTO CALIFORNIA LAMBERT COORDINAT 239
      C     SYSTEM                                                            240
      C                                                                       241
115           EAST(N)=DX1*COSINE-DY1*SINE+BEAC1E                              242
116           NORTH(N)=DX1*SINE+DY1*COSINE+BEAC1N                             243
117     300   CONTINUE                                                        244
118           IF (LAG.EQ.0) GO TO 360                                         245
119           ASSIGN 360 TO KEY                                               246
      C                                                                       247
      C     ELIMINATE DATA SETS FOR WHICH AN                                  248
      C     IMAGINARY FIX WAS OBTAINED                                        249
      C                                                                       250
120     310   LAG=0                                                           251
121           DO 350 N=1,LINE                                                 252
122           IF (IERR(N)-4) 330,320,320                                      253
123     320   LAG=LAG+1                                                       254
124           GO TO 350                                                       255
125     330   NMBR(N-LAG)=NMBR(N)                                             256
126           TIME(N-LAG)=TIME(N)                                             257
127           DO 340 I=1,2                                                    258
128           D(I,N-LAG)=D(I,N)                                               259
129     340   RAD(I,N-LAG)=RAD(I,N)                                           260
130           EAST(N-LAG)=EAST(N)                                             261
131           NORTH(N-LAG)=NORTH(N)                                           262
132           IERR(N-LAG)=IERR(N)                                             263
133     350   CONTINUE                                                        264
134           LINE=LINE-LAG                                                   265
135           GO TO KEY,(360,430)                                             266
      C                                                                       267
      C     CHECK NORTH AND EAST COORDINATES FOR                              268
      C     EXTREME VALUES BY CHAUVENET'S CRITERION                           269
      C                                                                       270
136     360   NBAR=-1.                                                        271
137           CALL STDEV (NORTH,LINE,NBAR,SDNRTH)                             272
138           EBAR=-1.                                                        273
139           CALL STDEV (EAST,LINE,EBAR,SDEAST)                              274
140           ALPHA=1.-1./FLOAT(2*LINE)                                       275
141           CHVR=TINORM(ALPHA,$365)                                         276
142           GO TO 370                                                       277
143     365   CHVR=5.0                                                        278
144           WRITE (6,930) ALPHA                                             279
145     370   GATE1=EBAR-CHVR*SDEAST                                          280
146           GATE2=EBAR+CHVR*SDEAST                                          281
147           GATEN1=NBAR-CHVR*SDNRTH                                         282
148           GATEN2=NBAR+CHVR*SDNRTH                                         283
149           LAG=0                                                           284
150           DO 420 N=1,LINE                                                 285
151           IF (EAST(N)-GATE1) 410,380,380                                  286
152     380   IF (EAST(N)-GATE2) 390,390,410                                  287
153     390   IF (NORTH(N)-GATEN1) 410,400,400                                288
154     400   IF (NORTH(N)-GATEN2) 420,420,410                                289
155     410   IERR(N)=IERR(N)+4                                               290
156           LAG=LAG+1                                                       291
157     420   CONTINUE                                                        292
158           ASSIGN 430 TO KEY                                               293
      C                                                                       294
      C     ELIMINATE ANY DATA SETS THAT HAVE AN EXTREME                      295
      C     VALUES OF THE NORTH OR EAST COORDINATES                           296
      C                                                                       297
159           IF (LAG.GT.0) GO TO 310                                         298
      C                                                                       299
      C     CALL SUBROUTINE FOR PLOTTING THE TRACK OF THE SURVEY VESSEL.      300
      C                                                                       301
160     430   NENTRY=1                                                        302
161           CALL NTRAN (ITAPE,1,LINE,NMBR,L(2))                             303
162           IF (NOPT(1).EQ.1) CALL BENLH2 (NORTH,EAST,NMBR)                 304
      C                                                                       305
      C     APPLY A CORRECTION TO ALLOW FOR THE DISTANCE THE DETECTOR IS TOWED 306
      C        ASTERN OF THE SURVEY SHIP.                                     307
      C                                                                       308
163     440   IF (L(3).NE.-1) GO TO 450                                       309
164           GO TO 440                                                       310
165     450   IF (L(3).LT.-1) GO TO 770                                       311
166           DN0=NORTH(1)-(NORTH(2)-NORTH(1))                                312
167           DE0=EAST(1)-(EAST(2)-EAST(1))                                   313
168           DENOM=SQRT((NORTH(1)-DN0)**2+(EAST(1)-DE0)**2)                  314
169           NCORD(1)=NORTH(1)-CABLE*(NORTH(1)-DN0)/DENOM                    315
170           ECORD(1)=EAST(1)-CABLE*(EAST(1)-DE0)/DENOM                      316
171           DO 480 N=2,LINE                                                 317
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172           DENOM=SQRT((NORTH(N)-NCORD(N-1))**2+(EAST(N)-ECORD(N-1))**2)                318
              C                                                                           319
              C     THE CORRECTION FOR THE DISTANCE BETWEEN VESSEL AND THE DETECTOR       320
              C     IS EQUAL TO 'CABLE' UNLESS THE VESSEL IS LESS THAN 'CABLE' FEET       321
              C     AWAY FROM THE LAST COMPUTED POSITION OF THE DETECTOR VEHICLE.  IN     322
              C     THIS EVENT, THE NEW COMPUTED DETECTOR POSITION IS THE SAME AS         323
              C     THE LAST DETECTOR POSITION                                            324
              C                                                                           325
173           IF (DENOM-CABLE) 470,470,460                                                326
174       460 NCORD(N)=NORTH(N)-CABLE*(NORTH(N)-NCORD(N-1))/DENOM                         327
175           ECORD(N)=EAST(N)-CABLE*(EAST(N)-ECORD(N-1))/DENOM                           328
176           GO TO 480                                                                   329
177       470 NCORD(N)=NCORD(N-1)                                                         330
178           ECORD(N)=ECORD(N-1)                                                         331
179       480 CONTINUE                                                                    332
180           CALL NTRAN (ITAPE,1,LINE,NCORD,LAG,1,LINE,ECORD,L(3))                       333
181       490 IF (L(4).NE.-1) GO TO 500                                                   334
182           GO TO 490                                                                   335
183       500 IF (L(4).LT.-1) GO TO 770                                                   336
              C                                                                           337
              C     CONVERT RADIATION READINGS TO COUNTS PER SECOND                       338
              C                                                                           339
184           IF (BKG(1)) 650, 650, 505                                                   3395
185       505 CCR(2,1)=RAD(2,1)/SEC                                                       340
186           CCR(1,1)=RAD(1,1)/SEC                                                       341
187           DO 510 N=2,LINE                                                             342
188           DO 510 I=1,2                                                                343
189       510 CCR(I,N)=RAD(I,N)/SEC                                                       344
              C                                                                           345
              C     COMPUTE THE MEAN AND STANDARD DEVIATION OF THE BACKGROUND COUNT       346
              C     RATE FROM THE RADIATION DATA THAT LIES WITHIN THE LIMITS OF THE       347
              C     ESTIMATED BACKGROUND COUNT RATE SET BY CHAUVENET'S CRITERION.         348
              C                                                                           349
190           IF (CCR(1,1).GT.2.*BKG(1)) CCR(1,1)=BKG(1)                                  350
191           IF (CCR(2,1).GT.2.*BKG(2)) CCR(2,1)=BKG(2)                                  351
192           ALPHA=1.-1./FLOAT(2*LINE)                                                   352
193           CHVR=TINORM(ALPHA,$515)                                                     353
194           GO TO 520                                                                   354
195       515 CHVR=5.                                                                     355
196           WRITE (6,930) ALPHA                                                         356
197       520 DO 590 I=1,2                                                                357
198           BGCR(I)=0.0                                                                 358
199           SIGMA(I)=0.0                                                                359
200           NCOUNT=0                                                                    360
201           GATE1=BKG(I)-CHVR*SQRT(BKG(I)/SEC)                                          361
202           GATE2=BKG(I)+CHVR*SQRT(BKG(I)/SEC)                                          362
203           DO 550 N=1,LINE                                                             363
204           IF (CCR(I,N)-GATE1) 550,550,530                                             364
205       530 IF (CCR(I,N)-GATE2) 540,550,550                                             365
206       540 NCOUNT=NCOUNT+1                                                             366
207           BGCR(I)=BGCR(I)+CCR(I,N)                                                    367
208       550 CONTINUE                                                                    368
209           BGCR(I)=BGCR(I)/FLOAT(NCOUNT)                                               369
210           DO 580 N=1,LINE                                                             370
211           IF (CCR(I,N)-GATE1) 580,580,560                                             371
212       560 IF (CCR(I,N)-GATE2) 570,580,580                                             372
213       570 SIGMA(I)=SIGMA(I)+(CCR(I,N)-BGCR(I))**2                                     373
214       580 CONTINUE                                                                    374
215       590 SIGMA(I)=SQRT(SIGMA(I)/FLOAT(NCOUNT))                                       375
216           WRITE (6,940) BKG,BGCR,SIGMA                                                376
              C                                                                           377
              C     CALL THE SUBROUTINE FOR PLOTTING UNCORRECTED RADIATION VALUES         378
              C                                                                           379
217           NENTRY=2                                                                    380
218           IF (NOPT(2).EQ.1) CALL RDPLT2 (NCORD,ECORD,CCR)                             381
219           IF (NOPT(3).NE.1) GO TO 650                                                 382
              C                                                                           383
              C     CORRECT RADIATION VALUES FOR BACKGROUND COUNT RATE AND TIME-DECAY     384
              C                                                                           385
220           SUM=0.0                                                                     386
221           SUM2=0.0                                                                    387
222           NBAR=0.0                                                                    388
223           EBAR=0.0                                                                    389
224           DO 620 N=1,LINE                                                             390
225           DO 610 I=1,2                                                                391
226           CCR(I,N)=CCR(I,N)-BGCR(I)                                                   392
227           IF (CCR(I,N) - 3.*SIGMA(I)) 610,610,600                                     393
228       600 CCR(I,N)=(CCR(I,N)-3.*SIGMA(I))*EXP(DECAY*(DELAY+TIME(N)/3600.))            394
          1 + 3.*SIGMA(I)                                                                 3945
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229     610   CONTINUE                                                          395
230           IF (CCR(1,N).LE.0.0) GO TO 620                                    396
231           SUM=SUM+CCR(1,N)                                                  397
232           SUM2=SUM2+CCR(2,N)                                                398
      C                                                                       399
      C     COMPUTE WEIGHTED MEAN AND STD. DEV. OF ACTIVITY LOCATION          400
      C                                                                       401
233           EBAR=EBAR+(ECORD(N)-ECORD(1))*CCR(1,N)                            402
234           NBAR=NBAR+(NCORD(N)-NCORD(1))*CCR(1,N)                            403
235     620   CONTINUE                                                          404
236           NBAR=NCORD(1)+NBAR/SUM                                            405
237           EBAR=ECORD(1)+EBAR/SUM                                            406
238           SDNRTH=0.0                                                        407
239           SDEAST=0.0                                                        408
240           DO 640 N=1,LINE                                                   409
241           IF (CCR(1,N)) 640,640,630                                         410
242     630   SDNRTH=SDNRTH+(NCORD(N)-NBAR)**2*CCR(1,N)                         411
243           SDEAST=SDEAST+(ECORD(N)-EBAR)**2*CCR(1,N)                         412
244     640   CONTINUE                                                          413
245           SDNRTH=SQRT(SDNRTH/SUM)                                           414
246           SDEAST=SQRT(SDEAST/SUM)                                           415
247           WRITE (6,950) SUM,SUM2                                            416
248           WRITE (6,960) NBAR,EBAR,SDNRTH,SDEAST                             417
      C                                                                       418
      C     COMPUTE AND PRINT 95 PC. CONFIDENCE LIMITS OF MEAN RADIATION      419
      C     LOCATION.                                                         420
      C                                                                       421
249           RTSUM=SQRT(SUM/BGCR(1))                                           422
250           CFIDN=1.96*SDNRTH/RTSUM                                           423
251           CFIDE=1.96*SDEAST/RTSUM                                           424
252           WRITE (6,970) CFIDN,CFIDE                                         425
253     650   DO 660 I=1,2                                                      426
254           CCR(I,LINE+1)=BGCR(I)                                             427
255     660   CCR(I,LINE+2)=SIGMA(I)                                            428
256           NWRD=(LINE+2)*2                                                   429
257           CALL NTRAN (ITAPE,1,NWRD,CCR,L(4))                                430
258           NENTRY=3                                                          431
259           IF (NOPT(3).EQ.1) CALL RDPLT2 (NCORD,ECORD,CCR)                   432
260           WRITE (6,980) NMAX,EMAX                                           433
261           WRITE (6,990) NMIN,EMIN                                           434
      C                                                                       435
      C     WRITE OUT THE NUMBER, COORDINATES AND ACTIVITY OF EACH DATA POINT  436
      C                                                                       437
262           KOUNT=50                                                          438
263           DO 720 N=1,LINE                                                   439
264           DO 690 J=1,3                                                      440
265           IF (FLD(36-J,1,IERR(N))) 670,670,680                              441
266     670   ISIGN(J)=BLANK                                                    442
267           GO TO 690                                                         443
268     680   ISIGN(J)=AS                                                       444
269     690   CONTINUE                                                          445
270           IF (KOUNT-50) 710,700,700                                         446
271     700   WRITE (6,1000) LEGEND                                             447
272           KOUNT=0                                                           448
273     710   WRITE (6,1010) NMBR(N),TIME(N),D(1,N),ISIGN(1),D(2,N),ISIGN(2),(RA 449
            1D(I,N),I=1,2),NORTH(N),EAST(N),ISIGN(3),NCORD(N),ECORD(N),(CCR(I,N 450
            2),I=1,2)                                                         451
274     720   KOUNT=KOUNT+1                                                     452
275           WRITE (6,1020)                                                    453
276           IF (.NOT.JOBEND) GO TO 10                                         454
277     730   CONTINUE                                                          455
      C                                                                       456
      C     END-FILE PLOT TAPE                                                457
      C                                                                       458
278           END FILE 9                                                        4585
279           DO 760 I=1,4                                                      459
280     740   IF (L(I).NE.-1) GO TO 750                                         460
281           GO TO 740                                                         461
282     750   IF (L(I).LT.-1) GO TO 770                                         462
283     760   CONTINUE                                                          463
284           CALL NTRAN (ITAPE,9)                                              464
285     770   STOP                                                              465
      C                                                                       466
286     780   FORMAT (3F3.0,2F7.0,1X,2F2.0,F3.0,F5.2,3F2.0,4(1X,F7.0),I3)       467
287     790   FORMAT (4I1,F10.0,1X,3I2,1X,F10.0,2(1X,F10.0),1X,A6)              468
288     800   FORMAT (13A6,L2)                                                  469
289     810   FORMAT (10X,13A6,10X,L2)                                          470
290     820   FORMAT (/5X,8HBEACON 1,F10.0,1HN,F10.0,1HE,5X,8HBEACON 2,F10.0,1HN 471
            1,F10.0,1HE//)                                                    472
```

```
291      830   FORMAT (5X,21HSQUARE DIST BETWEEN =,E16.8,5X,18HDISTANCE BETWEEN =
               1,F10.0)
292      840   FORMAT (5X,6HSINE =,E16.8,5X,8HCOSINE =,E16.8)
293      850   FORMAT (5X,16HINJECTION TIME =,2F3.0,10X,12HCLOCK SET AT,2F3.0,5X,
               121HDIGITIZING INTERVAL =,F3.0,7HSECONDS/5X,30HDAYS ELAPSED SINCE I
               2NJECTION =,F3.0)
294      860   FORMAT (5X,22HHALF-LIFE OF ISOTOPE =,F7.2,4HDAYS,5X,14HDECAY FACTO
               1R =,E16.8,5X,19HTIME-DELAY FACTOR =,F7.2,5HHOURS)
295      870   FORMAT (10X,14HCABLE LENGTH =,F4.0,10X,18HMEAN WATER DEPTH =,F4.0,
               110X,13HBOAT LENGTH =,F4.0)
296      880   FORMAT (10X,38HDISTANCE FROM RADAR MAST TO DETECTOR =,F6.1,5HFEET.
               1)
297      890   FORMAT (//40X,15HPLOTS GENERATED/10X,9HTRACKLINE,I5,10X,20HBACKGRO
               1UND RADIATION,I5,10X,19HCORRECTED RADIATION,I5)
298      900   FORMAT (5X,51HBEACON RANGES FOR DUMP SITE COMPUTE IMAGINARY ROOT.)
299      910   FORMAT (10X,37HLAMBERT COORDINATES OF INJECTION SITE,F10.0,1HN,F10
               1.0,1HE)
300      920   FORMAT (1H0,19X,7A6)
301      930   FORMAT (37H THERE WAS AN OVERFLOW WHEN ALPHA WAS,F6.3,5X,25HCHVR W
               1AS SET EQUAL TO 5.0)
302      940   FORMAT (//20X,53HSUMMARY STATISTICS OF BACKGROUND RADIATION COUNT
               1RATE/30X,13HRAD CHANNEL 1,5X,13HRAD CHANNEL 2/10X,21HEST. BKG. COU
               2NTS/SEC.,F10.0,8X,F10.0/10X,21HMEAN BKG. COUNTS/SEC.,F10.0,8X,F10.
               30/10X,21HSTD. DEV. COUNTS/SEC.,F10.0,8X,F10.0)
303      950   FORMAT (//20X,33HSUM OF CORRECTED RADIATION COUNTS/25X,19HRADIATIO
               1N CHANNEL 1,E16.8/25X,19HRADIATION CHANNEL 2,E16.8)
304      960   FORMAT (//20X,41HSUMMARY STATISTICS OF RADIATION LOCATION./24X,11H
               1NORTH COORD,10X,10HEAST COORD/16X,4HMEAN,5X,F10.0,10X,F10.0/11X,9H
               2STD. DEV.,5X,F10.0,10X,F10.0)
305      970   FORMAT (10X,10HCONFIDENCE/7X,13HLIMIT OF MEAN,5X,F10.0,10X,F10.0)
306      980   FORMAT (//7X,13HMAXIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE)
307      990   FORMAT (//7X,13HMINIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE//)
308     1000   FORMAT (1H1,9X,13A6//2X,10HLINE  TIME,5X,18HDISTANCE TO BEACON,5X,
               115HRADIATION COUNT,4X,16HBOAT COORDINATES,4X,16HBALL COORDINATES,3
               2X,19HCORRECTED RADIATION/9X,3HSEC,11X,1H1,10X,1H2,6X,4HRAD1,6X,4HR
               3AD2,9X,1HN,9X,1HE,9X,1HN,9X,1HE,7X,4HRAD1,3X,9H     RAD2)
309     1010   FORMAT (1X,I5,F6.0,F11.1,A1,F10.1,A1,4F10.0,A1,2F10.0,F11.0,F11.0)
310     1020   FORMAT (1H1)
311            END
```

```
10      -     7*      8      276
20      -     7       9*
30      -    13      14*
40      -    12      13      15*
50      -    35      36*
60      -    40      41*
70      -    40      44*
80      -    35      43      48*      52
90      -    50      53*
100     -    54*     55
110     -    54      56*
120     -    64      65*
130     -    61      64      66*
140     -    72      74*
150     -    69      75*
160     -    67      77*
170     -    80      81*
180     -    83      84*
190     -    82      86*
200     -    79      80      83       87*
210     -    89      90*
220     -    92      93*
230     -    91      92      95*
240     -    94      96*
250     -    99*    101
260     -    88      89     101      102*
270     -    76     103*
280     -   110     111*
290     -   110     114*
300     -   105     113     117*
310     -   120*    159
320     -   122     123*
330     -   122     125*
340     -   127     129*
350     -   121     124     133*
360     -   116     119     135      136*
365     -   143*
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```
370      -   142      145*
380      -   151      152*
390      -   152      153*
400      -   153      154*
410      -   151      152      153      154      155*
420      -   150      154      157*
430      -   135      158      160*
440      -   163*     164
450      -   163      165*
460      -   173      174*
470      -   173      177*
480      -   171      176      179*
490      -   181*     182
500      -   181      183*
505      -   184      185*
510      -   187      188      189*
515      -   195*
520      -   194      197*
530      -   204      205*
540      -   205      206*
550      -   203      204      205      208*
560      -   211      212*
570      -   212      213*
580      -   210      211      212      214*
590      -   197      215*
600      -   227      228*
610      -   225      227      229*
620      -   224      230      235*
630      -   241      242*
640      -   240      241      244*
650      -   184      219      253*
660      -   253      255*
670      -   265      266*
680      -   265      268*
690      -   264      267      269*
700      -   270      271*
710      -   270      273*
720      -   263      274*
730      -    49      277*
740      -   280*     281
750      -   280      282*
760      -   270      283*
770      -     9       56      165      183      282      285*
780      -    10RD    286*
790      -    11RD    287*
800      -    16RD    288*
810      -    17WR    289*
820      -    18WR    290*
830      -    21WR    291*
840      -    24WR    292*
850      -    25WR    293*
860      -    30WR    294*
         -    31WR    295*
         -    33WR    296*
         -    34WR    297*
900      -    42WR    298*
910      -    47WR    299*
920      -    53WR    300*
930      -   144WR    196WR    301*
940      -   216WR    302*
950      -   247WR    303*
960      -   248WR    304*
970      -   252WR    305*
980      -   260WR    306*
990      -   261WR    307*
1000     -   271WR    308*
1010     -   273WR    309*
1020     -   275WR    310*
ABS      -    83
ALOG     -    29
ALPHA    -   140=     141      144WR    192=     193      196WR
AS       -     4IN      6DA    268
BEAC1E   -     1CO     10RD     18WR     19       23       45       115
BEAC1N   -     1CO     10RD     18WR     19       22       46       116
BEAC2E   -     1CO     10RD     18WR     19       23
BEAC2N   -     1CO     10RD     18WR     19       22
BENLH2   -   162
BGCR     -     1CO     198=     207=     209=     213      216WR    226      249      254
```

PROGRAM -- RAPLOT II

		241	242	243	263	265	273WR				
NBAR	-	1CO	2RL	136=	137AG	147	148	222=	234=	236=	242
		248WR									
NCORD	-	2RL	169=	172	174=	177=	180AG	218AG	234	236	242
		259AG	273WR								
NCOUNT	-	200=	206=	209	215						
NENTRY	-	1CO	160=	217=	258=						
NMAX	-	1CO	2RL	260WR							
NMBR	-	3DI	58RD	63	70=	125=	161AG	162AG	273WR		
NMIN	-	1CO	2RL	261WR							
NOPT	-	1CO	11RD	34WR	162	218	219	259			
NORTH	-	2RL	116=	131=	137AG	153	154	162AG	166	168	169
		172	174	273WR							
NPLT	-	1CO	11RD	13	14=						
NSTART	-	68=	69	81=	82	90=	91	96	97	98	99
NSTOP	-	93=	96	97	101						
NTAPE	-	6DA	48RD	51AG	58RD	59AG					
NTRAN	-	51	57	59	161	180	257	284			
NWRD	-	256=	257AG								
RAD	-	3DI	58RD	74=	129=	185	186	189	273WR		
RDPLT2	-	218	259								
RMIN	-	10RD	25WR	27							
RTSUM	-	249=	250	251							
SCALE	-	1CO	11RD								
SDEAST	-	139AG	145	146	239=	243=	246=	248WR	251		
SDNRTH	-	137AG	147	148	238=	242=	245=	248WR	250		
SEC	-	10RD	25WR	65	185	186	189	201	202		
SENTNL	-	4IN	48RD	49	50	53WR					
SETIME	-	10RD	25WR	27=	28						
SIGMA	-	1CO	199=	213=	215=	216WR	227	228	255		
SINE	-	22=	24WR	45	46	115	116				
SITEE	-	1CO	45=	47WR							
SITEN	-	1CO	41=	46=	47WR						
SQDSTB	-	19=	20	21WR	38	108					
SORT	-	20	32	44	114	168	172	201	202	215	245
		246	249								
STDEV	-	137	139								
STOP	-	285									
SUM	-	220=	231=	236	237	245	246	247WR	249		
SUM2	-	221=	232=	247WR							
TIME	-	3DI	58RD	64	65=	71=	83	96	99	126=	228
		273WR									
TINORM	-	141	193								
WORD1	-	4IN	6DA	49							
WORD2	-	4IN	6DA	49							
ZHR	-	10RD	25WR	26=	28						
ZMIN	-	10RD	25WR	26							

INDEX

SUBROUTINE BENLH2 (NORTH,EAST,NMBR)

```
  1            SUBROUTINE BENLH2 (NORTH,EAST,NMBR)                                R-L   1
                                                                                  R-L   2
               C
               C   THIS SUBROUTINE GENERATES THE PLOT INSTRUCTIONS TO DRIVE A BENSON-R-L   3
               C   LEHNER MODEL 305 DIGITAL PLOTTER.  IF THE INSTRUCTIONS ARE BEING  R-L   4
               C   WRITTEN ON TAPE, USE OPTIONS N, K, AND E ON THE ASSIGN CARD.     R-L   5
               C      PROGRAMMER: PHILIP A. TURNER, GEOLOGY BR, U S A CERC         R-L   6
               C                                                                   R-L   7
  2            COMMON NOPT(4),SCALE,NPLT(3),GRID,DUMPN,DUMPE,INDATE,LEGEND(13),BER-L   8
              1AC1N,BEAC1E,BEAC2N,BEAC2E,NPTS,BGCR(2),SIGMA(2),NBAR,EBAR,NENTRY,NB-L   9
              2MAX,NMIN,EMAX,EMIN                                                 R-L  10
  3            DIMENSION EAST(2200), RAD(2,2200), NMBR(2200), X(2200), Y(2200), RR-L  11
              1ADUL(7)                                                            R-L  12
  4            REAL NORTH(2200),NBAR,NMAX,NMIN,NORGIN                             R-L  13
  5            ITRNP=0                                                            R-L  14
  6            GO TO 10                                                           R-L  15
  7            ENTRY RDPLT2 (NORTH,EAST,RAD)                                      R-L 155
  8            IF (NOPT(1).EQ.1) GO TO 120                                        R-L  16
  9            IF (NOPT(2).EQ.1.AND.NENTRY.EQ.3) GO TO 120                        R-L  17
               C   DEFINE THE LOGICAL UNIT ON WHICH PLOTTER COMMANDS ARE TO BE OUTPUTR-L  18
               C         CARD PUNCH = 3                                           R-L  19
               C      MAGNETIC TAPES = 7-34                                       R-L  20
               C                                                                  R-L  21
 10   10       CALL INPLOT (9)                                                    R-L  22
               C                                                                  R-L  23
               C   DETERMINE THE MAXIMUM AND MINIMUM VALUES FOR BOTH COORDINATES. R-L  24
               C                                                                  R-L  25
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                SUBROUTINE BENLH2 (NORTH,EAST,NMBR)

11              NMAX=NORTH(1)                                                   B-L  26
12              NMIN=NORTH(1)                                                   B-L  27
13              EMAX=EAST(1)                                                    B-L  28
14              EMIN=EAST(1)                                                    B-L  29
15              DO 20 N=2,NPTS                                                  B-L  30
16              NMAX=AMAX1(NMAX,NORTH(N))                                       B-L  31
17              NMIN=AMIN1(NMIN,NORTH(N))                                       B-L  32
18              EMAX=AMAX1(EMAX,EAST(N))                                        B-L  33
19              EMIN=AMIN1(EMIN,EAST(N))                                        B-L  34
20        20    CONTINUE                                                        B-L  35
          C                                                                     B-L  36
          C     CHECK SCALE TO BE SURE THAT NO FIXES WILL PLOT OFF THE MAP.     B-L  37
          C     CHANGE SCALE UNTIL ALL THE FIXES FIT ON THE PLOT.               B-L  38
          C                                                                     B-L  39
21              YSCALE=SCALE                                                    B-L  40
22              IF (NMAX-(NMIN+25.*SCALE)) 60,60,30                             B-L  41
23        30    ITRNP=1                                                         B-L  42
24              IF (EMAX-(EMIN+25.*SCALE)) 60,60,40                             B-L  43
25        40    IF ((EMAX-EMIN)-(NMAX-NMIN)) 60,50,50                           B-L  44
26        50    ITRNP=0                                                         B-L  45
27        60    IF (ITRNP.EQ.0) GO TO 90                                        B-L  46
28              ASSIGN 90 TO KEY                                                B-L  47
29        70    CELL=EMAX                                                       B-L  48
30              EMAX=NMAX                                                       B-L  49
31              NMAX=-EMIN                                                      B-L  50
32              EMIN=NMIN                                                       B-L  51
33              NMIN=-CELL                                                      B-L  52
34              DO 80 N=1,NPTS                                                  B-L  53
35              CELL=NORTH(N)                                                   B-L  54
36              NORTH(N)=-EAST(N)                                               B-L  55
37        80    EAST(N)=CELL                                                    B-L  56
38              GO TO KEY,(90,130)                                              B-L  57
39        90    IF (NMAX-(NMIN+25.*SCALE)) 110,110,100                          B-L  58
40        100   SCALE=SCALE+YSCALE                                              B-L  59
41              GO TO 90                                                        B-L  60
          C                                                                     B-L  61
          C     TAKE THE ORIGIN OF THE PLOT AS THE MINIMUM COORDINATES REMAINDEREDB-L  62
          C     BY THE PLOT SCALE.                                              B-L  63
          C                                                                     B-L  64
42        110   NORGIN=SCALE*AINT(NMIN/SCALE)                                   B-L  65
43              YORGIN=NORGIN/SCALE                                             B-L  66
44              EORGIN=SCALE*AINT(EMIN/SCALE)                                   B-L  67
45              XORGIN=EORGIN/SCALE                                             B-L  68
46        120   IF (NENTRY.EQ.3.AND.NOPT(2).EQ.1) GO TO 150                     B-L  69
          C                                                                     B-L  70
          C     DIVIDE THE COORDINATES (IN FEET)  BY THE SCALE (IN FEET).       B-L  71
          C                                                                     B-L  72
47              IF (NENTRY.EQ.1.OR.ITRNP.EQ.0) GO TO 130                        B-L  73
48              ASSIGN 130 TO KEY                                               B-L  74
49              GO TO 70                                                        B-L  75
50        130   DO 140 N=1,NPTS                                                 B-L  76
51              X(N)=EAST(N)/SCALE                                              B-L  77
52        140   Y(N)=NORTH(N)/SCALE                                             B-L  78
          C                                                                     B-L  79
          C     WRITE IN THE LEGEND, SCALE, TYPE OF PLOT AN INJECTION DATE AT THE B-L  80
          C     BOTTOM EDGE OF THE PLOT.                                        B-L  81
          C                                                                     B-L  82
53        150   CALL LETTER (78,8,0,1.0,-1.0,LEGEND)                           B-L  83
54              CALL LETTER (8,8,0,5.0,-2.2,8H1 INCH =)                         B-L  84
55              CALL NUMBER (SCALE,4,1,8,0,7.2,-2.2)                            B-L  85
56              CALL LETTER (4,8,0,9.8,-2.2,4HFEET)                             B-L  86
57              GO TO (160,170,180), NENTRY                                     B-L  87
58        160   CALL LETTER (25,8,0,12.,-2.2,25HPLOT OF SURVEY TRACK LINE)      B-L  88
59              GO TO 190                                                       B-L  89
60        170   CALL LETTER (29,6,0,12.,-2.0,29HPLOT OF UNCORRECTED RADIATION)  B-L  90
61              CALL LETTER (29,6,0,12.,-2.6,29HROUNDED TO NEAREST 100 COUNTS)  B-L  91
62              GO TO 190                                                       B-L  92
63        180   CALL LETTER (28,6,0,12.,-2.0,28HPLOT OF CORRECTED RADIATION/)   B-L  93
64              CALL LETTER (27,6,0,12.,-2.6,27HBACKGROUND RADIATION RATIOS)    B-L  94
65        190   CALL LETTER (14,6,0,20.,-2.0,14HINJECTION DATE)                 B-L  95
66              CALL LETTER (6,6,0,21.8,-2.5,INDATE)                            B-L  96
67              CALL PLOT (0.0,0.0,3)                                           B-L  97
68              CALL PLOT (XORGIN,YORGIN,1)                                     B-L  98
          C                                                                     B-L  99
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                SUBROUTINE BENLH2 (NORTH,EAST,NMBR)

      C     PLOT IN TIC MARKS, WITH COORDINATES, AT THE LEFT AND LOWER BORDERSR-L 100
      C     OF THE PLOT.                                                    R-L 101
      C                                                                     R-L 102
   69         CALL SYMBOL (XORGIN,YORGIN,.20,66)                           R-L 103
   70         IF (GRID.LE.0.0) GO TO 230                                   R-L 104
   71         TICN=GRID*(1.+AINT(NORGIN/GRID))                             R-L 105
   72         TICE=GRID*(1.+AINT(EORGIN/GRID))                             R-L 106
   73         YTIC=TICN/SCALE                                              R-L 107
   74         XSHIFT=XORGIN-1.28                                           R-L 108
   75   200   CALL REPSYM (XORGIN,YTIC)                                    R-L 109
   76         CALL NUMBER (TICN,.8,0.,4,0,XSHIFT,YTIC)                     R-L 110
   77         YTIC=YTIC+GRID/SCALE                                         R-L 111
   78         TICN=TICN+GRID                                               R-L 112
   79         IF (YTIC-(YORGIN+25.)) 200,200,210                           R-L 113
   80   210   XTIC=TICE/SCALE                                              R-L 114
   81         YSHIFT=YORGIN-.5                                             R-L 115
   82   220   CALL REPSYM (XTIC,YORGIN)                                    R-L 116
   83         CALL NUMBER (TICE,.8,0.,4,0,XTIC,YSHIFT)                     R-L 117
   84         XTIC=XTIC+GRID/SCALE                                         R-L 118
   85         TICE=TICE+GRID                                               R-L 119
   86         IF (XTIC-(XORGIN+25.))'220,220,230                           R-L 120
   87   230   CONTINUE                                                     R-L 121
      C                                                                   R-L 122
      C     PLOT  THE INJECTION SITE.                                     R-L 123
      C                                                                   R-L 124
   88         IF (DUMPN.GT.NMAX.OR.DUMPN.LT.NMIN) GO TO 240                R-L 125
   89         YD=DUMPN/SCALE                                               R-L 126
   90         XD=DUMPE/SCALE                                               R-L 127
   91         CALL SYMBOL (XD,YD,.10,70)                                   R-L 128
   92         XD=XD+.2                                                     R-L 129
   93         CALL LETTER (4,4,0,XD,YD,4HDUMP)                             R-L 130
      C                                                                   R-L 131
      C     PLOT THE MEAN LOCATION OF THE RADIATION DISTRIBUTION.         R-L 132
      C                                                                   R-L 133
   94   240   IF (NENTRY-3) 260,250,260                                    R-L 134
   95   250   IF (ITRNP.EQ.1) GO TO 260                                    R-L 135
   96         YB=NBAR/SCALE                                                R-L 136
   97         XB=EBAR/SCALE                                                R-L 137
   98         CALL SYMBOL (XB,YB,.10,71)                                   R-L 138
   99         XB=XB+.2                                                     R-L 139
  100         CALL LETTER (6,4,0,XB,YB,6HRADBAR)                           R-L 140
  101   260   NN=NPLT(NENTRY)                                              R-L 141
  102         NSTART=1+NN                                                  R-L 142
  103         IF (NENTRY-2) 270,290,310                                    R-L 143
      C                                                                   R-L 144
      C     PLOT THE TRACK LINE FOLLOWED BY THE SURVEY VESSEL.            R-L 145
      C                                                                   R-L 146
  104   270   CALL LINE (X,Y,NPTS,3,65,5)                                  R-L 147
  105         DO 280 N=1,NPTS,NN                                           R-L 148
  106         Z=FLOAT(NMBR(N))                                             R-L 149
  107         CALL NUMBER (Z,3.0,2.0,X(N),Y(N))                            R-L 150
  108   280   CONTINUE                                                     R-L 151
  109         GO TO 440                                                    R-L 152
      C                                                                   R-L 153
      C     PLOT THE BACKGROUND RADIATION AT EVERY NNTH POINT.            R-L 154
      C                                                                   R-L 155
  110   290   CALL SYMBOL (X(1),Y(1),.3,67)                                R-L 156
  111         Z=RAD(1,1)/100.                                              R-L 157
  112         CALL NUMBER (Z,.3,0.,2.0,X(1),Y(1))                          R-L 158
  113         DO 300 I=NSTART,NPTS                                         R-L 159
  114         CALL REPSYM (X(I),Y(I))                                      R-L 160
  115         IF (MOD(I,NN).NE.0) GO TO 300                                R-L 161
  116         Z=RAD(1,I)/100.                                              R-L 162
  117         CALL NUMBER (Z,.3,0.,2.0,X(I),Y(I))                          R-L 163
  118   300   CONTINUE                                                     R-L 164
  119         GO TO 440                                                    R-L 165
      C                                                                   R-L 166
      C     PLOT CORRECTED RADIATION VALUES AT EVERY NNTH POINT.          R-L 167
      C                                                                   R-L 168
  120   310   RADUL(1)=3.*SIGMA(1)                                         R-L 169
  121         RADUL(2)=100.                                                R-L 170
  122         DO 320 L=3,7                                                 R-L 171
  123   320   RADUL(L)=2.*RADUL(L-1)                                       R-L 172
  124         LAST=0                                                       R-L 173
  125         DO 420 I=1,NPTS                                              R-L 174
      C                                                                   R-L 175
```

```
                SUBROUTINE BENLH2 (NORTH,EAST,NMBR)

      C     DATA POINTS HAVING CORRECTED RADIATION COUNTS MORE THAN 3 STANDARDR-L 176
      C     DEVIATIONS BELOW MEAN BACKGROUND COUNT RATE ARE NOT PLOTTED.  SUCHR-L 177
      C     LOW READINGS MAY INDICATE THAT THE DETECTOR WAS OVERTURNED OR WAS R-L 178
      C     'FLYING'                                                        R-L 179
      C                                                                     R-L 180
126           IF (RAD(1,I)+RADUL(1)) 420,420,330                            R-L 181
127     330   DO 350 L=1,7                                                  R-L 182
128           IF (RAD(1,I)-RADUL(L)) 340,340,350                            R-L 183
129     340   NSYM=64+L                                                     R-L 184
130           IH=1                                                          R-L 185
131           IF (NSYM.GT.65) IH=2                                          R-L 186
132           IF (NSYM.GT.69) IH=4                                          R-L 187
133           GO TO 360                                                     R-L 188
134     350   CONTINUE                                                      R-L 189
135           NSYM=72                                                       R-L 190
136           IH=4                                                          R-L 191
137     360   IF (NSYM-LAST) 380,370,380                                    R-L 192
138     370   CALL REMSYM (X(I),Y(I))                                       R-L 193
139           GO TO 390                                                     R-L 194
140     380   CALL SYMBOL (X(I),Y(I),IH,NSYM)                               R-L 195
141           LAST=NSYM                                                     R-L 196
142     390   IF (MOD(I,NN)) 400,400,420                                    R-L 197
143     400   IF (RAD(1,I)-BGCR(1)) 420,420,410                             R-L 198
144     410   Z=RAD(1,I)/BGCR(1)                                            R-L 199
145           CALL NUMBER (Z,3,0,2,0,X(I),Y(I))                             R-L 200
146     420   CONTINUE                                                      R-L 201
147           XEDGE=AMAX1((EMAX/SCALE)+2.,XORGIN+27)                        R-L 202
148           YPT=YORGIN+12.5                                               R-L 203
149           CALL LETTER (26,4,0,XEDGE,YPT,26HCORRECTED COUNT RATE (C/S))  R-L 204
150           YPT=YPT-.5                                                    R-L 205
151           XSHIFT=XEDGE+.5                                               R-L 206
152           XSHFT2=XSHIFT+2.0                                             R-L 207
153           NSYM=64                                                       R-L 208
154           IH=1                                                          R-L 209
155           DO 430 L=1,7                                                  R-L 210
156           NSYM=NSYM+1                                                   R-L 211
157           IF (NSYM.GT.65) IH=2                                          R-L 212
158           IF (NSYM.GT.69) IH=4                                          R-L 213
159           CALL SYMBOL (XEDGE,YPT,IH,NSYM)                               R-L 214
160           CALL LETTER (16,3,0,XSHIFT,YPT,16HCCR .LT. OR .EQ.)           R-L 215
161           CALL NUMBER (RADUL(L),5,1,3,0,XSHFT2,YPT)                     R-L 216
162     430   YPT=YPT-.4                                                    R-L 217
163           CALL SYMBOL (XEDGE,YPT,IH,72)                                 R-L 218
164           CALL LETTER (16,3,0,XSHIFT,YPT,16H        CCR .GT.)           R-L 219
165           CALL NUMBER (RADUL(7),5,1,3,0,XSHFT2,YPT)                     R-L 220
      C                                                                     R-L 221
      C     MOVE PEN TO RIGHT BORDER OF PLOT IN PREPARATION FOR NEXT PLOT.  R-L 222
      C                                                                     R-L 223
166     440   XEDGE=AMAX1(EMAX/SCALE+9.,XORGIN+34.)                         R-L 224
167           CALL PLOT (XEDGE,YORGIN,3)                                    R-L 225
168           CALL PLOT (0.0,0.0,1)                                         R-L 226
169           CALL PLOT (0.0,0.0,-3)                                        R-L 227
170           IF (ITRNP.EQ.0) GO TO 460                                     R-L 228
171           CELL=EMAX                                                     R-L 229
172           EMAX=-NMIN                                                    R-L 230
173           NMIN=EMIN                                                     R-L 231
174           EMIN=-NMAX                                                    R-L 232
175           NMAX=CELL                                                     R-L 233
176           DO 450 N=1,NPTS                                               R-L 234
177           CELL=EAST(N)                                                  R-L 235
178           EAST(N)=-NORTH(N)                                             R-L 236
179     450   NORTH(N)=CELL                                                 R-L 237
180     460   RETURN                                                        R-L 238
181           END                                                           R-L 239-
SYMBOL

10      -     6       10*
20      -     15      20*
30      -     22      23*
40      -     24      25*
50      -     25      26*
60      -     22      24      25      27*
70      -     29*     49
80      -     34      37*
90      -     27      28      38      39*     41
100     -     39      40*
110     -     39      42*
```

```
120     -     8       9      46*
130     -    38      47      48      50*
140     -    50      52*
150     -    46      53*
160     -    57      58*
170     -    57      60*
180     -    57      63*
190     -    59      62      65*
200     -    75*     79
210     -    79      80*
220     -    82*     86
230     -    70      86      87*
240     -    88      94*
250     -    94      95*
260     -    94      95     101*
270     -   103     104*
280     -   105     108*
290     -   103     110*
300     -   113     115     118*
310     -   103     120*
320     -   122     123*
330     -   126     127*
340     -   128     129*
350     -   127     128     134*
360     -   133     137*
370     -   137     138*
380     -   137     140*
390     -   139     142*
400     -   142     143*
410     -   143     144*
420     -   125     126     142     143     146*
430     -   155     162*
440     -   109     119     166*
450     -   176     179*
460     -   170     180*
AINT    -    42      44      71      72
AMAX1   -    16      18     147     166
AMIN1   -    17      19
BEAC1E  -     2CO
BEAC1N  -     2CO
BEAC2E  -     2CO
BEAC2N  -     2CO
BENLH2  -     1
BGCR    -     2CO   143     144
CELL    -    29=     33      35=     37     171=    175     177=    179
DUMPE   -     2CO     90
DUMPN   -     2CO     88      89
EAST    -     1AG     3DI      7      13      14      18      19      36     37=     51
             177     178=
EBAR    -     2CO     97
EMAX    -     2CO     13=     18=     24      25      29      30=    147     166     171
             172=
EMIN    -     2CO     14=     19=     24      25      31      32=     44     173     174=
EORGIN  -    44=     45      72
FLOAT   -   106
GRID    -     2CO     70      71      72      77      78      84      85
I       -   113     114AG   115     116     125     126     128    138AG   140AG   142
             143     144
IH      -   130=    131=    132=    136=    140AG   154=    157=    158=   159AG   163AG
INDATE  -     2CO
INPLOT  -    10
ITRNP   -     5=     23=     26=     27      47      95     170
KEY     -    28=     38      48=
L       -   122     123     127     128     129     155    161AG
LAST    -   124=    137     141=
LEGEND  -     2CO
LETTER  -    53      54      56      58      60      61      63      64      65      66
             93     100     149     160     164
LINE    -   104
MOD     -   115     142
N       -    15      16      17      18      19      34      35      36      37      50
             51      52     105     106     176     177     178     179
NBAR    -     2CO     4RL     96
NENTRY  -     2CO      9      46      47      57      94     101     103
NMAX    -     2CO     4RL     11=     16=     22      25      30      31=     39      88
             174     175=
NMBR    -     1AG     3DI     106
NMIN    -     2CO     4RL     12=     17=     22      25      32      33=     39      42
```

```
                                SUBROUTINE BENLH2 (NORTH,EAST,NMBR)

                 88      172     173=
NN          -   101=    102     105     115     142
NOPT        -    2C0      8       9      46
NORGIN      -    4RL     42=     43      71
NORTH       -    1AG     4RL      7      11      12      16      17      35     36=     52
                178     179=
NPLT        -    2C0     101
NPTS        -    2C0      15     34      50    104AG    105     113     125     176
NSTART      -   \02=     113


NSYM        -   129=     131     132     135=    137     140AG   141     153=    156=    157
                158     159AG
NUMBER      -    55       76      83     107     112     117     145     161     165
PLOT        -    67       68     167     168     169
RAD         -     3DI      7     111     116     126     128     143     144
RADUL       -     3DI     120=    121=    123=    126     128    161AG   165AG
RDPLT2      -     7
REPSYM      -    75       82     114     138
RETURN      -   180
SCALE       -     2C0     21      22      24      39      40=     42      43      44      45
                 51      52     55AG     73      77      80      84      89      90      96
                 97     147     166
SIGMA       -     2C0     120
SYMBOL      -    69       91      98     110     140     159     163
TICE        -    72=      80     83AG    85=
TICN        -    71=      73     76AG    78=
X           -     3DI     51=    104AG   110AG   114AG   138AG   140AG
XB          -    97=     98AG    99=
XD          -    90=     91AG    92=
XEDGE       -   147=     151     159AG   163AG   166=    167AG
XORGIN      -    45=     68AG    69AG    74      75AG    86      147     166
XSHFT2      -   152=
XSHIFT      -    74=     151=    152
XTIC        -    80=      82AG    84=     86
Y           -     3DI     52=    104AG   110AG   114AG   138AG   140AG
YB          -    96=     98AG
YD          -    89=     91AG
YORGIN      -    43=     68AG    69AG    79      81      82AG    148     167AG
YPT         -   148=     150=    159AG   162=    163AG
YSCALE      -    21=      40
YSHIFT      -    81=
YTIC        -    73=      75AG    77=     79
Z           -   106=     107AG   111=    112AG   116=    117AG   144=    145AG

     1              SUBROUTINE STDEV(X,N,XND,S)                                    STDEV
                   C-------------------------------------------------------------------STDEV
                   C     CALCULATES THE STANDARD DEVIATION OF A SEQUENCE OF DATA POINTS  STDEV
                   C-------------------------------------------------------------------STDEV
     2              DIMENSION X(1)                                                 STDEV
     3              ENS=XND                                                        STDEV
     4              CALL AMEAN(X,N,XND)                                            STDEV
     5              S=0.                                                           STDEV
     6              DO1 I=1,N                                                      STDEV
     7            1 S=S+(X(I)-XND)*(X(I)-XND)                                      STDEV
     8              IF(ENS .LT. 0.) GO TO 2                                        STDEV
     9              N=N-1                                                          STDEV
    10            2 S = SQRT(S/FLOAT(N))                                           STDEV
    11              RETURN                                                         STDEV
    12              END                                                            STDEV


SYMBOL      = = = = = = = = = = = = = = =    REFERENCES    = = = = = = = = = = = = = = =

1           -     6       7*
2           -     8      10*
AMEAN       -     4
ENS         -     3=      8
FLOAT       -    10
I           -     6       7
N           -     1AG     4AG     6       9=     10
RETURN      -    11
S           -     1AG     5=      7=     10=
SQRT        -    10
STDEV       -     1
X           -     1AG     2DI     4AG     7
XND         -     1AG     3       4AG     7
```

SUBROUTINE AMEAN(X,N,XBAR)

```
1           SUBROUTINE AMEAN(X,N,XBAR)                                        AMEAN
          C-----------------------------------------------------------------AMEAN
          C     CALCULATES THE ARITHMETIC MEAN OF A SEQUENCE OF DATA POINTS  AMEAN
          C-----------------------------------------------------------------AMEAN
2           DIMENSION X(1)                                                    AMEAN
3           XBAR=0.                                                           AMEAN
4           DO1 I=1,N                                                         AMEAN
5         1 XBAR=XBAR+X(I)                                                    AMEAN
6           XBAR = XBAR/FLOAT(N)                                              AMEAN
7           RETURN                                                            AMEAN
8           END                                                               AMEAN
```

```
SYMBOL     = = = = = = = = = = = = = = =    REFERENCES   = = = = = = = = = = = = = = =

I       -      4        5*
AMEAN   -      1
FLOAT   -      6
I       -      4        5
N       -      1AG      4        6
RETURN  -      7
X       -      1AG      2DI      5
XBAR    -      1AG      3=       5=       6=
```

```
1           FUNCTION TINORM(ALPHA,$)                                          TINORM
2           DIMENSION A(3),B(3)                                               TINORM
3           DATA(A(I),I=1,3)/.010328,.802853,2.515517/,(B(I),I=1,3)/.0010308, TINORM
          1.189269,1.432788/                                                  TINORM
          C-----------------------------------------------------------------TINORM
          C     APPROXIMATION TO INVERSE NORMAL DISTRIBUTION                  TINORM
          C-----------------------------------------------------------------TINORM
4           IF(.NOT.(ALPHA.GT.0..AND.ALPHA.LT.1.)) GO TO 1                    TINORM
5           X=ALPHA                                                           TINORM
6           IF(X.GT..5) X=1.-X                                                TINORM
7           X=SQRT(-2.*ALOG(X))                                               TINORM
8           TINORM=X-(A(3)+X*(A(2)+X*A(1)))/(1.+X*(B(3)+X*(B(2)+X* B(1))))    TINORM
9           CALL OVERFL(I)                                                    TINORM
10          IF(I.EQ.1) RETURN 2                                               TINORM
11          IF(ALPHA.LT..5) TINORM=-TINORM                                    TINORM
12          RETURN                                                            TINORM
13        1 RETURN 2                                                          TINORM
14          END                                                               TINORM
```

```
SYMBOL     = = = = = = = = = = = = = = =    REFERENCES   = = = = = = = = = = = = = = =

1       -      4       13*
A       -      2DI      3DA      8
ALOG    -      7
ALPHA   -      1AG      4        5        11
B       -      2DI      3DA      8
I       -      3DA      9AG      10
OVERFL  -      9
RETURN  -     10       12       13
SQRT    -      7
TINORM  -      1        8=       11=
X       -      5=       6        7=       8
```

APPENDIX B

LISTING AND INDEX OF RAPLOT III PROGRAM

FORTRAN IV Listing of RAPLOT III and Subroutines TRACK and TINORM with an Index to all Statement Numbers, Variable Names, and Subroutine Calls

```
      PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060 CRT

C     PROGRAM -- RAPLOT III  MODIFIED FOR IBM-7094 WITH SC-4060 CRT                1
C     THE PURPOSE OF THIS PROGRAM IS TO REDUCE THE RADIOACTIVITY SURVEY            2
C     DATA FROM THE RIST PROJECT AND PLOT THE SURVEY ON A BENSON-LEHNER            3
C     INCREMENTAL PLOTTER.  THE FOLLOWING PLOTS ARE THE OUTPUT:                    4
C        TRACKLINE FOLLOWED BY SURVEY VESSEL                                       5
C        PLOT OF UNCORRECTED RADIATION VALUES (BACKGROUND SURVEY)                  6
C        SYMBOL PLOT OF RADIATION VALUES CORRECTED FOR BACKGROUND AND              7
C                 DECAY SINCE INJECTION TIME.                                      8
C        PROGRAMMER:  PHILIP A. TURNER                                             9
C                     GEOLOGY BRANCH                                              10
C                     U S ARMY COASTAL ENGINEERING RESEARCH CENTER                 11
C                     5201 LITTLE FALLS ROAD                                      12
C                     WASHINGTON, D. C.   20016                                   13
C        COMPLETED IN JANUARY  1969                                               14
C                                                                                 15
C     FORMAT AND ENTRIES ON DATA CONTROL CARD                                     16
C         COL  1- 3  CABLE LENGTH IN FEET TO THE NEAREST FOOT.                    17
C         COL  4- 6  WATER DEPTH PLUS FREEBOARD TO THE NEAREST FOOT.              18
C         COL  7- 9  DISTANCE FROM RADAR MAST TO CABLE STANCHION IN FEET          19
C                    TO THE NEAREST FOOT.                                         20
C         COL 10-16  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR            21
C                    CHANNEL 1.                                                   22
C         COL 17-23  ESTIMATED BACKGROUND COUNT RATE IN COUNTS/SEC FOR            23
C                    CHANNEL 2.                                                   24
C         COL 25-28  TIME OF INJECTION IN HOURS AND MINUTES.                      25
C         COL 29-31  THE NUMBER OF DAYS SINCE THE INJECTION                       26
C         COL 32-36  THE HALF LIFE OF THE RADIOISOTOPE IN DAYS.                   27
C                      THE DECIMAL POINT MUST BE PUNCHED IN.                      28
C         COL 37-40  THE TIME WHEN THE SURVEY WAS STARTED, IN HOURS AND           29
C                      MINUTES.                                                   30
C         COL 44-50  BEACON1 NORTH COORD/ LAMBERT COORDINATES OF RADAR            31
C         COL 52-58  BEACON1  EAST COORD/ BEACONS TO THE NEAREST FOOT.            32
C         COL 60-66  BEACON2 NORTH COORD/ BEACON1 IS ALWAYS UPCOAST.              33
C         COL 68-74  BEACON2  EAST COORD/                                         34
C         COL 75-77  THE NUMBER OF LINES OF DATA TO BE SKIPPED AT THE             35
C                      BEGINNING OF A DATA SET IN ORDER TO AVOID                  36
C                      READING IN SOME BAD DATA.                                  37
C     FORMAT AND ENTRIES ON PLOT CONTROL CARD                                     38
C         COL  1- 3  PLOT OPTION CONTROL.  TO USE, PUNCH THE NUMERAL 1            39
C                    IN THE COLUMN INDICATED.                                     40
C                    1 = PLOT TRACKLINE FOLLOWED BY SURVEY VESSEL.                41
C                    2 = PLOT UNCORRECTED RADIATION VALUES.                       42
C                    3 = PLOT RADIATION VALUES CORRECTED FOR BACKGROUND           43
C                        AND DECAY SINCE TIME ZERO.                               44
C                    4 = UNUSED. LEAVE BLANK.                                     45
C         COL  5-14  MAP SCALE EXPRESSED IN UNITS PER INCH                        46
C         COL 16-17  OPTION 1 / USE WHEN SPOTTING DATA FOR EACH PLOT              47
C         COL 18-19     ]    2 / OPTION.  USER CAN SPECIFY THAT EVERY NTH        48
C         COL 20-21     ]    4 / POINT BE PLOTTED.  IF LEFT BLANK, THE           49
C                              PROGRAM ASSUMES EVERY POINT IS TO BE               50
C                              PLOTTED.                                           51
C         COL 23-32  INTERVALS ON THE COORDINATE GRID AT WHICH TICK               52
C                    MARKS WITH THE LAMBERT COORDINATES WILL BE POSTED.           53
C                    IF FIELD IS LEFT BLANK, PROGRAM WILL ASSUME THAT             54
C                    NO TICK MARKS ARE TO BE PLOTTED AND POSTED.                  55
C         COL 34-43  BEACON 1 / INJECTION SITE. DISTANCE IN METERS TO             56
C         COL 45 54  BEACON 2 / THE NAMED BEACONS. IF FIELDS ARE LEFT             57
C                              BLANK, SITE IS NOT PLOTTED.                        58
C         COL 56-61  DAY,MONTH AND YEAR THE SAND WAS INJECTED                     59
C     FORMAT AND ENTRIES ON PLOT IDENTIFICATION CARD                              60
C         COL  1-78  THIS FIELD WILL BE PLOTTED ON THE LOWER MARGIN OF            61
C                    THE MAP.                                                     62
C         COL 80     PUNCH 'T' HERE ON THE LAST DATA SET.                         63
1           COMMON /AA/ NOPT(4),NPLT(3),SCALE,GRID,DUMPN,DUMPE,NBAR,EBAR,LEGEN   64
           1D(13),INDATE,LINE,BGCR,SIGMA,NMAX,NMIN,EMAX,EMIN,JOBEND,NENTRY,NCA   65
           2LLS,NCAM                                                             66
2           REAL NORTH(2000),NCORD(2000),NBAR,NMAX,NMIN                          67
3           DIMENSION NMBR(2000), TIME(2000), D(2,2000), EAST(2000), ECORD(200   68
           10), RAD(2000), CCR(2000), FATH(2000)                                 69
4           EQUIVALENCE (RAD(1),CCR(1)), (D(1,1),NCORD(1)), (D(1,1001),ECORD(1   70
           1)),                                                                  71
5           LOGICAL JOBEND                                                       72
6           DATA CORR1,CORR2/2.9,2.8/IFLAG/1H*/                                  73
7           WRITE (6,610)                                                        74
8           NCAM=9                                                               75
9           NCALLS=0                                                             76
10     10   NCALLS=NCALLS+1                                                      77
```

```
      PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060 CRT

      C                                                                      78
      C     READ IN DATA CONTROL CARD                                        79
      C                                                                      80
11          READ (5,620) CABLE,DEPTH,BOAT,BKG,ZHR,ZMIN,DAYS,HLIFE,SETIME,RMIN,  81
     1SEC,BEAC1N,BEAC1E,BEAC2N,BEAC2E,ISKIP                                  82
      C                                                                      83
      C     READ IN PLOT CONTROL PARAMETERS                                  84
      C                                                                      85
12          READ (5,630) NOPT,SCALE,(NPLT(I),I=1,3),GRID,DUMP1,DUMP2,INDATE  86
13          DO 30 I=1,3                                                      87
14          IF (NPLT(I)) 20,20,30                                            88
15    20    NPLT(I)=1                                                        89
16    30    CONTINUE                                                         90
      C                                                                      91
      C     READ IN PLOT LEGEND                                              92
      C                                                                      93
17          READ (5,640) LEGEND,JOBEND                                       94
18          WRITE (6,650) LEGEND,JOBEND                                      95
19          WRITE (6,660) BEAC1N,BEAC1E,BEAC2N,BEAC2E                        96
      C                                                                      97
      C     COMPUTE PROGRAM PARAMETERS FROM DATA CONTROL CARD ENTRIES        98
      C                                                                      99
20          SQDSTB=(BEAC2N-BEAC1N)**2+(BEAC2E-BEAC1E)**2                    100
21          DISTB=SQRT(SQDSTB)                                              101
22          WRITE (6,670) SQDSTB,DISTB                                      102
23          SINE=(BEAC2N-BEAC1N)/DISTB                                      103
24          COSINE=(BEAC2E-BEAC1E)/DISTB                                    104
25          WRITE (6,680) SINE,COSINE                                       105
26          WRITE (6,690) ZHR,ZMIN,SETIME,RMIN,SEC,DAYS                     106
27          ZHR=ZHR+ZMIN/60.                                                107
28          SETIME=SETIME+RMIN/60.                                          108
29          DELAY=SETIME+DAYS*24.-ZHR                                       109
30          IF (HLIFE.GT.0.0) DECAY=ALOG(2.)/(HLIFE*24.)                    110
31          WRITE (6,700) HLIFE,DECAY,DELAY                                 111
32          WRITE (6,710) CABLE,DEPTH,BOAT                                  112
33          CABLE=BOAT+SQRT(CABLE**2-DEPTH**2)                              113
34          WRITE (6,720) CABLE                                             114
35          WRITE (6,730) (NOPT(I),I=1,3)                                   115
      C                                                                     116
      C     COMPUTE COORDINATES OF THE INJECTION SITE FROM THE DISTANCES FROM 117
      C     THE BEACONS                                                     118
      C                                                                     119
36          IF (DUMP1) 70,70,40                                             120
37    40    DUMP1=(DUMP1+CORR1)*3.28083                                     121
38          DUMP2=(DUMP2+CORR2)*3.28083                                     122
39          DX1=(SQDSTB+DUMP1*DUMP1-DUMP2*DUMP2)/(DISTB*2.)                 123
40          DY1=DUMP1*DUMP1-DX1*DX1                                         124
41          IF (DY1) 50,50,60                                               125
42    50    SITEN=-999999.                                                  126
43          WRITE (6,740)                                                   127
44          GO TO 70                                                        128
45    60    DY1=-SQRT(DY1)                                                  129
46          SITEE=DX1*COSINE-DY1*SINE+BEAC1E                                130
47          SITEN=DX1*SINE+DY1*COSINE+BEAC1N                                131
48          WRITE (6,750) SITEN,SITEE                                       132
      C                                                                     133
      C     READ IN THE DATA FILE FROM ONE RIST SURVEY, ELIMINATING ANY LINES 134
      C      THAT CONTAIN A -3, WHICH IS AN ERROR FLAG                      135
      C                                                                     136
49    70    N=1                                                             137
50    80    CALL RESET                                                      138
51          READ (5,760) NMBR(N),TIME(N),D(1,N),D(2,N),RAD(N),FATH(N),JFLAG 139
      C                                                                     140
      C     CHECK FOR END OF FILE                                           141
      C                                                                     142
52          CALL CHECK (E)                                                  143
53          IF (E) 100,90,100                                               144
      C                                                                     145
      C     CHECK ERROR FLAG ON INPUT RECORD                                146
      C                                                                     147
54    90    IF (IFLAG.NE.JFLAG) GO TO 80                                    148
55          IF (NMBR(N).LT.0) GO TO 80                                      149
56          IF (TIME(N).LT.0.0) GO TO 80                                    150
57          IF (D(1,N).LT.0.0) GO TO 80                                     151
58          IF (D(2,N).LT.0.0) GO TO 80                                     152
59          IF (RAD(N).LT.0.0) GO TO 80                                     153
60          IF (FATH(N).LT.0.0) GO TO 80                                    154
61          IF (N.GE.2000) GO TO 100                                        155
62          N=N+1                                                           156
63          GO TO 80                                                        157
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                PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060 CRT

 64     100     CONTINUE                                                        158
 65             N=N-1                                                           159
 66             LINE=N-1                                                        160
 67             IF (ISKIP.LE.0) GO TO 130                                       161
        C                                                                       162
        C       SKIP LEADING CARD IMAGES THAT CONTAIN BAD DATA.                 163
        C                                                                       164
 68             NSTART=ISKIP+1                                                  165
 69             DO 120 N=NSTART,LINE                                            166
 70             NN=N-ISKIP                                                      167
 71             NMBR(NN)=NMBR(N)                                                168
 72             TIME(NN)=TIME(N)                                                169
 73             DO 110 I=1,2                                                    170
 74     110     D(I,NN)=D(I,N)                                                  171
 75             RAD(NN)=RAD(N)                                                  172
 76     120     FATH(NN)=FATH(N)                                                173
 77             LINE=LINE-ISKIP                                                 174
 78     130     MSTOP=LINE-1                                                    175
        C                                                                       176
        C       CHECK DISTANCES TO RADAR BEACONS FOR ERRORS.  IF DISTANCE/TIME   177
        C       FOR SUCCESSIVE BEACON RANGES INDICATE A SHIP SPEED .GT. 6 KNOTS  178
        C       (3.09 METERS/SEC),RANGE IS IN ERROR.                            179
        C                                                                       180
 79             DO 240 I=1,2                                                    181
 80             DO 170 M=1,MSTOP                                                182
 81             IF (D(I,M)) 170,170,140                                         183
 82     140     NSTART=M+1                                                      184
 83             DO 160 N=NSTART,LINE                                            185
 84             IF (ABS(D(I,N)-D(I,M))-(TIME(N)-TIME(M))*3.08865) 170,170,150   186
 85     150     D(I,N)=-1.                                                      187
 86     160     CONTINUE                                                        188
 87     170     CONTINUE                                                        189
 88             DO 230 M=1,MSTOP                                                190
 89             IF (D(I,M)) 180,180,230                                         191
 90     180     NSTART=M                                                        192
        C                                                                       193
        C       CORRECT ERRONEOUS BEACON RANGES BY LINEAR INTERPOLATION (ON TIME) 194
        C       BETWEEN NON-ERRONEOUS RANGES.                                   195
        C                                                                       196
 91             DO 200 N=NSTART,LINE                                            197
 92             IF (D(I,N)) 200,200,190                                         198
 93     190     NSTOP=N                                                         199
 94             GO TO 210                                                       200
 95     200     CONTINUE                                                        201
 96     210     DTIME=TIME(NSTOP)-TIME(NSTART-1)                                202
 97             DD1=D(I,NSTOP)-D(I,NSTART-1)                                    203
 98             N=NSTART                                                        204
 99     220     D(I,N)=D(I,NSTART-1)+DD1*(TIME(N)-TIME(NSTART-1))/DTIME         205
100             N=N+1                                                           206
101             IF (N-NSTOP) 220,230,230                                        207
102     230     CONTINUE                                                        208
103     240     CONTINUE                                                        209
        C                                                                       210
        C       COMPUTE POSITION OF SHIP FROM DISTANCES FROM THE TWO BEACONS    211
        C                                                                       212
104             LAG=0                                                           213
105             DO 270 N=1,LINE                                                 214
        C                                                                       215
        C       MAKE CONSTANT CORRECTION FOR CUBIC AUTOTAPE INTERROGATOR        216
        C       AND CONVERT TO FEET                                             217
        C                                                                       218
106             DFT1=(D(1,N)+CORR1)*3.28083                                     219
107             DFT2=(D(2,N)+CORR2)*3.28083                                     220
108             DX1=(SQDSTB+DFT1*DFT1-DFT2*DFT2)/(2.*DISTB)                     221
109             DY1=DFT1*DFT1-DX1*DX1                                           222
        C                                                                       223
        C       CHECK FOR IMAGINARY ROOT.                                       224
        C                                                                       225
110             IF (DY1) 250,250,260                                            226
111     250     NORTH(N)=-1.                                                    227
112             LAG=LAG+1                                                       228
113             GO TO 270                                                       229
114     260     DY1=-SQRT(DY1)                                                  230
        C                                                                       231
        C       ROTATE COORDINATES AND TRANSLATE INTO CALIFORNIA LAMBERT COORDINAT 232
        C       SYSTEM                                                          233
        C                                                                       234
115             EAST(N)=DX1*COSINE-DY1*SINE+BEAC1E                              235
116             NORTH(N)=DX1*SINE+DY1*COSINE+BEAC1N                             236
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117     270   CONTINUE                                                          237
118           IF (LAG.EQ.0) GO TO 330                                           238
119           ASSIGN 330 TO KEY                                                 239
              C                                                                 240
              C     ELIMINATE DATA SETS FOR WHICH AN                            241
              C     IMAGIN ARY FIX WAS OBTAINED                                 242
              C                                                                 243
120     280   LAG=0                                                             244
121           DO 320 N=1,LINE                                                   245
122           IF (NORTH(N)) 290,290,300                                         246
123     290   LAG=LAG+1                                                         247
124           GO TO 320                                                         248
125     300   NN=N-LAG                                                          249
126           NMBR(NN)=NMBR(N)                                                  250
127           TIME(NN)=TIME(N)                                                  251
128           DO 310 I=1,2                                                      252
129     310   D(I,NN)=D(I,N)                                                    253
130           RAD(NN)=RAD(N)                                                    254
131           EAST(NN)=EAST(N)                                                  255
132           NORTH(NN)=NORTH(N)                                                256
133     320   CONTINUE                                                          257
134           LINE=LINE-LAG                                                     258
135           GO TO KEY, (330,400)                                              259
              C                                                                 260
              C     CHECK NORTH AND EAST COORDINATES FOR                        261
              C     EXTREME VALUES BY CHAUVENET'S CRITERION                     262
              C                                                                 263
136     330   NBAR=-1.                                                          264
137           CALL STDEV (NORTH,LINE,NBAR,SDNRTH)                               265
138           EBAR=-1.                                                          266
139           CALL STDEV (EAST,LINE,EBAR,SDEAST)                                267
140           ALPHA=1.-1./FLOAT(2*LINE)                                         268
141           CALL TINORM (CHVR,ALPHA,$335)                                     269
142           GO TO 340                                                         270
143     335   CHVR=5.                                                           271
144           WRITE (6,770) ALPHA                                               272
145     340   GATE1=EBAR-CHVR*SDEAST                                            273
146           GATE2=EBAR+CHVR*SDEAST                                            274
147           GATEN1=NBAR-CHVR*SDNRTH                                           275
148           GATEN2=NBAR+CHVR*SDNRTH                                           276
149           LAG=0                                                             277
150           DO 390 N=1,LINE                                                   278
151           IF (EAST(N)-GATE1) 380,350,350                                    279
152     350   IF (EAST(N)-GATE2) 360,360,380                                    280
153     360   IF (NORTH(N)-GATEN1) 380,370,370                                  281
154     370   IF (NORTH(N)-GATEN2) 390,390,380                                  282
155     380   NORTH(N)=-1.                                                      283
156           LAG=LAG+1                                                         284
157     390   CONTINUE                                                          285
158           ASSIGN 400 TO KEY                                                 286
              C                                                                 287
              C     ELIMINATE ANY DATA SETS THAT HAVE AN EXTREME                288
              C     VALUES OF THE NORTH OR EAST COORDINATES                     289
              C                                                                 290
159           IF (LAG.GT.0) GO TO 280                                           291
              C                                                                 292
              C     CALL SUBROUTINE FOR PLOTTING THE TRACK OF THE SURVEY VESSEL.  293
              C                                                                 294
160     400   NENTRY=1                                                          295
161           IF (NOPT(1).EQ.1) CALL TRACK (NORTH,EAST,NMBR)                    296
              C                                                                 297
              C     APPLY A CORRECTION TO ALLOW FOR THE DISTANCE THE DETECTOR IS TOWED  298
              C        ASTERN OF THE SURVEY SHIP.                             299
              C                                                                 300
162           DN0=NORTH(1)-(NORTH(2)-NORTH(1))                                  301
163           DE0=EAST(1)-(EAST(2)-EAST(1))                                     302
164           DENOM=SQRT((NORTH(1)-DN0)**2+(EAST(1)-DE0)**2)                    303
165           NCORD(1)=NORTH(1)-CABLE*(NORTH(1)-DN0)/DENOM                      304
166           ECORD(1)=EAST(1)-CABLE*(EAST(1)-DE0)/DENOM                        305
167           DO 430 N=2,LINE                                                   306
168           DENOM=SQRT((NORTH(N)-NCORD(N-1))**2+(EAST(N)-ECORD(N-1))**2)      307
              C                                                                 308
              C     THE CORRECTION FOR THE DISTANCE BETWEEN VESSEL AND THE DETECTOR  309
              C     IS EQUAL TO 'CABLE' UNLESS THE VESSEL IS LESS THAN 'CABLE' FEET  310
              C     AWAY FROM THE LAST COMPUTED POSITION OF THE DETECTOR VEHICLE.  IN  311
              C     THIS EVENT, THE NEW COMPUTED DETECTOR POSITION IS THE SAME AS  312
              C     THE LAST DETECTOR POSITION                                  313
              C                                                                 314
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169             IF (DENOM-CABLE) 420,420,410                                    315
170       410   NCORD(N)=NORTH(N)-CABLE*(NORTH(N)-NCORD(N-1))/DENOM             316
171             ECORD(N)=EAST(N)-CABLE*(EAST(N)-ECORD(N-1))/DENOM               317
172             GO TO 430                                                       318
173       420   NCORD(N)=NCORD(N-1)                                             319
174             ECORD(N)=ECORD(N-1)                                             320
175       430   CONTINUE                                                        321
          C                                                                     322
          C     CONVERT RADIATION READINGS TO COUNTS PER SECOND                 323
          C                                                                     324
176             CCR(1)=RAD(1)/SEC                                               325
177             DO 450 N=2,LINE                                                 326
178             IF (NMBR(N).NE.NMBR(N-1)+1) GO TO 440                           327
179             CCR(N)=RAD(N)/(TIME(N)-TIME(N-1))                               328
180             GO TO 450                                                       329
181       440   CCR(N)=RAD(N)/SEC                                               330
182       450   CONTINUE                                                        331
          C                                                                     332
          C     COMPUTE THE MEAN AND STANDARD DEVIATION OF THE BACKGROUND COUNT 333
          C     RATE FROM THE RADIATION DATA THAT LIES WITHIN THE LIMITS OF THE 334
          C     ESTIMATED BACKGROUND COUNT RATE SET BY CHAUVENET'S CRITERION.   335
          C                                                                     336
183             IF (CCR(1).GT.2.*BKG) CCR(1)=BKG                                337
184             ALPHA=1.-1./FLOAT(2*LINE)                                       338
185             CALL TINORM (CHVR,ALPHA,$455)                                   339
186             GO TO 460                                                       340
187       455   CHVR=5.                                                         341
188             WRITE (6,770) ALPHA                                             342
189       460   BGCR=0.0                                                        343
190             SIGMA=0.0                                                       344
191             NCOUNT=0                                                        345
192             GATE1=BKG-CHVR*SQRT(BKG/SEC)                                    346
193             GATE2=BKG+CHVR*SQRT(BKG/SEC)                                    347
194             DO 490 N=1,LINE                                                 348
195             IF (CCR(N)-GATE1) 490,490,470                                   349
196       470   IF (CCR(N)-GATE2) 480,490,490                                   350
197       480   NCOUNT=NCOUNT+1                                                 351
198             BGCR=BGCR+CCR(N)                                                352
199       490   CONTINUE                                                        353
200             BGCR=BGCR/FLOAT(NCOUNT)                                         354
201             DO 520 N=1,LINE                                                 355
202             IF (CCR(N)-GATE1) 520,520,500                                   356
203       500   IF (CCR(N)-GATE2) 510,520,520                                   357
204       510   SIGMA=SIGMA+(CCR(N)-BGCR)**2                                    358
205       520   CONTINUE                                                        359
206             SIGMA=SQRT(SIGMA/FLOAT(NCOUNT))                                 360
207             WRITE (6,780) BKG,BGCR,SIGMA                                    361
          C                                                                     362
          C     CALL THE SUBROUTINE FOR PLOTTING UNCORRECTED RADIATION VALUES   363
          C                                                                     364
208             NENTRY=2                                                        365
209             IF (NOPT(2).EQ.1) CALL RADPLT (NCORD,ECORD,CCR)                 366
210             IF (NOPT(3).NE.1) GO TO 570                                     367
          C                                                                     368
          C     CORRECT RADIATION VALUES FOR BACKGROUND COUNT RATE AND TIME-DECAY 369
          C                                                                     370
211             SUM=0.0                                                         371
212             NBAR=0.0                                                        372
213             EBAR=0.0                                                        373
214             SDNRTH=0.0                                                      374
215             SDEAST=0.0                                                      375
216             DO 540 N=1,LINE                                                 376
217             CCR(N)=CCR(N)-BGCR                                              377
218             IF(CCR(N)-3.*SIGMA) 540,540,530                                 378
219       530   CCR(N)=(CCR(N)-3.*SIGMA)*EXP(DECAY*(DELAY+TIME(N)/3600.))      379
               1  + 3.*SIGMA                                                    3795
220             SUM=SUM+CCR(N)                                                  380
221             NBAR=NBAR+(NCORD(N)-NCORD(1))*CCR(N)                            381
222             EBAR=EBAR+(ECORD(N)-ECORD(1))*CCR(N)                            382
223       540   CONTINUE                                                        383
224             WRITE (6,790) SUM                                               384
          C                                                                     385
          C     COMPUTE WEIGHTED MEAN AND STD. DEV. OF ACTIVITY LOCATION        386
          C                                                                     387
225             NBAR=NCORD(1)+NBAR/SUM                                          388
226             EBAR=ECORD(1)+EBAR/SUM                                          389
227             DO 560 N=1,LINE                                                 390
228             IF (CCR(N)) 560,560,550                                         391
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229      550    SDNRTH=SDNRTH+(NCORD(N)-NBAR)*(NCORD(N)-NBAR)*CCR(N)                    392
230             SDEAST=SDEAST+(ECORD(N)-EBAR)*(ECORD(N)-EBAR)*CCR(N)                    393
231      560    CONTINUE                                                                394
232             SDNRTH=SQRT(SDNRTH/SUM)                                                 395
233             SDEAST=SQRT(SDEAST/SUM)                                                 396
234             WRITE (6,800) NBAR,EBAR,SDNRTH,SDEAST                                   397
         C                                                                              398
         C      COMPUTE AND PRINT 95 PC. CONFIDENCE LIMITS OF MEAN RADIATION            399
         C      LOCATION.                                                               400
         C                                                                              401
235             RTSUM=SQRT(SUM/BGCR)                                                    402
236             CFIDN=1.96*SDNRTH/RTSUM                                                 403
237             CFIDE=1.96*SDEAST/RTSUM                                                 404
238             WRITE (6,810) CFIDN,CFIDE                                               405
239      570    NENTRY=3                                                                406
240             IF (NOPT(3).EQ.1) CALL RADPLT (NCORD,ECORD,CCR)                         407
241             WRITE (6,820) NMAX,EMAX                                                 408
242             WRITE (6,830) NMIN,EMIN                                                 409
         C                                                                              410
         C      WRITE OUT THE NUMBER, COORDINATES AND ACTIVITY OF EACH DATA POINT       411
         C                                                                              412
243             KOUNT=50                                                                413
244             DO 600 N=1,LINE                                                         414
245             IF (KOUNT-50) 590,580,580                                               415
246      580    WRITE (6,840) LEGEND                                                    416
247             KOUNT=0                                                                 417
248      590    WRITE (6,850) NMBR(N),TIME(N),NORTH(N),EAST(N),NCORD(N),ECORD(N),C      418
               1CR(N),FATH(N)                                                          419
249      600    KOUNT=KOUNT+1                                                           420
250             WRITE (6,860)                                                           421
251             IF (.NOT.JOBEND) GO TO 10                                               422
252             STOP                                                                    423
         C                                                                              424
253      610    FORMAT (1H1)                                                            425
254      620    FORMAT (3F3.0,F7.0,8X,2F2.0,F3.0,F5.2,3F2.0,4(1X,F7.0),I3)              426
255      630    FORMAT (4I1,F10.0,1X,3I2,1X,F10.0,2(1X,F10.0),1X,A6)                    427
256      640    FORMAT (13A6,L2)                                                        428
257      650    FORMAT (10X,13A6,10X,L2)                                                429
258      660    FORMAT (/5X,8HBEACON 1,F10.0,1HN,F10.0,1HE,5X,8HBEACON 2,F10.0,1HN      430
               1,F10.0,1HE//)                                                          431
259      670    FORMAT (5X,21HSQUARE DIST BETWEEN =,E16.8,5X,18HDISTANCE BETWEEN =      432
               1,F10.0)                                                                433
260      680    FORMAT (5X,6HSINE =,E16.8,5X,8HCOSINE =,E16.8)                          434
261      690    FORMAT (5X,16HINJECTION TIME =,2F3.0,10X,12HCLOCK SET AT,2F3.0,5X,      435
               121HDIGITIZING INTERVAL =,F3.0,7HSECONDS/5X,30HDAYS ELAPSED SINCE I     436
               2NJECTION =,F3.0)                                                       437
262      700    FORMAT (5X,22HHALF-LIFE OF ISOTOPE =,F7.2,4HDAYS,5X,14HDECAY FACTO      438
               1R =,E16.8,5X,19HTIME-DELAY FACTOR =,F7.2,5HHOURS)                      439
263      710    FORMAT (10X,14HCABLE LENGTH =,F4.0,10X,18HMEAN WATER DEPTH =,F4.0,      440
               110X,13HBOAT LENGTH =,F4.0)                                             441
264      720    FORMAT (10X,38HDISTANCE FROM RADAR MAST TO DETECTOR =,F6.1,5HFEET.      442
               1)                                                                      443
265      730    FORMAT (//40X,15HPLOTS GENERATED/10X,9HTRACKLINE,I5,10X,20HBACKGRO      444
               1UND RADIATION,I5,10X,19HCORRECTED RADIATION,I5)                        445
266      740    FORMAT (5X,51HBEACON RANGES FOR DUMP SITE COMPUTE IMAGINARY ROOT.)      446
267      750    FORMAT (10X,37HLAMBERT COORDINATES OF INJECTION SITE,F10.0,1HN,F10      447
               1.0,1HE)                                                                448
268      760    FORMAT (I6,3F7.1,F7.0,7X,F7.0,A1)                                       449
269      770    FORMAT (37H THERE WAS AN OVERFLOW WHEN ALPHA WAS,F6.3,5X,25HCHVR W      450
               1AS SET EQUAL TO 5.0)                                                   451
270      780    FORMAT (//20X,53HSUMMARY STATISTICS OF BACKGROUND RADIATION COUNT       452
               1RATE/10X,21HEST. BKG. COUNTS/SEC.,F10.0/10X,21HMEAN BKG. COUNTS/SE     453
               2C.,F10.0/10X,21HSTD. DEV. COUNTS/SEC.,F10.0)                           454
271      790    FORMAT (//10X,33HSUM OF CORRECTED RADIATION COUNTS,E16.8)               455
272      800    FORMAT (//20X,41HSUMMARY STATISTICS OF RADIATION LOCATION./24X,11H      456
               1NORTH COORD/10X,10HEAST COORD/16X,4HMEAN/5X,F10.0/10X,F10.0/11X,9H     457
               2STD. DEV./5X,F10.0/10X,F10.0)                                          458
273      810    FORMAT (10X,10HCONFIDENCE/7X,13HLIMIT OF MEAN,5X,F10.0,10X,F10.0)       459
274      820    FORMAT (//7X,13HMAXIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE)                460
275      830    FORMAT (//7X,13HMINIMUM COORD,5X,F10.0,1HN,9X,F10.0,1HE//)              461
276      840    FORMAT (1H1,9X,13A6//2X,50HLINE  TIME  DISTANCE TO BEACON    BOAT      462
               1COORDTNATES,4X,50HBALL COORDINATES  UNCORRECTED  CORRECTED     DEP     463
               2TH/9X,3HSEC,8X,1H1,9X,1H2,6X,5HNORTH,6X,4HEAST,5X,5HNORTH,6X,4HEAS     464
               3T,4X,20HRADIATION COUNTS/SEC,6X,4HFEET)                                465
277      850    FORMAT (1X,I5,F6.0,20X,4F10.0,13X,F11.0,F10.0)                          466
278      860    FORMAT (1H1)                                                            467
279             END                                                                     468-
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PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060. CRT

10	-	10*	251							
20	-	14	15*							
30	-	13	14	16*						
40	-	36	37*							
50	-	41	42*							
60	-	41	45*							
70	-	36	44	49*						
80	-	50*	54	55	56	57	58	59	60	63
90	-	53	54*							
100	-	53	61	64*						
110	-	73	74*							
120	-	69	76*							
130	-	67	78*							
140	-	81	82*							
150	-	84	85*							
160	-	83	86*							
170	-	80	81	84	87*					
180	-	89	90*							
190	-	92	93*							
200	-	91	92	95*						
210	-	94	96*							
220	-	99*	101							
230	-	88	89	101	102*					
240	-	79	103*							
250	-	110	111*							
260	-	110	114*							
270	-	105	113	117*						
280	-	120*	159							
290	-	122	123*							
300	-	122	125*							
310	-	128	129*							
320	-	121	124	133*						
330	-	118	119	135	136*					
335	-	143*								
340	-	142	145*							
350	-	151	152*							
360	-	152	153*							
370	-	153	154*							
380	-	151	152	153	154	155*				
390	-	150	154	157*						
400	-	135	158	160*						
410	-	169	170*							
420	-	169	173*							
430	-	167	172	175*						
440	-	178	181*							
450	-	177	180	182*						
455	-	187*								
460	-	186	189*							
470	-	195	196*							
480	-	196	197*							
490	-	194	195	196	199*					
500	-	202	203*							
510	-	203	204*							
520	-	201	202	203	205*					
530	-	218	219*							
540	-	216	218	223*						
550	-	228	229*							
560	-	227	228	231*						
570	-	210	239*							
580	-	245	246*							
590	-	245	248*							
600	-	244	249*							
610	-	7WR	253*							
620	-	11RD	254*							
630	-	12RD	255*							
640	-	17RD	256*							
650	-	18WR	257*							
660	-	19WR	258*							
670	-	22WR	259*							
680	-	25WR	260*							
690	-	26WR	261*							
700	-	31WR	262*							
710	-	32WR	263*							
720	-	34WR	264*							
730	-	35WR	265*							
740	-	43WR	266*							
750	-	48WR	267*							
760	-	51RD	268*							
770	-	144WR	188WR	269*						

PROGRAM -- RAPLOT III MODIFIED FOR IBM-7094 WITH SC-4060 CRT

```
                        SUBROUTINE TRACK (NORTH,EAST,NMBR)

1                       SUBROUTINE TRACK (NORTH,EAST,NMBR)                      TRK   1
                                                                                TRK   2
      C
      C                 THIS SUBROUTINE GENERATES PLOT INSTRUCTIONS FOR THE STROMBERG-  TRK   3
      C                 CARLSON 4020 CATHODE RAY TUBE.                          TRK   4
      C                                                                         TRK   5
2                       COMMON /AA/ NOPT(4),NPLT(3),SCALE,GRID,DUMPN,DUMPE,NBAR,EBAR,LEGENTRK   6
                       1D(13),INDATE,NPTS,BGCR,SIGMA,NMAX,NMIN,EMAX,EMIN,JOBEND,NENTRY,NCATRK   7
                       2LLS,NCAM                                                TRK   8
3                       DIMENSION EAST(2000), NMBR(2000)                        TRK   9
4                       REAL NORTH(2000),NBAR,NMAX,NMIN,NMAXV                   TRK  10
5                       LOGICAL JOBEND                                          TRK  11
6     10                IF (NCALLS.GT.1) GO TO 20                               TRK  12
      C                                                                         TRK  13
      C                 INITIALIZE CAMERA, AND PRINT ID FRAME                   TRK  14
      C                                                                         TRK  15
7                       PHI=ALOG(2.)                                            TRK  16
8                       CALL FRAMEV                                             TRK  17
9                       CALL SETMIV (0,140,32,0)                                TRK  18
10    20                LAST=3                                                  TRK  19
11    30                IF (NOPT(LAST).NE.0) GO TO 40                           TRK  20
12                      LAST=LAST-1                                             TRK  21
13                      GO TO 30                                                TRK  22
                                                                                TRK  23
      C                 COMPUTE MAXIMUM AND MINIMUM VALUES OF NORTH AND EAST ARRAYS  TRK  24
      C                                                                         TRK  25
14    40                NMAX=NORTH(1)                                           TRK  26
15                      NMIN=NORTH(1)                                           TRK  27
16                      EMAX=EAST(1)                                            TRK  28
17                      EMIN=EAST(1)                                            TRK  29
18                      DO 50 N=2,NPTS                                          TRK  30
19                      NMAX=AMAX1(NMAX,NORTH(N))                               TRK  31
20                      NMIN=AMIN1(NMIN,NORTH(N))                               TRK  32
21                      EMAX=AMAX1(EMAX,EAST(N))                                TRK  33
22    50                EMIN=AMIN1(EMIN,EAST(N))                                TRK  34
23                      XRATIO=(EMAX-EMIN)/883.                                 TRK  35
24                      YRATIO=(NMAX-NMIN)/991.                                 TRK  36
25                      IF (XRATIO-YRATIO) 60,80,70                             TRK  37
26    60                EMAXV=EMIN+YRATIO*883.                                  TRK  38
27                      NMAXV=NMAX                                              TRK  39
28                      GO TO 80                                                TRK  40
29    70                NMAXV=NMIN+XRATIO*991.                                  TRK  41
30                      EMAXV=EMAX                                              TRK  42
31                      GO TO 80                                                TRK  43
32                      ENTRY RADPLT(NORTH,EAST,RAD)                            TRK 435
33                      DIMENSION RAD(2000)                                     TRK  44
34                      IF (NOPT(1).EQ.0.AND.NENTRY.EQ.2) GO TO 10              TRK  45
35                      IF (NOPT(1).EQ.0.AND.NOPT(2).EQ.0.AND.NENTRY.EQ.3) GO TO 10  TRK  46
                                                                                TRK  47
      C                 PRINT LEGEND AND INJECTION DATE AT BASE OF MAP.         TRK  48
      C                                                                         TRK  49
36    80                CALL PRINTV (78,LEGEND,24,24)                           TRK  50
37                      CALL PRINTV (-14,14HINJECTION DATE,720,8)               TRK  51
38                      CALL PRINTV (6,INDATE,848,8)                            TRK  52
39                      NN=NPLT(NENTRY)                                         TRK  53
40                      GO TO (90,110,140), NENTRY                              TRK  54
41    90                CALL PRINTV (-25,25HPLOT OF SURVEY TRACK LINE,24,8)     TRK  55
42                      CALL GRID1V (2,EMIN,EMAXV,NMIN,NMAXV,SCALE,SCALE,5,5,5,5,-5,-4)  TRK  56
                                                                                TRK  57
      C                 PLOT TRACK LINE FOLLOWED BY SURVEY VESSEL               TRK  58
      C                                                                         TRK  59
43                      DO 100 N=2,NPTS                                         TRK  60
44                      CALL LINEV (NXV(EAST(N-1)),NYV(NORTH(N-1)),NXV(EAST(N)),NYV(NORTH(TRK  61
                       1N)))                                                    TRK  62
45                      IF (MOD(N,NN).NE.0) GO TO 100                           TRK  63
46                      CALL POINTV (EAST(N),NORTH(N),-3)                       TRK  64
47                      D=FLOAT(NMBR(N))                                        TRK  65
48                      IX=NXV(EAST(N))+5                                       TRK  66
                                                                                TRK  67
      C                 PLOT FIX NUMBER OF EVERY NNTH FIX                       TRK  68
      C                                                                         TRK  69
49                      CALL LABLV (D,IX,NYV(NORTH(N)),4,1,4)                   TRK  70
50    100               CONTINUE                                                TRK  71
51                      GO TO 220                                               TRK  72
52    110               CALL PRINTV (-62,62HPLOT OF UNCORRECTED RADIATION IN STD. DEVS. FRTRK  73
                       10M MEAN BKG. CR.,24,8)                                  TRK  74
53                      CALL GRID1V (2,EMIN,EMAXV,NMIN,NMAXV,SCALE,SCALE,5,5,5,5,-5,-4)  TRK  75
                                                                                TRK  76
      C                 PLOT UNCORRECTED RADIATION VALUES IN STANDARD DEVIATIONS FROM MEANTRK  77
      C                 BACKGROUND COUNT RATE                                   TRK  78
      C                                                                         TRK  79
```

```
                SUBROUTINE TRACK (NORTH,EAST,NMBR)

      54            DO 120 N=1,NPTS                                          TRK  80
      55            IF (MOD(N,NN).NE.0) GO TO 120                            TRK  81
      56            IVAL=IFIX((RAD(N)-BGCR)/SIGMA+6.)                        TRK  82
      57            IF (IVAL.LT.0) IVAL=0                                    TRK  83
      58            IF (IVAL.GT.11) IVAL=11                                  TRK  84
      59            IVAL=-IVAL                                               TRK  85
      60            CALL POINTV (EAST(N),NORTH(N),IVAL)                      TRK  86
      61      120   CONTINUE                                                 TRK  87
                    C                                                        TRK  88
                    C     PRINT LEGEND FOR SYMBOLS REPRESENTING UNCORRECTED VALUES   TRK  89
                    C                                                        TRK  90
      62            CALL PRINTV (-6,6HLEGEND,912,800)                        TRK  91
      63            CALL POINTV (887,768,0,ANY)                              TRK  92
      64            CALL PRINTV (-8,8HCCR .LE.,903,768)                      TRK  93
      65            D=BGCR-5.*SIGMA                                          TRK  94
      66            CALL LABLV (D,975,768,6,1,6)                             TRK  95
      67            IY=752                                                   TRK  96
      68            DO 130 I=1,11                                            TRK  97
      69            N=-I                                                     TRK  98
      70            CALL POINTV (887,IY,N,ANY)                               TRK  99
      71            CALL PRINTV (-8,8HCCR .GT.,903,IY)                       TRK 100
      72            CALL LABLV (D,975,IY,6,1,6)                              TRK 101
      73            D=D+SIGMA                                                TRK 102
      74      130   IY=IY-16                                                 TRK 103
      75            GO TO 220                                                TRK 104
      76      140   CALL PRINTV (-38,38HPLOT OF CORRECTED RADIATION COUNT RATE,24,8)  TRK 105
      77            CALL GRID1V (2,EMIN,EMAXV,NMIN,NMAXV,SCALE,SCALE,5,5,5,5,-5,-4)   TRK 106
                    C                                                        TRK 107
                    C     PLOT CORRECTED RADIATION COUNT RATE AS BACKGROUND IF .LT. 3 STD.   TRK 108
                    C     DEVS. FROM BACKGROUND.  IF COUNT RATE IS MORE THAN 3 STD. DEVS.    TRK 109
                    C     BELOW BACKGROUND, THE VALUE IS NOT PLOTTED AT ALL.                 TRK 110
                    C                                                        TRK 111
      78            DO 190 N=1,NPTS                                          TRK 112
      79            IF (MOD(N,NN).NE.0) GO TO 190                            TRK 113
      80            IF (RAD(N)+3.*SIGMA) 190,160,150                         TRK 114
      81      150   IF (RAD(N)-3.*SIGMA) 160,160,170                         TRK 115
      82      160   IVAL=0                                                   TRK 116
      83            GO TO 180                                                TRK 117
                    C                                                        TRK 118
                    C     IF THE COUNT RATE IS .G.. BACKGROUND, THE VALUE IS PLOTTED ON A    TRK 119
                    C     POWER OF 2 *  25 SCALE                             TRK 120
                    C                                                        TRK 121
      84      170   IVAL=IFIX(ALOG(RAD(N)/100.)/PHI+3.)                      TRK 122
      85            IF (IVAL.LT.1) IVAL=1                                    TRK 123
      86            IF (IVAL.GT.12) IVAL=12                                  TRK 124
      87            IVAL=-IVAL                                               TRK 125
      88      180   CALL POINTV (EAST(N),NORTH(N),IVAL)                      TRK 126
      89      190   CONTINUE                                                 TRK 127
                    C                                                        TRK 128
                    C     PRINT LEGEND FOR SYMBOLS REPRESENTING CORRECTED VALUES     TRK 129
                    C                                                        TRK 130
      90            CALL PRINTV (-6,6HLEGEND,912,800)                        TRK 131
      91            CALL POINTV (887,768,0,ANY)                              TRK 132
      92            CALL PRINTV (-8,8HCCR .LE.,903,768)                      TRK 133
      93            D=3.*SIGMA                                               TRK 134
      94            CALL LABLV (D,975,768,6,1,6)                             TRK 135
      95            D=25.                                                    TRK 136
      96            IY=752                                                   TRK 137
      97            DO 200 I=1,12                                            TRK 138
      98            N=-I                                                     TRK 139
      99            CALL POINTV (887,IY,N,ANY)                               TRK 140
     100            CALL PRINTV (-8,8HCCR .GE.,903,IY)                       TRK 141
     101            CALL LABLV (D,975,IY,6,1,6)                              TRK 142
     102            D=D*2.                                                   TRK 143
     103      200   IY=IY-16                                                 TRK 144
                    C                                                        TRK 145
                    C     PLOT MEAN RADIATION LOCATION                       TRK 146
                    C                                                        TRK 147
     104            IX=NXV(EBAR)                                             TRK 148
     105            IY=NYV(NBAR)                                             TRK 149
     106            CALL POINTV (IX,IY,0,ANY)                                TRK 150
     107            CALL PRINTV (-8,8HO RADBAR,IX,IY)                        TRK 151
                    C                                                        TRK 152
                    C     PLOT POSITION OF INJECTION SITE                    TRK 153
                    C                                                        TRK 154
     108            IF (DUMPN.GT.NMAX.OR.DUMPN.LT.NMIN) GO TO 210            TRK 155
     109            IX=NXV(DUMPE)                                            TRK 156
     110            IY=NYV(DUMPN)                                            TRK 157
```

SUBROUTINE TRACK (NORTH,EAST,NMBR)

```
      111           CALL POINTV (IX,IY,0,ANY)                                    TRK 158
      112           CALL PRINTV (-6,6HO DUMP,IX,IY)                              TRK 159
      113     210   CONTINUE                                                     TRK 160
      114     220   CALL FRAMEV (2)                                              TRK 161
      115           IF (.NOT.JOBEND.OR.NENTRY.NE.LAST) RETURN                    TRK 162
      116           RETURN                                                       TRK 163
      117           END                                                          TRK 164
```

SUBROUTINE TRACK (NORTH,EAST,NMBR)

SYMBOL = = = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = = = = =

```
10      -     6*    34     35
20      -     6     10*
30      -    11*    13
40      -    11     14*
50      -    18     22*
60      -    25     26*
70      -    25     29*
80      -    25     28     31     36*
90      -    40     41*
100     -    43     45     50*
110     -    40     52*
120     -    54     55     61*
130     -    68     74*
140     -    40     76*
150     -    80     81*
160     -    80     81     82*
170     -    81     84*
180     -    83     88*
190     -    78     79     80     89*
200     -    97    103*
210     -   108    113*
220     -    51     75    114*
AA      -     2C0
ALOG    -     7     84
AMAX1   -    19     21
AMIN1   -    20     22
ANY     -   70AG   99AG
BGCR    -     2C0   56     65
D       -    47=   49AG   65=   66AG   72AG   73=    93=   94AG   95=   101AG
            102=
DUMPE   -     2C0   109
DUMPN   -     2C0   108    110
EAST    -     1AG    3DI   16     17     21     22     32    44AG   46AG   48
            60AG   88AG
EBAR    -     2C0   104
EMAX    -     2C0   16=    21=    23     30
EMAXV   -    26=    30=    42AG   53AG   77AG
EMIN    -     2C0   17=    22=    23     26     42AG   53AG   77AG
FLOAT   -    47
FRAMEV  -     8     114
GRID    -     2C0
GRID1V  -    42     53     77
I       -    68     69     97     98
IFIX    -    56     84
INDATE  -     2C0   38AG
IVAL    -    56=    57     58     59=    60AG   82=    84=    85     86     87=
            88AG
IX      -    48=    49AG   104=   106AG  107AG  109=   111AG  112AG
IY      -    67=    70AG   71AG   72AG   74=    96=    99AG   100AG  101AG  103=
            105=   106AG   107AG  110=   111AG  112AG
JOBEND  -     2C0    5LG   115
LABLV   -    49     66     72     94     101
LAST    -    10=    11     12=    115
LEGEND  -     2C0   36AG
LINEV   -    44
MOD     -    45     55     79
N       -    18     19     20     21     22     43     44AG   45     46AG   47
            48     49AG   54     55     56     60AG   69=    70AG   78     79
            80     81     84     88AG   98=    99AG
NBAR    -     2C0    4RL   105
NCALLS  -     2C0    6
NCAM    -     2C0
NENTRY  -     2C0   34     35     39     40     115
NMAX    -     2C0    4RL   14=    19=    24     27     108
NMAXV   -     4RL   27=    29=    42AG   53AG   77AG
NMBR    -     1AG    3DI   47
```

SUBROUTINE TRACK (NORTH,EAST,NMBR)

```
NMIN    -     2C0     4RL     15=     20=     24      29      42AG    53AG    77AG    108
NN      -    39=      45      55      79
NOPT    -     2C0     11      34      35
NORTH   -     1AG     4RL     14      15      19      20      32      44AG    46AG    49AG
             60AG    88AG
NPLT    -     2C0     39
NPTS    -     2C0     18      43      54      78
NXV     -    44AG     48     104     109
NYV     -    44AG    49AG    105     110
PHI     -     7=      84
POINTV  -     46      60      63      70      88      91      99     106     111
PRINTV  -     36      37      38      41      52      62      64      71      76      90
              92     100     107     112
RAD     -     32      33DI    56      80      81      84
RADPLT  -     32
RETURN  -    115     116
SCALE   -     2C0     42AG    53AG    77AG
SETMIV  -     9
SIGMA   -     2C0     56      65      73      80      81      93
TRACK   -     1
XRATIO  -    23=     25      29
YRATIO  -    24=     25      26
```

INDEX

SUBROUTINE TINORM(ZVAL,ALPHA,*)

```
 1          SUBROUTINE TINORM(ZVAL,ALPHA,*)                                    TINORM
 2          DIMENSION A(3), B(3)                                               TINORM
 3          DATA(A(I),I=1,3)/.010328,.802853,2.515517/,(B(I),I=1,3)/.0010308,  TINORM
           1.189269,1.432788/                                                  TINORM
       C---------------------------------------------------------------------TINORM
       C     APPROXIMATION TO INVERSE NORMAL DISTRIBUTION                     TINORM
       C---------------------------------------------------------------------TINORM
 4          IF(.NOT.(ALPHA.GT.0..AND.ALPHA.LT.1.)) GO TO 1                     TINORM
 5          X=ALPHA                                                            TINORM
 6          IF(X.GT..5) X=1.-X                                                 TINORM
 7          X=SQRT(-2.*ALOG(X))                                                TINORM
 8          ZVAL  =X-(A(3)+X*(A(2)+X*A(1)))/(1.+X*(B(3)+X*(B(2)+X* B(1))))     TINORM
 9          CALL OVERFL(I)                                                     TINORM
10          IF(I.EQ.1) RETURN 3                                                TINORM
11          IF(ALPHA.LT..5) ZVAL = - ZVAL                                      TINORM
12          RETURN                                                             TINORM
13        1 RETURN 3                                                           TINORM
14          END                                                                TINORM
```

INDEX

SUBROUTINE TINORM(ZVAL,ALPHA,*)

SYMBOL = = = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = = = =

```
1       -     4       13*
A       -     2DI     3DA     8
ALOG    -     7
ALPHA   -     1AG     4       5       11
B       -     2DI     3DA     8
I       -     3DA     9AG     10
OVERFL  -     9
RETURN  -     10      12      13
SQRT    -     7
TINORM  -     1
X       -     5=      6       7=      8
ZVAL    -     1AG     8=      11=
```

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13. ABSTRACT

RAPLOT II is a computer program for processing radiation and navigation data from field surveys of radioisotopic sand tracer (RIST) study, but is applicable to any survey type operation on the nearshore Continental Shelf. Collected data are punched onto paper tape by the data collection computer on the research vessel. The data are later transferred to magnetic tape which provides the input for the RAPLOT II Program. Program control parameters are on punched cards. The navigation data, which consists of ranges to two shore-based radar beacons, are first edited for spurious data, and then converted to rectangular coordinates (in this case the California Lambert Coordinate System). Radiation data are converted to count rate as counts per second. Background count rate is computed and subtracted from the observed count rate, and any radiation counts that are significantly above the background count rate are corrected for time of decay since the isotope was injected.

Output from the program is in three forms - printed output, graphical output, and magnetic tape record. The processed data are transferred to magnetic tape and made available for further processing, such as the generation of contour maps.

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Dynamic Oceanography						
Radioisotopic sand tracer						
Continental Shelf						
Hydrographic Survey						

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Philip A. Turner. 66 pp., including
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