B E D F O R D I N S T I T U T E O F O C E A N O G R A P H Y

DARTMOUTH, N.S.

STORAGE AND RETRIEVAL OF GEOPHYSICAL DATA

by

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ABSTRACT

The use of digital recording techniques in the acquisition of marine geophysical data has made it imperative that a reliable and efficient data storage and retrieval system be set up. The present note describes the system set up by the marine geophysics group at Bedford Institute of Oceanography. It is intended primarily as a manual for personnel using the data collected. The facility for retrieving data quickly from the system has already proved the usefulness of the system and justified the time involved in developing it.

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

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I. INTRODUCTION

During the past few years the quantity of data collected at sea for subsequent analysis by the Geophysics Group at B.I.O. has increased considerably. In the coming year it is expected that some 500,000 one-minute data records containing a wide variety of geophysical parameters will be recorded at sea and this amount is certainly not likely to decrease in future years. To ensure the full use of this data it has become necessary to set up an efficient data handling system. The majority of the data has been recorded both in the form of analogue records and in digital form on punched paper tape. The format of data recorded on paper tape has varied considerably depending on the variety of data being recorded and the frequency at which it is recorded. Initially only day, time and total magnetic field were recorded but subsequently this was increased to include gravity, Decca and VLF data as well. With the method of recording data developed at the Institute (Mason, 1966) the format on paper tape at any particular time depends on the instruments recording at that time.* Thus the format will change from day to day on any cruise as well as from cruise to cruise.

In setting up a data file it is obviously important to decide on a standard format which will be acceptable for all data recorded at sea. It must be possible to carry out routine processing with standard programs, and any particular portion of data must be quickly and easily accessible for processing. Figure 1 illustrates the steps in the construction of such a file for shipboard geophysical data. It should be emphasized here that the present note concerns the setting up of a permanent data file and is intended primarily as a manual for personnel working with these files.

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* With the BIODAL data logging system being developed this problem does not arise to the same extent.

FLOW CHART FOR CONSTRUCTION OF GEOPHYSICAL DATA FILE

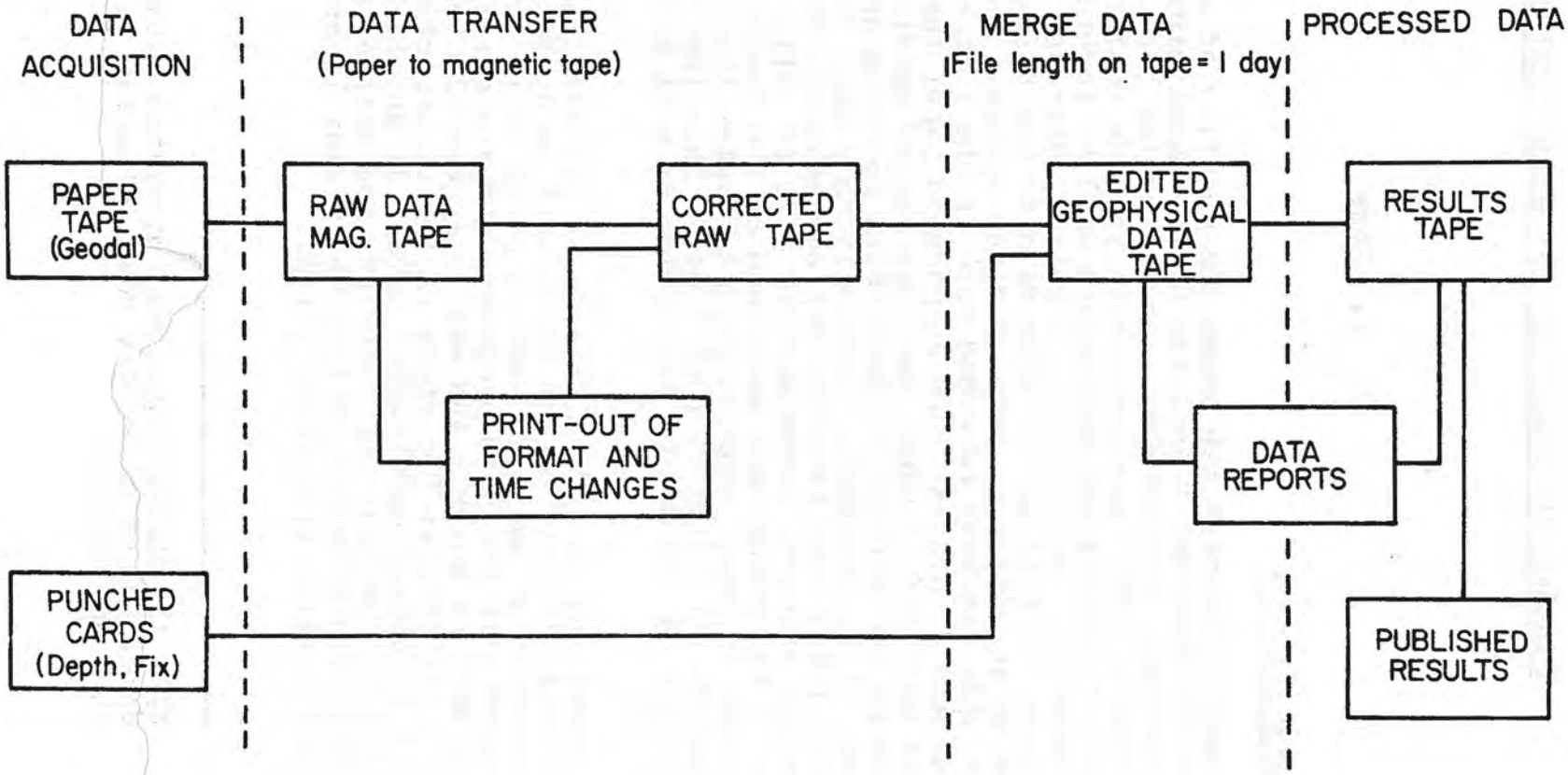


FIGURE 1

II. CONSTRUCTION OF THE EDITED RAW DATA FILE

There are four main steps in the construction of the edited data file. These are: 1) data acquisition; 2) transfer of GEODAL data on to magnetic tape; 3) correction of this raw data tape; 4) editing and merging of data on to the final edited magnetic tape. Figure 1 illustrates these steps.

1. Data Acquisition on board Ship

Data obtained at sea is recorded digitally on paper tape or cards and in analogue form on strip chart recorders. The data formats used for recording geophysical and navigational data are given in Appendix 1.

Geodal Data

The acquisition of geophysical data has to date been controlled and recorded by the data handling system developed at the Institute known as GEODAL (Geophysical Data Logger). Geodal can record all or any of magnetic, gravity, Decca and VLF data along with the day and time on 8-level paper tape. Successive one minute data entries are separated by an end-of-line symbol. Standard Friden code is used. When data for one variable is not being collected, this variable is not punched on tape. Thus the length of a data entry and therefore the data format in an entry, depend on the variables being recorded. Provided the format punched on the tape is one of the standard Geodal formats listed in Appendix 1, the data can be sorted by computer in the next step.

The BIODAL data logging system presently being developed labels all variables punched on the tape. The labelling is performed by the interfacing unit and is therefore independent of the channel being used. This will effectively eliminate the chance of incorrect sorting of the data in the data transfer stage. As this system is not yet in operation, however, it will not be considered further here.

Navigational Data

Various types of navigational data have been recorded at sea. All forms presently recorded can be handled at the edit stage and merged with the Geodal data on the standard data file provided they are recorded digitally in the correct format.

Provision for punching conventional Decca readings and VLF data is included in the Geodal system. Latitude and longitude fixes at start and end of lines, or at major course or speed changes, are punched on cards. These fixes should be the best possible fixes determined from all available data and not necessarily the values determined at the time of fixing. When Decca Lambda data is available, this is punched on paper tape at regular time intervals, e.g. five minutes. Radar transponder buoys have been used for detailed survey work on the Mid-Atlantic Ridge and will probably continue to be used for such deep sea survey work. The buoy identification number, range and bearing data are punched on paper tape at the required time interval.

Bathymetry Data

If Decca-Lambda or Radar Transponder Buoy data are being punched on paper tape, the bathymetry is incorporated with it. Otherwise, bathymetry data must be punched separately at time intervals of not more than thirty minutes and sufficiently frequently to completely define the bathymetry profile.

For easy processing it is essential that the data tapes produced must be good, i.e. free of all errors. This requires careful punching and checking of the tapes produced.

2. Transfer of Geodal Data from Paper to Magnetic Tape

The next step is to transfer the Geodal data from the paper to the more convenient magnetic tape, and to store it on the magnetic tape in a standard format which can accommodate all data recorded, but which is independent of the equipment actually being run on a particular cruise. This is accomplished with the program "Data Transfer". The program sorts out the data by counting the number of characters in a Geodal record and checking for alphanumeric characters in the case of conventional Decca. Control is then switched to one of a variety of data write statements depending on the number of characters, and hence the data present on the paper tape. The write statements are arranged so that a particular parameter, e.g. total magnetic field, is always written in the same location in the data block on the magnetic tape. Spaces are left in the data block when any parameter is missing. Each one minute record on paper tape is written as one BCD record on magnetic tape. Data obtained over some 25 days can be written on one 2400 ft. reel of magnetic tape.

A study of the legal Geodal formats, Appendix 1, will show that provided total magnetic field is punched every six seconds the computer can always sort out the data correctly. If either one minute magnetic or gravity values are punched, confusion can arise and the computer must be told which is present. Hence, if gravity is being recorded, it is convenient to punch magnetics every six seconds at all times.

The print-out obtained during the transfer gives an effective listing of what data has been written on the magnetic tape. Whenever the time interval between two successive readings is greater than one minute, the time of the first is printed followed by the complete entry of the second. Thus an immediate listing of all data gaps is obtained plus an automatic listing of the first entry in every hour. Also whenever the format of the data on the paper tape changes, the first entry of the new format is listed. If the number of characters in an entry does not correspond to a legal Geodal format, the entry is printed preceded by "illegal format" and is discarded. Figure 2 is an example page of a print-out obtained during a data transfer. The listing of the program together with operating instructions is given in Section III (1).

3. Correction of the Raw Data Magnetic Tape

Because there is at present no on-line quality control of the Geodal data, a number of format and time errors get through the system and on to the data tape. These errors are important as they can upset subsequent processing of data. They must therefore be corrected before any editing of the data can be performed. This is particularly important for time errors as the time is used as an index in all subsequent processing.

Time Corrections. Since all time intervals different from one minute are printed in the print-out obtained in the data transfer, it is a simple matter to scan this for time errors. It appears that most time errors that do occur are, in fact, calendar errors. These can be corrected by punching up a calendar correction card containing the correct day and time, (see Appendix 1). The incorrect time recorded on the tape must, however, be greater than previously recorded times since the computer checks the time on the tape at all times. If this time is greater than the time to be corrected, the computer assumes it has already passed the time to be corrected and will read the next card. A dummy card for the day after the last day of the cruise is required as the last card in the calendar correction pack.

```
HUDSON 6-65 NORTH ATLANTIC,DAY067-121 /

PRINTOUT OF FORMAT AND TIME INTERVAL CHANGES AND ILLEGAL INPUT FORMATS
      0
1061225316570588B18208F1049370607058706970737068707670637067707 7
1061259
1061300424970328B18661F09759702870377037702970387033703970347038
1061359
1061400535069928B19524E0896369936999699270027002699769856998699 4
1061459
1061500348369398B20526E1016269296927693069286927693169296924692 8
1061559
1061600737469288B20655E1048369406930693969496937693269426945693 0
1061659
1061700608970398B19232E0935470367031703370327030702870377026703 1
1061759
1061800636670868B17932F0960271007097709671057091709571027093710 0
1061859
1061900588771668B16819F1120871687167716171547169716171587165715 9
1061959
1062000718672318B15844F1298372407224793772367241/2467248/2447241
      0
1062018/1337271B15602F1357772767265726872717277727072717/2767264
1062059
1062100601873288B15099E1309573247329732973307327733173327332733 7
1062159
1062200678674070D13591E1098074027407739774037409740774047406740 3
1062259
1062300660174240D12231E0882074087415741674227424742074227422741 7
1062359
1070000745574800D11103F1080874867482718274847488748474817479747 4
1070059
1070100462675220D09919F1240675217520751475167521752675177523752 7
1070159
1070200502575710D08131F1288375657573756975687564756975717566757 3
1070259
1070300771874/3D06580F1280474857484748074667484747474657470747 9
1070359
1070400742374950D07380F0994074907495748374917495749074924907488
1070459
1070500725374620D08321E0979174697467744174487450745474617469747 2
1070521710674430D08697E107527147745274497449745074487446744 4
1070522709674360D08714E1079774527439744274357450745574467452743 9
1070559
1070600603574000D09438E1250773907399740473897398739573973967391
1070659
1070700522372830D11845F1322972892857992/2867281728772872817285
1070759
1070800525372290D15015F1240672307225722472307222721972327221722 6
ILLEGAL FORMAT
1070841438471990D17004F1198771957193719271917 8
      0
1070901419271750177 2F1174671757143718271727172717371767175717 8
1070959
1071000354171400D18987F1120671257130713571307130712871287133713 0
1071059
1071100271870860D19267F1070770837086708270797080708770867092708 3
1071159
1071200446170588B19122F1045070517058/0597057705470587060705670 5
1071259
1071300383570408B19617F1021470387035704370357039703/703170407036
1071359
```

FIGURE 2

If an error does occur in the time of day rather than the day itself, it can be corrected by punching up an illegal format correction card for that day, i.e. with an illegal alphanumeric character. This card is then assembled with the other format correction cards (see next paragraph), and when this entry is read, will cause the computer to halt. A complete correct data entry can then be read in on the card reader, see Operating Instructions Section III (2). Here again, only times greater than previously recorded correct times can be corrected in this way. All time errors which are less than previously recorded times should be noted for correction in the edit stage.

Format corrections. Since the first entry in the new format is always printed whenever the format of the data on the original paper tape changes, it is comparatively simple to check that all records entered on the magnetic tape are in the correct format. There will be times when an entry has the correct number of characters for a legal format but, because of some change in the punching routine, a complete cycle of data is not present. For example, if at some time, day, time, gravity and ten 6-second magnetics are being punched, each entry will contain 51 characters. If now the punch was turned off after 9 magnetic readings were punched, only 47 characters would be present. This is the legal number of characters for an entry containing day, time, and ten 6-second magnetics so that the record read off the paper tape would be stored on magnetic tape in this form, although what actually was present was day, time, gravity and 9 magnetic readings. This type of error can be easily picked up by checking format changes in the print-out if the operator is aware of what should have been recorded at various stages of the cruise. When an error is found the entry (which will always be printed in the print-out) is punched on a card in the correct final format as it should be written on the tape, blanks being left for data not present. (See Appendix 1). When all format corrections have been prepared a card is made for time 3660000, all format correction cards are sorted into correct time sequence and the cards converted to paper tape using the program "cards to paper tape".

The correction program also checks for illegal alphanumeric characters in an entry. When an illegal alphanumeric is encountered, the computer prints the line, spaces up the printer paper ten lines and stops. By selecting suitable sense switches all or part of the entry can be deleted, or a completely new entry read in on the card reader. The listing of the correction program together with operating instructions is given in Section III (2).

4. Edit and Merge Data

Having obtained a corrected copy of the Geodal tapes on magnetic tape the next step is to merge this with the other data available, notably bathymetry data and position fixes, and write the complete data in a convenient file format. With two magnetic tape units, paper tape reader and a card reader, there is a limit to the amount of data that can be merged in one pass. However it is possible to cope with all the data presently being recorded by the Geophysics group.

Edited Tape Format. The following editing of data is carried out while writing the edited data tape. Position fixes recorded are best fit fixes and not necessarily those recorded in the ship's log while underway. The six second magnetic readings recorded at sea are reduced to one minute average values at this stage and the one minute average field recorded together with the standard error of the six second values from the mean. It would seem reasonable to read in a skip table for gravity data at this stage also so that readings during MSD changes and major course or speed changes are eliminated. This feature is included as a subroutine in the edit program. Two subroutines are used, one to read in skip data and the other to control the gravity recorded during the editing. If skip data is available the subroutines are compiled with the rest of the program. If not, the call statements are omitted, and the subroutines removed. The navigation subroutine also has the facility of skipping all data between the end of one line and the start of the next. The start of lines must be coded on the fix cards by a "1" in the first column if this feature is to be used.

Data is written on the tape in binary form in blocks of ten minutes' data. The cruise is broken down into files of a day's length. Each day's data file is preceded by a file containing the file name and a list of the parameters being recorded in the file together with their location in the data block. The first file on the tape is preceded by a tape label giving the cruise name, location and other relevant information such as data recorded on the cruise, gravity constants for the cruise, etc. Figure 3 shows the layout of data on the tape. Each file on the tape is enclosed in filemarks. In this way the tape can be rapidly searched for data on any particular day.

FIGURE 3 Layout of data files on the edited data tape

TAPE LOAD POINT

1.	TAPE LABEL	BAFFIN 07-67 MONACO DAY 096-128 MAGNETICS, BATHYMETRY AND POSITION RECORDED	
	End of File	EOF	
2.1	FILE LABEL	BAFFIN 07-67 DAY 096	
	PARAMETER LIST	02 MAGNETICS (1 MIN AVERAGE) 03 STANDARD DEVIATION 04 DEPTH (UNCORRECTED FATHOMS) 05 LATITUDE 06 LONGITUDE 07 FIX CODE 15 DAY 16 TIME	
	End of File	EOF	
3.1	DATA BLOCKS 160 words/block representing 10 minutes of data. Total of 144 blocks in a day.		096 0000 " " " " " " 096 2359
	End of File	EOF	
2.2.	FILE LABEL	BAFFIN 07-67 DAY 097	
	PARAMETER LIST	02 MAGNETICS (1 MIN AVERAGE) 03 STANDARD DEVIATION 04 DEPTH (UNCORRECTED FATHOMS) 05 LATITUDE 06 LONGITUDE 07 FIX CODE 15 DAY 16 TIME	
	End of File	EOF	
3.2	DATA BLOCKS 160 words/block representing 10 minutes of data. Total of 144 blocks in a day.		097 0000 " " " " " 097 2359
	END OF FILE	EOF	

etc.

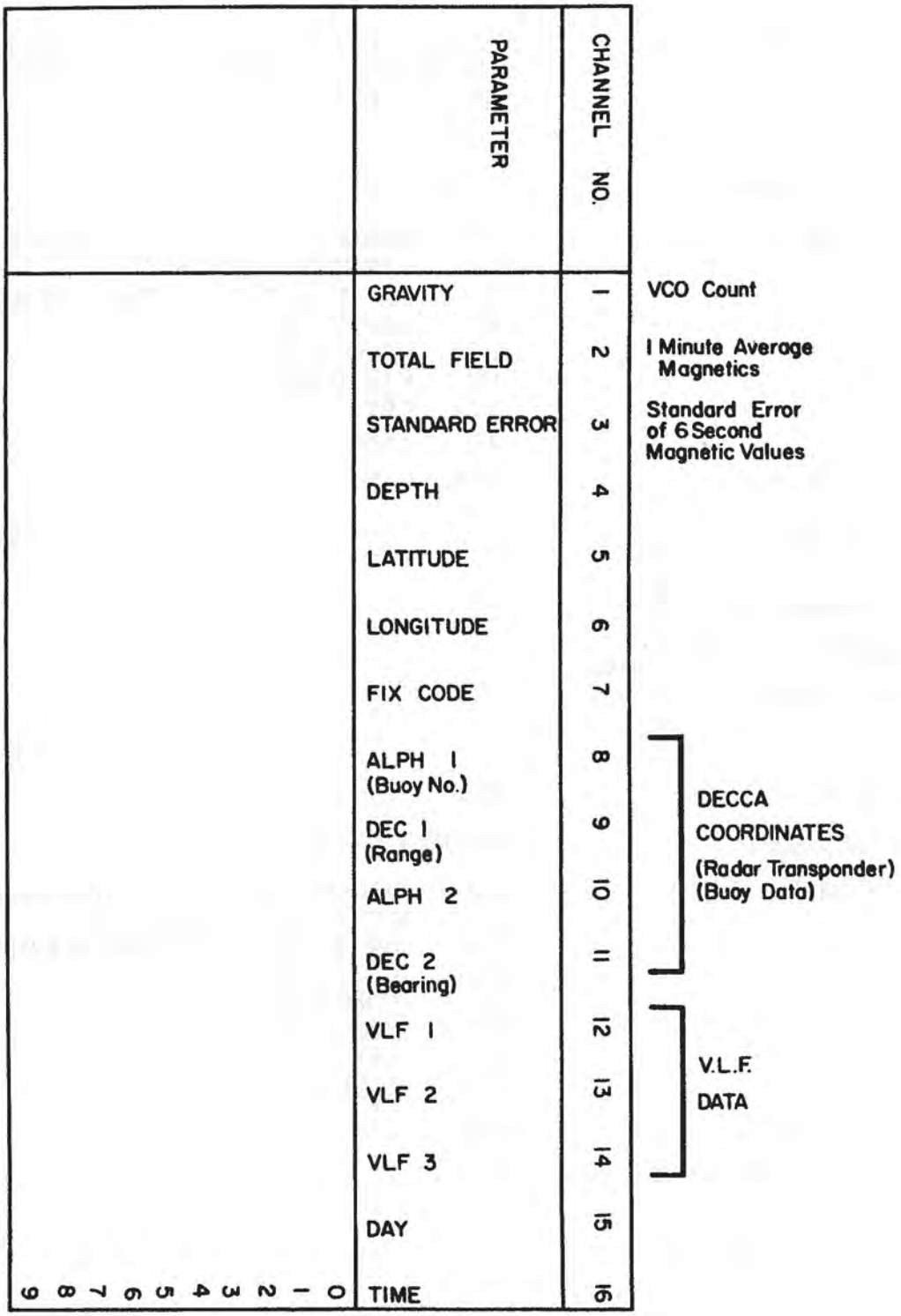

CHANNEL NO.
PARAMETER
GRAVITY
1
VCO Count
TOTAL FIELD
2
1 Minute Average Magnetics
STANDARD ERROR
3
Standard Error of 6 Second Magnetic Values
DEPTH
4
LATITUDE
5
LONGITUDE
6
FIX CODE
7
ALPH 1 (Buoy No.)
8
DECCA COORDINATES (Radar Transponder) (Buoy Data)
DEC 1 (Range)
9
ALPH 2
10
DEC 2 (Bearing)
11
VLF 1
12
V.L.F. DATA
VLF 2
13
VLF 3
14
DAY
15
TIME
16
9 8 7 6 5 4 3 2 1 0

FIGURE 4

A block of data consists of ten records of sixteen binary words. Each record of sixteen words corresponds to one minute of data. The data recorded and the channel in which it is recorded is shown in Figure 4. Buoy range and bearing data recorded in the survey area on the Mid-Atlantic Ridge in 1965-66 is stored in place of Decca coordinates. The geographical positions of the buoys as presently known are recorded in the tape label. Changing parameters like this causes no confusion in the processing as the parameter list at the beginning of the files involved will have the correct parameter name recorded. Since the edit tape read routines always check the parameter list before entering a processing subroutine (see Section IV (3)), this data will only be processed when the buoy parameters are correctly called. Positions in the survey areas involved are then directly calculated from the buoy data by a separate subroutine.

Line Printer Output. As with the data transfer program control of the data being transferred during the edit program is obtained with the line printer print-out. The following information is printed during the running of the program:

1. The tape label
2. The file label plus a list of the parameters being recorded together with their location in the file.
3. The first data block in the file.
4. All data blocks with no data in the tenth minute of the block. This normally corresponds to the last entry before a data gap.
5. Data blocks for times 0600, 1200, 1800.
6. The ten six second magnetic readings when the standard error for the one minute mean is greater than some value (normally 10). This entry is preceded by the calculated mean and standard error.
7. Whenever a navigation card is read the printer will print the time just read off the input tape, the time on the navigation card and the last time read off the depth tape.
8. If the time read off the tape is less than the time accumulated in the program counter, both times are printed and the computer waits for a correction.
9. When the day read off the input tape increases, the time of the next entry plus the day just completed is printed. The file written is closed and the computer halts. On restarting the computer the next day's file is started.

Figure 5 is an example of a print-out obtained. A listing of the program with operating instructions is given in Section III (3). Provided the raw data tape has been carefully corrected and the input card deck carefully made up, no problems should be encountered in this final stage of compiling the raw data file.

GEOPHYSICAL DATA FOR RUN BAFFIN 14-67 DAY 158

VARIABLE NAME	CHAN
GRAVITY (VCO VALUE)	1
AVERAGE MAGNETIC (IMIN)	2
STANDARD DEVIATION	3
DEPTH UNCORRECTED FATH.	4
LATITUDE	5
LONGITUDE	6
FIX CODE	7
DECCA LAMBDA (DEC1)	9
DECCA LAMBDA (DEC2)	11
VLF1	12
VLF2	13
VLF3	14
DAY	15
TIME	16

1580000 1580315 1580000

4163 52679 0 38 46290 -49429 1 90280 11620 1345 5183 8764158 0
4153 52678 0 0 0 0 0 0 0 1346 5182 8764158 1
4140 52678 0 0 0 0 0 0 0 1347 5182 8762158 2
4127 52677 0 0 0 0 0 0 0 1347 5182 8760158 3
4119 52675 0 0 0 0 0 0 0 1348 5181 8761158 4
4115 52674 0 38 0 0 0 82190 11100 1349 5181 8762158 5
4119 52673 0 0 0 0 0 0 0 1350 5180 8762158 6
4115 52672 0 0 0 0 0 0 0 1351 5180 8763158 7
4115 52673 0 0 0 0 0 0 0 1352 5180 8762158 8
4117 52673 0 0 0 0 0 0 0 1353 5179 8758158 9
1580238 52734 30
52861 52848 52823 52788 52751 52714 52687 52659 52630 52587 1580238
1580240 52606 21
52455 52533 52591 52625 52650 52661 52661 52648 52629 52611 1580240
1580241 52538 25
52606 52607 52602 52590 52580 52561 52531 52489 52433 52383 1580241
1580243 52489 23
52400 52411 52419 52438 52465 52497 52527 52556 52580 52602 1580243
1580315 1580355 1580315
1580355 1580510 1580355
1580359 52444 235
50797 0 0 52676 52678 52679 52680 52681 52684 52684 1580359
1580510 1580525 1580510
1580525 1580540 1580525
1580540 1580921 1580540

6027 52641 0 41 0 0 0 61750 00130 1387 5141 8747158 600
5985 52645 1 0 0 0 0 0 0 1386 5141 8748158 601
5932 52649 0 0 0 0 0 0 0 1385 5142 8749158 602
5879 52653 0 0 0 0 0 0 0 1384 5142 8751158 603
5840 52656 0 0 0 0 0 0 0 1383 5142 8751158 604
5805 52658 0 41 0 0 0 62230 00570 1382 5142 8752158 605
5775 52658 0 0 0 0 0 0 0 1381 5143 8753158 606
5752 52658 0 0 0 0 0 0 0 1380 5144 8752158 607
5733 52656 0 0 0 0 0 0 0 1379 5144 8754158 608
5718 52654 0 0 0 0 0 0 0 1378 5145 8757158 609
1580921 1581030 1580921
1581030 1581100 1581030
1581100 1581104 1581100
1581104 1581250 1581104

FIGURE 5

III. PROGRAM OPERATING INSTRUCTIONS

1. Data Transfer

1.1 Program Transfer of paper tape records to standard format magnetic tape.

1.2 Subroutines The program contains one subroutine RMT. This subroutine searches for a given time entry on a magnetic tape previously written by the Data Transfer Program. It is useful when, because of some error, a tape must be rewritten starting from some point partway through a tape.

1.3 Sense switches. Some extra facilities are available by the use of sense switches. The sense switch numbers and the facilities provided by turning them on are listed below:

Sense Switch 1: Read cruise label from a card and write cruise label and data format on magnetic tape. Print headings.

Sense Switch 2. Write filemark on magnetic tape and rewind tape.

Sense Switch 3: Call subroutine RMT. The subroutine reads a time off a card and searches for that time on the magnetic tape.

Sense Switch 4: Search forwards for a filemark.

Sense Switch 5: Search backwards for a filemark.

Sense Switch 6: Backspace tape after required entry has been located by subroutine RMT.

1.4 Program Description. Figures 6 and 6a are flow charts of the program and subroutine. A listing of the program is given in Appendix 2. After initialization etc., the program reads an entry from Geodal paper tape and then passes through a number of control statements to determine the number of characters in the entry and therefore the data present on the tape. If a legal entry has been read it is written in the correct format on magnetic tape, time and format counters are checked for a time interval greater than one minute or a change in input format, the counters are set and another entry read off the paper tape.

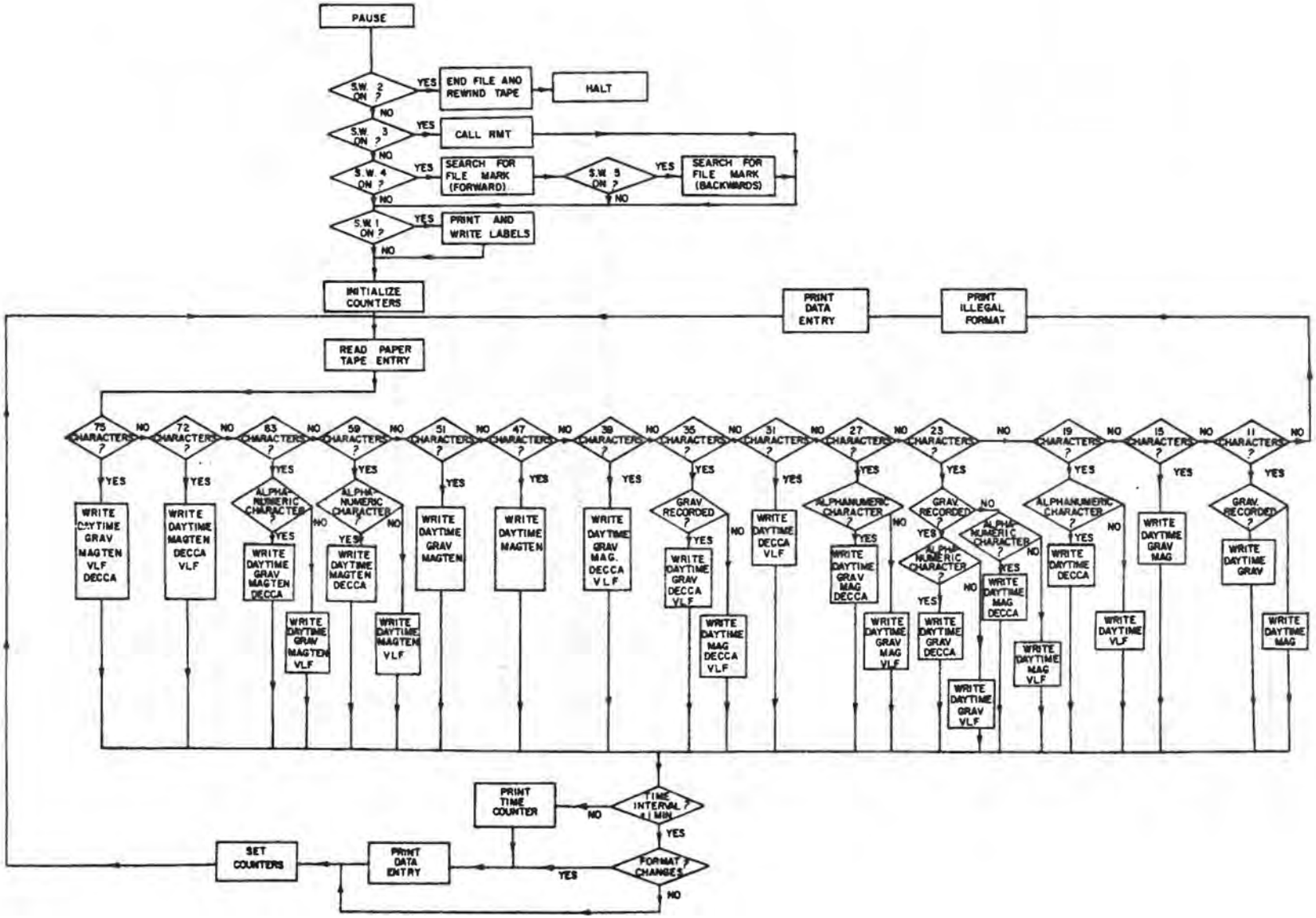

PAUSE
S.W. 2 ON ?
YES
END FILE AND REWIND TAPE
HALT
NO
S.W. 3 ON ?
YES
CALL RMT
NO
S.W. 4 ON ?
YES
SEARCH FOR FILE MARK (FORWARD)
S.W. 5 ON ?
YES
SEARCH FOR FILE MARK (BACKWARDS)
NO
NO
S.W. 1 ON ?
YES
PRINT AND WRITE LABELS
NO
INITIALIZE COUNTERS
PRINT DATA ENTRY
PRINT ILLEGAL FORMAT
READ PAPER TAPE ENTRY
75 CHARACTERS ?
72 CHARACTERS ?
63 CHARACTERS ?
59 CHARACTERS ?
51 CHARACTERS ?
47 CHARACTERS ?
39 CHARACTERS ?
35 CHARACTERS ?
31 CHARACTERS ?
27 CHARACTERS ?
23 CHARACTERS ?
19 CHARACTERS ?
15 CHARACTERS ?
11 CHARACTERS ?
YES
NO
WRITE DAYTIME GRAV MAGTEN VLF DECCA
WRITE DAYTIME MAGTEN DECCA VLF
ALPHA-NUMERIC CHARACTER ?
WRITE DAYTIME GRAV MAGTEN DECCA
WRITE DAYTIME GRAV MAGTEN VLF
WRITE DAYTIME MAGTEN DECCA
WRITE DAYTIME MAGTEN VLF
WRITE DAYTIME GRAV MAGTEN
WRITE DAYTIME MAGTEN
WRITE DAYTIME GRAV MAG. DECCA VLF
GRAV RECORDED ?
WRITE DAYTIME GRAV DECCA VLF
WRITE DAYTIME MAG DECCA VLF
WRITE DAYTIME DECCA VLF
WRITE DAYTIME GRAV MAG DECCA
WRITE DAYTIME GRAV MAG VLF
WRITE DAYTIME GRAV DECCA
WRITE DAYTIME GRAV VLF
WRITE DAYTIME MAG DECCA
WRITE DAYTIME MAG VLF
WRITE DAYTIME DECCA
WRITE DAYTIME VLF
WRITE DAYTIME GRAV MAG
WRITE DAYTIME GRAV
WRITE DAYTIME MAG
PRINT TIME COUNTER
TIME INTERVAL ? 1 MIN
SET COUNTERS
PRINT DATA ENTRY
FORMAT ? CHANGES

FIGURE 6

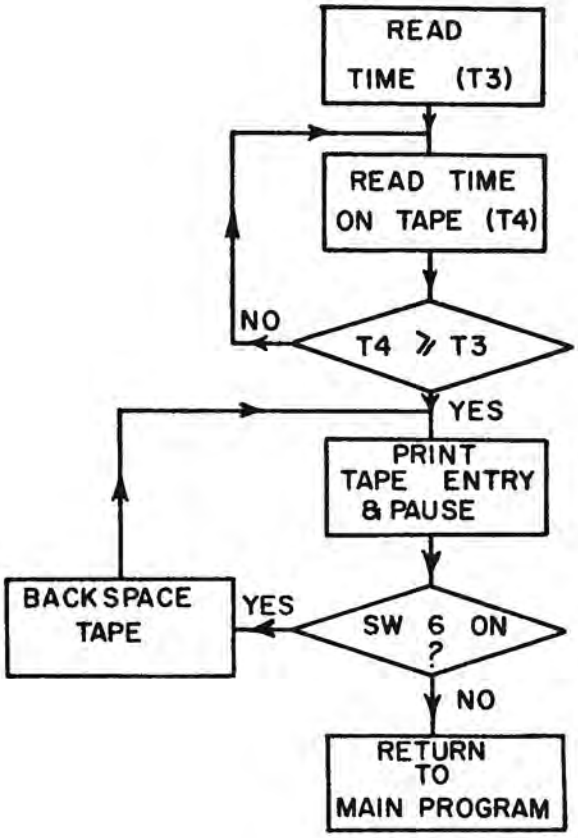

READ
TIME (T3)
READ TIME
ON TAPE (T4)
NO
T4 ⩾ T3
YES
PRINT
TAPE ENTRY
& PAUSE
BACKSPACE
TAPE
YES
SW 6 ON
?
NO
RETURN
TO
MAIN PROGRAM

FIGURE 6a

1.5 Operating Instructions

1.5.1 Starting a new cruise or new magnetic tape

The first instruction in the program is a PAUSE so that after the program has been read in (either from cards or paper tape) the computer should halt at the PAUSE instruction.

1) Load magnetic tape and set tape unit number to 3.
2) Load the first paper tape in the reader.
3) Put cruise label card in the card reader.
4) Set sense switch 1 on.
5) Push GO.
6) Switch off sense switch 1.

The computer will read the label card, write labels on the magnetic tape and print the headings on the printer. It will then proceed to read paper tape from the tape reader.

1.5.2 Loading a new paper tape

1) Check all sense switches are off.
2) Load new paper tape in reader
3) Push STOP and MC.
4) Push GO twice. The first time will bring the computer to the PAUSE instruction, the second will start the computer reading the paper tape.

The first entry on each paper tape will be printed on the print-out proceeded by a zero since clearing the computer resets the time counter to zero.

1.5.3 Searching for a particular entry on the magnetic tape

If a paper tape has been read out of order it is possible to search for the last correct entry written on the magnetic tape and continue the data transfer from this point.

1) Push STOP and MC.
2) Switch sense switch 3 on.
3) Rewind the magnetic tape back past the required correct entry.
4) Load the card reader with the time of the required entry. Push GO twice.

The computer will be switched to the subroutine RMT (Read magnetic tape). The time will be read from the card (I8 format) and the computer will search

(A I3, I4)
(DAY, TIME)

for that time or the first time greater than that on the card. Having found the entry satisfying this condition it will print the complete entry and stop. If, because of a previous time error, this is not the required entry, the process can be repeated. If the data transfer is to be continued from the entry printed, switch off all sense switches and push GO. To backspace the tape so as to overwrite the entry printed, switch on sense switch 6 and press GO. The computer will backspace the tape, read the entry prior to the last one printed, and print this entry.

1.5.4 Writing a filemark on the tape at the conclusion of a transfer of data.
If for any reason the transfer of data is concluded, a filemark should be written on the magnetic tape. This is done as follows:

1) Press STOP and MC.
2) Switch sense switch 2 on.
3) Press GO twice.

The computer will write an end-of-file mark on the tape and rewind the tape.

1.5.5 Searching for a filemark. There are two reasons for wanting to search for a filemark:

i) If the transfer of data was terminated in the middle of a cruise and it is desired to continue writing the tape from the point at which the process was stopped.

ii) If only a portion of a reel of tape has been used for a cruise and it is desired to write a second cruise on the tape.

In the first case it is necessary to write over the filemark, in the other it is not. To search for and overwrite a filemark:

1) Switch on sense switches 4 and 5.
2) Load next paper tape in the tape reader.
3) Press GO.

To search for a filemark and start writing a new cruise following the filemark:

1) Switch on sense switches 4 and 1.
2) Load cruise label in the card reader.

3) Load first paper tape in the tape reader.
4) Press GO.

In this second case the computer will write the tape labels following the filemark and then proceed to read the paper tape.

1.5.6 Computer halts. If an illegal character (e.g.) even parity) is read from the paper tape the computer will halt. The illegal character read can be checked by setting the program address counter to 3721 and pressing "read storage". If the character read is the same as on the tape, an error has occurred in punching the tape. On pressing "GO" the computer will skip that character. If not, the error occurred in reading the tape. The character read should be re-read in this case. If the paper tape reader should drop "Ready" the computer can be re-started in the read subroutine by the following procedure:

Press P

Type in 03102 on the keyboard

Press Transfer

Press Keyboard Off

Press GO.

III.

2. Correction of Raw Data Tape

2.1 Program: Correction of magnetic tapes from cards and paper tape.

2.2. Subroutines: None.

2.3 Sense Switches: Sense switch control is provided to write labels on the corrected tape, to control the data being read and the data rejected when an alphanumeric character is encountered. The use of the sense switches has been tailored to the type of errors that have occurred on the Geodal tapes. Modification of the program to deal with other types of errors is comparatively simple. The following operations are provided by the sense switches.

Sense switch 1: Read first entries off cards.

Sense switch 2: With sense switch 2 off the time of the first entry to be transferred to the corrected tape is read off cards and this entry located on the raw data tape. With sense switch 2 on this search procedure is bypassed.

Sense switch 3: Write tape labels on the corrected tape.

Sense switch 4: Print all time counters

Sense switch 5: Set Decca readings zero. Otherwise test sense switch 6. This is used when an alphanumeric character occurs in the Decca reading. The rest of the entry is retained.

Sense switch 6: Read correct entry from cards. Otherwise reject record and read next entry.

2.4 Program Description Figure 7 is a flow diagram of the program. A listing of the program is given in Appendix 3. The method of making up the calendar correction card pack and format correction paper tape has already been discussed in Section II (3).

The program reads the time for calendar corrections plus the corrections from cards, and the correct day and time for a format correction plus the entry in the

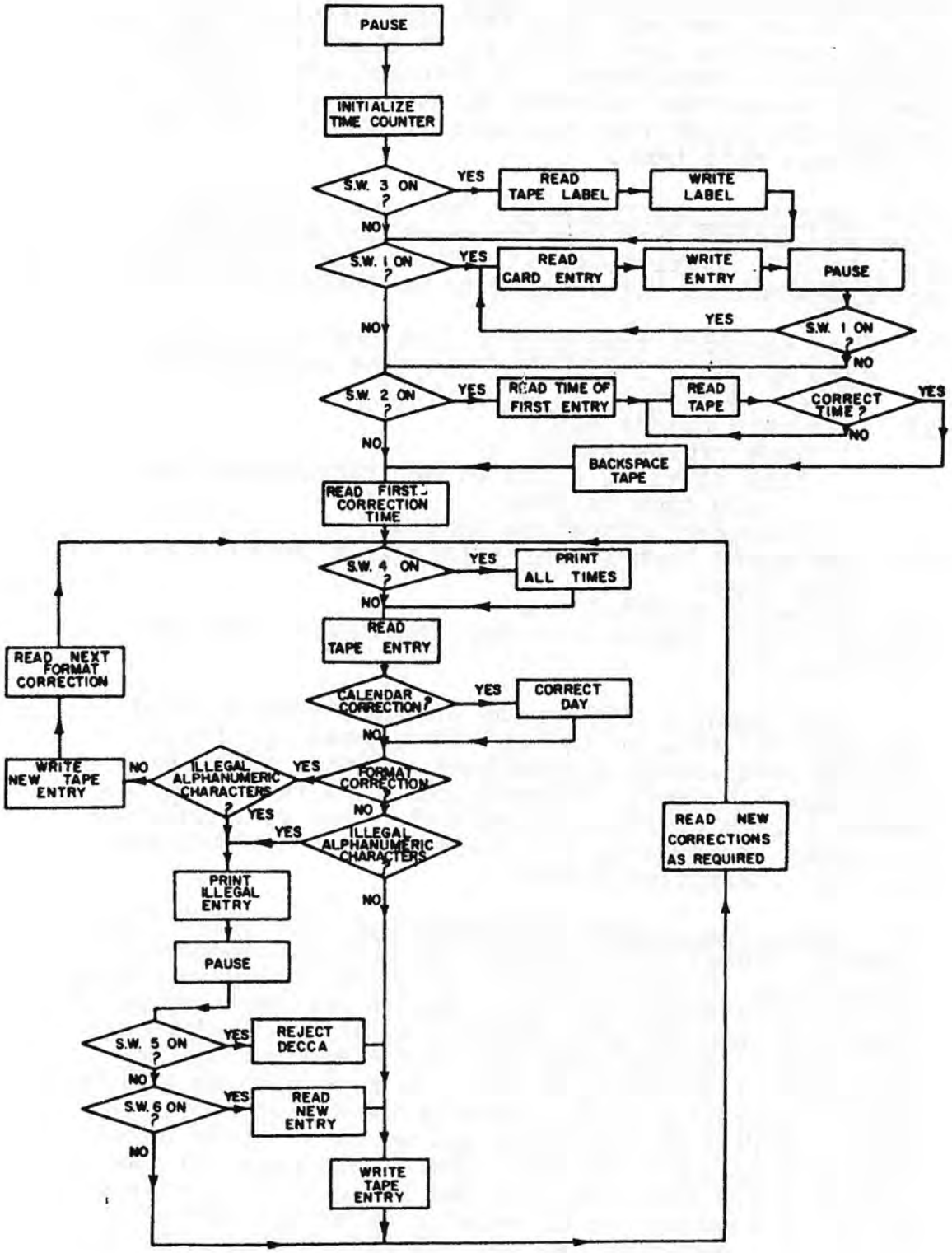

PAUSE
INITIALIZE TIME COUNTER
S.W. 3 ON ?
YES
READ TAPE LABEL
WRITE LABEL
NO
S.W. 1 ON ?
YES
READ CARD ENTRY
WRITE ENTRY
PAUSE
YES
S.W. 1 ON ?
NO
NO
S.W. 2 ON ?
YES
READ TIME OF FIRST ENTRY
READ TAPE
CORRECT TIME ?
YES
NO
NO
BACKSPACE TAPE
READ FIRST CORRECTION TIME
S.W. 4 ON ?
YES
PRINT ALL TIMES
NO
READ TAPE ENTRY
CALENDAR CORRECTION ?
YES
CORRECT DAY
NO
READ NEXT FORMAT CORRECTION
WRITE NEW TAPE ENTRY
NO
ILLEGAL ALPHANUMERIC CHARACTERS ?
YES
FORMAT CORRECTION ?
YES
NO
YES
ILLEGAL ALPHANUMERIC CHARACTERS ?
NO
READ NEW CORRECTIONS AS REQUIRED
PRINT ILLEGAL ENTRY
PAUSE
S.W. 5 ON ?
YES
REJECT DECCA
NO
S.W. 6 ON ?
YES
READ NEW ENTRY
NO
WRITE TAPE ENTRY

FIGURE 7

correct format from paper tape. On finding these times on the raw data tape the correction is applied. At the same time each entry is checked for illegal alphanumeric characters. An internal sense light is used to ensure the calendar correction is only applied the first time the correction time is read on the raw data tape.

2.5 Operating Instructions The correction paper tape and calendar correction cards are prepared as explained in Section II (3). The normal procedure after assembling the program is as follows:

1) Load magnetic tape unit 3 with the raw data tape and Unit 2 with the new tape on which the corrected data is to be written.
2) Load card reader with:
   Tape cruise label
   Time of first entry to be transferred from old tape to new.
   Calendar correction cards.
3) Load paper tape reader with format correction paper tape.
4) Set sense switch 3 on.
5) Set sense switch 5 on (but see next paragraph)
6) Press GO.

The computer will write the tape labels, find the required time on the old tape, read the first calendar and format corrections and proceed to re-write the old tape. Whenever the time read from the magnetic tape corresponds with the time of a calendar or format correction, the correction is applied and the next correction read.

2.6 Check for Illegal Alphanumerics The correction program automatically checks for illegal alphanumeric characters. Practically all of these characters occur in the Decca store reading. Two of the most common of these are automatically taken care of by deleting the Decca store reading when they occur and writing the remainder of the entry on the new tape. If an alpha-numeric character occurs in some other location, the entry is printed, the paper spaced up 10 lines so the entry can be read and the computer stopped. If the illegal character occurs in the Decca store reading, the Decca reading can be deleted by switching sense switch 5 on and pressing GO. If the character is not in the Decca reading but in some other entry, two methods of dealing with the error are possible.

1) With both sense switch 5 and 6 off the complete entry is deleted on pressing GO.

2) With sense switch 5 off and sense switch 6 on, a correct entry is read off a card inserted in the card reader when GO is pressed.

The latter is obviously preferable but the operator must remember to remove the calendar correction cards from the card reader and insert the card with the correct entry in the reader before pressing GO.

If the proper care is taken in scanning the printout from the Data Transfer and preparing the correction cards, the tape obtained at the conclusion of this stage will be a near perfect data tape.

III.

3. Edit and Merge Data

3.1 Program: Edit and Write Final Data Tape.

3.2 Subroutines: The program contains the following eight subroutines:

1) Subroutine COMPARE. This subroutine is used for searching a partly completed edit tape for a particular file label, normally an END OF TAPE file.
2) Subroutine EDIT. This is the subroutine which controls the editing and writing of a day's data on the edit tape. The remaining subroutines are called by this subroutine.
3) Subroutine ADDFIG. This subroutine controls the base value of the total magnetic field to be added to the four magnetic field figures recorded on the input tape.
4) Subroutine MCHECK. This subroutine checks that the six second magnetic field values are reasonable by determining that the first differences of successive readings are less than the value specified on a control card. It then calculates the average field for one minute using the accepted 6 second values, and the standard error of the 6 second values from the mean.
5) Subroutine NAV. This subroutine reads navigation data from cards and bathymetry data from paper tape, or bathymetry and buoy range and bearing data from paper tape. It then merges this data correctly with the Geodal data read from the input magnetic tape. Subroutine NAV is replaced by subroutine NAVDEC if Decca-Lambda and bathymetry data is to be read in from paper tape.
6) Subroutine SKIPRD. This subroutine is used with 7) if gravity data during MSD and course or speed changes is to be eliminated. It reads a gravity skip table for the day being processed.
7) Subroutine SKIP. This subroutine controls the recording of gravity data according to data read under SKIPRD.
8) Subroutine ALLSKIP. This subroutine skips all data between the end of one line and the start of the next.

3.3 Sense Switches. The following sense switches are used to control the data recorded.

Sense Switch 1.	Convert time from local to GMT.
Sense Switch 2.	Convert magnetic readings to readings in gammas.
Sense Switch 3.	Convert time read on input tape to that given by time counter.
Sense Switch 4.	Include ALLSKIP facility for skipping data between lines.
Sense Switch 5.	Read buoy range and bearing data from paper tape (Sense Switch 6 must also be on).
Sense Switch 6.	Read paper tape for bathymetry data (also buoy range and bearing data if Sense Switch 5 is on).

3.4 Program Description Figures 8 (a - f) give the flow diagrams of the main program and subroutines. A listing of the complete program is given in Appendix 4. The main program sets up the files of one day's length on the tape and controls the writing of all headings and parameter lists. The editing and assembly of the data blocks in a particular day's file is controlled by subroutine EDIT. The other subroutines are used to edit and merge the various types of data to be stored. With the present configuration of the CDC 3100 all peripherals are used in the editing process and practically the whole available memory is used by the program. The time recorded on the corrected raw data tape is used to control the construction of the 10-minute data blocks recorded. If a data gap of less than ten minutes occurs on the raw data tape, the program will check if other data is present. If the data gap is greater than 10 minutes however the program only checks to see if any navigation data occurs during the time of the data gap. Thus bathymetry data will not be stored unless some other geophysical data is also available at the same time.

3.5 Operating Instructions

3.5.1 Input data formats. The formats of the various input data have already been discussed in Section II and are illustrated in Appendix 1.

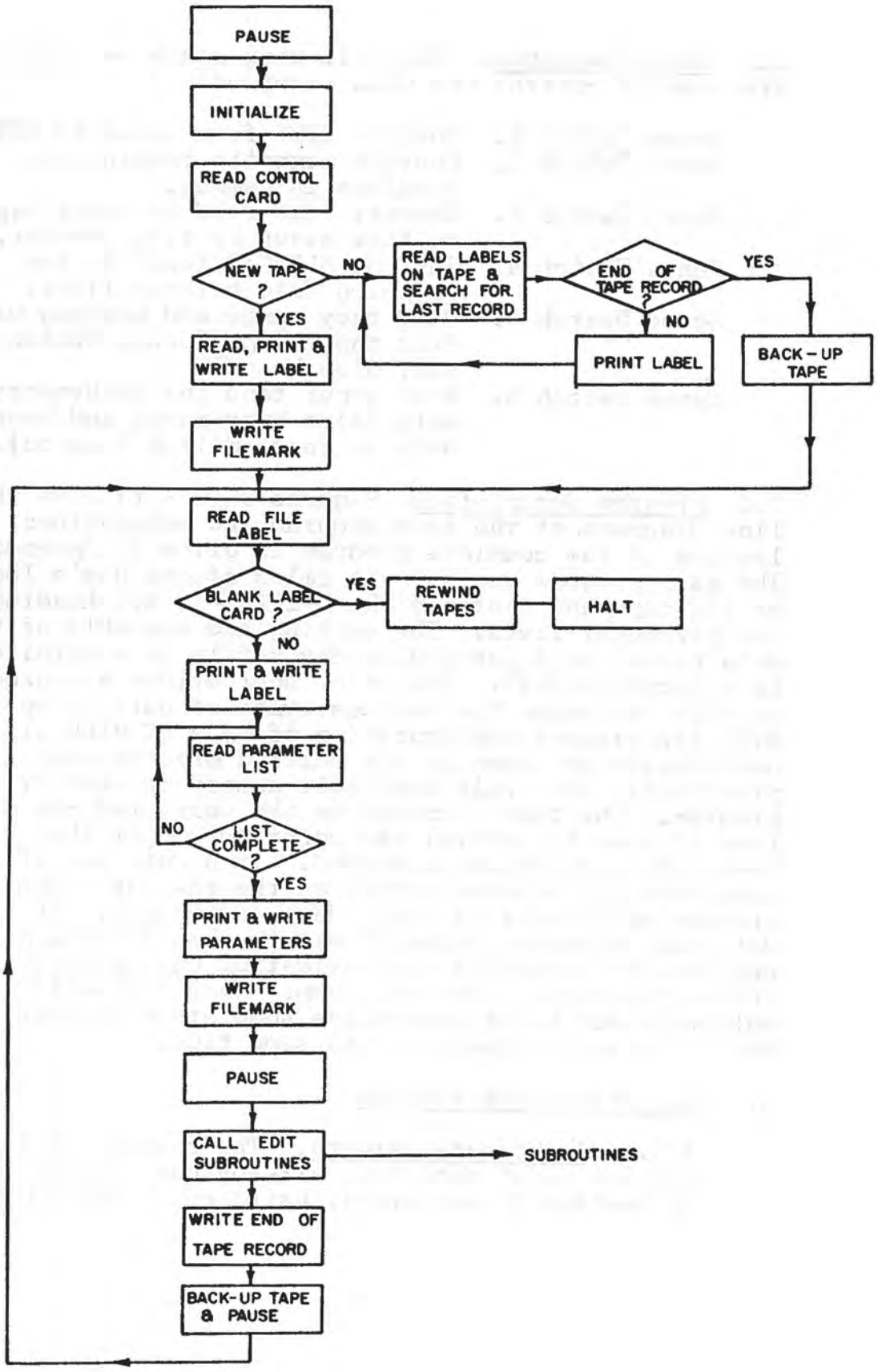

PAUSE
INITIALIZE
READ CONTOL CARD
NEW TAPE ?
NO
YES
READ LABELS ON TAPE & SEARCH FOR LAST RECORD
END OF TAPE RECORD ?
YES
NO
PRINT LABEL
BACK-UP TAPE
READ, PRINT & WRITE LABEL
WRITE FILEMARK
READ FILE LABEL
BLANK LABEL CARD ?
YES
REWIND TAPES
HALT
NO
PRINT & WRITE LABEL
READ PARAMETER LIST
NO
LIST COMPLETE ?
YES
PRINT & WRITE PARAMETERS
WRITE FILEMARK
PAUSE
CALL EDIT SUBROUTINES
SUBROUTINES
WRITE END OF TAPE RECORD
BACK-UP TAPE & PAUSE

FIGURE 8a

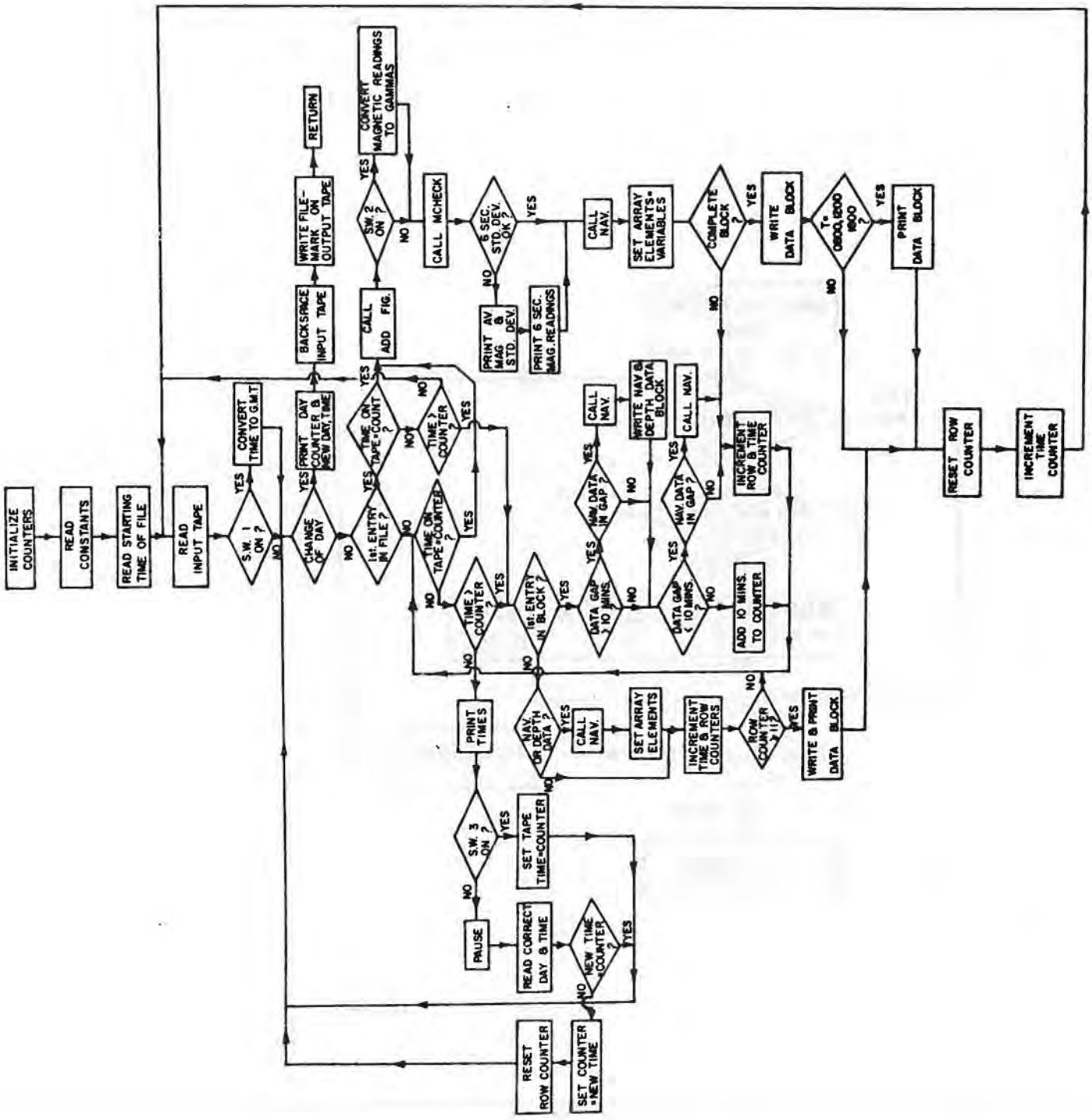

INITIALIZE COUNTERS
READ CONSTANTS
READ STARTING TIME OF FILE
READ INPUT TAPE
S.W. 1 ON ?
CONVERT TIME TO G.M.T
CHANGE OF DAY
PRINT DAY COUNTER & NEW DAY, TIME
1st. ENTRY IN FILE ?
TIME ON TAPE = COUNTER ?
TIME > COUNTER ?
BACKSPACE INPUT TAPE
WRITE FILE-MARK ON OUTPUT TAPE
RETURN
CALL ADD FIG.
SW. 2 ON ?
CONVERT MAGNETIC READINGS TO GAMMAS
CALL MCHECK
6 SEC. STD. DEV. OK ?
PRINT AV & STD. DEV.
PRINT 6 SEC. MAG. READINGS
CALL NAV.
SET ARRAY ELEMENTS - VARIABLES
COMPLETE BLOCK ?
WRITE DATA BLOCK
T = 0600, 1200, 1800 ?
PRINT DATA BLOCK
RESET ROW COUNTER
INCREMENT TIME COUNTER
NAV DATA IN GAP ?
CALL NAV.
WRITE NAV & DEPTH DATA BLOCK
CALL NAV.
INCREMENT ROW & TIME COUNTER
TIME > COUNTER ?
1st. ENTRY IN BLOCK ?
DATA GAP > 10 MINS.
DATA GAP < 10 MINS ?
ADD 10 MINS. TO COUNTER
PRINT TIMES
NAV OR DEPTH DATA ?
CALL NAV.
SET ARRAY ELEMENTS
INCREMENT TIME & ROW COUNTERS
ROW COUNTER > 11 ?
WRITE & PRINT DATA BLOCK
S.W. 3 ON ?
SET TAPE TIME-COUNTER
PAUSE
READ CORRECT DAY & TIME
NEW TIME COUNTER ?
RESET ROW COUNTER
SET COUNTER = NEW TIME
YES
NO

FIGURE 8b

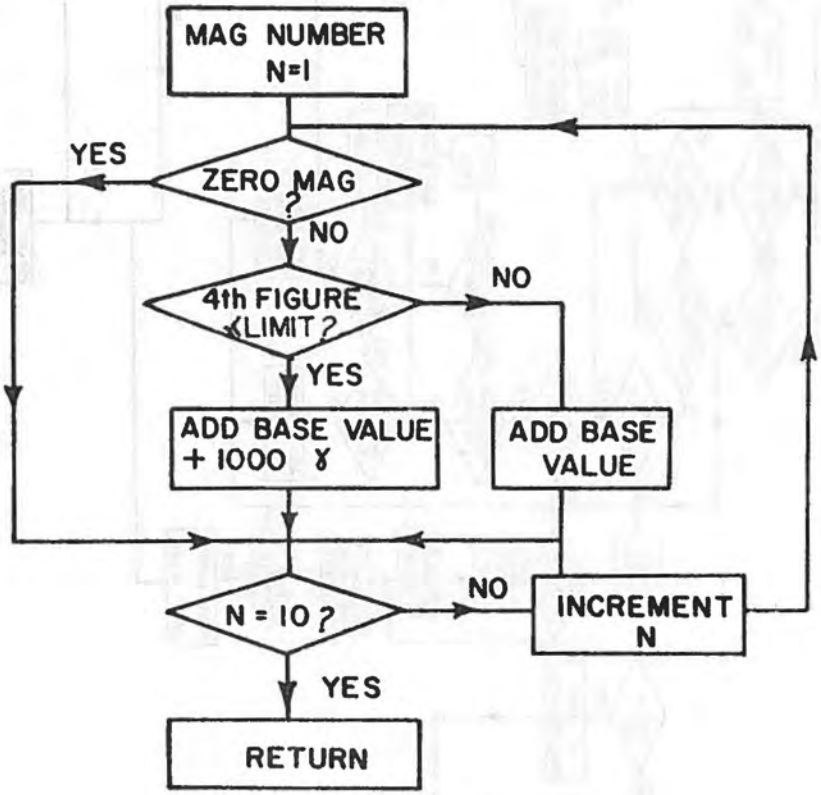

MAG NUMBER
N=1
YES
ZERO MAG ?
NO
4th FIGURE
LIMIT ?
NO
YES
ADD BASE VALUE
+ 1000 Y
ADD BASE
VALUE
N = 10 ?
NO
INCREMENT
N
YES
RETURN

FIGURE 8c

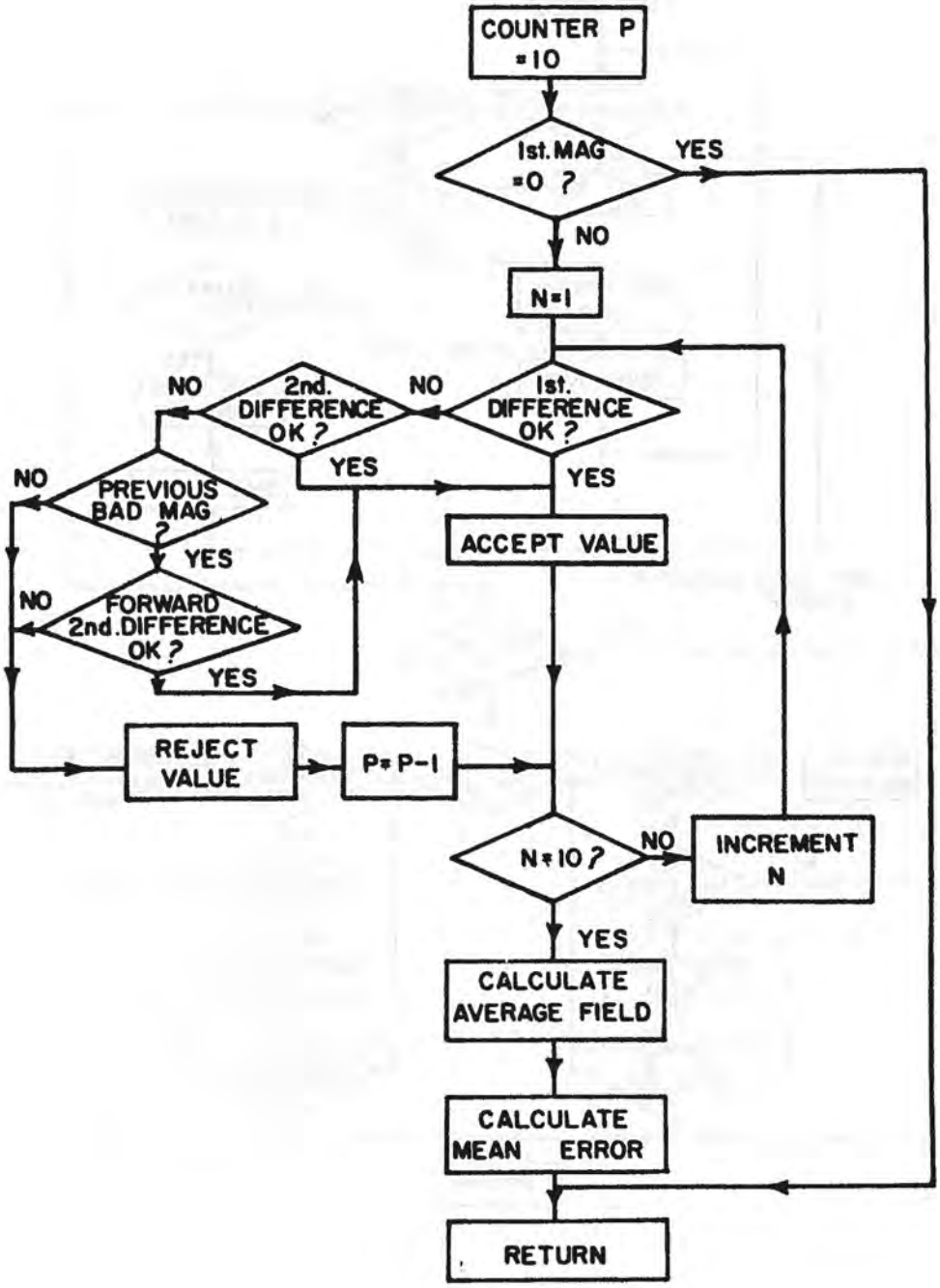

COUNTER P =10
1st. MAG =0 ?
YES
NO
N=1
NO
2nd. DIFFERENCE OK ?
NO
1st. DIFFERENCE OK ?
YES
YES
NO
PREVIOUS BAD MAG ?
YES
NO
FORWARD 2nd. DIFFERENCE OK ?
YES
ACCEPT VALUE
REJECT VALUE
P= P-1
N=10 ?
NO
INCREMENT N
YES
CALCULATE AVERAGE FIELD
CALCULATE MEAN ERROR
RETURN

FIGURE 8d

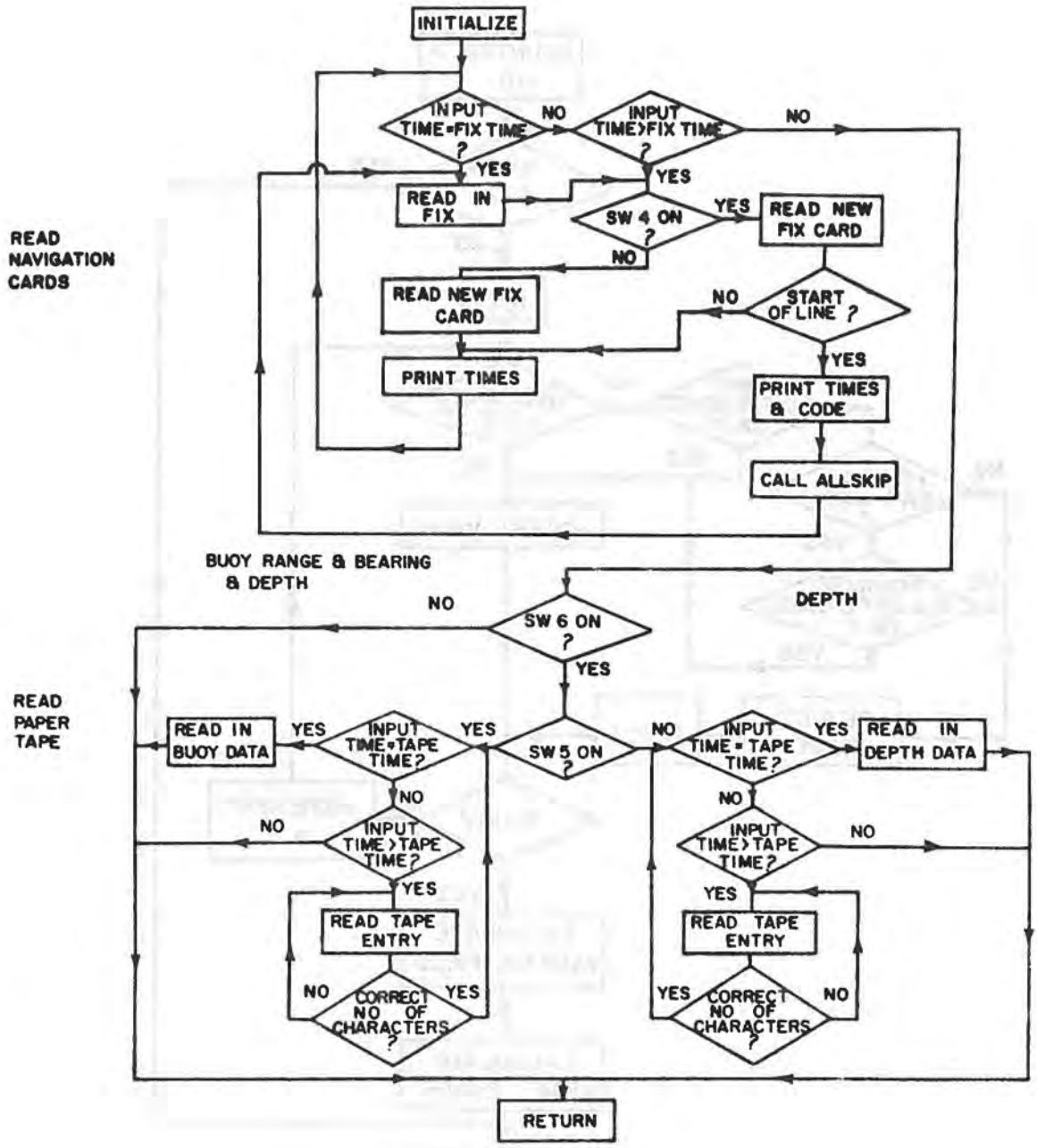
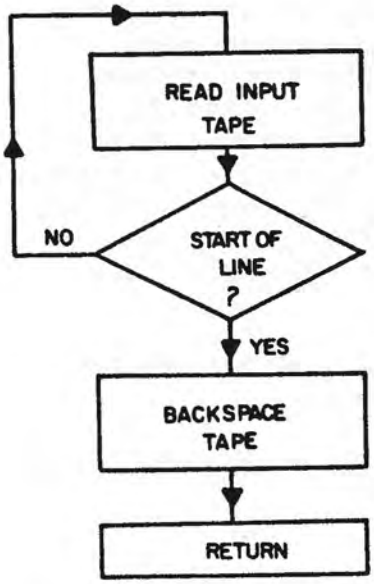
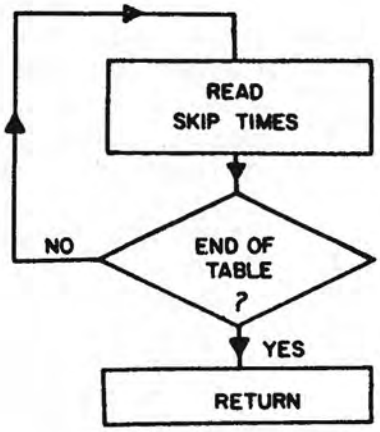

INITIALIZE
INPUT TIME=FIX TIME ?
NO
INPUT TIME>FIX TIME ?
NO
YES
YES
READ IN FIX
SW 4 ON ?
YES
READ NEW FIX CARD
NO
READ NEW FIX CARD
NO
START OF LINE ?
YES
PRINT TIMES
PRINT TIMES & CODE
CALL ALLSKIP
READ NAVIGATION CARDS
BUOY RANGE & BEARING & DEPTH
DEPTH
NO
SW 6 ON ?
YES
READ PAPER TAPE
READ IN BUOY DATA
YES
INPUT TIME=TAPE TIME?
YES
SW 5 ON ?
NO
INPUT TIME=TAPE TIME?
YES
READ IN DEPTH DATA
NO
NO
INPUT TIME>TAPE TIME?
NO
YES
READ TAPE ENTRY
NO
CORRECT NO OF CHARACTERS ?
YES
NO
INPUT TIME>TAPE TIME?
NO
YES
READ TAPE ENTRY
YES
CORRECT NO OF CHARACTERS ?
NO
RETURN

FIGURE 8e


READ INPUT TAPE
NO
START OF LINE ?
YES
BACKSPACE TAPE
RETURN


READ SKIP TIMES
NO
END OF TABLE ?
YES
RETURN

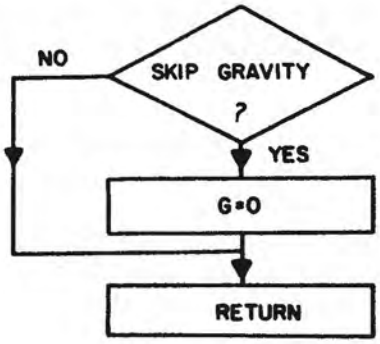

NO
SKIP GRAVITY ?
YES
G=0
RETURN

FIGURE 8f

3.5.2 Writing the final data tape. The first instruction in the program is a PAUSE. After pressing GO the values of several counters and other constants used in the program are fixed, the printer instructed to space up one page and a control card is read on the card reader. This control card sets up the tape units to be used and whether a new tape is to be written or whether one previously written is to be continued. The program then proceeds to write the required labels, read starting time of file, read navigation and depth data and write the data file. The procedure to be followed is:

i) Load magnetic tapes and set unit numbers according to the control card.

ii) Load card reader with cards in the following order:

a) Control card
b) Tape label (if control card specifies a new tape).
c) End of file card (if control card specifies a new tape).
d) File name for first day.
e) Cards containing variable names and data channels.
f) End of file card (Channel No. 17)
g) Card containing fifth magnetic field figure, allowable 6 second difference, GMT and field conversion factors if required, MLIM (4th magnetic field figure below which F = F + 10000).
h) Card with starting time of data - normally time 0000 of the particular day, e.g. 0810000.
i) If gravity skip data is to be read in the cards for the day being processed, it must be put next in the card deck.
j) Navigational fix cards for the day.

Cards d - j are repeated for subsequent days. If no navigational data is available, a dummy card for time 2359 of the particular day or a card for some subsequent day must be included.

iii) Set sense switch 4 if the data between lines is to be automatically skipped.

iv) Set sense switch 6 on if depth data is to be read off paper tape. Set sense switch 5 on if buoy range and bearing data is on the depth tape.

v) Load depth data in paper tape reader.

vi) If GMT correction to be made, set sense switch 1 on.

vii) If total field correction is to be made, set sense switch 2 on.

viii) Press GO.

3.5.3 Printout from Edit Program. The following information is printed during the running of the program (Figure 5).

i) Tape label

ii) File label, and a list of variables with corresponding channel in file.

iii) First data block in file.

iv) All data blocks with no data in the tenth minute of the block.

v) Data blocks for times 0600, 1200, 1800.

vi) The ten 6-second magnetic readings when the standard error of the 1-minute-average is greater than 10. This entry is preceded by the calculated average and the standard error.

vii) When the day read off the input tape increases, the time of the next entry plus the day just completed is printed. The computer will stop at a PAUSE instruction. On pressing GO the computer returns to the main program to start a new file for the following day.

viii) Whenever a navigation card is read the printer will print the time just read off the input tape, the time on the navigation card, and the last time read off the depth tape.

ix) If the time read off the tape is less than the time accumulated in the counter, both times are printed and the computer halts at a PAUSE provided sense switch 3 is off. With sense switch 3 on the input time is automatically made equal to the counter time and the program continues.

3.5.4 PAUSE Instructions. The computer will stop at a PAUSE instruction under the following conditions:

i) At the start of the program, press GO.

ii) At the end of each day's file, i.e. when the day read off the input tape is greater than the day's data being processed. Press GO and the computer will start the next file. If no more files are to be written a blank card will cause the computer to rewind the tapes and terminate the program.

iii) If the time read off the input tape is less than the time accumulated on the counter. Load the card reader with a card containing the correct day and day + time (FORMAT 2I8) and press GO. If a number of errors occur in the time on the input tape and the correct time is that accumulated by the counter, the two can be set equal and the PAUSE statement can be bypassed by setting sense switch 3 on.

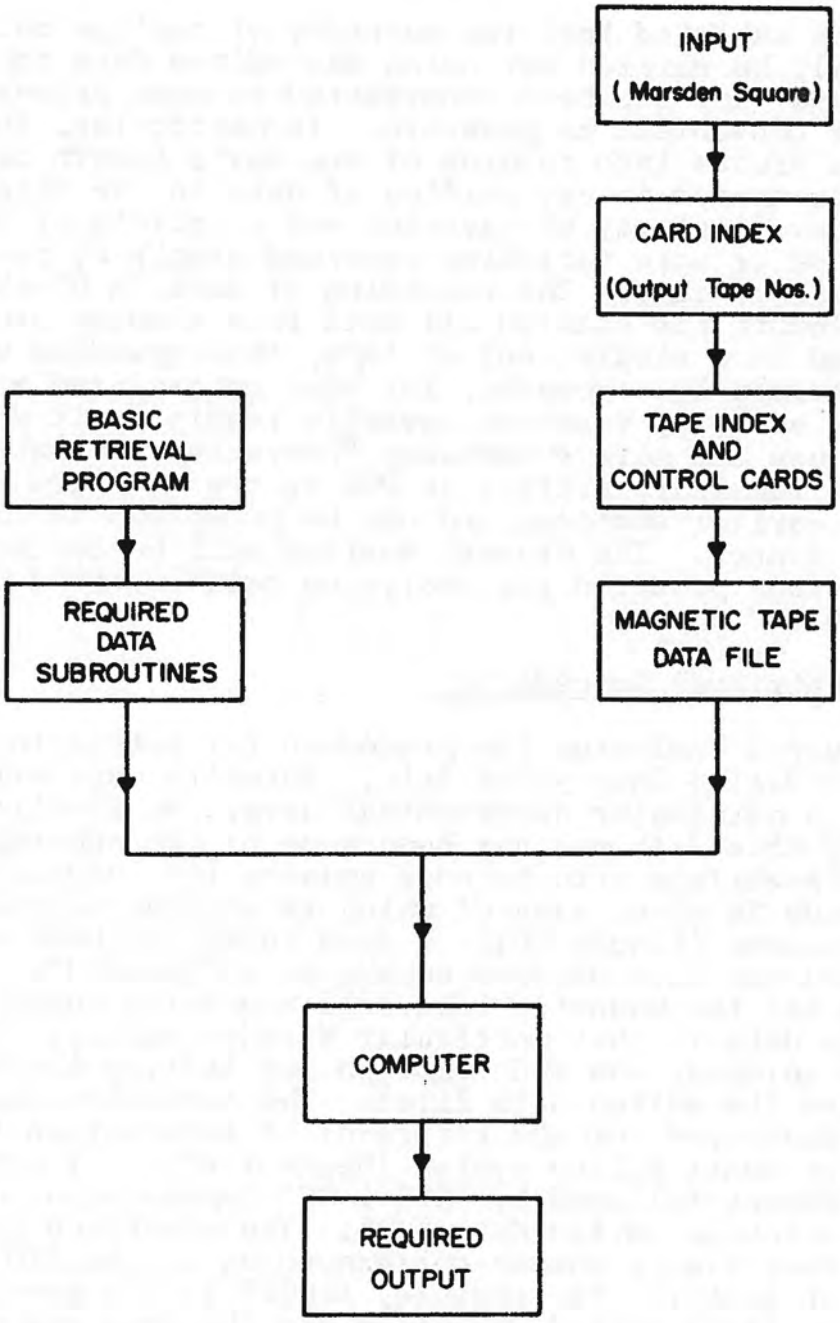

INPUT
(Marsden Square)
CARD INDEX
(Output Tape Nos.)
TAPE INDEX
AND
CONTROL CARDS
BASIC
RETRIEVAL
PROGRAM
REQUIRED
DATA
SUBROUTINES
MAGNETIC TAPE
DATA FILE
COMPUTER
REQUIRED
OUTPUT

FIGURE 9

IV. RETRIEVAL OF DATA FROM THE GEOPHYSICS DATA FILE

1. Introduction

It is expected that the majority of routine data processing will be carried out using the edited data tape file since this tape has been constructed to make processing of data on it as convenient as possible. In particular, the division of a cruise into records of one day's length besides ensuring rapid access to any portion of data in the file, provides a convenient way of carrying out a variety of separate analyses on one or more variables recorded simply by rescanning a short section of tape. The recording of data in blocks of 10 minutes' length has enabled all data from a major cruise to be recorded on a single reel of tape, thus speeding up processing enormously. However, for some specialized analyses requiring, for example, 6-second magnetic readings, it may be necessary to use the more cumbersome "Corrected Raw Data" tapes. These tapes are written in BCD in the standard format discussed in earlier sections and can be processed in the conventional manner. The present section will be concerned with the routines produced for analysing data recorded on the "Edited Data" tapes.

2. General Retrieval Procedures

Figure 9 indicates the procedure for retrieving data from the Marine Geophysics file. Normally data will be required for a particular geographical area. To facilitate searching for this data use has been made of the subdivision of the earth's surface into Marsden squares 10° longitude by 10° latitude in size, each of which is assigned a unique three digit number (Figure 10). A card index has been made up with a card for each Marsden square as a "keyword". Listed on each card are the magnetic tape file accession numbers which contain data in that particular Marsden square. Each card has two columns, raw and compiled for listing the raw data tapes and the edited data files. The accession number is modelled on that used for the retrieval of information from the geophysics chart filing system (Heaps 1967). It consists of a serial number followed by "R" or "C" depending on whether the tape is a raw or edited data tape. The accession number ends with a four figure number corresponding to the BIO cruise identification number. For example, 1C0767 is the accession number for the first edited data file and the data was obtained on cruise number 07-67, the last two digits being the year.

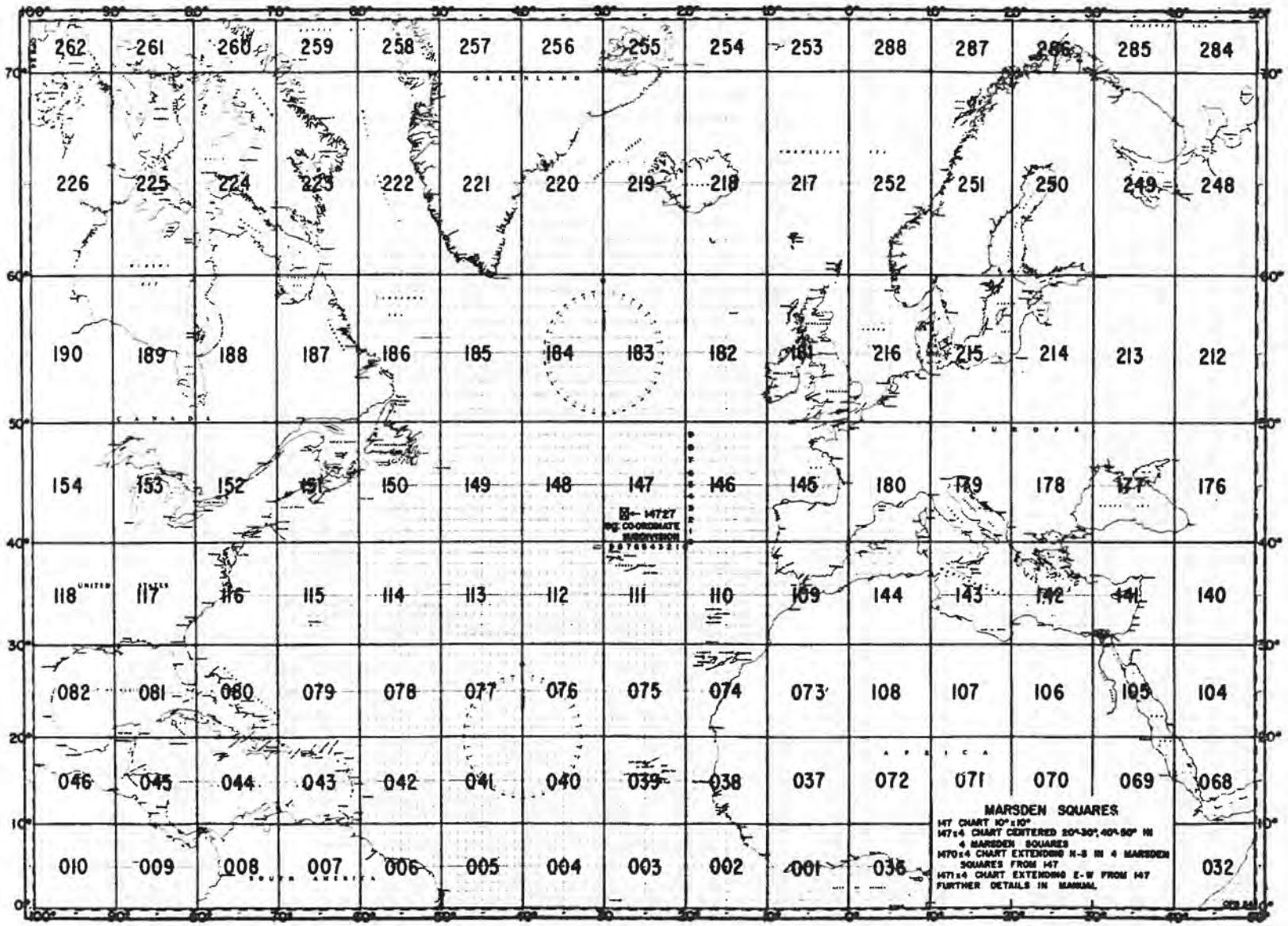

262 261 260 259 258 257 256 255 254 253 288 287 286 285 284
226 225 224 223 222 221 220 219 218 217 252 251 250 249 248
190 189 188 187 186 185 184 183 182 181 216 215 214 213 212
154 153 152 151 150 149 148 147 146 145 180 179 178 177 176
118 117 116 115 114 113 112 111 110 109 144 143 142 141 140
082 081 080 079 078 077 076 075 074 073 108 107 106 105 104
046 045 044 043 042 041 040 039 038 037 072 071 070 069 068
010 009 008 007 006 005 004 003 002 001 036 032
MARSDEN SQUARES
147 CHART 10° x 10°
147 x 4 CHART CENTERED 20°-30°, 40°-50° N
4 MARSDEN SQUARES
147 x 4 CHART EXTENDING N-S IN 4 MARSDEN SQUARES FROM 147
147 x 4 CHART EXTENDING E-W FROM 147
FURTHER DETAILS IN MANUAL

FIGURE 10

A second card index contains the file accession cards. An accession number is given to each magnetic tape. If two or more complete cruises are filed on one tape, as will occur with the edited data files of cruises lasting a month or less, each cruise will have a different accession number. The accession card contains the accession number in the top left hand corner and the tape number in the top right hand corner. The Marsden squares for which data is available on the tape are listed, as also is the data recorded. The card also contains a detailed description of the location and data recorded for each day. The data recorded each day is coded accoring to the channel number used in constructing the edited tape (Figure 4).

1 C 0767				Tape No. 2	
MARSDEN SQUARES	145-151, 109-115				
DATA RECORDED	Magnetics, Bathymetry, Latitude, Longitude				
DAY	MARSDEN SQ.	DATA	DAY	MARSDEN SQ.	DATA
96	151	(2,3,4,5,6,7,	106	109	(2,3,4,5,6,
97	151,150	(15,16	117	109	(7,15,16
98	150		118	109,110	
99	150,149		119	110,111	
100	149,148		120	111	
101	148		121	111,112	
102	148,147		122	112,113	
103	147,146		123	113	
104	146		124	113,114	
105	146,145,109		125	114	

FIGURE 11 - Copy of an actual file accession card.

Having obtained the required file accession card(s), the information needed to retrieve the required data from the data file using the basic retrieval program and subroutines, is known. Thus the data can be quickly retrieved by the computer.

3. Basic Retrieval Program

In designing a general program for retrieving and processing data from the edited data file, the facility of scanning through a day's data a number of times has been used. With this facility it is possible to write all the normally required processing routines as sub-routines of a main retrieval program. To carry out a particular processing sequence it is then only necessary to collect the required standard sub-routines together and build up a complete retrieval and processing program. The final reduced data is then output in the required form. Provided the necessary computing facilities are available it is possible to build up a quite elaborate program from the standard subroutines which will reduce all the data available in the raw data file and produce a final results tape. With the facilities presently available at the Institute this is not so, but with expected additions to the system later this year it should become possible.

3.1 Main Program The main program controls the retrieval of data. It searches for a particular file on the tape, reads and prints file labels, and controls the processing subroutines called. When all subroutines have been called and processing of that file is completed the main program will proceed to open the next day's file if this is desired and start processing data in this file. When the data for the required number of days has been processed, the program will rewind the tapes and halt the computer.

Figure 12 is a generalised flow chart of a retrieval program. Before each processing subroutine is called, subroutine CHECK is called. This sub-routine reads a card to determine what variable is to be processed in the next sub-routine and checks the parameter list at the start of the file to ensure that it has been recorded. If not, the line printer prints "Parameter not present" and the next subroutine is skipped.

For most geophysical data processing procedures, the first subroutine will involve reading navigational data, interpolating and storing this for processing of other parameters such as magnetics or gravity.

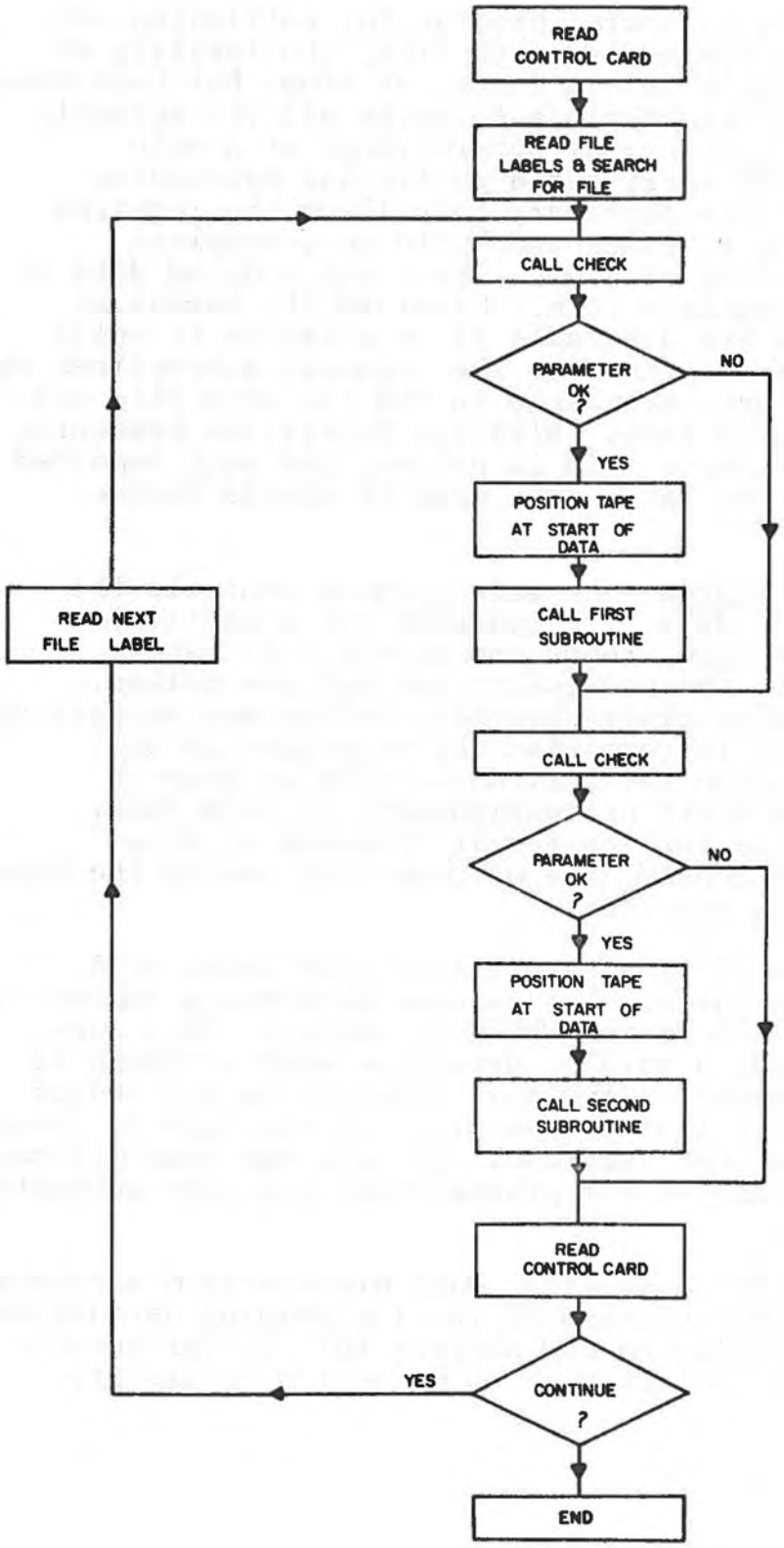

READ CONTROL CARD
READ FILE LABELS & SEARCH FOR FILE
CALL CHECK
PARAMETER OK ?
NO
YES
POSITION TAPE AT START OF DATA
CALL FIRST SUBROUTINE
READ NEXT FILE LABEL
CALL CHECK
PARAMETER OK ?
NO
YES
POSITION TAPE AT START OF DATA
CALL SECOND SUBROUTINE
READ CONTROL CARD
CONTINUE ?
YES
END

FIGURE 12

Thus a complete program might proceed as follows:

1st pass: Read navigational data and store 5 min. fixes in memory.

2nd pass: Read magnetic field data and output magnetic anomalies on a scratch tape.

3rd pass: Read gravity data, compute free air anomalies, and update scratch tape to contain magnetic and gravity data.

4th pass: Read bathymetry data and scratch tape. Print all data at a specified time interval on the line printer.

Such a program could be used for producing a detailed geophysical data report. Alternatively, the same subroutines 1 and 2 could be used to prepare a scratch tape of magnetic anomalies for spectral analysis.

3.2 Subroutines Any set of self-contained subroutines can be used with the basic program provided, of course, they conform with the limitations of the computing facilities available.

The following points should however be borne in mind when writing any subroutine for use in the retrieval system:

1. All data available for each complete day is recorded in a single data file on the tape.

2. The data is written in binary form in blocks of ten one-minute records. With the range of data presently being recorded each block of data consists of 160 integer words.

3. Since subroutine CHECK can be used to check through the parameter list at the start of a file for the variable to be processed and find its location in the read array before passing control to the subroutine, the correct variable can always be selected for processing. If the variable has not been recorded in a particular file, that file can be skipped.

4. Retrieval Program Operating Instructions

4.1 Program. Read and Process Geophysical Data File.

4.2 Subroutines The basic program contains two subroutines plus those required for actual processing of the data.

i) Subroutine COMPARE. This subroutine is used for searching for a particular file label.

ii) Subroutine CHECK. This subroutine is used to check the parameter list at the beginning of each one day file to see that a particular variable has been recorded in that day and to determine its location in the data block.

iii) Data Subroutines. These are dependent on the particular data being retrieved from the file and the form in which it is to be output.

4.3 Sense Switches. No sense switches are used in the basic program.

4.4 Operating Instructions. A listing of the main program plus subroutines COMPARE and CHECK is given in Appendix 5. The first instruction is a PAUSE. After pressing GO the computer reads a control card to determine if the first file is to be processed. If not, it reads the next card to determine which file is the first to be processed and then proceeds to search for this file printing out the labels of all files passed in its search. Having located the correct starting file the printer spaces up one page, prints the parameter list at the head of the file and proceeds to subroutine CHECK. Subroutine CHECK reads a parameter card and looks for this parameter in the list that was read from the tape and positions the tape at the first data block. The first data subroutine is then called. After all subroutines have been completed, a further control card is read to see whether the next file is to be processed. If so, the process is repeated, otherwise, the tapes are rewound and the computer halted. The procedure is as follows:

i) Load magnetic tape units with the edited data tape and a scratch tape and set the unit numbers according to the control card.

ii) Load the card reader with cards in the following order:

Control card
Parameter to be processed in first pass.
Parameter to be processed in second pass, etc.
Control card, etc.

The continuation control card and parameter cards are repeated for the number of files to be processed. The parameter cards need only be included if subroutine CHECK is used.

iii) Press GO.
The required files will be processed, after which the computer will halt.

APPENDIX I

CARD AND TAPE FORMATS

Friden code is used on all paper tapes.

1. List of standard Geodal tape formats:

Number		Data Recorded	Characters
1		DAY, TIME	7
2	a)	DAY, TIME, GRAV	11
	b)	DAY, TIME, MAG	
3		DAY, TIME, GRAV, MAG	15
4	a)	DAY, TIME, DECCA	19
	b)	DAY, TIME, VLF	
5	a)	DAY, TIME, GRAV, DECCA	23
	b)	DAY, TIME, GRAV, VLF	
	c)	DAY, TIME, MAG, DECCA	
	d)	DAY, TIME, MAG, VLF	
6	a)	DAY, TIME, GRAV, MAG, DECCA	27
	b)	DAY, TIME, GRAV, MAG, VLF	
7		DAY, TIME, DECCA, VLF	31
8	a)	DAY, TIME, GRAV, DECCA, VLF	35
	b)	DAY, TIME, MAG, DECCA, VLF	
9		DAY, TIME, GRAV, MAG, DECCA, VLF	39
10		DAY, TIME MAGTEN	47
11		DAY, TIME, GRAV, MAGTEN	51
12	a)	DAY, TIME MAGTEN, DECCA	
	b)	DAY, TIME MAGTEN, VLF	59
13	a)	DAY, TIME, GRAV, MAGTEN, DECCA	63
	b)	DAY, TIME, GRAV, MAGTEN, VLF	
14		DAY, TIME, MAGTEN, DECCA, VLF	71
15		DAY, TIME, GRAV, MAGTEN, DECCA, VLF	75

NOTES: DECCA reading corresponds to two 6-character records, the first of each being an alphanumeric character.

NOTES (Cont'd)

MAG refers to 1 minute magnetic field reading.
MAGTEN refers to ten 6-second magnetic field readings.
VLF reading consists of three 4-digit readings

The order of data sampling, and hence the location of data in the record on the paper tape, is determined by the programmer. The order is:

DAY, TIME, MAG1, DECCA1, DECCA2, MAG2, MAG3, MAG4, MAG5, MAG6, MAG7, MAG8, VLF1, MAG9, VLF2, MAG10, VLF3, E.O.L. code.

Whenever a particular parameter is not recorded that reading is not present on the tape and the record length is reduced by the requisite number of characters.

2. Navigation Card Format.

Columns	Data
1	Code for start or end of line "1" for start, "2" for end
4 - 6	Day
7 - 10	Time
15 - 20	Latitude in degrees, minutes and tenths of a minute. -ve for south latitude
24 - 30	Longitude in degrees, minutes and tenths of a minute, -ve for west longitude.
33	Type of fix code

Code	Type of Fix
1	Short to medium range electronic system, e.g. Decca; Loran, A, B; Console, etc.
2	Long range electronic system, e.g. Loran C; Omega; VLF; Dectra, etc.
3	Celestial (stars & planets)
4	LAN and sun lines
5	Dead reckoning
6	R.D.F. bearings
7	Visual and radar range and bearings
8	Satellite navigation
9	Acoustic navigation

3. Paper tape format for manual recording of Decca Lambda and Depth.

Characters	Data
1 - 3	Day
4 - 7	Time
8	Space
9 - 12	Depth (uncorrected fathoms)
13	Space
14 - 19	First Decca coordinate
20	Space
21 - 26	Second Decca coordinate
E.O.L.	

4. Paper tape format for Buoy range and bearing data plus depth.

Characters	Data
1 - 3	Day
4 - 7	Time
8	Space
9 - 10	Buoy number
11	Space
12 - 15	Bearing (degrees and tenths of degree)
16	Space
17 - 20	Range (in miles and hundredths of miles)
21	Space
22 - 25	Depth (uncorrected fathoms)
E.O.L.	

5. Paper tape format for bathymetry tapes.

Character	Data
1 - 3	Day
4 - 7	Time
8	Space
9 - 12	Depth
E.O.L.	

6. Data Format on Raw Magnetic Tape.

Data is recorded in BCD code , one BCD record for each one-minute data record on paper tape. The format corresponds to the maximum Geodal format on paper tape (see (1) above). However if data is missing in a record, blanks are left on the tape rather than crowding the data present to the left as occurs on the paper tape, i.e. 75 characters are always written although any of these characters may be blanks in a particular instance.

7. Format of cards for correction of tape errors.

7.1 Calendar correction card.

The card contains the first and last times the error occurs plus the correct day. The format is:

Column	Data
2 - 8	Day amd Time written on tape at which error first occurs.
10 - 16	Day and Time written on tape at which error last occurs.
18 - 20	Correct day

7.2 Format corrections.

Cards are punched with the characters in the columns corresponding to the locations in the magnetic tape entry. Blanks are left where data is absent. The cards are then copied on to paper tape.

```
00000  *     TRANSFER OF PAPER TAPE RECORDS TO STANDARD FORMAT MAGNETIC TAPE
00000  C     PROGRAM ACCEPTS PAPER TAPE DATA MAX OF 80 BITS/LINE, DECIDES WHAT
00000  C     DATA IS PRESENT AND WRITES DATA ON MAGNETIC TAPE IN STANDARD
00000  C     FORMAT
00000  C     SENSE SWITCH DATA 1.WRITE HEADINGS 2.ENDFILE + REWIND 3.CALL RMT
00000  C     4.CALL SELECT 11 5.CALL SELECT 12 6.BACKSPACE IN RMT
00004       INTEGER T,T1,T2,T3
00004       DIMENSION I(200),LAB(100)
00004       PAUSE
00006  1    FORMAT(80R1)
00011  2    FORMAT(I7,I7)
00014  100  FORMAT(I8)
00016  101  FORMAT(15H ILLEGAL FORMAT)
00024  111  FORMAT(1X,80R1)
00030  C     ------------------------------------------------------------------
00030  C     STATEMENTS 50,75 ARE THE FORMAT STATEMENTS FOR WRITING THE
00030  C     MAGNETIC TAPE ENTRY FOR THE DIFFERENT INPUT DATA
00030  50   FORMAT(75R1)
00033  51   FORMAT(55R1,4X,4R1,4X,4R1)
00041  52   FORMAT(15R1,12X,48R1)
00046  53   FORMAT(7R1,4X,44R1,4X,4R1,4X,4R1)
00056  54   FORMAT(7R1,4X,4R1,12X,48R1)
00065  55   FORMAT(15R1,12X,28R1,4X,4R1,4X,4R1)
00076  56   FORMAT(7R1,4X,4R1,12X,28R1,4X,4R1,4X,4R1)
00110  57   FORMAT(27R1,28X,4R1,4X,4R1,4X,4R1)
00120  60   FORMAT(7R1,4X,16R1,28X,4R1,4X,4R1,4X,4R1)
00132  62   FORMAT(11R1,4X,12R1,28X,4R1,4X,4R1,4X,4R1)
00144  63   FORMAT(7R1,8X,12R1,28X,4R1,4X,4R1,4X,4R1)
00156  64   FORMAT(27R1)
00161  65   FORMAT(15R1,40X,4R1,4X,4R1,4X,4R1)
00171  66   FORMAT(7R1,4X,16R1)
00176  67   FORMAT(7R1,4X,4R1,40X,4R1,4X,4R1,4X,4R1)
00210  68   FORMAT(11R1,4X,12R1)
00215  69   FORMAT(11R1,44X,4R1,4X,4R1,4X,4R1)
00225  70   FORMAT(7R1,8X,12R1)
00232  71   FORMAT(7R1,48X,4R1,4X,4R1,4X,4R1)
00242  72   FORMAT(15R1)
00245  73   FORMAT(7R1,4X,4R1)
00251  74   FORMAT(11R1)
00254  75   FORMAT(7R1)
00257  C
00257  C
00257  C     SENSE SWITCH CONTROL STATEMENTS
00257       IF(SENSE SWITCH 2)230,240
00263  230  ENDFILE 3
00265       REWIND3
00267       GO TO 250
00270  240  IF(SENSE SWITCH 3)210,211
00274  210  CALL RMT
00275       GO TO 220
00276  211  IF(SENSE SWITCH 4)212,220
00302  212  CALL SELECT(3,11)
00305       IF(SENSE SWITCH 5)213,220
00311  213  CALL SELECT (3,12)
00314  220  IF(SENSE SWITCH 1)500,600
00320  C
00320  C     WRITE DATA FORMAT ON MAGNETIC TAPE
00320  500  WRITE OUTPUT TAPE 3,5000
00324  5000 FORMAT(12H DATA FORMAT/84H TIME(1-7),GRAV(8-11),MAG1(12-15),DECCA(
00324      116-27),MAG2-3(28-55),VLF1(56-59),MAG4(60-63)/87H VLF2(64-67),MAG10
00324      2(68-71),VLF3(72-75),LAT(76-81),LONG(82-88),FIX CODE(89),DEPTH(90-9
```

```
00324          33).)
00406    C
00406    C      READ,WRITE AND PRINT TAPE LABEL
00406    C
00406          READ 1,(LAB(K),K=1,80)
00425          WRITE OUTPUT TAPE 3,1,(LAB(K),K=1,80)
00445          PRINT 1,(LAB(K),K=1,80)
00464          PRINT 6000
00467    6000  FORMAT(71H PRINTOUT OF FORMAT AND TIME INTERVAL CHANGES AND ILLEGA
00467         IL INPUT FORMATS)
00513    C     INITIALIZATION
00513    600   K=0
00515          T1=0
00517          MOFF1=4000000
00521    C     MOFF1=-1 IF IT IS ASSUMED THAT GRAV IS NOT PUNCHED WHEN CONFUSION
00521    C     ARISES I.E. MAG BUT NOT GRAV PRESENT ON THE INPUT TAPE.
00521    C     MOFF1=4000000 IF GRAV NOT MAG PRESENT ON THE INPUT TAPE
00521    C     MOFF1=0 IF COMPUTER IS TO DECIDE BY READING CARDS
00521    C     ----------------------------------------------------------------
00521    C     READ PAPER TAPE AND COUNT CHARACTERS PUNCHED
00521    3     READ INPUT TAPE 8,1,(I(II),II=1,80)
00541          DO 10 J=80,1,-1
00543          IF(I(J)-48)11,10,11
00551    10    CONTINUE
00561    11    T2=I(7)+10*I(6)+100*I(5)+1000*I(4)+10000*I(3)+100000*I(2)+100000
00561         0*I(1)
00620    C     CONTROL STATEMENTS FOR DIFFERNENT INPUT DATA
00620          IF(J-75)12,30,12
00625    12    IF(J-63)13,31,13
00632    13    IF(J-59)14,32,14
00637    14    IF(J-51)15,33,15
00644    15    IF(J-47)16,34,16
00651    16    IF(J-39)17,35,17
00656    17    IF(J-35)18,36,18
00663    18    IF(J-31)19,37,19
00670    19    IF(J-27)20,38,20
00675    20    IF(J-23)21,39,21
00702    21    IF(J-19)22,40,22
00707    22    IF(J-15)23,41,23
00714    23    IF(J-11)24,42,24
00721    24    IF(J-61)241,45,241
00726    241   IF(J-62)25,44,25
00733    25    IF(J)26,3,26
00737    C
00737    C     PRINT ILLEGAL FORMAT AND DATA
00737    26    PRINT 101
00742          PRINT 111,(I(II),II=1,80)
00761          GO TO 3
00762    C     ----------------------------------------------------------------
00762    C     WRITE STATEMENTS FOR PRODUCING OUTPUT TAPE OF STANDARD FORMAT
00762    30    WRITE OUTPUT TAPE 3,50,(I(II),II=1,75)
01002          GO TO 4
01003    31    IF(I(16)-9)312,312,311
01011    311   WRITE OUTPUT TAPE 3,51,(I(II),II=1,63)
01031          GO TO 4
01032    312   WRITE OUTPUT TAPE 3,52,(I(II),II=1,63)
01052          GO TO 4
01053    32    IF(I(12)-9)322,322,321
01061    321   WRITE OUTPUT TAPE 3,53,(I(II),II=1,59)
01101          GO TO 4
01102    322   WRITE OUTPUT TAPE 3,54,(I(II),II=1,59)
01122          GO TO 4
```

```
01123  33     WRITE OUTPUT TAPE 3,55,(I(II),II=1,51)
01143         GO TO 4
01144  34     WRITE OUTPUT TAPE 3,56,(I(II),II=1,47)
01164         GO TO 4
01165  35     WRITE OUTPUT TAPE 3,57,(I(II),II=1,39)
01205         GO TO 4
01206  36     IF(MOFF1)361,364,3651
01212  3651   IF(MOFF1-4000000)364,363,364
01217  364    READ 2,MOFF1,MOFF2
01226  C      MOFF1,MOFF2 IS THE TIME INTERVAL FOR WHICH NO MAG READINGS WERE
01226  C      OBTAINED. INPUT DATA OF THIS FORMAT ASSUMED TO BE TIME,GRAV,DECCA,
01226  C      VLF DURING THIS INTERVAL
01226  365    IF(T2-MOFF1)361,362,362
01233  361    WRITE OUTPUT TAPE 3,60,(I(II),II=1,35)
01253         GO TO 4
01254  362    IF(T2-MOFF2)363,363,361
01261  363    WRITE OUTPUT TAPE 3,62,(I(II),II=1,35)
01301         IF(T2-MOFF2)4,366,4
01306  366    MOFF1=0
01310         GO TO 4
01311  37     WRITE OUTPUT TAPE 3,63,(I(II),II=1,31)
01331         GO TO 4
01332  38     IF(I(16)-9)382,382,381
01340  381    WRITE OUTPUT TAPE 3,64,(I(II),II=1,27)
01360         GO TO 4
01361  382    WRITE OUTPUT TAPE 3,65,(I(II),II=1,27)
01401         GO TO 4
01402  39     IF(MOFF1)391,398,3991
01406  3991   IF(MOFF1-4000000)398,395,398
01413  398    READ 2,MOFF1,MOFF2
01422  C      INPUT DATA OF THIS FORMAT DURING TIME INTERVAL MOFF1,MOFF2 ASSUMED
01422  C      TO BE TIME,GRAV, AND EITHER DECCA OR VLF
01422  399    IF(T2-MOFF1)391,392,392
01427  391    IF(I(12)-9)394,394,393
01435  393    WRITE OUTPUT TAPE 3,66,(I(II),II=1,23)
01455         GO TO 4
01456  394    WRITE OUTPUT TAPE 3,67,(I(II),II=1,23)
01476         GO TO 4
01477  392    IF(T2-MOFF2)395,395,391
01504  395    IF(I(12)-9)397,397,396
01512  396    WRITE OUTPUT TAPE 3,68,(I(II),II=1,23)
01532         IF(T2-MOFF2)4,400,4
01537  400    MOFF1=0
01541         GO TO 4
01542  397    WRITE OUTPUT TAPE 3,69,(I(II),II=1,23)
01562         GO TO 4
01563  40     IF(I(8)-9)402,402,401
01571  401    WRITE OUTPUT TAPE 3,70,(I(II),II=1,19)
01611         GO TO 4
01612  402    WRITE OUTPUT TAPE 3,71,(I(II),II=1,19)
01632         GO TO 4
01633  41     WRITE OUTPUT TAPE 3,72,(I(II),II=1,15)
01653         GO TO 4
01654  42     IF(MOFF1)421,424,4251
01660  4251   IF(MOFF1-4000000)424,423,424
01665  424    READ 2,MOFF1,MOFF2
01674  C      INPUT DATA OF THIS FORMAT DURING TIME INTERVAL MOFF1,MOFF2 ASSUMED
01674  C      TO BE TIME,GRAV.
01674  425    IF(T2-MOFF1)421,422,422
01701  421    WRITE OUTPUT TAPE 3,73,(I(II),II=1,11)
01721         GO TO 4
01722  422    IF(T2-MOFF2)423,423,421
```

```
01727  423    WRITE OUTPUT TAPE 3,74,(I(II),II=1,11)
01747         IF(T2-MOFF2)4,426,4
01754  426    MOFF1=0
01756         GO TO 4
01757  45     DO 451 II=63,56,-1
01761  451    I(II)=I(II-2)
01774         GO TO 452
01775  44     DO 441 II=63,56,-1
01777  441    I(II)=I(II-1)
02012  452    DO 442 II=52,55
02014  442    I(II)=0
02024         GO TO 31
02025  43     WRITE OUTPUT TAPE 3,75,(I(II),II=1,7)
02045         GO TO 4
02046  C      ------------------------------------------------------------------
02046  C      PRINT DATA IF TIME BETWEEN DATA INPUT CHANGES BY MORE THAN ONE MIN
02046  C     I UTE OR FORMAT CHANGES.
02046  4      T=T2-T1
02051         IF(T-1)8,6,8
02056  6      IF(J-K)5,7,5
02063  5      PRINT 111,(I(II),II=1,80)
02102  7      T1=T2
02104         K=J
02106         GO TO 3
02107  8      PRINT 100,T1
02114  9      PRINT 111,(I(II),II=1,80)
02133         T1=T2
02135         K=J
02137         GO TO 3
02140  250    STOP
02142         END
```

SUBPROGRAMS

RMT SELECT

PROGRAM ALLOCATION

02220	K	02221	T1	02222	MOFF1	02223	II
02224	J	02225	T2	02226	MOFF2	02227	T
02230	I	02540	LAB				

PROGRAM END

```
00004          SUBROUTINE RMT
00004    C     THIS SUBROUTINE READS MAGNETIC TAPE TO FIND LAST ENTRY SPECIFIED
00004    C     BY T3
00004          DIMENSION I(80)
00004          INTEGER T3,T4
00004    1000  FORMAT(80R1)
00007    1001  FORMAT(1X,80R1)
00013    100   FORMAT(I6)
00015          READ 100,T3
00022    300   READ INPUT TAPE 3,1000,(I(II),II=1,80)
00042          IF(I(1)-9)200,300,300
00050    200   T4=I(7)+10*I(6)+100*I(5)+1000*I(4)+10000*I(3)+100000*I(2)+100000
00050         10*I(1)
00107          IF(T4-T3)300,400,400
00114    400   PRINT 1001,(I(II),II=1,80)
00133          PAUSE
00135          IF(SENSE SWITCH 6)420,430
00141    420   BACKSPACE 3
00143          BACKSPACE 3
00145          READ INPUT TAPE 3,1000,(I(II),II=1,80)
00165          GO TO 400
00166    430   RETURN
00170          END
```

PROGRAM ALLOCATION

00217	RMT	00221	T3	00222	II	00223	T4
00224	I						

PROGRAM END

```
00000  *     CORRECTION OF MAG TAPE FROM CARDS AND PAPER TAPE
00004        INTEGER T,T1,T2,T3,DAY,T4
00004        DIMENSION I(80),J(80),LAB(80)
00004        PAUSE
00006  10    FORMAT(100R1)
00011  12    FORMAT(I7,80R1)
00015  15    FORMAT(I8)
00017  20    FORMAT(2I8,I4)
00022  25    FORMAT(80R1)
00025  5000  FORMAT(12H DATA FORMAT/84H TIME(1-7),GRAV(8-11),MAG1(12-15),DECCA(
00025       116-27),MAG2-8(28-55),VLF1(56-59),MAG9(60-63)/87H VLF2(64-67),MAG10
00025       2(68-71),VLF3(72-75),LAT(76-81),LONG(82-88),FIX CODE(89),DEPTH(90-9
00025       33).)
00107        T3=0
00111  C
00111  C     WRITE LABEL WITH SENSE SWITCH 3 ON.
00111        IF(SENSE SWITCH 3)30,31
00115  30    WRITE OUTPUT TAPE 2,5000
00121        READ 25,(LAB(II),II=1,80)
00140        WRITE OUTPUT TAPE 2,25,(LAB(II),II=1,80)
00160  C
00160  C     READ FIRST ENTRIES OFF CARDS
00160  31    IF(SENSE SWITCH 1)1,2
00164  1     READ 10,(I(II),II=1,80)
00203        WRITE OUTPUT TAPE 2,10,(I(II),II=1,80)
00223        IF(SENSE SWITCH 1)1,2
00227  2     IF(SENSE SWITCH 2)3,4
00233  C     READ TIME OF FIRST CORRECT ENTRY WITH SWITCH 2 OFF.
00233  4     READ 15,T4
00240  13    READ INPUT TAPE 3,12,T,(I(II),II=1,80)
00262  133   IF(T-T4)13,3,13
00267  3     BACKSPACE 3
00271  C     READ CALENDAR CORRECTION.T1,T2 TIME FOR WHICH CORRECTION IS TO BE
00271  C    1APPLIED.
00271  32    READ 20,T1,T2,DAY
00302  51    IF(SENSE SWITCH 4)52,5
00306  52    PRINT 50,T,T1,T2,T3
00321  50    FORMAT(4I8)
00324        CALL EJECT
00325  5     READ INPUT TAPE 3,10,(I(II),II=1,80)
00345        IF(I(2)-9)500,500,5
00353  500   T=I(7)+10*I(6)+100*I(5)+1000*I(4)+10000*I(3)+100000*I(2)+1000000*I
00353       1(1)
00412        IF(T-3650000)134,134,5
00417  134   IF(T-T1)80,6,7
00424  6     SENSE LIGHT 1
00426        I(1)=DAY/100
00433        I(2)=DAY/10-10*I(1)
00446        I(3)=DAY-100*I(1)-10*I(2)
00462        T=I(7)+10*I(6)+100*I(5)+1000*I(4)+10000*DAY
00506        GO TO 800
00507  7     IF(T-T2)6,6,32
00514  80    IF(SENSE LIGHT 1)81,800
00520  81    READ 20,T1,T2,DAY
00531  800   IF(T-T3)14,11,8
00536  C     READ FORMAT CORRECTION FROM TAPE
00536  8     READ INPUT TAPE 8,25,(J(II),II=1,80)
00556        T3=J(7)+10*J(6)+100*J(5)+1000*J(4)+10000*J(3)+100000*J(2)+1000000*
00556       1J(1)
00615        IF(T-T3)14,11,8
00622  11    DO 110 II=1,80
```

```
00624          IF(J(II)-9)110,110,1101
00632   1101   IF(J(II)-48)111,110,111
00640   110    CONTINUE
00645          GO TO 112
00646   111    PRINT 25,(J(II),II=1,80)
00665          T3=0
00667          GO TO 187
00670   112    WRITE OUTPUT TAPE 2,10,(J(II),II=1,80)
00710          GO TO 51
00711   C      CHECK FOR ALPHANUMERICS
00711   14     DO 170 II=1,80
00713          IF(I(II)-9)170,170,165
00721   170    CONTINUE
00726          GO TO 17
00727   165    IF(II-16)175,170,175
00734   175    IF(II-22)180,170,180
00741   180    IF(I(II)-48)186,170,186
00747   186    IF(II-25)185,190,185
00754   190    DO 191 II=16,27
00756   191    I(II)=0
00766          GO TO 170
00767   17     WRITE OUTPUT TAPE 2,10,(I(II),II=1,80)
01007          GO TO 51
01010   185    PRINT 25,(I(II),II=1,80)
01027   187    CALL EJECT
01030          PAUSE
01032          IF(SENSE SWITCH 5)190,60
01036   60     IF(SENSE SWITCH 6)176,51
01042   176    READ 25,(I(II),II=1,80)
01061          GO TO 14
01062          STOP
01064          END
```

SUBPROGRAMS

EJECT

PROGRAM ALLOCATION

01122	T3	01123	II	01124	T4	01125	T
01126	T1	01127	T2	01130	DAY		
01131	I	01251	J	01371	LAB		

PROGRAM END

APPENDIX 4

```
00000  *     EDIT AND WRITE FINAL DATA TAPE
00000  C     ------------------------------------------------------------------
00000  C     OUTPUT FILES
00000  C
00000  C                    VTAPE FILE 1 TAPE LABEL
00000  C
00000  C     WRITE TAPE VTAPE,RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004        DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004        DIMENSION RL(8)
00004        INTEGER RNM,CHNO,DELT
00004        REAL MEANV
00004  C     ------------------------------------------------------------------
00004  C      COMMON STORAGE
00004        COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004  C
00004  C
00004        DIMENSION SUM(12)
00004        INTEGER VTAPE,SCRATCH,EOF,CHNN,BLANK
00004        INTEGER F,D,T,TN1,TN2,TN3
00004  C
00004  C     PROGRAM CONSTANTS
00004  C
00004        NEW=152950
00006        RL(1)=5657904
00014        RL(2)=-6722508
00024        RL(3)=4617584
00032        RL(4)=-3994575
00042        RL(5)=-3994575
00052        RL(6)=-3994575
00062        RL(7)=-3994575
00072        RL(8)=-3994575
00102        BLANK=-3994575
00105        PAUSE 4095
00107  C
00107  C     INITIALIZE
00107  C
00107        DIMENSION M(10)
00107        INTEGER F,D,T,TN1,TN2 ,TN3
00107        COMMON M,J2,K,F,D,M4,T,TN1,TN2,MAC,TN3
00107        TN1=0
00111        TN2=0
00113        TN3=0
00115        PRINT 1
00120  1     FORMAT(1H1)
00123  2     FORMAT(//////)
00126  C     ------------------------------------------------------------------
00126  C     READ TAPE CONTROL CARD AND WRITE TAPE LABEL IF -NEW- IS SPECIFIED,
00126  C     OTHERWISE POSITION OUTPUT TAPE TO END OF PREVIOUS DATA RECORDS
00126  C
00126        READ 20,KONTROL,VTAPE,SCRATCH
00137  20    FORMAT(R3,26X,I1,29X,I1)
00145        REWIND VTAPE
00147        REWIND SCRATCH
00151        IF(KONTROL-NEW)3,6,3
00156  C
00156  C     READ AND PRINT TAPE LABEL
00156  C
00156  3     READ INPUT TAPE VTAPE,7,(SUM(I),I=1,10)
00200        PRINT 30,(SUM(I),I=1,10)
00221  30    FORMAT(1X,10A8)
00225        CALL EOFCK(VTAPE,LITE)
```

```
00230          GO TO(31,3),LITE
00235  C
00235  C       SEARCH FOR =END OF TAPE= RECORD, AND LIST RUN NAMES  ENCOUNTERED
00235  C
00235  31      READ TAPE VTAPE,RNM
00243          PRINT 32,(RNM(I),I=1,8)
00262  32      FORMAT(21X,8A4)
00266          CALL COMPARE (RNM,RL,8,LITE)
00273          GO TO (5,4),LITE
00300  4       CALL SELECT (VTAPE,11)
00303          PAUSE
00305          CALL SELECT (VTAPE,11)
00310          GO TO 31
00311  C
00311  C       POSITION TAPE TO WRITE OVER =END OF TAPE= RECORD
00311  C
00311  5       CALL SELECT(VTAPE,12)
00314          CALL SELECT(VTAPE,11)
00317          PRINT 1
00322          GO TO 1000
00323  C
00323  C       READ NEW LABEL FROM CARDS, WRITE ON TAPE AND PRINT
00323  C
00323  6       READ 7,(SUM(I),I=1,10)
00344  7       FORMAT(10A8)
00347          CALL EOFCK(1536,LITE)
00352          PRINT 30,(SUM(I),I=1,10)
00373          GO TO (9,8),LITE
00400  8       WRITE OUTPUT TAPE VTAPE,7,(SUM(I),I=1,10)
00422          GO TO 6
00423  9       ENDFILE VTAPE
00425          GO TO 1000
00426  C       ---------------------------------------------------------------
00426  C       READ RUN IDENTIFICATION FROM CARDS
00426  C
00426  1000    READ 100,(RNM(I),I=1,8),DELT
00447  100     FORMAT(8X,8A4,5X,I4)
00454          IF (RNM(1)-BLANK)1100,9000,1100
00462  C
00462  C       READ VARIABLE IDENTIFICATION FROM CARDS
00462  C
00462  1100    J=1
00464          PRINT 1
00467          PRINT 101,(RNM(I),I=1,8)
00506  101     FORMAT(27H GEOPHYSICAL DATA FOR RUN  8A4,//, 31H       VARIABLE NAM
00506         1E       CHAN)
00532  1101    READ 110,CHNN,(VNM(N,CHNN),N=1,3)
00561  110     FORMAT(5X,I2,1X,3A8)
00566          CALL EOFCK(1536,LITE)
00571          GO TO(2000,1102),LITE
00576  1102    IF(CHNN-16)1103,1103,1104
00603  1103    CHNO(J)=CHNN
00606          JBIG=J
00610          J=J+1
00613          PRINT 111,(VNM(N,CHNN),N=1,3),CHNN
00642  111     FORMAT(1X,3A8,3X,I2)
00647          GO TO 1101
00650  1104    PRINT 114
00653  114     FORMAT(5X,45HCHANNEL NUMBER EXCEEDS 16. PROGRAM TERMINATED)
00672          GO TO 9000
00673  2000    WRITE TAPE VTAPE,RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00723          ENDFILE VTAPE
```

```
00725          PAUSE
00727          CALL EDIT
00730   C
00730   C      WRITE =END OF TAPE= RECORD AND BACK UP SO THAT THIS RECORD WILL BE
00730   C      WRITTEN OVER DURING THE NEXT RUN.  IF THIS IS THE LAST RUN, THE
00730   C      =END OF TAPE= RECORD WILL REMAIN IN PLACE TO MARK THE END OF DATA
00730   C
00730          WRITE TAPE VTAPE,RL,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00760          CALL SELECT(VTAPE,12)
00763          CALL SELECT(VTAPE,11)
00766          PAUSE
00770          GO TO 1000
00771   C      ------------------------------------------------------------------
00771   C      TERMINATE PROGRAM
00771   C      ------------------------------------------------------------------
00771   9000   REWIND VTAPE
00773          PRINT 1
00776          PRINT 1
01001          STOP
01003          END

SUBPROGRAMS

  EOFCK       COMPARE     SELECT      EDIT

PROGRAM ALLOCATION

 01034    NEW        01035    BLANK      01036    KONTROL    01037    VTAPE
 01040    SCRATCH    01041    I          01042    LITE       01043    J
 01044    CHNN       01045    N

 01046    RL         01066    SUM

COMMON ALLOCATION

 00000    RNM        00010    CHNO       00031    VNM        00177    MEANV
 00241    FACT       00303    JBIG       00304    KOUNT      00305    DELT
 00306    M          00320    J2         00321    K          00322    F
 00323    D          00324    M4         00325    T          00326    TN1
 00327    TN2        00330    MAC        00331    TN3

PROGRAM END
```

```
 00004          SUBROUTINE COMPARE(X,Y,LBIG,LITE)
 00004          DIMENSION X(1),Y(1)
 00004          INTEGER X,Y
 00004          M=0
 00006          DO 9 L=1,LBIG
 00010  9       M=X(L)-Y(L)+M
 00032          IF(M)10,11,10
 00036  10      LITE=2
 00040          GO TO 9999
 00041  11      LITE=1
 00043  9999    RETURN
 00045          END

PROGRAM ALLOCATION

 00056     COMPARE    00060     M          00061     L


PROGRAM END
```

```
00004          SUBROUTINE EDIT
00004    C     SUBROUTINE READS RAW DATA MAGNETIC TAPE AND WRITES DATA FILE IN
00004    C    1BLOCKS OF 10 MINUTES.THE LENGTH OF EACH FILE IS 1 DAY OF DATA.
00004    C    2THE FILE IS PRECEDED BY A FILE CONTAINING THE DAY AND VARIABLE
00004    C    3IDENTIFICATION AND IS CLOSED BY A FILEMARK.
00004    C
00004          DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004          INTEGER RNM,CHNO,DELT
00004          REAL MEANV
00004          COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004          INTEGER F,T,TI,D,V,E,GMT,TI,G,VLF1,VLF2,VLF3,DEC1,DEC2,DAY,TN1,
00004         1TN2,ALPH1,ALPH2,T4
00004          DIMENSION M(10),I(100),II(16,10),IDUM(1)
00004          COMMON M,J,K,F,D,MLIM,T,TN1,TN2,MAC
00004    500   FORMAT(16,13,15,F8.1,12)
00012    510   FORMAT(18)
00014    520   FORMAT(3R1,3I4,R1,I5,R1,I5,1214,16,17,11,14)
00027    530   FORMAT(218)
00032    540   FORMAT(1X,416,218,12,1X,R1,16,1X,R1,16,316,13,14)
00046    550   FORMAT(30X,18,2X,16,2X,15)
00054    560   FORMAT(80R1)
00057    570   FORMAT(3X,1017,2X,17)
00064    580   FORMAT(1H0)
00067    C
00067    C     READ FIFTH MAGNETIC FIELD FIGURE,ALLOWABLE 6 SEC DIFFERENCE, GMT
00067    C    1CONVERSION FACTOR,INVERSE MAGNETIC FIELD CONVERSION FACTOR,
00067    C    2STARTING TIME ON INPUT TAPE.
00067    C     INITIALIZE COUNTERS
00067          READ 500,F,D,GMT,C,MLIM
00104          READ 510,TI
00111          MAC=0
00113          TI=0
00115          KOUNT=1
00117    C     ------------------------------------------------------------------
00117    C     SKIP TAPE LABEL
00117    310   READ INPUT TAPE 3,560,(I(K),K=1,80)
00137          IF (I(2)-9)313,313,310
00145    313   DAY=I(3)+10*I(2)+100*I(1)
00160          IF(DAY-TI/10000)310,314,310
00170    314   BACKSPACE 3
00172    C
00172    C     READ INPUT TAPE,FIND FIRST TIME,PUT ZEROS IN UNFILLED ARRAY
00172    C    1POSITIONS IF FIRST TIME OCCURS PARTWAY THROUGH ARRAY.
00172    C     CHECK FOR NAVIGATION DATA IN DATA GAPS
00172    C
00172    1000  DO 2000 J=1,10
00174    4     READ INPUT TAPE 3,520,ID,IA,IY,T,G,M(1),ALPH1,DEC1,ALPH2,DEC2,(M(N
00174         1),N=2,8),VLF1,M(9),VLF2,M(10),VLF3,LAT,LONG,IFC,IZ
00273          IF(IA-9)40,40,4
00300    40    DAY=100*ID+10*IA+IY
00310          IF(SENSE SWITCH 1)41,42
00314    41    T=T+GMT
00317    42    T=T+10000*DAY
00323          IF(TI)10,401,422
00327    422   IF(DAY-TI)10,401,2401
00334    2401  IF((T-10000*TI)-2359)401,401,240
00344    240   PRINT 530,T,TI
00353          PRINT 510,KOUNT
00360          CALL EJECT
00361          BACKSPACE 3
00363          ENDFILE 1
```

```
00365          GO TO 3000
00366   401    IF(KOUNT-1)1,2,1
00373   2      IF(T-TI)4,11,3
00400   1      IF(T-TI)10,11,13
00405   13     IF(J-1)3,3,12
00412   3      IF(T-(TI+10))5,6,71
00421   C
00421   C      INSERT NAVIGATION DATA IF PRESENT DURING DATA GAP
00421   71     IF(TN1-(TI+10))72,7,7
00430   72     DO 733 J=1,10
00432          DO 73 K=1,16
00434   73     II(K,J)=0
00450   733    CONTINUE
00455          T4=T
00457          T=TN1
00461          CALL NAV(LAT,LONG,IFC,IZ,ALPHI,DEC1,DEC2)
00471          KT=T
00473          T=T4
00475          II(4,5)=IZ
00504          II(5,5)=LAT
00513          II(6,5)=LONG
00522          II(7,5)=IFC
00531          II(15,5)=DAY
00540          II(16,5)=KT-10000*DAY
00552          CALL WRITEB(1,II(1,1),IDUM(1))
00570          J=1
00572          GO TO 7
00573   5      DO 100 K=1,14
00575          II(K,J)=0
00604   100    CONTINUE
00611          II(15,J)=DAY
00620          II(16,J)=TI-10000*DAY
00632          IF(TN1)50,50,53
00636   53     IF(TI-TN1)51,50,51
00643   51     IF(TI-TN2)52,50,52
00650   50     T4=T
00652          T=TI
00654          CALL NAV(LAT,LONG,IFC,IZ,ALPHI,DEC1,DEC2)
00664          TI=T
00666          T=T4
00670          II(4,J)=IZ
00677          II(5,J)=LAT
00706          II(6,J)=LONG
00715          II(7,J)=IFC
00724   52     TI=TI+1
00727          J=J+1
00732          GO TO 1
00733   6      TI=TI+10
00736          GO TO 1
00737   7      TI=TI+10
00742          GO TO 1
00743   10     IF(SENSE SWITCH 3)111,112
00747   111    T=TI
00751          DAY=T/10000
00755          GO TO 422
00756   112    PRINT 530,T,TI
00765          CALL EJECT
00766          PAUSE
00770          READ 530, DAY,T
00777          IF(TI-T)113,11,113
01004   113    TI=T
01006          J=MOD(T,10)+1
```

```
01013          GO TO 422
01014   12     DO 101 K=1,14
01016          II(K,J)=0
01025   101    CONTINUE
01032          II(15,J)=DAY
01041          II(16,J)=TI-10000*DAY
01053          IF(TI-TN1)1011,1010,1011
01060   1011   IF(TI-TN2)1012,1010,1012
01065   1010   T4=T
01067          T=TI
01071          CALL NAV(LAT,LONG,IFC,IZ,ALPHI,DEC1,DEC2)
01101          TI=T
01103          T=T4
01105          II(4,J)=IZ
01114          II(5,J)=LAT
01123          II(6,J)=LONG
01132          II(7,J)=IFC
01141   1012   TI=TI+1
01144          J=J+1
01147          IF(J-11)1,300,300
01154   C
01154   C      ADD FIFTH MAG FIGURE,CORRECT TO GAMMAS IF REQUIRED,AVERAGE
01154   C     2MAGNETICS,MERGE NAVIGATION AND DEPTH DATA, AND INSERT DATA IN
01154   C     2CORRECT ARRAY LOCATIONS.
01154   C
01154   11     CALL ADDFIG
01155   123    IF(SENSE SWITCH 2)120,121
01161   120    DO 103 N=1,10
01163   103    M(N)=100000*C/M(N)+0.5
01203   121    CALL MCHECK(MAV,E)
01206          IF(E-20)122,122,160
01213   122    CALL NAV(LAT,LONG,IFC,IZ,ALPHI,DEC1,DEC2)
01223          II(1,J)=G
01232          II(2,J)=MAV
01241          II(3,J)=E
01250          II(4,J)=IZ
01257          II(5,J)=LAT
01266          II(6,J)=LONG
01275          II(7,J)=IFC
01304          II(8,J)=ALPHI
01313          II(9,J)=DEC1
01322          II(10,J)=ALPH2
01331          II(11,J)=DEC2
01340          II(12,J)=VLF1
01347          II(13,J)=VLF2
01356          II(14,J)=VLF3
01365          II(15,J)=DAY
01374          II(16,J)=T-10000*DAY
01406          TI=TI+1
01411          KOUNT=KOUNT+1
01414          ITZ=MOD(TI,100)
01420          IF(ITZ-60)2000,2001,2001
01425   2001   TI=TI+40
01430   2000   CONTINUE
01435   C      ---------------------------------------------------------------
01435   C      WRITE TAPE,PRINT BLOCK IF FIRST ENTRY FOR DAY OR QUARTER OF DAY
01435          CALL WRITEB (1,II(1,1),IDUM(1))
01453          IF(DAY-TI)200,251,200
01460   251    IF(II(16,1)-0600)252,200,252
01472   252    IF(II(16,1)-1200)253,200,253
01504   253    IF(II(16,1)-1800)250,200,250
01516   200    PRINT 580
```

```
01521          DO 210 J=1,10
01523          PRINT 540,(II(K,J),K=1,16)
01546   210    CONTINUE
01553          TI=DAY
01555   250    GO TO 1000
01556   300    CALL WRITER (I,II(I,1),IDUM(I))
01574          BACKSPACE 3
01576          GO TO 200
01577   160    PRINT 550,T,MAV,E
01610          PRINT 570,(M(N),N=1,10),T
01631          GO TO 122
01632   3000   RETURN
01634          END
```

SUBPROGRAMS

EJECT NAV WRITER MOD ADDFIG MCHECK

PROGRAM ALLOCATION

01676	EDIT	01700	GMT	01701	C	01703	TI
01704	TI	01705	DAY	01706	ID	01707	IA
01710	IY	01711	G	01712	ALPH1	01713	DEC1
01714	ALPH2	01715	DEC2	01716	N	01717	VLF1
01720	VLF2	01721	VLF3	01722	LAT	01723	LONG
01724	IFC	01725	IZ	01726	T4	01727	KT
01730	MAV	01731	E	01732	ITZ		
01733	I	02077	II	02337	IDUM		

COMMON ALLOCATION

00000	RNM	00010	CHNO	00031	VNM	00177	MEANV
00241	FACT	00303	JBIG	00304	KOUNT	00305	DELT
00306	M	00320	J	00321	K	00322	F
00323	D	00324	MLIM	00325	T	00326	TN1
00327	TN2	00330	MAC				

PROGRAM END

```
00004          SUBROUTINE ADDFIG
00004    C     THIS SUBROUTINE ADDS FIFTH FIGURE TO MAGNETIC READINGS
00004          DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004          INTEGER RNM,CHNO,DELT
00004          REAL MEANV
00004          COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004          INTEGER F,I,D,TNI,TN2
00004          DIMENSION M(10)
00004          COMMON M,J,K,F,D,MLIM,T,TNI,TN2
00004          DO 114 N=1,10
00006          IF(M(N))114,114,116
00013    116   M4=M(N)/1000
00020    130   IF(M4-MLIM)113,113,111
00025    113   M(N)=M(N)+F
00031          GO TO 114
00032    111   M(N)=M(N)+F+10000
00037          GO TO 114
00040    114   CONTINUE
00045          RETURN
00047          END
```

PROGRAM ALLOCATION

00055	ADDFIG	00057	N	00060	M4

COMMON ALLOCATION

00000	RNM	00010	CHNO	00031	VNM	00177	MEANV
00241	FACT	00303	JBIG	00304	KOUNT	00305	DELT
00306	M	00320	J	00321	K	00322	F
00323	D	00324	MLIM	00325	T	00326	TNI
00327	TN2						

PROGRAM END

```
00004          SUBROUTINE MCHECK(MAV,E)
00004    C     THIS SUBROUTINE CHECKS MAGNETIC DATA,CALCULATES 1 MINUTE MEAN,AND
00004    C    1DETERMINES THE STANDARD DEVIATION OF THE 6 SECOND READINGS
00004    C
00004          DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004          INTEGER RNM,CHNO,DELT
00004          REAL MEANV
00004          COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004          INTEGER F,T,D,TN1,TN2,DI,E
00004          DIMENSION MD(10),DI(11),M(10)
00004          COMMON M,J,K,F,D,M4,T,TN1,TN2,MAC
00004    250   FORMAT(I8,2X,I6,1X,I2)
00011    C     CALCULATE DIFFERENCES
00011          P=10.0
00013    251   IF(M(1))2261,2261,2550
00020    2550  DO 255 N=1,10
00022    2551  IF(N-1)215,215,2010
00027    215   DI(1)=IABS(M(1)-MAC)
00037          GO TO 2050
00040    2010  IF(M(N))207,207,202
00045    202   DI(N)=IABS(M(N-1)-M(N))
00055    200   CONTINUE
00055    2050  IF(DI(N)-D)205,205,2051
00063    2051  IF(N-1)2072,2072,206
00070    2072  MT=M(1)
00073          GO TO 207
00074    206   IF(M(N-1))208,208,207
00101    208   IF(N-2)2081,2081,209
00106    209   M2D=IABS(M(N)-M(N-2))
00115          IF(M2D-2*D)205,205,2091
00124    2091  IF(M(N-2))2080,2080,207
00131    2080  IF(N-10)2081,2071,2071
00136    2081  DI(N+1)=IABS(M(N)-M(N+1))
00146    2082  IF(DI(N+1)-D)205,205,2071
00154    2071  ND=IABS(M(N)-MAC)
00163          IF(ND-D)205,205,207
00170    205   MAC=M(N)
00173          GO TO 255
00174    207   M(N)=0
00177          P=P-1
00205    255   CONTINUE
00212          IF(P-1)2001,2002,2000
00222    2001  MAV=MT
00224          MAC=MT
00226          E=0
00230          GO TO 226
00231    2002  MAV=M(1)
00234          MAC=M(1)
00237          E=0
00241          GO TO 226
00242    C     CALCULATE AVERAGE FIELD
00242    2000  MAV=(M(1)+M(2)+M(3)+M(4)+M(5)+M(6)+M(7)+M(8)+M(9)+M(10))/P
00325          DO 210 N=1,10
00327          IF(M(N))211,211,212
00334    211   MD(N)=0
00337          GO TO 210
00340    212   MD(N)=M(N)-MAV
00344    210   CONTINUE
00351          IF(P)213,213,214
00355    213   E=0
00357          GO TO 216
```

```
00360  C      CALCULATE STANDARD DEVIATION
00360  214    X=SQRT((MD(1)*MD(1)+MD(2)*MD(2)+MD(3)*MD(3)+MD(4)*MD(4)+MD(5)*MD(5
00360         1)+MD(6)*MD(6)+MD(7)*MD(7)+MD(8)*MD(8)+MD(9)*MD(9)+MD(10)*MD(10))/(
00360         2P*(P-1)))
00524          E=X+0.5
00530          GO TO 226
00531  216     PRINT 250,T,MAV,E
00546  2261    E=0
00550          MAV=0.
00552  226     RETURN
00554          END
```

SUBPROGRAMS

```
  IABS       SQRT
```

PROGRAM ALLOCATION

```
00651    MCHECK    00652    P         00654    N         00655    MT
00656    M2D       00657    ND        00660    X

00662    MD        00674    DI
```

COMMON ALLOCATION

```
00000    RNM       00010    CHNO      00031    VNM       00177    MEANV
00241    FACT      00303    JBIG      00304    KOUNT     00305    DELT
00306    M         00320    J         00321    K         00322    F
00323    D         00324    M4        00325    T         00326    TN1
00327    TN2       00330    MAC
```

PROGRAM END

```
00004          SUBROUTINE NAV(LAT,LONG,IFC,IZ,ALPHI,DEC1,DEC2)
00004    C
00004    C      SUBROUTINE READS NAVIGATIONAL DATA FROM CARDS AND BATHYMETRY DATA
00004    C     1FROM CARDS AND,OR,PAPER TAPE.WHEN READING PAPER TAPE THE NUMBER OF
00004    C     2CHARACTERS IN AN ENTRY IS CHECKED BEFORE THE DATA IS ACCEPTED.
00004    C      WITH SENSE SWITCH 5 ON RADAR TRANSPONDER BUOY DATA IS READ OFF
00004    C         PAPER TAPE AND STORED IN PLACE OF ALPHI, DEC1, DEC2
00004          DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004          INTEGER RNM,CHNO,DELT
00004          INTEGER T,F,D,TN1,TN2,FC,TN3,RNG,DEG,Z,ALPHI,DEC1,DEC2
00004          REAL MEANV
00004          COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004          COMMON M,JJ,K,F,D,M4,T,TN1,TN2,MAG,IN3
00004          DIMENSION M(10),J(14)
00004    300   FORMAT(3X,I7,4X,I6,3X,I7,2X,I1,3X,I4)
00015    301   FORMAT(I1,2X,I7,4X,I6,3X,I7,2X,I1,3X,I4)
00027    320   FORMAT(40R1)
00032          LAT=0
00034          LONG=0
00036          IFC=0
00040          IZ=0
00042    310   IF(T-TN1)313,311,3120
00047    3120  IF(SENSE SWITCH 4)3121,312
00053    3121  READ 301,IX,TN1,LTD,LNG,FC,Z
00072          IF (I1-1)302,303,302
00077    303   PRINT 305,IX,T,TN2
00110    305   FORMAT(5X,I1,218,/)
00115          CALL ALLSKIP(TN1)
00117          GO TO 311
00120    312   READ 300,TN1,LTD,LNG,FC,Z
00135    302   PRINT 3130,T,TN1,TN2
00146    3130  FORMAT(318)
00151          GO TO 310
00152    311   LAT=LTD
00154          LONG=LNG
00156          IFC=FC
00160          IZ=Z
00162          GO TO 312
00163    C
00163    C      READ DEPTH DATA FROM PAPER TAPE IF SENSE SWITCH 6 ON
00163    313   IF(SENSE SWITCH 6)3131,315
00167    3131  IF(SENSE SWITCH 5)316,3133
00173    C      READ BUOY NO, RANGE, BEARING. STORE IN IFC,LAT,LONG
00173    C
00173    316   IF(T-TN3)315,3165,3161
00200    3161  DO 3162 J1=1,30
00202    3162  J(J1)=44
00212          READ INPUT TAPE 8,320,(J(J1),J1=1,30)
00232          DO 3163 J1=30,1,-1
00234          IF(J(J1)-44)3164,3163,3164
00242    3163  CONTINUE
00252    3164  IF(J1-25)3161,3166,3161
00257    3166  DO 3168 J1=22,25
00261          IF(J(J1)-48)3168,3169,3168
00267    3169  J(J1)=0
00272    3168  CONTINUE
00277          JZ=J(25)+10*J(24)+100*J(23)+1000*J(22)
00317          RNG=J(20)+10*J(19)+100*J(18)+1000*J(17)
00337          DEG=J(15)+10*J(14)+100*J(13)+1000*J(12)
00357          NO=J(10)+10*J(9)
00365          TN3=J(7)+10*J(6)+100*J(5)+1000*J(4)+10000*J(3)+100000*J(2)+1000000
```

```
00365          1*J(1)
00424           GO TO 316
00425   3165    IZ=JZ
00427           ALPHI=NO
00431           DEC1=DEG
00433           DEC2=RNG
00435           GO TO 315
00436   3133    IF(T-TN2)315,317,314
00443   314     DO 3132 JI=1,14
00445           J(JI)=48
00450   3132    CONTINUE
00455           READ INPUT TAPE 8,320,(J(JI),JI=1,14)
00475   3140    DO 3141 JI=14,1,-1
00477           IF(J(JI)-48)3142,3141,3142
00505   3141    CONTINUE
00515           GO TO 315
00516   3142    IF(JI-12)314,3143,314
00523   3143    DO 3146 JI=9,12
00525           IF(J(JI)-9)3146,3146,3147
00533   3147    J(JI)=0
00536   3146    CONTINUE
00543           JZ=J(12)+10*J(11)+100*J(10)+1000*J(9)
00563           TN2=J(7)+10*J(6)+100*J(5)+1000*J(4)+10000*J(3)+100000*J(2)+1000000
00563          1*J(1)
00622           GO TO 3133
00623   317     IZ=JZ
00625   315     RETURN
00627           END
```

SUBPROGRAMS

ALLSKIP

PROGRAM ALLOCATION

00705	NAV	00706	IX	00707	LID	00710	LNG
00711	FC	00712	Z	00713	II	00714	JI
00715	JZ	00716	RNG	00717	DEG	00720	NO
00721	J						

COMMON ALLOCATION

00000	RNM	00010	CHNO	00031	VNM	00177	MEANV
00241	FACT	00303	JBIG	00304	KOUNT	00305	DELT
00306	M	00320	JJ	00321	K	00322	F
00323	D	00324	M4	00325	T	00326	TN1
00327	TN2	00330	MAC	00331	TN3		

PROGRAM END

```
00004          SUBROUTINE ALLSKIP(TNI)
00004          INTEGER T,TNI
00004    401   READ INPUT TAPE 3,400,T
00012    400   FORMAT(I7)
00014          IF (T-TNI)401,402,403
00021    403   PRINT 405,T,TNI
00032    405   FORMAT(2I8)
00035          PAUSE
00037    402   BACKSPACE 3
00041          RETURN
00043          END

PROGRAM ALLOCATION

 00050     ALLSKIP    00052     T


PROGRAM END
```

APPENDIX 5

```
00000  *     READ AND PROCESS GEOPHYSICAL DATA FILES
00004        INTEGER ETAPE,RNM,CHNN,CHNO,DELT,RL,SCRATCH,BEGN,CONT
00004        REAL MEANV
00004        DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004        DIMENSION SUM(12),RL(8),DLT(300),DLNG(300),IT(300)
00004        COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004        COMMON ETAPE,SCRATCH
00004        COMMON JDAY,K
00004        BEGN=4806117
00006        CONT=5138803
00010        PAUSE
00012        JDAY=0
00014        READ 2,KONTROL,ETAPE,SCRATCH
00025  2     FORMAT(A4,25X,I1,29X,I1)
00033        READ INPUT TAPE ETAPE,1,(SUM(I),I=1,10)
00055  1     FORMAT(10A8)
00060        PRINT 10,(SUM(I),I=1,10)
00101  10    FORMAT(1X,10A8)
00105  11    FORMAT(1H1)
00110        CALL SELECT(ETAPE,11)
00113        IF(KONTROL-BEGN)3,6,3
00120  3     READ 30,(RL(I),I=1,8)
00137  30    FORMAT(8X,8A4)
00142  31    READ TAPE ETAPE,RNM
00150        PRINT 32,(RNM(I),I=1,8)
00167  32    FORMAT(21X,8A4)
00173        CALL COMPARE(RNM,RL,8,LITE)
00200        GO TO(5,4),LITE
00205  4     CALL SELECT(ETAPE,11)
00210        CALL SELECT(ETAPE,11)
00213        GO TO 31
00214  5     CALL SELECT(ETAPE,12)
00217        CALL SELECT(ETAPE,11)
00222        PRINT 11
00225  6     READ TAPE ETAPE,RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00255        PRINT 60,(RNM(I),I=1,8),JBIG,DELT,KOUNT
00302  60    FORMAT(21X,8A4,10X,I3,I4,I7)
00311        DO 61 J=1,JBIG
00313        CHNN=CHNO(J)
00316  61    PRINT 62,(VNM(N,CHNN),N=1,3),CHNN
00352  62    FORMAT(1X,3A8,3X,I2)
00357        CALL SELECT(ETAPE,11)
00362  7     CONTINUE
00362  80    CALL CHECK
00363        IF(K)81,81,71
00367  71    CALL SELECT(ETAPE,12)
00372        CALL SELECT(ETAPE,11)
00375        CALL POSITION(DLT,DLNG,IT)
00401  81    CALL CHECK
00402        IF(K)82,82,72
00406  72    CALL SELECT(ETAPE,12)
00411        CALL SELECT(ETAPE,11)
00414        CALL DEPTH
00415  82    CALL CHECK
00416        IF(K)85,85,73
00422  73    CALL SELECT(ETAPE,12)
00425        CALL SELECT(ETAPE,11)
00430        CALL MAV20(DLT,DLNG,IT)
00434  85    PRINT 11
00437        READ 70,KONTROL
00444  70    FORMAT(A4)
```

```
00446          IF(KONTROL-CONT)8,6,8
00453  8       REWIND ETAPE
00455          STOP
00457          END
```

SUBPROGRAMS

SELECT COMPARE CHECK POSITION DEPTH MAV20

PROGRAM ALLOCATION

00475	BEGN	00476	CONT	00477	KONTROL	00500	I
00501	LITE	00502	J	00503	CHNN	00504	N
00505	SUM	00535	RL	00545	DLT	01675	DLNG
03025	IT						

COMMON ALLOCATION

00000	RNM	00010	CHNO	00031	VNM	00177	MEANV
00241	FACT	00303	JBIG	00304	KOUNT	00305	DELT
00306	ETAPE	00307	SCRATCH	00310	JDAY	00311	K

PROGRAM END

```
00004          SUBROUTINE COMPARE(X,Y,LBIG,LITE)
00004          DIMENSION X(1),Y(1)
00004          INTEGER X,Y
00004          M=0
00006          DO 9 L=1,LBIG
00010  9       M=X(L)-Y(L)+M
00032          IF(M)10,11,10
00036  10      LITE=2
00040          GO TO 9999
00041  11      LITE=1
00043  9999    RETURN
00045          END

PROGRAM ALLOCATION

 00056    COMPARE   00060    M          00061    L


PROGRAM END
```

```
00004          SUBROUTINE CHECK
00004          INTEGER RNM,CHNO,DELT
00004          INTEGER ETAPE,SCRATCH,CHNN
00004          DIMENSION RNM(8),CHNO(17),VNM(3,17),MEANV(17),FACT(17)
00004          DIMENSION VNN(3)
00004          REAL MEANV
00004          COMMON RNM,CHNO,VNM,MEANV,FACT,JBIG,KOUNT,DELT
00004          COMMON ETAPE,SCRATCH
00004          COMMON JDAY,K
00004          READ 10,(VNN(N),N=1,3)
00025    10    FORMAT(8X,3A8)
00030          DO 20 K=1,16
00032          CHNN=CHNO(K)
00035          DO 21 N=1,3
00037          IF(VNM(N,CHNN)-VNN(N))20,21,20
00056    21    CONTINUE
00063          K=CHNN
00065          GO TO 50
00066    20    CONTINUE
00073          PRINT 25
00076    25    FORMAT(54H VARIABLE NOT PRESENT.CONTROL RETURNED TO MAIN PROGRAM)
00116          K=0
00120    50    RETURN
00122          END
```

PROGRAM ALLOCATION

00131	CHECK	00133	N	00134	CHNN		
00135	VNN						

COMMON ALLOCATION

00000	RNM	00010	CHNO	00031	VNM	00177	MEANV
00241	FACT	00303	JBIG	00304	KOUNT	00305	DELT
00306	ETAPE	00307	SCRATCH	00310	JDAY	00311	K

PROGRAM END

APPENDIX 6

Time required for processing data for the geophysical files.

1. Computer Time

   i) Data Transfer. Approximately two hours to write one 2400 ft. reel of magnetic tape. This corresponds to roughly 25 days of data.

   ii) Correction of Raw Data Tape - One hour per raw data tape.

   iii) Edit and Write Final Data Tape. Approximately one hour per raw data tape. Depends largely on the amount of bathymetry data to be read from paper tape.

   Thus approximately 4 hours of computing time is required to process 25 days of data.

2. Non-computing Time

   For a major cruise the majority of time involved in producing the data file will be spent in preparing data to be fed into the computer. This work can be greatly reduced with the proper control on board ship. Scanning the Data Transfer printout for data errors and producing correction cards for the correction of the raw data tapes is comparatively trivial for an operator familiar with the data being recorded. By far the greatest proportion of time is involved in obtaining the best possible navigational fixes for the cruise. With the requirements of the data filing system specified much of this work can be completed at sea making the data available for general use within a few weeks of the completion of the cruise.

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