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NEW LONDON LABORATORY  
NAVAL UNDERWATER SYSTEMS CENTER  
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6 GRAPHIT - A PLOTTING ROUTINE FOR THE  
MONROE OPTICAL PRINTER.

10 by  
David M. Potter, George Botseas, and Clair J. Becker

9 NUSC - TM -  
NUSC/NL Technical Memorandum No. 2211-272-70

11 21 August 1970

INTRODUCTION

During the PARKA cruises of 1968 and 1969 propagation loss measurements were conducted in real-time using the UNIVAC 1230 computer system installed aboard USNS SANDS. The real-time analysis of the data demanded a quality control system which would enable the senior scientist to continually monitor the data as the experiment progressed. Procedure GRAPHIT was written to provide this capability. Under operator control, time series plots were displayed on the high speed Monroe optical printer. Any of the 200 available combinations of plots could be plotted, with each plot displaying the results of the latest 5 hours of data. Procedure GRAPHIT, its usage and theory of operation are described in this memorandum.

ADMINISTRATIVE INFORMATION

This memorandum was prepared under NUSC Project Title: Long-Range Acoustic Transmission Experiments for Surveillance Systems Development; R. Hasse and R. Martin, NUSC/NL Principal Investigators. The sponsoring activity was ONR, Code 102-OS, Dr. J. B. Hersey, Program Manager.

AVAILABLE GRAPHS

A total of two hundred different graphs are available to the requestor. They are as follows:

Propagation Loss	6 hydrophones	X	5 frequencies
Ambient Noise	6 hydrophones	X	5 frequencies
Signal-to-Noise Ratio	6 hydrophones	X	5 frequencies

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NUSC/NL Tech Memo  
2211-272-70

Propagation Loss Difference	6 hydrophones	X	5 frequencies
Angle of Arrival	4 hydrophone pairs	X	8 arrivals
Single Path Loss	6 hydrophones	X	8 arrivals

#### GRAPH FORMAT

Each graph contains the latest five hours of data plus whatever data has been taken during the present hour. Following the identification header, the data is graphed on the Monroe, one data point per line, six lines per inch. The data is scaled ten units (db or degrees) per inch. A grid and a reference line are also plotted. Appendix A contains a facsimile of a typical graph. (The dots do not produce such a blanketing effect on the Monroe printer).

Following the processing of each shot, the plot data was written on magnetic tape. At the end of each hourly sequence of shots, an end-of-file mark was written on the tape to provide a reference point.

#### OPERATOR USAGE

When a graph was desired, the computer operator entered the requests on the teletype.

When the computer honored the message, the message processor's executive routine (See NUSL Tech Memo 2211-100-70) called on routine GRAF, which would set bits, as indicated by the message, in the request cells for GRAPHIT. Following this, procedure GRAPHIT was called and outputted one graph. The graphs remaining on request were outputted at the discretion of the executive routine. See Appendix B for the message format and codes for the various graphs.

#### THEORY OF OPERATION

When GRAPHIT is called, it scans the request cells, searching for a non-zero word. If none is found, GRAPHIT exits. If a non-zero request cell is located, the routine transfers control to the appropriate labeling segment. Here the request cell is scanned for a set bit. The position of the set bit within the request cell supplies the program with the relative position of the data within the input buffer from magnetic tape as well as the hydrophone and frequency designations. The relative position of the data is converted to a core location by adding on the base address of the particular data block. This address is then stored in a specific location enabling the program to reference the correct data.

The program next prints the four-line identifying header. The first line gives the type of graph. The second line identifies the particular hydrophone-frequency or hydrophone-arrival combination. The third line gives the latest range value and the fourth the present date and time.

Next, a jump-table index is set, directing the program to the correct plotting segment after each data record is read.

The program back-reads the magnetic tape, counting records as it reads, until it encounters an end of file mark. Then five files are back-spaced. This positions the tape at the start of the latest five hours of data. The tape is now read forward, one record at a time. If a data record is read, the ASCII code for the plot symbol, either a D, representing a deep shot, or an S, representing a shallow shot, is put in the B5 register. The data value is rounded off to the nearest integer and is converted from dB or degrees to a printer column position by adding the proper conversion factor. The column position is placed in the B4 register. If it is a shallow shot, B4 is incremented by 20 so that the data is plotted 20 columns to the right of the deep shots. The 80 word output buffer is flooded with period codes. The grid symbols are placed every tenth column and a reference marker is placed in column 41.

If the data point falls outside the 80 word buffer, then the buffer is sent to the printer without the data point. Otherwise, the code for the data point is placed in the column position specified by B4 and the buffer is sent to the printer.

The read-print sequence continues until an end-of-file is detected. If it is not the sixth file mark, the read-print sequence continues. When the sixth file mark is detected, the backward record count is checked. If it is zero, the program exits. If it is not zero, another record is read, the data plotted and the backward record count is decreased by one. This continues until the count reaches zero. At this time the tape is back at its original position and the program exits.

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Appendix A

Sample Graph



**Appendix B**  
**Message Format**

	REFERENCE LINE									
	F.5	F.4	F.3	F.2	F.1	DEEP	SHM			
1 PROPLOSS	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	1 0 0	1 2 0			
2 NOISE	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	- 2 0	- 4 0			
3 S/N	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	1 0	- 1 0			
4 PROP DIF	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	6 5 4 3 2 1	0	- 2 0			
5 AOA	46 45 44 43 42 41	38 37 36 35 34 33	32 31 30 29 28 27 26 25 24 23 22 21 19 17 16 15 14 13 12 11			0	- 2 0			
6 AOA						0	- 2 0			
7 SIPLOSS	46 45 44 43 42 41	38 37 36 35 34 33	32 31 30 29 27 26 25 24 23 22 21 19 17 16 15 14 13 12 11			1 0 0	1 2 0			
10 SIPLOSS			18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1			1 0 0	1 2 0			

X →

FORMAT FOR GRAPH MESSAGE IS : GRAF<sub>1</sub>X<sub>2</sub>X<sub>3</sub>Y<sub>3</sub>X<sub>3</sub>Y<sub>3</sub>X<sub>3</sub>ETC.

LEGEND

SINGLE DIGIT NUMBERS ARE HYDROPHONE NUMBERS.

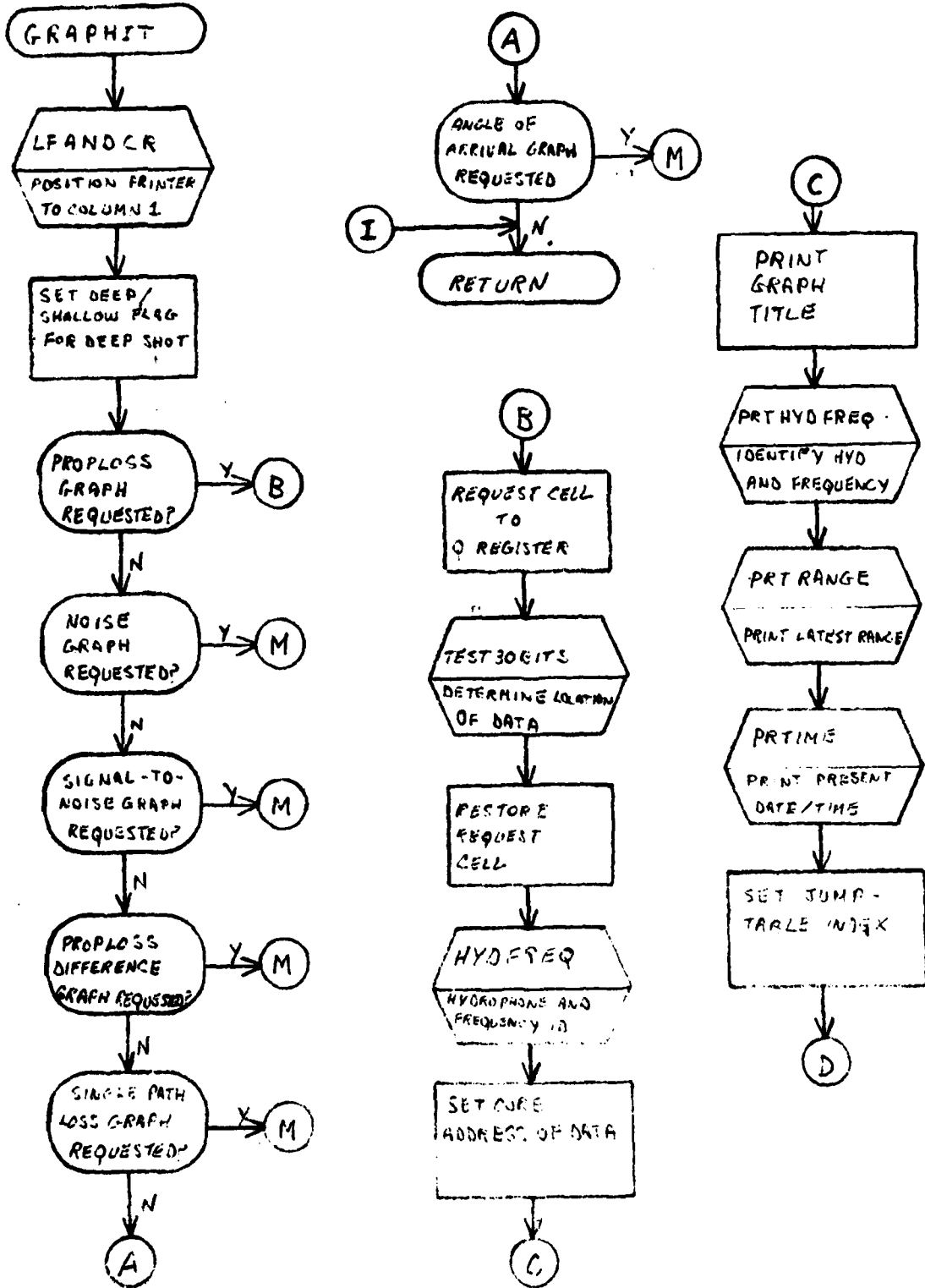
TWO DIGIT NUMBERS:

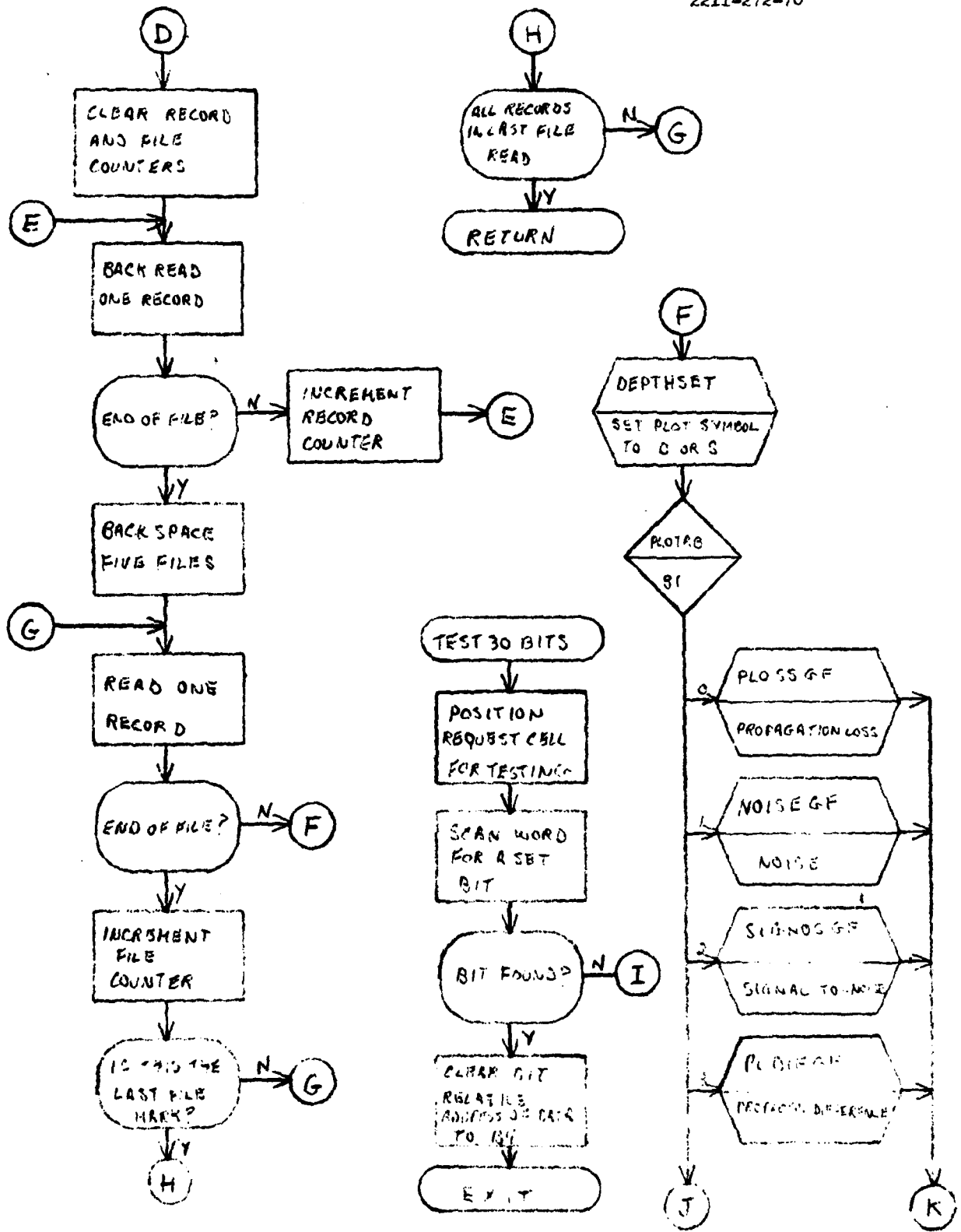
FIRST DIGIT IS HYDROPHONE PAIR NUMBER (AOA) OR HYDROPHONE NUMBER (SIPLOSS).

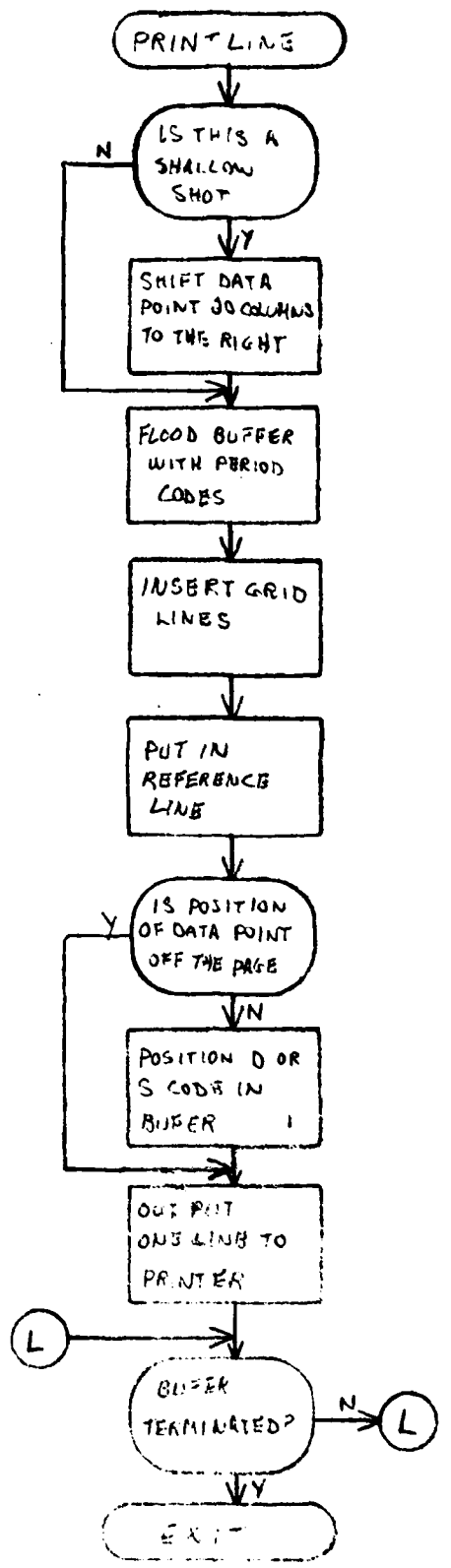
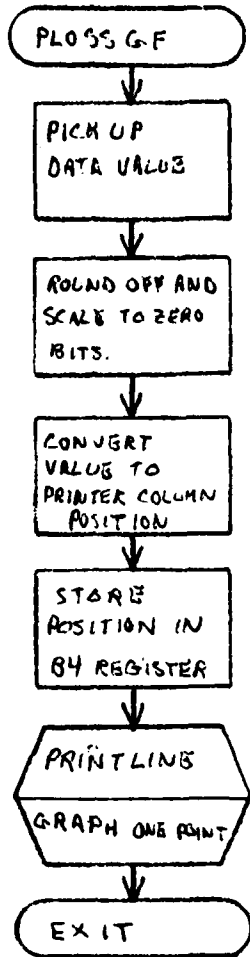
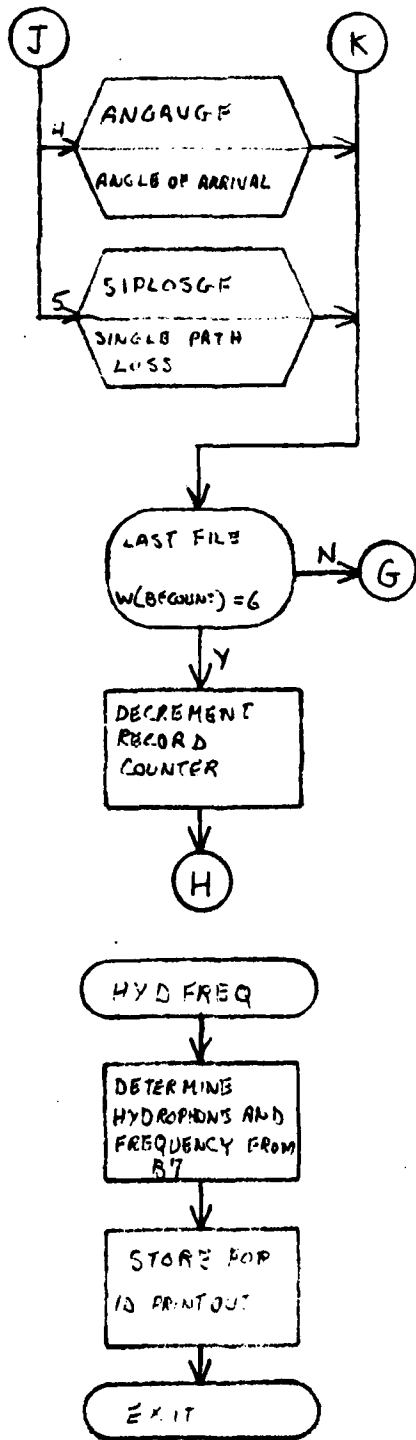
SECOND DIGIT IS ARRIVAL NUMBER.

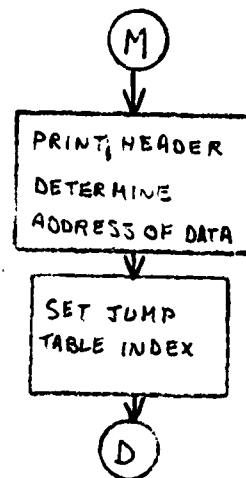
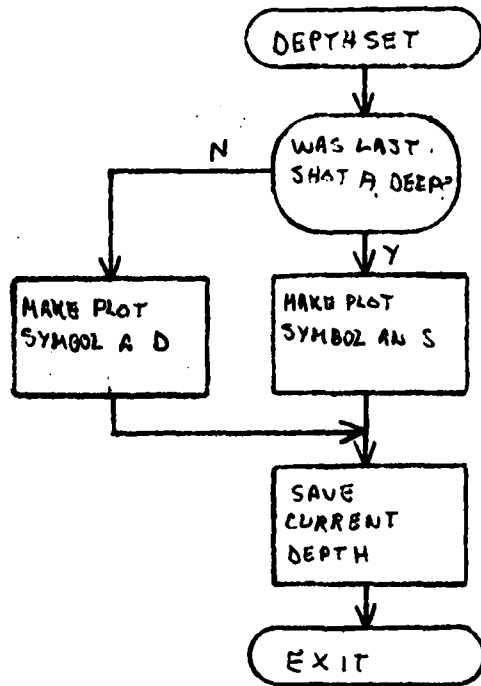
Appendix C

Flow Charts









Appendix D  
Program Listing

```
GRAF      ENTRY'SETS GRAPH REQUEST BITS
RJP*0PTMSG
CL*B1
GRAF11    ENT*A*W(MSGTAB+B1)
JP*WONGRAF*AZERO'NO MORE REQUESTS
SUB*8*90
RJP*MP3*AP05'OP ERR
ENT*A*290
SUB*A*W(MSGTAB+1+B1)
RJP*MP3*ANEG'OP ERR
ENT*B2*W(MSGTAB+B1)
ENT*A*W(PLOSS-1+B2)
ENT*G*1
LSH*G*W(MSGTAB+1+B1)
SEL*SU*X77777'SET REQUEST BIT
STR*A*W(PLOSS-1+B2)'STORE REQUEST
ENT*B1*2+B1'NEXT REQUEST
JP*GRAF11
WONGRAF   RJP*GRAPHIT'PUT OUT 1 GRAPH
EXIT
```

PROCEDURE\*GRAPHIT  
LFAIDCR  
CL\*W(LSTOEP TH)  
ENT\*\*W(PLUS\*)\*AZERO\*WHICH GRAPH  
JP\*LLOSS  
ENT\*\*W(NOISE\*)\*AZERO  
JP\*LNOISE  
ENT\*\*W(SIG2NO\*)\*AZERO  
JP\*LSIGNOS  
ENT\*\*W(DELTA PL\*)\*AZERO  
JP\*LPLDIF  
ENT\*\*W(AOAS)\*ANOT  
ENT\*\*W(AOAS+1)\*AZERO  
JP\*LABLEAOA  
ENT\*\*W(SIPLUS)\*ANOT  
ENT\*\*W(SIPLUS+1)\*AZERO  
JP\*LABLESPP  
RETURN\*NO REQUESTS

TEST30BITSENTRY

CL\*A  
LSH\*AG\*29D\*POSITION FOR TESTING  
RPT\*300  
LSH\*AG\*1\*ANEG\*TEST FOR A REQUEST  
RETURN\*NO REQUEST  
SEL\*CL\*4000000000\*CLEAR REQUEST  
LSH\*AG\*1+B7\*REPOSITION  
EXIT

HYDFREQ

ENTRY  
ENT\*\*B7\*SHIFT COUNT  
RSH\*AO\*300  
DIV\*0  
ENT\*B1\*A  
ENT\*\*L(PHONESHS+B1)  
ADD\*Q\*1  
STR\*\*W(HYDNO)  
STR\*\*W(FREQNO)  
EXIT

PRHYDFREQ

ENTRY  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*HYDROPHONE NO\*  
FORM-DEC\*PLAB\*410\*HYDNO  
FORM-TEXT\*PLAB\*510\*FREQUENCY  
FORM-DEC\*PLAB\*610\*FREQNO  
ENT\*\*A\*PLAB  
MONRUE  
EXIT

PRRANGE

ENTRY  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*RANGE  
FORM-DEC\*PLAB\*310\*RANGE  
ENT\*\*A\*PLAB  
MONRUE  
EXIT

PRTIME

ENTRY  
SIL-EX\*SHUTCHM:  
UP TIME  
RIL-EX\*SHUTCHM:  
CLEAR\*240\*PLAB

FORM-TEXT\*PLAB\*250\*MONTH  
FORM-DEC\*PLAB\*310\*1MONTH  
FORM-TEXT\*PLAB\*370\*DAY  
FORM-DEC\*PLAB\*410\*1DAY  
FORM-TEXT\*PLAB\*460\*HOUR  
FORM-DEC\*PLAB\*510\*1HOUR  
FORM-TEXT\*PLAB\*540\*MINUTE  
FORM-DEC\*PLAB\*610\*1MINUTE  
FORM-TEXT\*PLAB\*640\*SECOND  
FORM-DEC\*PLAB\*710\*1SEC  
ENT\*A\*PLAB

MONROE  
EXIT

LLOSS

ENT\*Q\*W(PLOSS)  
RJP\*TEST30BITS  
STR\*Q\*W(PLOSS)\*RESTORE REQUEST CELL  
RJP\*HYDFREQ  
ENT\*B7\*LOSSDATA+B7  
STR\*B7\*L(PLPICKUP)\*PICK UP ADDRESS  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*PROPAGATION LOSS VS RANGE  
ENT\*A\*PLAB  
MONROE  
RJP\*PRTHYDFREQ  
RJP\*PRTRANGE  
RJP\*PRTIME

CL\*L(PLOTIT)\*FOR JP TABLE  
JP\*GETDATA

LNOISE

ENT\*Q\*W(NOISE)\*REQUEST CELL  
RJP\*TEST30BITS\*TEST FOR REQUEST  
STR\*Q\*W(NOISE)\*RESTORE REQUEST CELL  
RJP\*HYDFREQ\*STORE HYD AND FREQ NO.  
ENT\*B7\*NOSDATA+B7  
STR\*B7\*L(NOSPICKUP)\*PICKUP ADDRESS  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*NOISE SPECTRUM LEVEL  
ENT\*A\*PLAB  
MONROE  
RJP\*PRTHYDFREQ  
RJP\*PRTRANGE  
RJP\*PRTIME

PUT\*1\*L(PLOTIT)\*FOR JP TABLE  
JP\*GETDATA

LSIGNS

ENT\*Q\*W(SIG2:10%)  
RJP\*TEST30BITS  
STR\*Q\*W(SIG2:10%)  
RJP\*HYDFREQ  
ENT\*B7\*SIGNSDATA+B7  
STR\*B7\*L(SNPICKUP)\*PICKUP ADDRESS  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*SIGNAL TO NOISE  
ENT\*A\*PLAB

MONROE

RJP\*PRTHYDFREQ  
RJP\*PRTRANGE  
RJP\*PRTIME  
PUT\*2\*L(PLOTIT)\*FOR JP TABLE  
JP\*GETDATA

LPLUJF ENT\*G\*\* (DELTAPL\$)  
RJP\*TEST30BITS  
STR\*G\*\* (DELTAPL\$)  
RJP\*HYOFRE\$  
ENT\*B7\*PLUIFDATA+B7  
STR\*B7\*L (PLDIFPKUP)  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*PROPLOSS DIFFERENCE  
ENT\*A\*PLAB  
MONROE  
RJP\*PRTHYUFRU  
RJP\*PRTRANGE  
RJP\*PRIME  
PUT\*3\*L (PLOTIT)  
JP\*GETDATA

LADLLAUA ENT\*G\*\* (AOAS)  
ENT\*A\*\* (AOAS+1)  
LSH\*AG\*270\*POSITION FOR TESTING  
RPT\*32D  
LSH\*A\*1\*ANEG\*TEST FOR A REQUEST  
RETURN\*NO REQUEST  
SEL\*CL\*4000000000\*CLEAR REQUEST  
LSH\*AG\*1+B7\*REPOSITION  
STR\*G\*\* (AOAS)  
STR\*A\*\* (AOAS+1)\*RESTORE REQUEST CELLS  
ENT\*A\*B7\*SHIFT COUNT  
RSH\*AG\*30D  
DIV\*8D  
ADD\*A\*1  
ADD\*G\*1  
STR\*A\*\* (ARIVLNO)  
STR\*G\*\* (PAIRNO)  
ENT\*B7\*AOADATA+B7  
STR\*B7\*L (AOAPICKUP)  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*ANGLE OF ARRIVAL  
ENT\*A\*PLAB  
MONROE  
CLEAR\*240\*PLAB  
FORM-TEXT\*PLAB\*250\*ARRIVAL NUMBER  
FORM-DEC\*PLAB\*410\*ARIVLNO  
FORM-TEXT\*PLAB\*460\*PAIR  
FORM-DEC\*PLAB\*510\*PAIRNO  
ENT\*A\*PLAB  
MONROE  
RJP\*PRTRANGE  
RJP\*PRIME  
PUT\*4\*L (PLOTIT)  
JP\*GETDATA

LADLESPL ENT\*G\*\* (SIPLU\$)  
ENT\*A\*\* (SIPLU+1)  
LSH\*AG\*110\*POSITION FOR TESTING  
RPT\*40D  
LSH\*AG\*1\*ANEG\*TEST REQUEST BITS  
RETURN\*NO REQUESTS  
SEL\*CL\*4000000000\*CLEAR REQUEST  
LSH\*AG\*1+B7\*REPOSITION  
STR\*G\*\* (SIPLU\$)

```
STR***(SIPLUS+1)
ENT**B7'SHIFT COUNT
RSH**A**300
UIV**00
ADD**A**1
STR**G**L(161)
ENT**U**U(PHONESHS+B1)
STR**A**W(ARIVLNO)
STR**U**W(HYDNO)
ENT**B7**SPPL+B7
STR**B7**L(PLPICKUP)
CLEAN**240**PLAB
FORM-TEXT**PLAB**250**SINGLE PATH LOSS
ENT**A**PLAB
MONROE
CLEAR**240**PLAB
FORM-TEXT**PLAB**250**ARRIVAL NUMBER
FORM-DEC**PLAU**410**ARIVLNO
FORM-TEXT**PLAB**460**HYD
FORM-DEC**PLAB**510**HYDNO
ENT**A**PLAB
MONROE
RJP**PRTRANGE
RJP**PRTIME
PUT**5**L(PLOTIT)
JP**GLTDATA
PLOTAB 0*PLOSSGF
1*NOISEGF
2*SIGNOSGF
3*PLUIFGF
4*ANGAVGF
5*SIPLUSGF
GETDATA CL***(BFCOUNT)
CL***(BRCOUNT)'INITIALIZE
GRAF2 ENT**B4**5'BACK READ
ENT**B6**4'UNIT 4
MAGTAPE
ENT**Q**20'MASK FOR EOF
ENT**LP**W(STATWRD)*AZERO'EOF/
JP*GRAF1'YES
RPL*Y+1***(BRCOUNT)'NO
JP*GRAF2'BACK ONE MORE
GRAF1 ENT**B5**4'BACKSPACE 5 FILES
CL***(LSTDEPTH)
GRAF3 ENT**B4**6
ENT**B6**4
MAGTAPE
BJP**B5**GRAF3
GRAF4 ENT**B4**1'READ 1 RECORD
ENT**B6**4'UNIT 4
INTAPE***(GRAFBCW)
MAGTAPE
ENT**Q**20'EOF MASK
ENT**LP**W(STATWRD)*ANOT
JP*PLOTIT'NOT EOF
RPL*Y+1***(BFCOUNT)
SUB**A**6'6 FILES END/
JP*GRAF4*ANOT'NOT 6TH FILE MARK
```

```

GRAF5 JSK*00*W(BRCOUNT)*BRCOUNT EQ 0/
      JP*GRAF4*NO KEEP ON
      RETURN*YES END IF
PLOFIT CL*H1
      RJP*DEPTHSET*PLOTS A D OR AN S
      RJP*L(PLOTAB+B1)
GRAF6 ENT*A*W(BFCOUNT)
      SUB*A*6*LAST FILE/
      JP*GRAF4*ANOT*NO
      KPL*Y-1*W(BRCOUNT)*YES
      JP*GRAF5
DEPTHSET ENTRY
      ENT*05*L(LSTDEPTH)
      ENT*A*B5
      SUB*A*27*AZERO*LAST ONE DEEP/
      JP*MAKEITU*NO
      ENT*B5*65'S
      ENT*A*A*SKIP
MAKEITU ENT*B5*27*CODE FOR D
      STR*05*L(LSTDEPTH)
      EXIT
PRINTLINE ENTRY
      ENT*0*65*CODE FOR S
      ENT*Y-0*L(LSTDEPTH)*ANOT*SHALLOW SHOT
      ENT*B4*200+B4*SHIFT UP 20DB
      ENT*0*22
      RPT*00*ADV
      STR*0*W(BF)
      ENT*B6*100
      ENT*0*41
      RPT*7*ADDB
      STR*0*W(BF+B6)*GRID
      PUT*72*W(BF+40D)
      ENT*A*B4
      JP*PRT2*ANEG*OFF SCALE
      SUB*A*80D
      JP*PRT2*APOS*OFF SCALE
      STR*05*L(BF+B4)*D OR S FOR DATA POINT
PRT2 OUT*MONROE*W(BUFLIM)
PRT1 JP*PRT1*MONO
      EXIT
PLUSGF ENTRY
      ENT*0*21+
PLPICKUP ENT*A*W(U)
      ADU*A*4
      RSH*A*3
      SUB*0*A
      STR*0*L(104)
      RJP*PRINTLINE
      EXIT
PLDIFGF ENTRY
PLDIFKUP ENT*A*W(U)*DATA
      ADU*A*4*APOS
      SUB*A*10
      RSH*A*3*ROUND OFF
      ADU*A*40U
      ENT*0*4+A
      RJP*PRINTLINE

```

```
EXIT  
AIGAVGF ENTRY  
AOPICKUP ENT*A*W(0)'DATA  
ADD*A*400  
ENT*B4*A  
RJP*PRINTLINE  
EXIT  
SIGNOSGF ENTRY  
SNPICKUP ENT*A*W(U)  
ADD*A*4*APOS  
SUB*A*10  
RSH*A*3  
ADD*A*300  
ENT*B4*A  
RJP*PRINTLINE  
EXIT  
NOISEGF ENTRY  
NOSPICKUP ENT*A*W(U)  
ADD*A*4*APOS  
SUB*A*10  
RSH*A*3  
ADD*A*600  
ENT*B4*A  
RJP*PRINTLINE  
EXIT  
END-PROC*GRAPHIT  
PLOSS 0  
NOISES 0  
SIG2NOS 0  
DELTAPLS 0  
A0AS 0  
U  
SIPLOS 0  
U
```

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By D. M. Potter, G. Botseas, and C. J. Becker		

<b>TECHNICAL MEMORANDUM</b> XXXXXX	<b>EVALUATION REPORT</b>
<b>CALIBRATION MEMORANDUM</b>	<b>SERVICE TEST REPORT</b>
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