AD-A067 397 NAVY UNDERWATER SOUND LAB NEW LONDON CONN F/G 20/1

CONSTANT LOSS CONTOURS FOR AMOS NEAR-SURFACE PROPAGATION.(U)

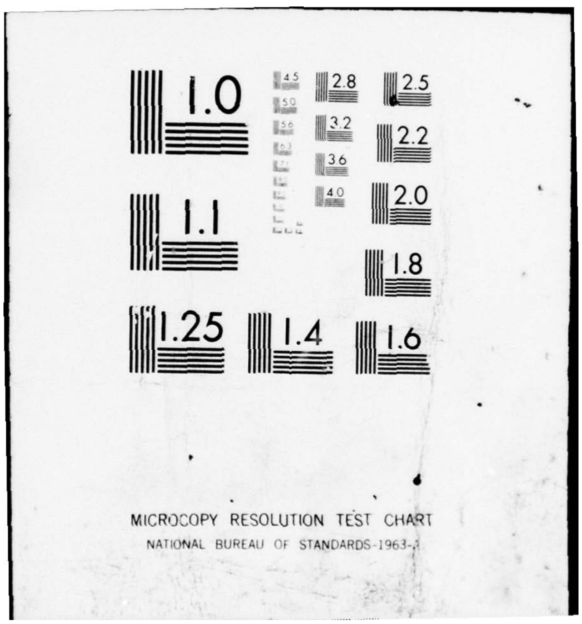
FEB 64 L T EINSTEIN, A G REIS

UNCLASSIFIED USL-TM-907-30-64 NL

| OF |

AD
A0 67397

END
DATE
FILMED
6 --79
DDC


1.0
4.5
5.0
5.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

BUSHIPS (Code 689B) 44

MOST Project -2

USL Technical Memorandum No. 907-30-64
USL Problem No. 1-610-01-00

LEVEL II

CONSTANT LOSS CONTOURS FOR AMOS NEAR-SURFACE PROPAGATION (USL PROGRAM NO. 0131)

S-F001 03 06-8230

28 February 1964

by
Lloyd T. Einstein
and
Arthur G. Reis, Jr.

U. S. NAVY UNDERWATER SOUND LABORATORY
FORT TRUMBULL, NEW LONDON, CONNECTICUT

12 25p. 9 Technical memo,

U. S. Navy Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

6 CONSTANT LOSS CONTOURS FOR AMOS NEAR-SURFACE PROPAGATION

by

10 Lloyd T. Einstein [redacted] Arthur G. Reis, Jr

USL Technical Memorandum No. 907-30-64

11 28 Feb[redacted]64

14 USL-TM-907-30-64

INTRODUCTION

A computational program has been prepared by the Digital Computing Branch to provide single frequency constant loss contours for the AMOS near-surface propagation model. This IBM 704 program, designated USL Program No. 0131, is in Fortran language and is described in Appendixes A and B.

THEORY

Study A of reference (a) contains a detailed description of the method by which Project AMOS near-surface transmission data were analyzed. The set of four equations which were developed have been utilized over the past decade in both the design of sonar equipments and the development of optimum tactical procedures. The purpose of Program No. 0131 is to provide an improved method for displaying this information, making use of the Laboratory's automatic X-Y plotter to eliminate the need for laborious hand graphing. Contours of this type have appeared in Study B of reference (a) and in reference (b). It is felt that the contents of reference (a) are widely enough known in the sonar field to preclude repetition here. The remainder of this memorandum, therefore, will deal with the specific details of the program design.

Examination of the equations of ref. (a) show that most of the parameters are functions of source, receiver, and layer depth. Therefore, the greatest saving in com-

254 200

puting time can be made by fixing the source and layer depths and searching along a constant receiver depth for specific values of propagation loss. This procedure is simplified by the fact that the loss, for these restrictions, is monotonic with range. The only complicating factor occurs at two zonal boundaries, at which a shift takes place from one describing equation to another. Discontinuities of as much as several db have been observed at these interchange points. To avoid possible problems, the bounds of any trial range region are made to converge until they are separated by a selectable range increment, ΔR. Thereafter, a linear interpolation for final range is made, regardless of the total loss variation in this interval. The program accepts values of ΔR between 0.1 and 1.0 kyds.

The limits of the computation are set by establishing a "window" in range and depth, which corresponds to receiver locations of interest for a fixed source depth. Since the AMOS equations assume equal loss along reverse paths, the nomenclature "source depth" and "receiver depth" are arbitrary, and the output curves can be interpreted as showing the effect of either own ship or target motion in depth. The range interval of the window is bounded by "R_{MIN}" and "R_{MAX}," where R_{MAX} must be no greater than 100 kyds, and the difference no less than 10 kyds. The depth interval is bounded by "Z_{MIN}" and "Z_{MAX}," which, along with the source, receiver, and layer depths, are limited to a maximum of 1500 feet. The depth cuts at which computations are made in the window are spaced by intervals of "ΔZ," which can be no more than 200 feet. In addition, the minimum value of ΔZ is restricted to 10 feet or 0.01 of the total window depth interval, whichever is larger. The set of constant loss contours are bounded by "N_{MIN}" and "N_{MAX}", with intermediate values spaced at intervals of ΔN. Twenty such contours may be computed and plotted in any set; however, only the first thirteen may be printed out, due to the space limitation of the printer. Neither N_{MIN} nor N_{MAX} may exceed a value of 200 db, while ΔN is restricted to the interval between 1 and 20 db. If a contour falls outside of the window, a "no value" indication is stored.

The remaining parameters which affect the computation are sea state, surface temperature, and frequency. Input temperatures are restricted to the interval between 30° and 100°F. The frequency must be between 0.5 and 50 kc, even though the AMOS data represented only a 2 to 25 kc variation.

It is felt that these extensions are somewhat questionable, as is the maximum depth limit, but they are provided as a convenience to the user, assuming that he is aware of the possible errors that may result.

One of the important features of the program design is an automatic checking of all the input parameters before the computation begins. This feature prevents the loss of computer and plotter time for non-acceptable cases, and presents the user with a complete listing of all faulty inputs. An example of such a printout is given in Figure (1).

The program performs all computations for a single case and stores the resulting range points in a loss-depth matrix prior to output. Thereafter, any combination of printing, writing tape, and punching cards can be selected by the settings of sense switches 1, 3, and 2, respectively.

COMPUTER PROGRAM DESCRIPTION

A flow chart for USL Program No. 0131 is Appendix A, and the IBM 704 Fortran Program is Appendix B.

The basic input data deck required by the program consists of seven cards which contain the input parameters. Consecutive cases can be run by adding indicator cards and either one or seven new parameter cards, depending upon the extent of the change desired. The card formats are given in Table 1.

TABLE 1

CARD FORMAT

Card No.	Cols.	Contents
1	1-4	"0131"
	5-80	(Unused)
2	1-42	Any 42 letter-number-symbol combination.
	43-80	(Unused)
3	1-15	R_{MIN} (kyds) [$\leq (R_{MAX}$ - 10 kyds)]
	16-30	R_{MAX} (kyds) [$\leq$100 kyds]
	31-45	ΔR (kyds) [0.1 to 1.0 kyds]
	46-80	(Unused)

TABLE 1 (Cont'd)

CARD FORMAT

Card No.	Cols.	Contents
4	1-15	Z_{MIN} (ft) [≤1500 ft]
	16-30	Z_{MAX} (ft) [<1500 ft]
	31-45	ΔZ (ft) [10 to 200 ft]
	46-80	(Unused)
5	1-15	N_{MIN} (db) [≤200 db]
	16-30	N_{MAX} (db) [<200 db]
	31-45	ΔN (db) [1 to 20 db]
	46-80	(Unused)
6	1-15	S, Sea State
	16-30	T, Temperature (°F.) [30° to 100°]
	31-80	(Unused)
7	1-15	f, frequency (kc) [0.5 to 50 kc]
	16-30	L, layer depth (ft) [≤1500 ft]
	31-45	Z_o, source depth (ft) [<1500 ft]
	46-57	Any combination of letters and symbols used to identify card output packages.
	58-80	(Unused)
8	1	(+) means that cards of type 1-7 will be read in for the next case; (-) means that only a card of type 7 follows.

NOTE:

All numerical input parameters are in F 15.7 format, with the exception of card No. 1.

The program uses Tape Unit No. 3 for primary data input, and Tape Unit No. 5 for output to the plotter. The functions controlled by the sense switch settings are listed at the beginning of the Fortran program in Appendix B for convenient reference. At least one of the first three sense switches must be down, or no output at all will result.

If a tape failure occurs, an option is provided, through sense switch 6, to read the input parameters directly from the on-line card reader. No automatic scaling for the plotter is included in the program. The running time is dependent on the size of ΔR and the total number of points computed, which is the product of the loss contours (≤ 20) and depth cuts (≤ 100). A typical time for 793 points (13 contours and 61 depths) and a ΔR of 0.2 kyds is 3 minutes for tape only, 5 minutes for printout and tape, and 60 minutes for printout and punch. The use of cards as either input or output mode should be discouraged, since the running time per case becomes obviously prohibitive.

Three sample computations have been performed, which correspond to the parameters of Figs. 1A, 3A, and 5A of Study B, ref. (a). The printout format for the first case is given in Fig. 2, and plots of the three cases are given in Figs. 3, 4, and 5, respectively.

SUMMARY

An IBM 704 Fortran program, USL Program No. 0131, has been written to provide single frequency constant loss contours for the AMOS near-surface propagation model. This program provides an improved capability to evaluate the general characteristics of an extensive sound field by automatically plotting the computed contours.

Lloyd T. Einstein

LLOYD T. EINSTEIN
Research Associate

Arthur G. Reis, Jr.

ARTHUR G. REIS, JR.
Mathematician

LIST OF REFERENCES

(a) H. W. Marsh, Jr. and M. Schulkin, "Report on the Status of Project AMOS," USL Research Report No. 255, of 21 March 1955 (CONF)

(b) T. P. Condron, P. M. Onyx and K. R. Dickson, "Contours of Propagation Loss vs. Range for Standard Conditions at 2, 5, and 8 kc," USL Tech. Memo. No. 1110-14-55, of 20 April 1955 (CONF)

```
                         TESTING DATA REJECTION
                        OUTPUT TO TAPE NO. 5
SOURCE TOO DEEP,ZO =      2225.0000000

LAYER TOO DEEP, L =    2500.0000000

FREQUENCY ERROR, F =      500.0000000

TEMPERATURE ERROR, T =      212.0000000

WINDOW DEPTH ERROR, ZMIN =       0.
                    ZMAX =    2000.0000000

DELTA Z TOO SMALL, DZ =       0.

LOSS DOMAIN ERROR,  NMIN =      0.          NMAX =    250.0000000

DELTA N IS TOO SMALL AND =      0.5000000

WINDOW TOO SMALL, RMIN =      0.0010000     RMAX =      0.2000000

DELTA R IS TOO LARGE AND =    80.0000000

CORRECT THE ABOVE LISTED INPUT DATA ERRORS
THE PROGRAM CANNOT BE CONTINUED FOR THIS DATA

HIT THE START KEY IF THE DATA FOR A SUBSEQUENT RUN IS READY
```

Fig. 1 - Printout for Automatic Checking of Input Data

SINGLE FREQUENCY AMOS-LOSS CONTOURS NO. 0131

SAMPLE PROBLEM
OUTPUT TO TAPE NO. 5

R(MIN) = 0.00 (KYD)	R(MAX) = 40.00 (KYD)	DELTA R = 0.20 (KYD)
Z(MIN) = 20.00 (FT)	Z(MAX) = 500.00 (FT)	DELTA Z = 20.00 (FT)
LOSS(MIN) = 60.00 (DB)	LOSS(MAX) = 100.00 (DB)	LOSS CHANGE = 5.00 (DB)
SEA STATE = 2.0	TEMPERATURE = 50.0 (DEG F)	
FREQUENCY = 2.0 (KC)	LAYER DEPTH = 100.0 (FT)	SOURCE DEPTH = 20.0 (FT)

TABLE OF CONTOUR RANGES IN KYDS.

Z (FT)	60.0DB	65.0DB	70.0DB	75.0DB	80.0DB	85.0DB	90.0DB	95.0DB	100.0DB	0. DB	0. DB	0. DB	0. DB
20.0	1.00	1.76	3.06	4.86	7.37	11.63	16.76	22.39	28.36				
40.0	0.99	1.75	2.94	4.59	6.82	10.84	15.87	21.42	27.34				
60.0	0.98	1.73	2.81	4.31	6.30	10.00	14.90	20.38	26.24				
80.0	0.97	1.67	2.65	4.02	5.81	9.08	13.85	19.22	25.01				
100.0	0.94	1.57	2.48	3.72	5.32	8.09	12.67	17.92	23.63				
120.0	0.94	1.59	2.57	3.79	5.32	7.15	11.37	16.47	22.07				
140.0	0.92	1.54	2.49	3.67	5.10	6.80	9.98	14.89	20.36				
160.0	0.89	1.47	2.33	3.46	4.81	6.39	8.49	13.15	18.46				
180.0	0.86	1.38	2.14	3.16	4.43	5.92	7.62	11.29	16.37				
200.0	0.82	1.29	1.95	2.80	3.91	5.32	6.96	9.32	14.12				
220.0	0.80	1.25	1.87	2.66	3.62	4.91	6.39	8.04	11.72				
240.0	0.81	1.27	1.90	2.72	3.71	4.84	6.10	7.46	9.24				
260.0	0.81	1.28	1.93	2.76	3.78	4.80	5.96	7.40	8.94				
280.0	0.82	1.29	1.95	2.81	3.85	4.79	6.06	7.50	9.04				
300.0	0.82	1.31	1.97	2.85	3.92	4.82	6.14	7.59	9.14				
320.0	0.83	1.32	1.99	2.89	3.98	4.89	6.22	7.68	9.23				
340.0	0.83	1.32	2.01	2.92	4.04	4.97	6.30	7.76	9.33				

Fig. 2 - Printout Format

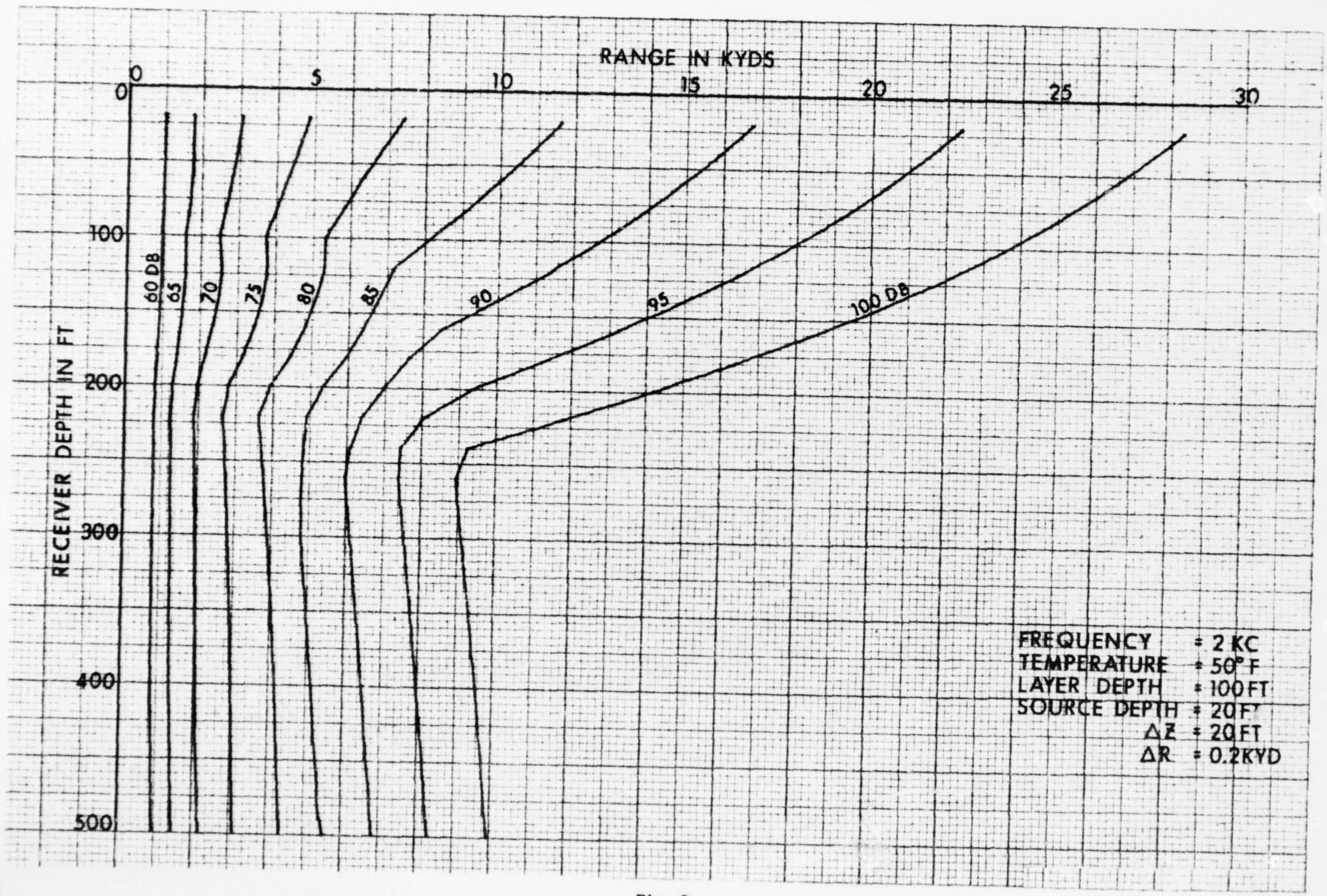

RANGE IN KYDS
0
5
10
15
20
25
30
RECEIVER DEPTH IN FT
0
100
200
300
400
500
60 DB
65
70
75
80
85
90
95
100 DB
FREQUENCY = 2 KC
TEMPERATURE = 50° F
LAYER DEPTH = 100 FT
SOURCE DEPTH = 20 FT
ΔZ = 20 FT
ΔR = 0.2 KYD

Fig. 3

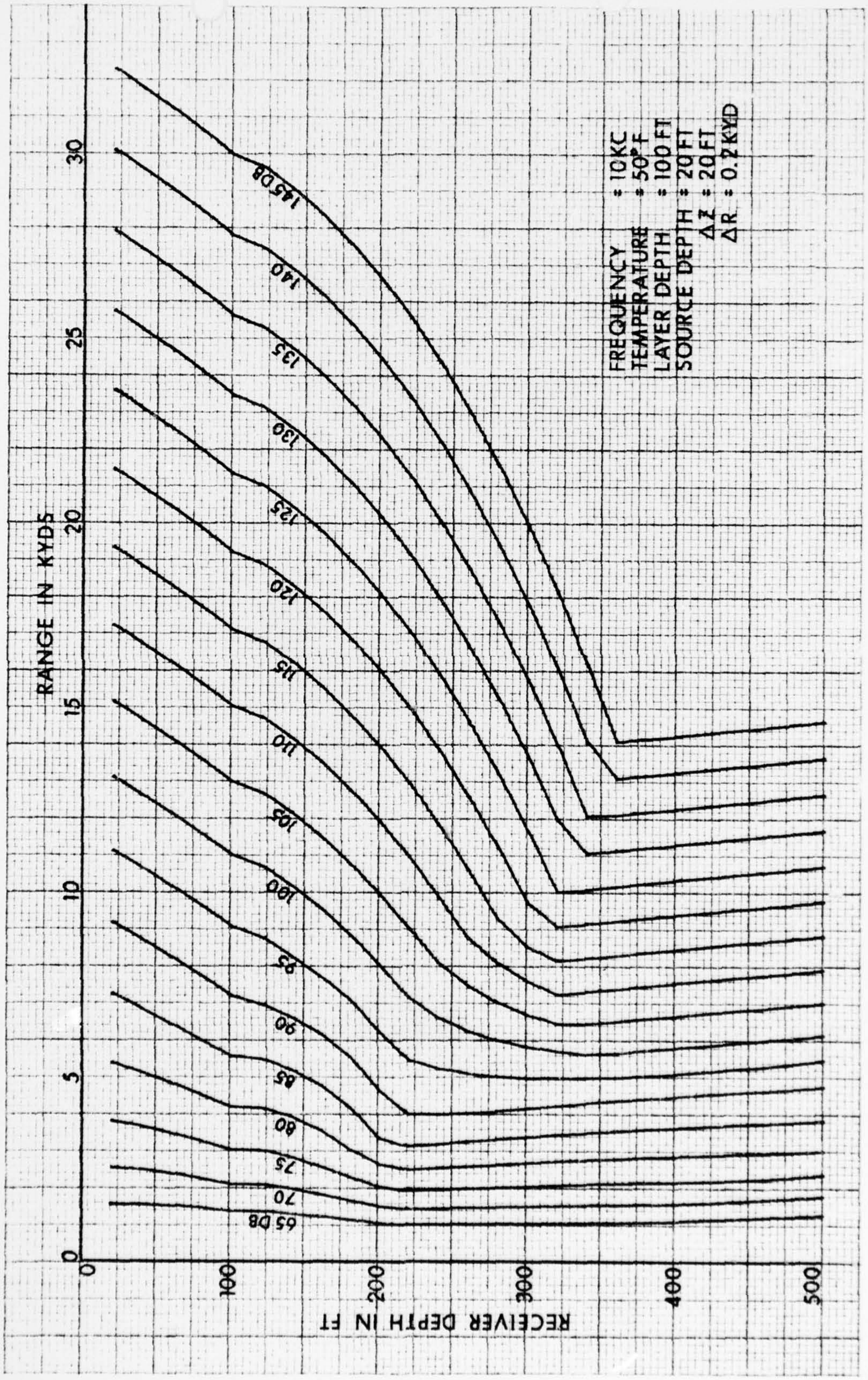

RANGE IN KYDS
0
5
10
15
20
25
30
RECEIVER DEPTH IN FT
0
100
200
300
400
500
65 DB
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145 DB
FREQUENCY : 10 KC
TEMPERATURE : 50° F
LAYER DEPTH : 100 FT
SOURCE DEPTH : 20 FT
ΔZ : 20 FT
ΔR : 0.2 KYD

Fig. 4

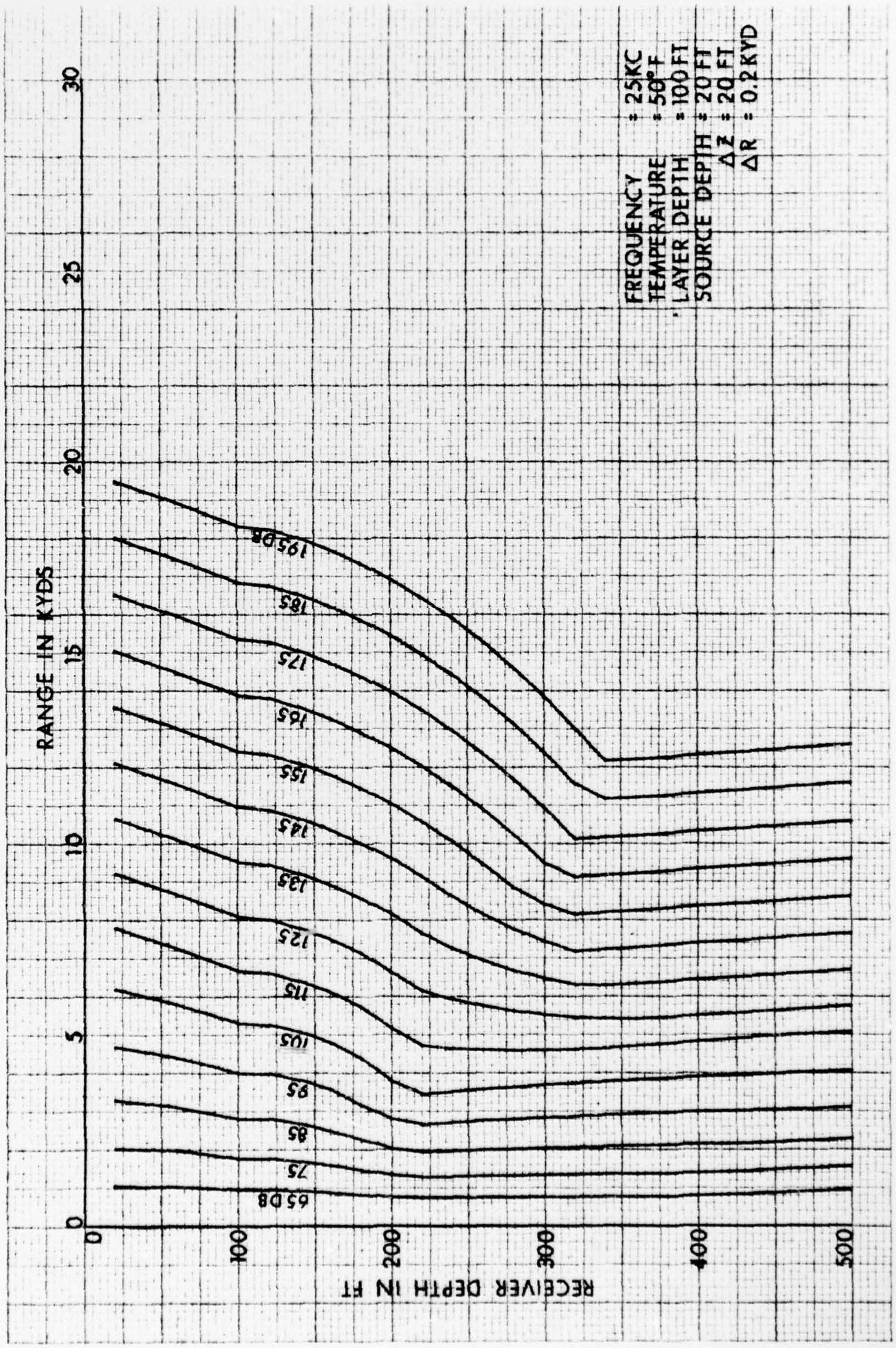
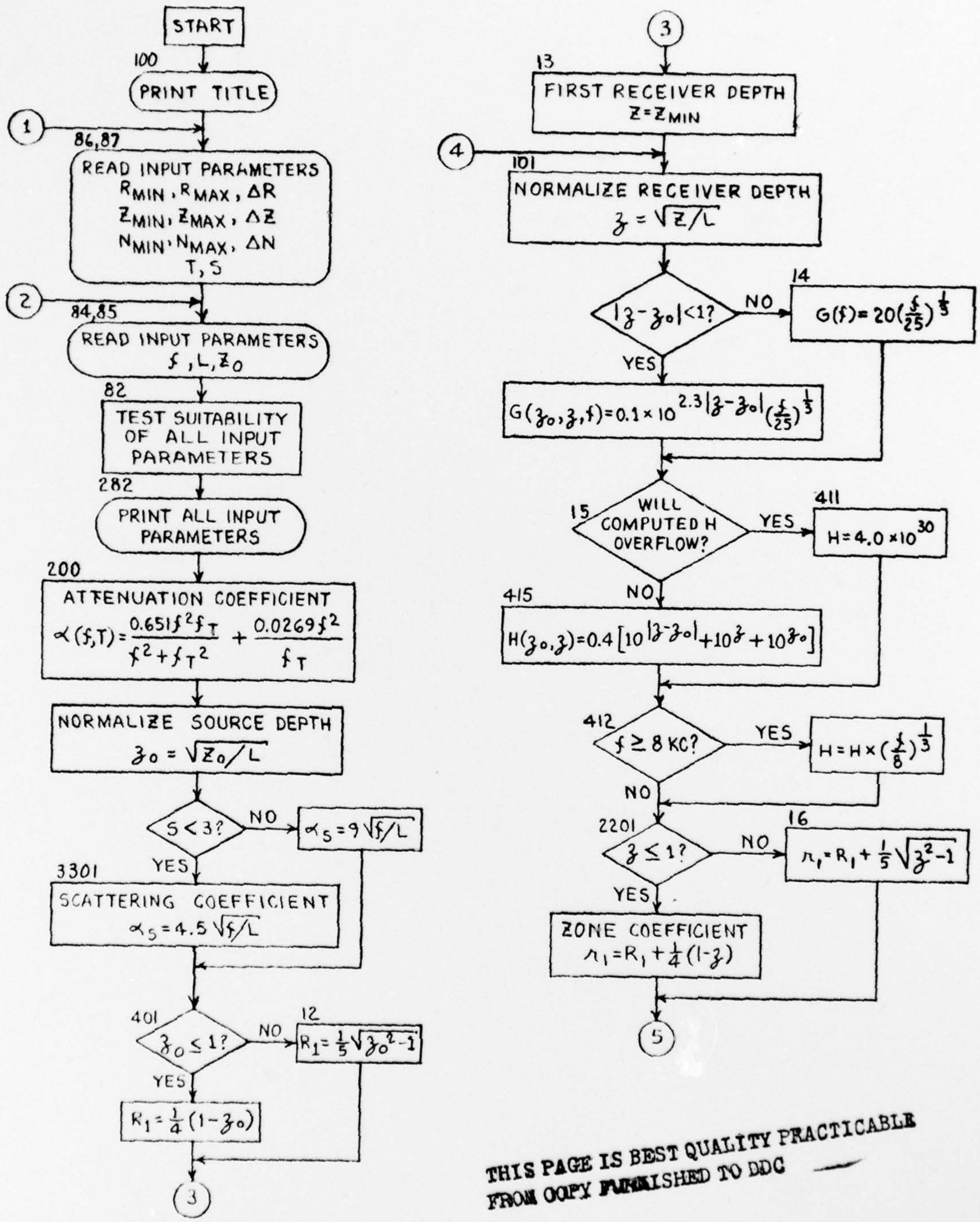

RANGE IN KYDS
0
5
10
15
20
25
30
RECEIVER DEPTH IN FT
0
100
200
300
400
500
65DB
75
85
95
105
115
125
135
145
155
165
175
185
195DB
FREQUENCY : 25KC
TEMPERATURE : 50°F
LAYER DEPTH : 100 FT
SOURCE DEPTH : 20 FT
ΔZ : 20 FT
ΔR : 0.2 KYD

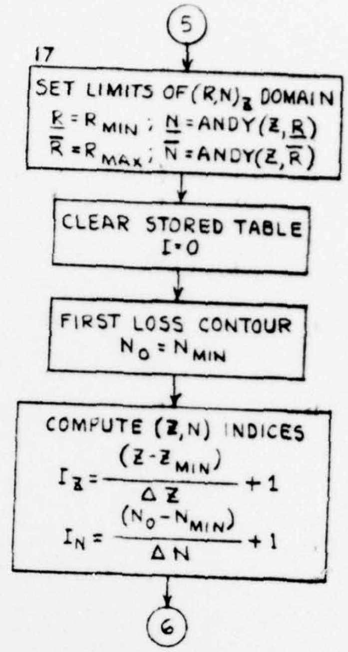
Fig. 5

APPENDIX A

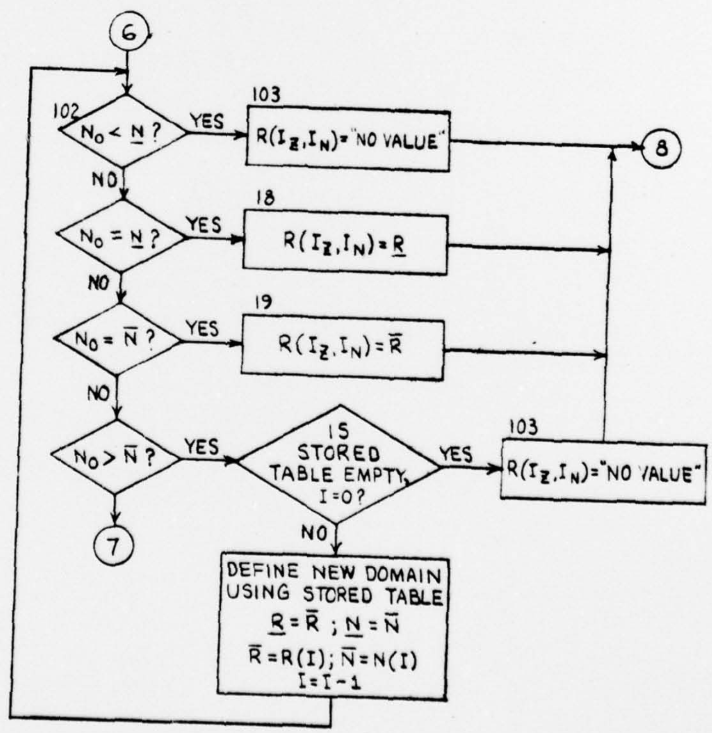
FLOW CHART FOR USL PROGRAM NO. 0131
"CONSTANT LOSS CONTOURS FOR AMOS PROPAGATION"



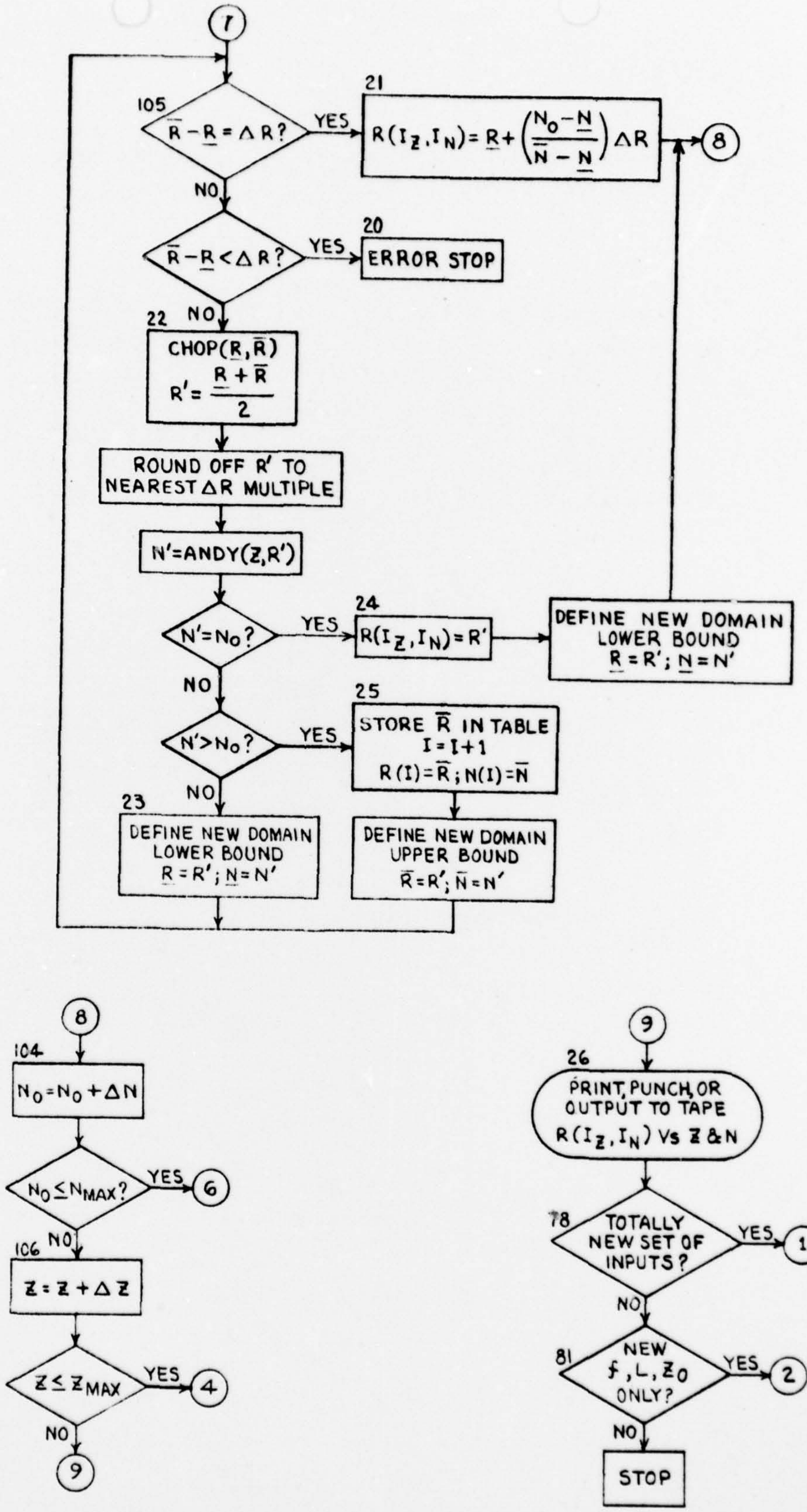
THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC



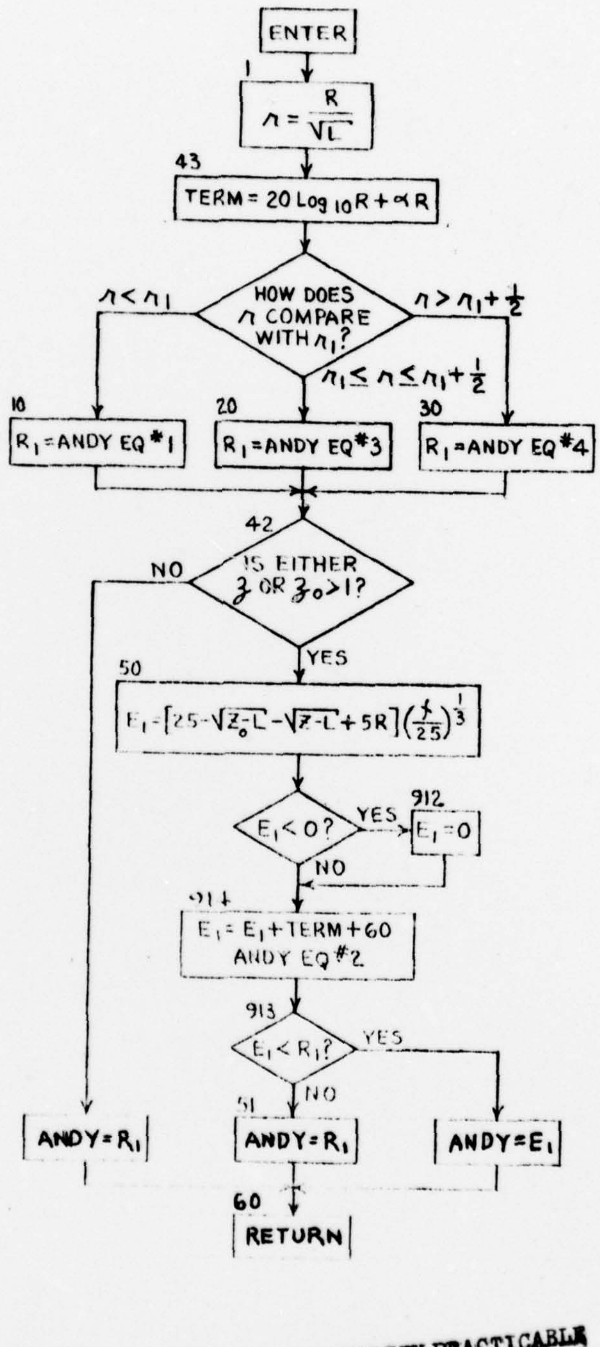
5
17
SET LIMITS OF (R,N)$_Z$ DOMAIN
$\underline{R} = R_{MIN}$; $\underline{N} = ANDY(Z, \underline{R})$
$\overline{R} = R_{MAX}$; $\overline{N} = ANDY(Z, \overline{R})$
CLEAR STORED TABLE
I=0
FIRST LOSS CONTOUR
$N_0 = N_{MIN}$
COMPUTE (Z,N) INDICES
$I_Z = \frac{(Z - Z_{MIN})}{\Delta Z} + 1$
$I_N = \frac{(N_0 - N_{MIN})}{\Delta N} + 1$
6



6
102
$N_0 < \underline{N}$?
YES
103
$R(I_Z, I_N)$ = "NO VALUE"
8
NO
$N_0 = \underline{N}$?
YES
18
$R(I_Z, I_N) = \underline{R}$
NO
$N_0 = \overline{N}$?
YES
19
$R(I_Z, I_N) = \overline{R}$
NO
$N_0 > \overline{N}$?
YES
IS STORED TABLE EMPTY, I=0?
YES
103
$R(I_Z, I_N)$ = "NO VALUE"
7
NO
DEFINE NEW DOMAIN USING STORED TABLE
$\underline{R} = \overline{R}$; $\underline{N} = \overline{N}$
$\overline{R} = R(I)$; $\overline{N} = N(I)$
I=I-1


7
105
$\bar{R} - \underline{R} = \Delta R$?
YES
21
$R(I_Z, I_N) = \underline{R} + \left(\frac{N_0 - \underline{N}}{\bar{N} - \underline{N}}\right) \Delta R$
8
NO
$\bar{R} - \underline{R} < \Delta R$?
YES
20
ERROR STOP
NO
22
CHOP($\underline{R}, \bar{R}$)
$R' = \frac{\underline{R} + \bar{R}}{2}$
ROUND OFF R' TO NEAREST ΔR MULTIPLE
N'=ANDY(Z,R')
$N' = N_0$?
YES
24
$R(I_Z, I_N) = R'$
DEFINE NEW DOMAIN LOWER BOUND
$\underline{R} = R'$; $\underline{N} = N'$
NO
$N' > N_0$?
YES
25
STORE $\bar{R}$ IN TABLE
I = I+1
$R(I) = \bar{R}$; $N(I) = \bar{N}$
DEFINE NEW DOMAIN UPPER BOUND
$\bar{R} = R'$; $\bar{N} = N'$
NO
23
DEFINE NEW DOMAIN LOWER BOUND
$\underline{R} = R'$; $\underline{N} = N'$
8
104
$N_0 = N_0 + \Delta N$
$N_0 \leq N_{MAX}$?
YES
6
NO
106
$Z = Z + \Delta Z$
$Z \leq Z_{MAX}$
YES
4
NO
9
9
26
PRINT, PUNCH, OR OUTPUT TO TAPE
$R(I_Z, I_N)$ Vs Z & N
78
TOTALLY NEW SET OF INPUTS?
YES
1
NO
81
NEW f, L, Z_0 ONLY?
YES
2
NO
STOP

SUBROUTINE "ANDY" FOR USL PROGRAM NO. 0131



APPENDIX B

FORTRAN PROGRAM NO. 0131

```
      SINGLE FREQUENCY AMOS-LOSS CONTOURS USING SUBROUTINE ANDY.     0131

      SENSE SWITCH SETTINGS

      SENSE SWITCH 1   (PRINTER)
      UP - CONTOURS NOT PRINTED     DOWN - TABLE OF CONSTANT AMOS-LOSS
                                           CONTOURS IS PRINTED

      SENSE SWITCH 2   (CARDS)
      UP - NO PUNCHING              DOWN - I.D. CARD AND CONTOURS ARE
                                           PUNCHED FOR DATA PLOTTER

      SENSE SWITCH 3   (OUTPUT TAPE UNIT 5)
      UP - NO OUTPUT                DOWN - CONTOURS ARE WRITTEN ON TAPE
                                           UNIT 5 FOR THE DATA PLOTTER

      SENSE SWITCH 4   (NOT USED)

      SENSE SWITCH 5   (NOT USED)

      SENSE SWITCH 6   (DATA INPUT)
      UP - INPUT FROM TAPE UNIT 3   DOWN - INPUT FROM CARD READER *

      * NOTE THAT THE CARD FORMAT IS IDENTICAL IN EITHER INPUT MODE


      DIMENSION RR(100),EEN(100),R(100,20),B(20)
      EQUIVALENCE (ZO,ZO)
      COMMON R1,AA,G,H,AS,EL,ZE,ZEO,F,IN,ZO
S ONE DEC 1.0
S TWO DEC 0.000002
S THR DEC 3.0
S ATE DEC   8.000
S TEN DEC 0.001
S IDD DEC 131
SVALN OCT 000000777777
SLIFT DEC 80000
SMONG DEC 10000
      T37 = 31.0
      IF(SENSE SWITCH 3)1000,100
 1000 REWIND 5
      END FILE 5
  100 PRINT 1
    1 FORMAT(1H1,30X46HSINGLE FREQUENCY AMOS-LOSS CONTOURS   NO. 0131)
   99 IF(SENSE SWITCH 6)98,97
   97 READ INPUT TAPE 3,96,ID
   96 FORMAT(I4)
```

```
S       CLA ID
S       SUB IDD
S       TZE*95
    294 PRINT 94
     94 FORMAT(11H WRONG DATA/1H1)
S       HTR*100
     95 READ INPUT TAPE 3,93,HEAD,ER,CARD,NO,MEN,CLA,TURE
     93 FORMAT(7A6)
S       TRA*92
     98 READ 96,ID
S       CLA ID
S       SUB IDD
S       TNZ*294
        READ 93,HEAD,ER,CARD,NO,MEN,CLA,TURE
     92 IF(SENSE SWITCH 3)201,202
    201 PRINT 206,HEAD,ER,CARD,NO,MEN,CLA,TURE
    206 FORMAT(1H0,32X7A6/1H ,32X20HOUTPUT TO TAPE NO. 5)
        GO TO 204
    202 IF(SENSE SWITCH 1)203,204
    203 PRINT 207,HEAD,ER,CARD,NO,MEN,CLA,TURE
    207 FORMAT(1H0,32X7A6)
    204 IF(SENSE SWITCH 2)205,89
    205 PUNCH 208,HEAD,ER,CARD,NO,MEN,CLA,TURE
    208 FORMAT(7A6)
      2 FORMAT(3F15.7)
     89 IF(SENSE SWITCH 6)86,87
     87 READ INPUT TAPE 3,2,RMIN,RMAX,DELR,ZMIN,ZMAX,DELZ,ENMIN,ENMAX,DELE
       1N,SS,T
     85 READ INPUT TAPE 3,83,F,EL,ZO,FL,AG
     83 FORMAT(3F15.7,2A6)
     82 SENSE LIGHT 0
        ZO = ABSF(ZO)
        IF(ZO - 1500.0)500,500,501
    501 PRINT 502, ZO
    502 FORMAT(23H0SOURCE TOO DEEP,ZO = ,F15.7/1H0)
        SENSE LIGHT 1
    500 EL = ABSF(EL)
        IF(EL - 1.0)503,504,504
    503 EL = 1.0
    504 IF(EL - 1500.0)505,505,506
    506 PRINT 507,EL
    507 FORMAT(21H0LAYER TOO DEEP, L = ,F15.7/1H0)
        SENSE LIGHT 1
    505 F = ABSF(F)
        IF((F - 50.0)*(F - 0.500))508,508,509
    509 PRINT 510,F
    510 FORMAT(22H0FREQUENCY ERROR, F = , F15.7/1H0)
        SENSE LIGHT 1
    508 SS = ABSF(SS)
        T = ABSF(T)
        IF((T- 30.0)*(T-100.0))511,511,512
    512 PRINT 513,T
    513 FORMAT(24H0TEMPERATURE ERROR, T = ,F15.7,/1H0)
        SENSE LIGHT 1
```

```
511 ZMIN = ABSF(ZMIN)
    ZMAX = ABSF(ZMAX)
    IF(ZMIN - 1500.0)514,514,515
514 IF(ZMAX - 1500.0)516,516,515
515 PRINT 517,ZMIN,ZMAX
517 FORMAT(28HOWINDOW DEPTH ERROR, ZMIN = ,F15.7/20X8H ZMAX = ,F15.7/1
   1HO)
    SENSE LIGHT 1
516 DELZ = ABSF(DELZ)
    IF(DELZ - MAX1F(10.0,((ZMAX-ZMIN)/99.0)))518,519,519
518 PRINT 520,DELZ
520 FORMAT(25HODELTA Z TOO SMALL, DZ = ,F15.7/1HO)
    SENSE LIGHT 1
519 IF(DELZ - 200.0)521,521,522
522 DELZ = 200.0
521 ENMIN = ABSF(ENMIN)
    ENMAX = ABSF(ENMAX)
    IF(ENMIN - 200.0)523,523,524
523 IF(ENMAX - 200.0)525,525,524
524 PRINT 526,ENMIN,ENMAX
526 FORMAT(27HOLOSS DOMAIN ERROR,  NMIN =,F15.7,5X6HNMAX =,F15.7/1HO)
    SENSE LIGHT 1
525 DELEN= ABSF(DELEN)
    IF(DELEN -0.99998)527,527,528
528 IF(DELEN - 20.0000)529,530,530
530 DELEN = 20.0
529 GO TO 531
527 PRINT 532,DELEN
532 FORMAT(27HODELTA N IS TOO SMALL AND =,F15.7/1HO)
    SENSE LIGHT 1
531 RMIN = ABSF(RMIN)
    RMAX = ABSF(RMAX)
    IF(RMIN - 0.001)533,534,534
533 RMIN = 0.001
534 IF(RMAX - 100.0)535,535,536
536 RMAX = 100.0
535 IF(ABSF(RMAX)-ABSF(RMIN)-10.0)537,538,538
537 PRINT 539,RMIN,RMAX
539 FORMAT(25HOWINDOW TOO SMALL, RMIN =,F15.7,5X6HRMAX =,F15.7/1HO)
    SENSE LIGHT 1
538 DELR = ABSF(DELR)
    IF(DELR - 0.1)540,541,541
540 DELR = 0.1
541 IF(DELR - 1.0)542,542,543
543 PRINT 544,DELR
544 FORMAT(27HODELTA R IS TOO LARGE AND =,F15.7/1HO)
    SENSE LIGHT 1
542 IF(SENSE LIGHT 1)545,282
545 PRINT 546
546 FORMAT(43HOCORRECT THE ABOVE LISTED INPUT DATA ERRORS/46HOTHE PROG
   1RAM CANNOT BE CONTINUED FOR THIS DATA/1HO/60HOHIT THE START KEY IF
   2 THE DATA FOR A SUBSEQUENT RUN IS READY/1H1)
```

```
S      HTR*81
   282 IF(SENSE SWITCH 1)210,209
   210 PRINT 3,RMIN,RMAX,DELR,ZMIN,ZMAX,DELZ,ENMIN,ENMAX,DELEN,SS,T,F,EL,
      1ZO
       GO TO 212
   209 IF(SENSE SWITCH 3)211,212
   211 PRINT 3,RMIN,RMAX,DELR,ZMIN,ZMAX,DELZ,ENMIN,ENMAX,DELEN,SS,T,F,EL,
      1ZO
   212 IF(SENSE SWITCH 2)213,200
   213 PUNCH 208,FL,AG
       GO TO 200
    86 READ 2,RMIN,RMAX,DELR,ZMIN,ZMAX,DELZ,ENMIN,ENMAX,DELEN,SS,T
    84 READ 83,F,EL,ZO,FL,AG
S      TRA*82
    81 IF(SENSE SWITCH 6)80,79
    80 READ 2,SIGN
S      TRA*78
    79 READ INPUT TAPE 3,2,SIGN
S   78 CLA SIGN
S      TPL*99
       IF(SENSE SWITCH 6)84,85
   200 IZZ = ((ZMAX-ZMIN)/DELZ)+1.2
       INN = ((ENMAX-ENMIN)/DELEN)+1.2
       X = (6.0 - (2100.0/(T + 459.6)))
       FT = 1.23*(10.0**X)
       AA = (((0.651)*(F**2)*FT) /((F**2+FT**2))) +((0.0269*(F**2))/FT)
       ZEO= SQRTF(ZO/EL)
S      LDQ SS
S      CLA THR
S      TLQ*3301
       AS = 9.0*SQRTF(F/EL)
       GO TO 3300
  3301 AS = 4.5*SQRTF(F/EL)
  3300 CONTINUE
   401 CONTINUE
S      CLA ZEO
S      FSB ONE
S      TPL*12
       R11= (1.0-ZEO)/4.0
S      TRA*13
    12 R11 = SQRTF((ZEO**2)- 1.0)/5.0
    13 Z  = ZMIN
   101 ZE = SQRTF(Z/EL)
S      CLA ZE
S      FSB ZEO
S      SSP
S      STO TEMP
S      FSB ONE
S      TZE*14
S      TPL*14
       G  = 0.10*(10.0**(2.3*TEMP))*((F/25.0)**0.3333333)
S      TRA*15
    14 G  = 20.0*((F/25.0)**0.3333333)
S   15 LDQ T37
```

```
S       CLA ZE
S       TLQ*411
S       CLA TEMP
S       TLQ*411
S       CLA ZEO
S       TLQ*411
   415 H   = 0.4*(10.0**TEMP+10.0**ZE+10.0**ZEO)
S       TRA*412
   411 H = 4.0E+30
S  412 CLA F
S       FSB ATE
S       TMI*2201
        H   = H*((F/ATE)**0.3333333)
S2201 CLA ZE
S       FSB ONE
S       TPL*16
        R1 = R11+ (1.0-ZE)/4.0
S       TRA*17
    16 R1 = R11+ SQRTF((ZE**2)-1.0)/5.0
    17 RLBAR = RMIN
        ENLBAR = ANDY(Z,RLBAR)
        RUBAR = RMAX
        ENUBAR = ANDY(Z,RUBAR)
        I   = 0
        ENO = ENMIN
S  102 CLA ENO
S       FSB ENLBAR
S       TZE*18
S       STO TEMP
S       SSP
S       FSB TWO
S       TMI*18
S       CLA TEMP
S       TMI*103
S       CLA ENO
S       FSB ENUBAR
S       TZE*19
S       STO TEMP
S       SSP
S       FSB TWO
S       TMI*19
S       CLA TEMP
S       TMI*105
S       CLA I
S       TZE*103
S       TMI*20
        RLBAR = RUBAR
        ENLBAR = ENUBAR
        RUBAR =RR(I)
        ENUBAR =EEN(I)
        I = I-1
S       TRA*102
    19 IZ = ((Z - ZMIN)/DELZ)+1.2
        IN = ((ENO - ENMIN)/DELEN)+1.2
        R(IZ,IN) = RUBAR
```

```
S        TRA*104
     18  IZ = ((Z - ZMIN)/DELZ)+1.2
         IN = ((ENO - ENMIN)/DELEN)+1.2
         R(IZ,IN) = RLBAR
S        TRA*104
    103  IZ = ((Z - ZMIN)/DELZ)+1.2
         IN = ((ENO - ENMIN)/DELEN)+1.2
B        R(IZ,IN) = VALN
S   104  CLA ENO
S        FAD DELEN
S        STO ENO
S        LDQ ENMAX
S        TLQ*106
S        TRA*102
    105  IZ = ((Z - ZMIN)/DELZ)+1.2
         IN = ((ENO - ENMIN)/DELEN)+1.2
S        CLA RUBAR
S        FSB RLBAR
S        FSB DELR
S        STO TEMP
S        SSP
S        FSB TWO
S        TMI*21
S        CLA TEMP
S        TPL*22
S        TMI*20
     21  R(IZ,IN)= RLBAR+((ENO-ENLBAR)/(ENUBAR-ENLBAR))*DELR
S        TRA*104
S    20  CLA RUBAR
S        FSB RLBAR
S        FSB DELR
S        LDQ I
S        HPR
S        TRA*181
     22  ARE = (RLBAR + RUBAR)/2.0
         K = (ARE/DELR + 0.5)
         CAY = K
         ARE = CAY*DELR
         EN = ANDY(Z,ARE)
S        CLA EN
S        FSB ENO
S        STO TEMP
S        SSP
S        FSB TWO
S        TMI*24
S        CLA TEMP
S        TMI*23
S        TPL*25
     23  RLBAR = ARE
         ENLBAR= EN
         GO TO 105
     24  IZ = ((Z - ZMIN)/DELZ)+1.2
         IN = ((ENO - ENMIN)/DELEN)+1.2
         R(IZ,IN) = ARE
         RLBAR = ARE
         ENLBAR = EN
         GO TO 104
```

```
   25 I = I + 1
      RR(I) = RUBAR
      EEN(I)= ENUBAR
      RUBAR = ARE
      ENUBAR= EN
      GO TO 105
S 106 CLA Z
S     FAD DELZ
S     STO Z
S     LDQ ZMAX
S     TLQ*26
S     TRA*101
C     THIS IS LIKE A SUBROUTINE
   26 IF(SENSE SWITCH 1)300,301
  301 IF(SENSE SWITCH 3)302,303
  303 IF(SENSE SWITCH 2)302,181
  181 DO 182 II = 1,20
S     STZ B(II)
      DO 182 J=1,100
S     STZ R(J,II)
  182 CONTINUE
S     TRA*81
  300 B(1)= ENMIN
      DO 304 II = 2,INN
  304 B(II) = B(II-1) + DELEN
      PRINT 306
      PRINT 305,B(1),B(2),B(3),B(4),B(5),B(6),B(7),B(8),B(9),B(10),B(11)
     1,B(12),B(13)
  306 FORMAT(1H0,32X32HTABLE OF CONTOUR RANGES IN KYDS.)
  305 FORMAT(1H0,6HZ (FT),F6.1,2HDB,F6.1,2HDB,F6.1,2HDB,F6.1,2HDB,F6.1,2
     1HDB,F6.1,2HDB,F6.1,2HDB,F6.1,2HDB,F6.1,2HDB,F6.1,2HDB,F6.1,2HDB,F6
     2.1,2HDB,F6.1,2HDB)
      Z = ZMIN
S     TRA*307
  308 Z = Z + DELZ
  307 IZ = ((Z - ZMIN)/DELZ)+1.2
      IF(INN - 13)3390,3390,3391
 3391 IPN = 13
      GO TO 3392
 3390 IPN = INN
 3392 PRINT 309,Z,(R(IZ,II),II = 1,IPN)
  309 FORMAT(1H0,F6.1,13(F8.2))
S     LDQ Z
S     CLA ZMAX
S     TLQ*308
      PRINT 1002
 1002 FORMAT(1H1)
S     TRA*301
  302 EN = ENMIN
S     TRA*3555
   28 EN = EN + DELEN
 3555 IF(SENSE SWITCH 1) 31,35
   35 PRINT 135,EN
  135 FORMAT(1H0,3HN =,F6.1,3H DB)
   31 Z = ZMIN
```

```
S       TRA*32
     33 Z = Z + DELZ
     32 IZ = ((Z - ZMIN)/DELZ)+1.2
        IN = ((EN-ENMIN)/DELEN)+1.2
S       CAL VALN
S       COM
S       ANA R(IZ,IN)
S       TZE*344
     36 IF(SENSE SWITCH 2)37,38
     37 IP1 = Z + 0.5
        IP2 = 100.0*R(IZ,IN)+0.5
        IP1 = IP1 + MONG
        IP2 = IP2 + MONG
        PUNCH 901,IP1,IP2,EN
    901 FORMAT(6XI6,6XI6,32XF15.7   )
     38 IF(SENSE SWITCH 3)39,40
     39 IMX = Z + 0.5
        IMX = IMX + MONG
        IMY = 100.0*R(IZ,IN) + 0.5
        IMY = IMY + MONG
        WRITE OUTPUT TAPE 5,1004,IMX,IMY
   1004 FORMAT(2I6)
        GO TO 40
    344 IF(SENSE SWITCH 1)40,34
     34 PRINT 11,Z
S    40 CLA ZMAX
S       LDQ Z
S       TLQ*33
        IF(SENSE SWITCH 3)1003,1006
   1003 WRITE OUTPUT TAPE 5,1004,LIFT,LIFT
   1006 IF(SENSE SWITCH 2)1005,1007
   1005 PUNCH 901,LIFT,LIFT
S  1007 CLA ENMAX
S       LDQ EN
S       TLQ*28
        IF(SENSE SWITCH 3)1881,181
   1881 END FILE 5
S       TRA*181
    902 FORMAT(2F6.3)
     10 FORMAT(1H+,22XF15.7,5XF15.7,/)
     11 FORMAT(1H ,22XF15.7,9X8HNO VALUE,/)
      3 FORMAT(9HOR(MIN) =,F7.2,6H (KYD),15X8HR(MAX) =,F7.2,6H (KYD),14X9H
       1DELTA R =,F7.2,6H (KYD)/9HOZ(MIN) =,F8.2,5H (FT),15X8HZ(MAX) =,F8.
       22,5H (FT),14X9HDELTA Z =,F8.2,5H (FT)/12HOLOSS(MIN) =,F7.2,5H (DB)
       3,13X11HLOSS(MAX) =,F7.2,5H (DB),12X13HLOSS CHANGE =,F7.2,5H (DB)/1
       42HOSEA STATE =,F5.1,20X13HTEMPERATURE =,F5.1,8H (DEG F)/12HOFREQUE
       5NCY =,F5.1,5H (KC),15X13HLAYER DEPTH =,F7.1,5H (FT),10X14HSOURCE D
       6EPTH =,F7.1,5H (FT))
      9 FORMAT(1HO,2XF15.7)
        END(0,1,1,1,1)
```

```
      FUNCTION SUBPROGRAM ANDY                                        0131
      FUNCTION ANDY(Z,R)
      EQUIVALENCE (ZO,ZO)
      COMMON ARE1,AA,G,H,AS,EL,ZE,ZEO,F,IN,ZO
SHALF DEC    0.5000000
S ONE DEC    1.0000000
S CON DEC    0.43429448
S ATE DEC    8.0000000
S SIX DEC 60.0
      ZO = ZO
    1 ARE = R /SQRTF(EL)
   43 TERM = 20.0*CON*LOGF(R) + AA*R
S     CLA ARE
S     FSB ARE1
S     TMI*10
S     FSB HALF
S     TZE*20
S     TMI*20
S     TRA*30
   10 R1 = TERM + (ARE/ARE1)*G + 60.0
S     TRA*42
   20 R1 = TERM +(2.0*(ARE - ARE1))*H + (1.0-(2.0*(ARE - ARE1)))*G +60.0
S     TRA*42
   30 R1 =((TERM - AA*R)/2.0) + (AA+AS)*R + H -AS*((ARE1+HALF)*(EL**.50)
     1) + 10.0*CON*LOGF((ARE1+HALF)*(EL**.50)) + 60.0
S  42 CLA ONE
S     FSB ZE
S     TMI*50
S     STO E1
S     CLA ONE
S     FSB ZEO
S     LRS 35
S     FMP E1
S     TMI*50
      ANDY = R1
      GO TO 60
   50 E1 = (25.0 -((ABSF(Z-EL))**HALF) - ((ABSF(ZO-EL))**HALF) + 5.0*R)*
     1((F/25.0)**0.3333333)
S     CLA E1
S     TMI*912
S 914 FAD TERM
S     FAD SIX
S     STO E1
      GO TO 913
S 912 STZ E1
S     CLA E1
S     TRA*914
S 913 CLA E1
S     LDQ R1
S     TLQ*51
S     STO ANDY
S     TRA*60
S  51 STQ ANDY
   60 RETURN
      END(0,1,1,1,1)
```

DISTRIBUTION LIST

External

BuShips (Code 689B)
(Code 689E)
NEL (M. A. Pedersen)

Internal

USL Code	100	B. Deligeorges
	101	E. S. Eby
	900	G. S. Egeland
	900A	W. C. Hay
	900B	W. C. Nordstrom
	900C	P. M. Onyx
	902	A. G. Reis, Jr.
	904.2 (5)	
	904.3	
	905	
	905.1	
	905.2	
	907	
	907S	
	907.3	
	907.5	
	908	
	909	
	910	
	913	
	914	
	920	
	921	
	921.4	
	921.5	
	921.6	
	922	
	923	
	923.1	
	923.3	
	930	
	931	
	931.1	
	932	
	952	
	954	
	960	