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CONGRATS TEMPERATURE AND SALINITY TO SOUND SPEED CONVERSION.

by

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INTRODUCTION

CONGRATS (CONtinuous Gradient RAy Tracing System) is an integrated collection of ray tracing programs designed to model acoustic propagation and reverberation, as described in references (a) and (b). Although sound speed data is often obtained from temperature and salinity readings at various depths, the fundamental CONGRATS programs, S0990 and S0991, formerly required a table of velocity versus depth as an input. Hence, it was sometimes necessary to convert the empirical data into a velocity-depth profile before using the CONGRATS series. CONGRATS has now been revised to convert a temperature and salinity profile to a velocity profile automatically. Velocity data, in the format described previously in reference (a), is still accepted by the programs. It is hoped, however, that the use of the new option will remove the burden of some preliminary hand computations from the user. This memorandum will contain a discussion of the metnod used in the conversion of temperature to velocity, a detailed description of the data necessary to implement the conversion, a sample run along with its output, and a listing of the revised Subroutine INPUT and the new Subroutine BT.

METHOD

Although Wilson's equation is most widely used in the calculation of sound speed in water, a simplified formula was programmed for the CONGRATS series. According to C. C. Leroy, this formula fits Wilson's data with a better accuracy than does Wilson's equation (over a domain restricted to areas of operational interest) and approaches Greenspan

and Tschiegg's results for very low salinity water (see reference (c)). The formula is presented in Table 1.

The basic formula, $V = V_o + V_a$, is sufficiently accurate (see reference (c)) under the following conditions: depth less than 7,000 meters, temperature less than 25° Centigrade, and salinity between 30 and 40 parts per thousand. The remaining three terms are added for increased accuracy if the above conditions are not met. If the temperature is greater than or equal to 25° centigrade, the correction term V_b is added; if the depth is greater than 7,000 meters, V_c is added; and if the salinity is less than 30 parts per thousand, V_d is added.

DATA DESCRIPTION

The input deck of CONGRATS Programs S0990 and S0991, as described in reference (a), consists of sets, each of which is an ordered collection of standard, eighty-column, punched cards. The conversion of temperature and salinity data to a velocity profile is implemented by substituting a temperature and salinity profile set for the velocity profile set. The rest of the input deck is unaffected by this change. The first card of the temperature and salinity profile set is divided into six fields of ten columns each, following the format convention set in reference (a). The first field contains the word "THERMAL," starting in column 1, and the second contains the word "PROFILE," starting in column 11. These two fields identify the temperature and salinity profile set. The third field contains either the word "CONTINUOUS," in which case the resultant velocity profile is fitted with continuous gradients, or the word "CONSTANT," in which case the constant gradient curve fitting technique is used. In either case, the word must begin in column 21. The last three fields of the THERMAL PROFILE card are numeric fields, each of which is read into the computer using an F10.5 format. The first numeric field contains the number of points in the profile and the second numeric field contains the latitude in degrees. The third numeric field may contain the salinity in parts per thousand, if the salinity is constant throughout the profile. If salinity varies with depth, this field may be left blank.

The second card of the temperature and salinity profile set is the units card which uses three fields of ten columns each, starting in columns 1, 11 and 21 respectively. The first field contains the units of depth, the second contains the units of temperature and the third indicates the units in which the resultant velocities are to be printed and/or plotted. Table 2 of reference (a), together with the following additions, is a complete list of acceptable input units, their CONGRATS abbreviations, their conversion factors and the resulting program units.

Input Units	Abbreviation	Conversion Factor	Result
Centigrade	C	1.00000000	C
Fahrenheit	Fahr	0.55555555	C

Note: 32 must be subtracted from the number of degrees Fahrenheit before multiplication by the conversion factor.

The cards containing the temperature profile, arranged in order of increasing depth, follow the units card. These cards use three numeric fields, starting in columns 1, 11 and 21, of ten columns each: the first field contains the depth, the second contains the temperature, and the third contains the salinity. If the salinity is constant as a function of depth and the salinity field has been filled on the first card of the set, the third field of the profile cards may be left blank.

The possible choices for indicating the salinity are charted in Table 2. If the salinity field on each card of the temperature profile and the constant salinity field on the first card of the set are both left blank, then the salinity is considered to be zero parts per thousand throughout the profile. If the salinity field on each profile card is left blank but the constant salinity field on the first card of the set contains a positive number, then the salinity is considered constant and its value is the number indicated on the first card. In both cases the resultant constant salinity value is printed at each depth of the temperature and salinity profile in the computer printout. If a positive value is shown in the third field of one or more profile cards, the constant salinity field of the first card is ignored and the resultant salinity profile consists entirely of the salinity values from the profile cards. It should be noted that a negative salinity will cause the program to terminate with an error stop.

The cards presented in Fig. 1 are an example of a temperature and salinity profile set. The first card indicates that the resultant velocity profile is to be fitted with continuous gradients, that there are 19 points in the profile, that the latitude is 39 degrees, and that the salinity, which is constant, is 38.2 parts per thousand. The second card indicates that depths are in feet, temperatures are in degrees Fahrenheit, and that the resultant velocities are to be printed in feet per second. The remaining cards contain the depths and temperatures of the profile. Salinity values are absent from these cards because the salinity is constant and indicated on the first card of the set.

An example of a temperature and salinity profile in which salinity varies with depth is presented in Fig. 2. The use of the continuous

gradient curve fitting technique is requested; there are 10 points in the profile, and the latitude is 40°. The depth units are feet, the temperature units are degrees Fahrenheit, and the velocity units are feet per second. Since salinity varies with depth, the profile cards indicate temperature and salinity for each depth and the salinity field on the first card of the set is left blank.

If a plot of temperature versus depth and/or salinity versus depth is desired, a THERMAL AXES card must be included in the input deck. This card contains the words "THERMAL" and "AXES" starting in columns 1 and 11, respectively. The third field contains the units in which the axes are to be plotted. Inches and centimeters are the available units. The fourth field, which is numeric, contains the length of the depth axis, which is plotted vertically. The numbers in the fifth and sixth fields are the lengths of the horizontal temperature and salinity axes, respectively. A zero temperature axis length or salinity axis length will suppress the temperature versus depth or salinity versus depth plot, respectively. Both plots will be suppressed if the depth axis length is zero. Figure 3(a) presents a THERMAL AXES card which would cause both a temperature and salinity profile to be plotted. The depth axis would be 10 inches long in both plots; the temperature axis, 8 inches long; and the salinity axis, 5 inches long. The card shown in Fig. 3(b) would cause only one plot to be drawn. The temperature versus depth plot would have a depth axis of 10 inches and a temperature axis of 6 inches, and the value of the salinity at the surface would be printed at the left of the plot. If the user desires other information plotted by the program, the appropriate AXES cards (as described in reference (a)) must be added for each type of plot, e.g., for a velocity profile plot to be drawn, a VELOCITY AXES card must be added to the input deck.

EXAMPLES

Two different sample runs have been selected to illustrate the use of a temperature and salinity profile in the CONGRATS series. Example 1 uses the temperature and salinity profile shown in Fig. 1. Figure 4 is a listing of the Example 1 run deck. The resultant computer printout (see Fig. 5) shows the temperature and salinity profile with the constant salinity value, 38.2 parts per thousand, printed along with each depth and temperature of the profile. The latitude, which is 39°, is printed below the thermal profile. The velocity profile, which has been computed by the program, is listed, followed by the velocity tolerance used to fit the data. The THERMAL AXES card (see Fig. 3(b)) listed in Fig. 4 causes the temperature-depth profile to be drawn. The resultant plot is shown in Fig. 6. The surface salinity (which in this case is the salinity throughout the profile) is printed to the left of the temperature profile because the salinity plot has been suppressed. The generated velocity-depth profile is plotted in Fig. 7.

Example 2 uses the temperature and salinity profile presented in Fig. 2. The input deck (listed in Fig. 8) generates the computer printout shown in Fig. 9 and calls for four plots: a temperature profile, a salinity profile, a velocity profile, and a ray trace (Figs. 10, 11, 12 and 13 respectively).

SUMMARY

The fundamental CONGRATS programs, S0990 and S0991, have been revised to accommodate temperature and salinity data, in addition to velocity data, as a function of depth. Velocity data is still an acceptable input, leaving the programs entirely compatible with old input decks. The ray plotting, eigenray generation and eigenray processing functions of the CONGRATS series (as described in references (a) and (b)) have not been affected by the addition of the new input set. Subroutine INPUT has been changed in order to read and interpret the THERMAL cards and a new subroutine, BT, has been written to convert the THERMAL PROFILE into a VELOCITY PROFILE. These two routines are listed in the appendix.

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REFERENCES

(a) H. Weinberg, "CONGRATS I: Ray Plotting and Eigenray Generation," USL Report No. 1052, 31 October 1969.

(b) J. S. Cohen and L. T. Einstein, "CONGRATS II: Eigenray Processing Programs," USL Report No. 1069 (being edited).

(c) C. C. Leroy, "Development of Simple Equations for Accurate and More Realistic Calculation of the Speed of Sound in Sea Water," JASA 46, No. 1 (Part 2), July 1969, pp. 216-226.

TABLE 1

FORMULA FOR THE CALCULATION OF SOUND SPEED IN SEA WATER

COMPLETE $V = V_o + V_a + V_b + V_c + V_d$

BASIC $V = V_o + V_a$

in which

Term	Conditions for Use of Term
$V_o = 1493 + 3(T - 10) - 6 \times 10^{-3}(T - 10)^2 - 4 \times 10^{-2}(T - 18)^2 + 1.2(S - 35) - 10^{-2}(T - 18)(S - 35) + Z/61$	Always
$V_a = + 10^{-1}D^2 + 2 \times 10^{-4}D^2(T - 18)^2 + 10^{-1}D\phi/90$	Always
$V_b = 2.6 \times 10^{-4}T(T - 5)(T - 25)$	$T \geq 25^{\circ}C$
$V_c = - 10^{-3}D^2(D - 4)(D - 8)$	$Z > 7000$ m
$V_d = 1.5 \times 10^{-3}(S - 35)^2(1 - D) + 3 \times 10^{-6}T^2(T - 30)(S - 35)$	$S < 30^{\circ}/_{oo}$

where

V is the sound speed in m/s

T is the temperature in $^{\circ}C$

S is the salinity in $^{\circ}/_{oo}$

Z is the depth in m , and $D = Z/1000$

ϕ is the latitude in degrees

NOTE: V_o can also be written:

$$V_o = 1449.44 - 4.56T - 0.046\ T^2 + 1.2(S - 35) - 10^{-2}(T - 18)(S - 35) + Z/61$$

TABLE 2

Salinity Field on Profile Cards	Salinity Field on First Card of Set	Resultant Salinity
Zero	Zero	Constant Zero
Zero	Positive	Constant Positive
Positive	Zero	Profile of Values
Positive	Positive	Profile of Values

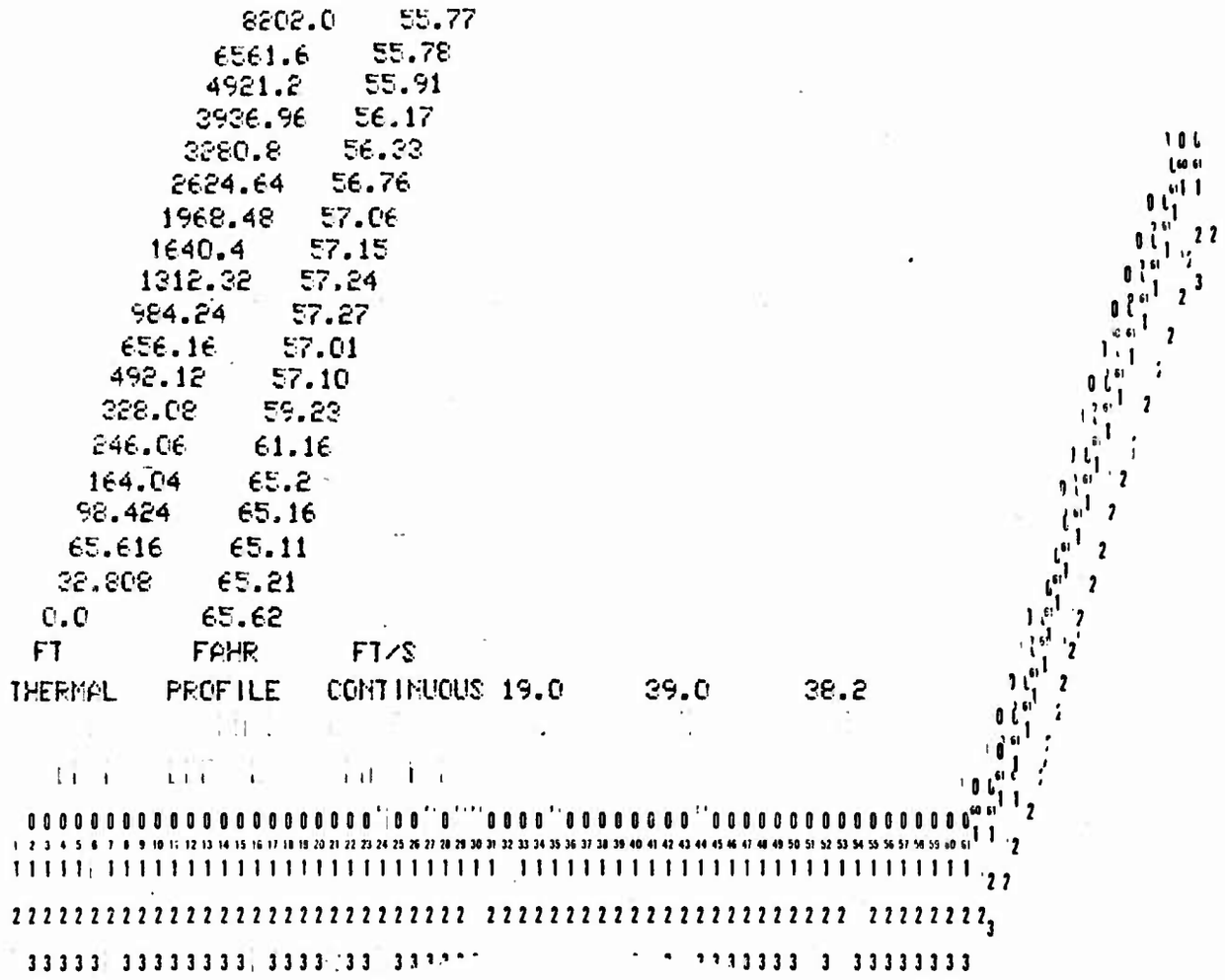


Fig. 1 - Temperature and Salinity Set 1

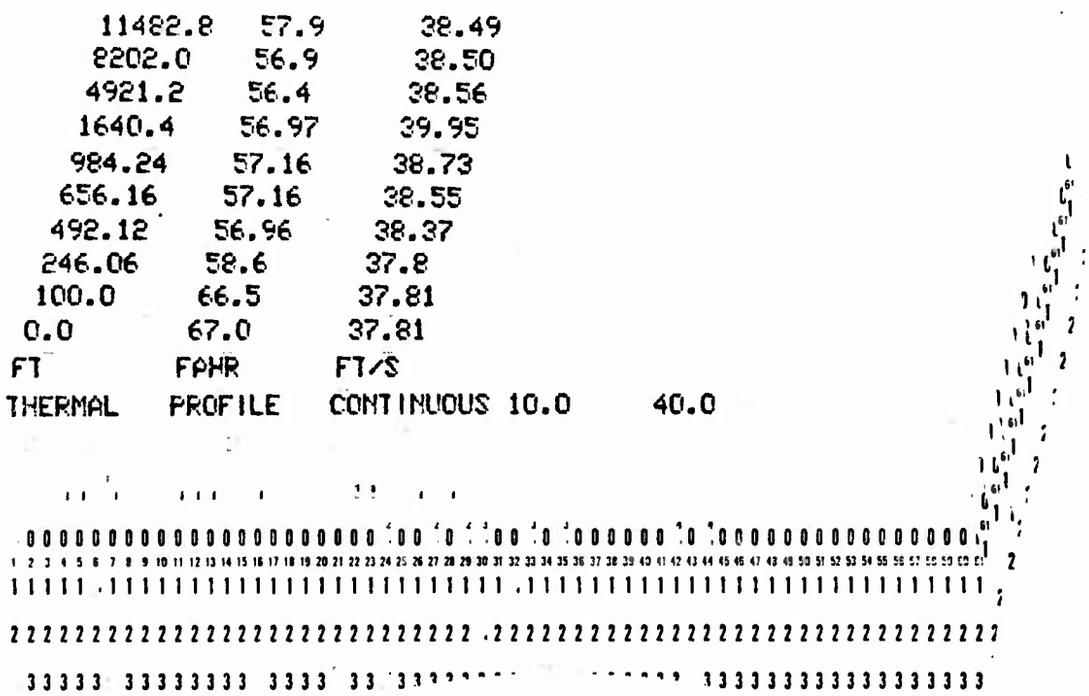
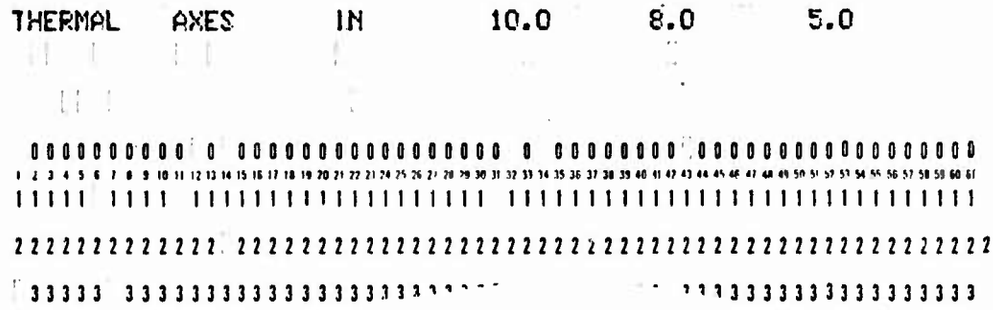
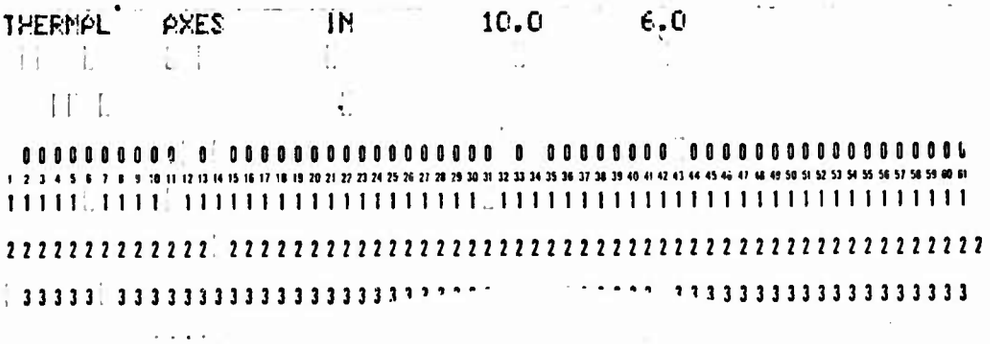


Fig. 2 - Temperature and Salinity Set 2



(a) Example 1



(b) Example 2

Fig. 3 - THERMAL AXES Cards

```
@ RUN A0011100,3,2071,S0991,FC,2,50   JSCOHEN
@ ASG X=0106
@ XQT COR
IN X
TRI X
@ XQT S0991
COMMENT
                                EXAMPLE 1
THERMAL   PROFILE   CONTINUOUS 19.0      39.0      38.2
FT        FAHR      FT/S
0.0       65.62
32.808    65.21
65.616    65.11
98.424    65.16
164.04    65.2
246.06    61.16
328.08    59.23
492.12    57.10
656.16    57.01
964.24    57.27
1312.32   57.24
1640.4    57.15
1968.48   57.06
2624.64   56.76
3280.8    56.33
3936.96   56.17
4921.2    55.91
6561.6    55.78
8202.0    55.77
THERMAL   AXES      IN        10.0      6.0
VELOCITY  TOLERANCE FT/S      2.0
VELOCITY  AXES      IN        10.0      7.0
PROCESS
END
@ EOF
@ FIN
```

Fig. 4 - Listing of Example 1 Run Deck

EXAMPLE 1

THERMAL PROFILE

CARD	DEPTH-FT	TEMPERATURE-FAHR	SALINITY-/1000	CARD	DEPTH-FT	TEMPERATURE-FAHR	SALINITY-/1000
1	.00	65.62	38.20	11	1312.32	57.24	38.20
2	32.81	65.21	38.20	12	1640.40	57.15	38.20
3	65.62	65.11	38.20	13	1968.48	57.06	38.20
4	98.42	65.16	38.20	14	2624.64	56.76	38.20
5	164.04	65.20	38.20	15	3280.80	56.33	38.20
6	246.06	61.16	38.20	16	3936.96	56.17	38.20
7	328.08	59.23	38.20	17	4921.20	55.91	38.20
8	492.12	57.10	38.20	18	6561.60	55.78	38.20
9	656.16	57.01	38.20	19	8202.00	55.77	38.20
10	984.24	57.27	38.20				

LATITUDE = 39.00000 DEGREES

VELOCITY PROFILE

CARD	DEPTH-FT	VELOCITY-FT/S	CARD	DEPTH-FT	VELOCITY-FT/S
1	.00	4994.68	11	1312.32	4970.12
2	32.81	4993.11	12	1640.40	4975.01
3	65.62	4993.13	13	1968.48	4979.91
4	98.42	4993.93	14	2624.64	4989.01
5	164.04	4995.22	15	3280.80	4997.35
6	246.06	4974.96	16	3936.96	5007.33
7	328.08	4965.45	17	4921.20	5022.22
8	492.12	4955.76	18	6561.60	5049.00
9	656.16	4957.93	19	8202.00	5076.68
10	984.24	4964.88			

GROUP	COORDINATE	UNITS	INITIAL	FINAL	INCREMENT
VELOCITY	TOLERANCE	FT/S	2.00	2.00	.00

Fig. 5 - Example 1 Computer Print-Out

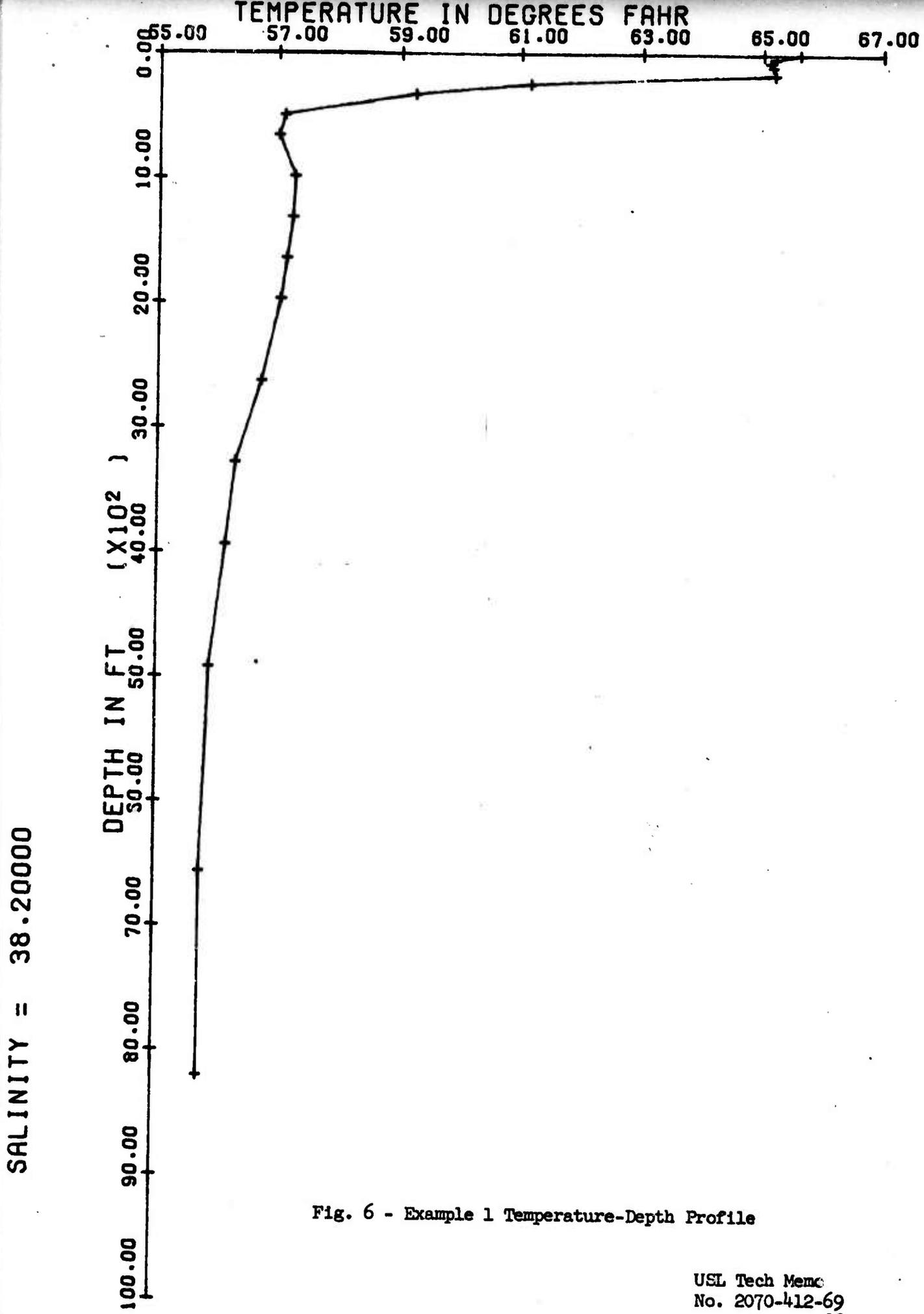


Fig. 6 - Example 1 Temperature-Depth Profile

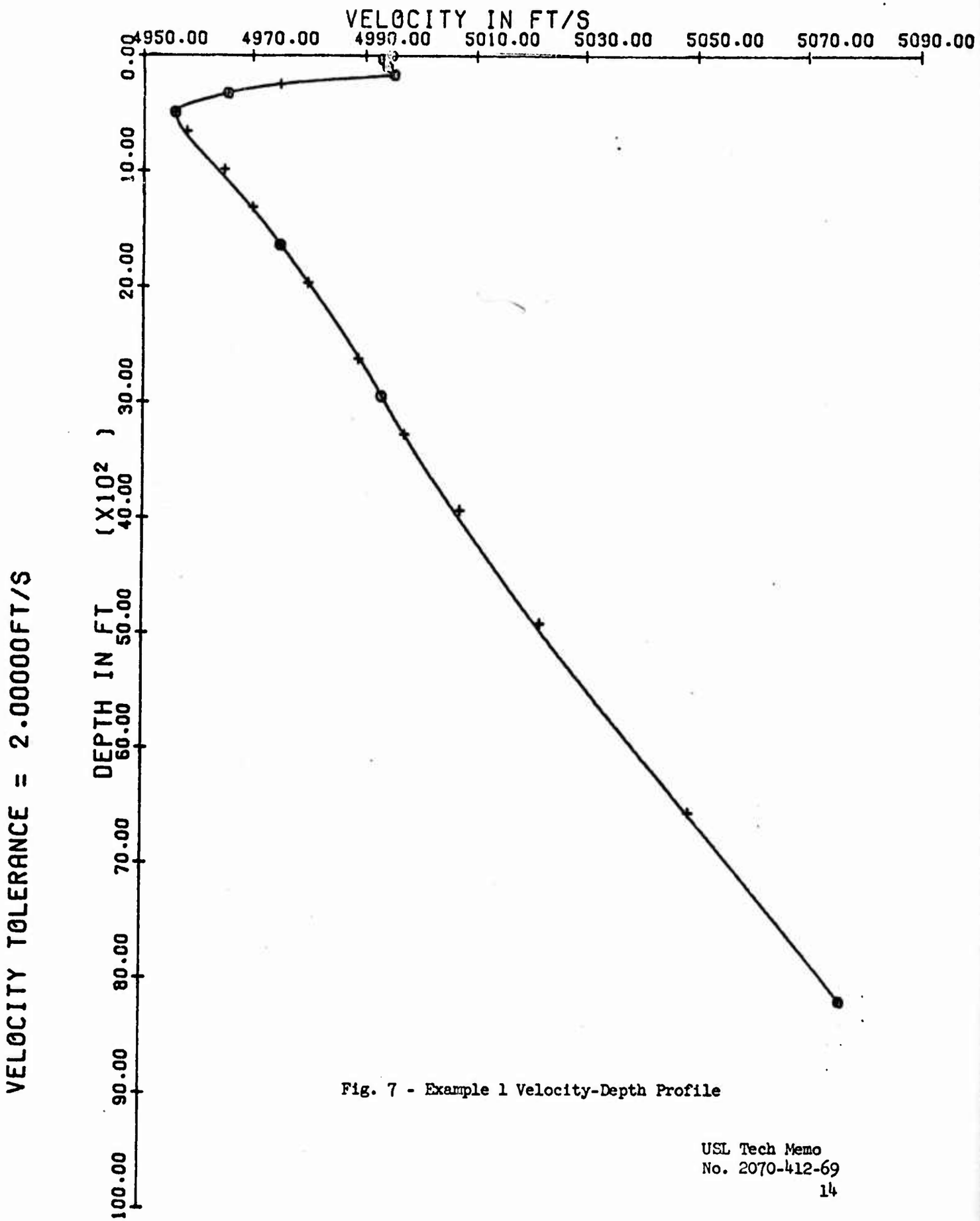


Fig. 7 - Example 1 Velocity-Depth Profile

```
@ RUN A0011100,3,2071,S0991,FC,2,50   JSCOHEN
@ ASG X=U106
@ XQT COR
IN X
TR1 X
@ XQT S0991
COMMENT
                                EXAMPLE 2
THERMAL   PROFILE   CONTINUOUS 10.0      40.0
FT        FAHR      FT/S
0.0       67.0      37.81
100.0     66.5      37.81
246.06    58.6      37.8
492.12    56.96     38.37
656.16    57.16     38.55
984.24    57.16     38.73
1640.4    56.97     39.95
4921.2    56.4      38.56
8202.0    56.9      38.50
11482.8   57.9      38.49
THERMAL   AXES      IN          6.0       6.0       6.0
VELOCITY  TOLERANCE FT/S        2.0
VELOCITY  AXES      IN          6.0       6.0
SONAR     ANGLE     DEG         2.0       13.5      0.10
SONAR     DEPTH     FT          20.0
MAXIMUM   REVERSALS             10.0
BOTTOM    PROFILE               2.0
KYD       FT
0.0       11480.0
100.0     11480.0
BOTTOM    AXES      IN          20.0      6.0
PROCESS
END
@ EOF
@ FIN
```

Fig. 8 - Listing of Example 2 Run Deck

EXAMPLE 2

THERMAL PROFILE

CARD	DEPTH-FT	TEMPERATURE-FAHR	SALINITY-/1000	CARD	DEPTH-FT	TEMPERATURE-FAHR	SALINITY-/1000
1	.00	67.00	37.81	6	984.24	57.16	38.73
2	100.00	66.50	37.81	7	1640.40	56.97	39.95
3	246.06	58.60	37.80	8	4921.20	56.40	38.56
4	492.12	56.96	38.37	9	8202.00	56.90	38.50
5	656.16	57.16	38.55	10	11482.80	57.90	38.49

LATITUDE = 40.00000 DEGREES

VELOCITY PROFILE

CARD	DEPTH-FT	VELOCITY-FT/S	CARD	DEPTH-FT	VELOCITY-FT/S
1	.00	5000.14	6	984.24	4966.39
2	100.00	4999.27	7	1640.40	4981.07
3	246.06	4958.86	8	4921.20	5026.63
4	492.12	4955.63	9	8202.00	5084.65
5	656.16	4960.24	10	11482.80	5146.42

GROUP	COORDINATE	UNITS	INITIAL	FINAL	INCREMENT
VELOCITY	TOLERANCE	FT/S	2.00	2.00	.00
SONAR	ANGLE	DEG	2.00000	13.50000	.10000
SONAR	DEPTH	FT	20.00	20.00	.00
MAXIMUM	REVERSALS		10.00000	10.00000	.00000

BOTTOM PROFILE

CARD	RANGE-KYD	DEPTH-FT	CARD	RANGE-KYD	DEPTH-FT
1	.00000	11480.00	2	100.00000	11480.00

Fig. 9 - Example 2 Computer Print Out

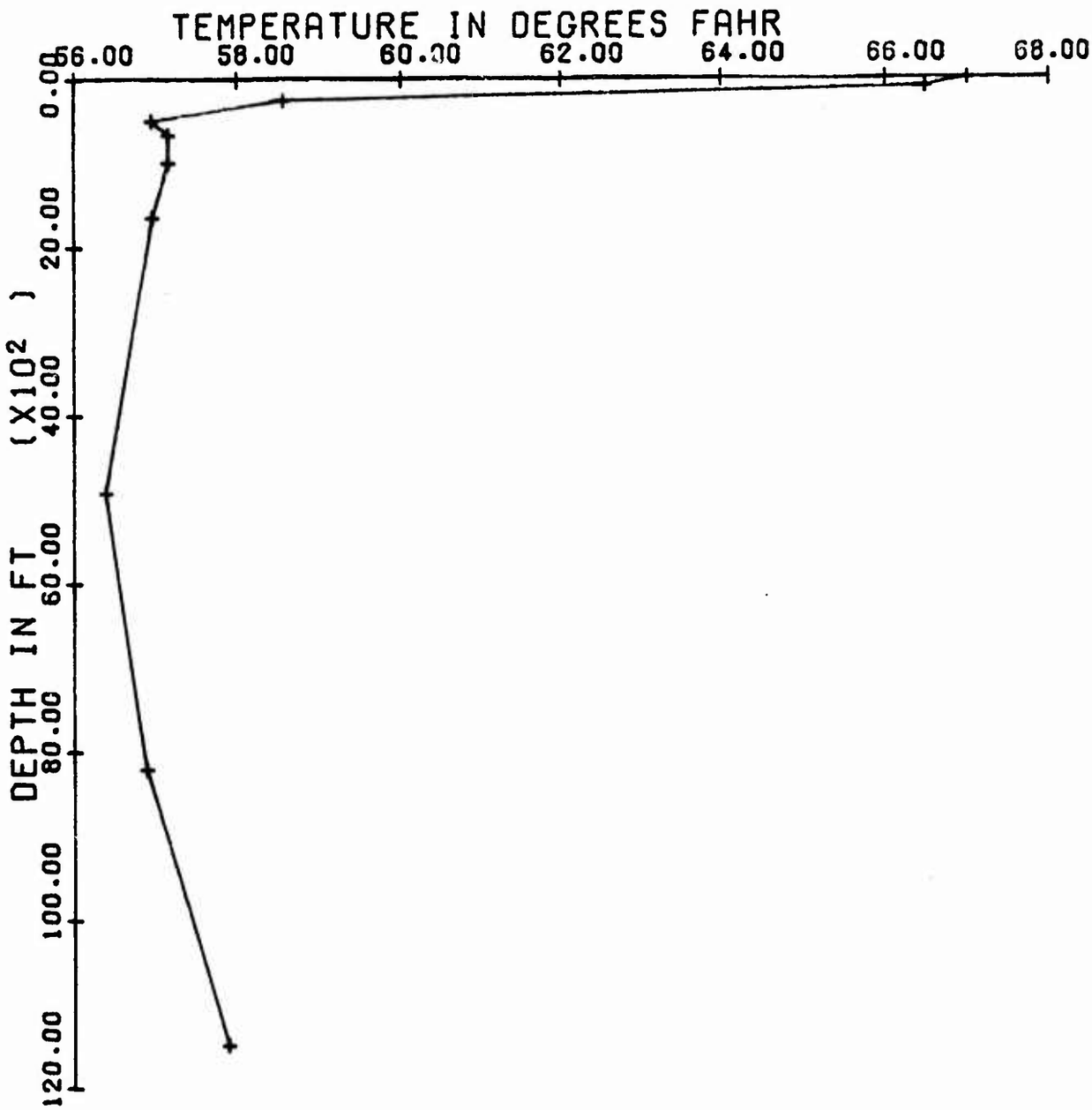


Fig. 10 - Example 2 Temperature-Depth Profile

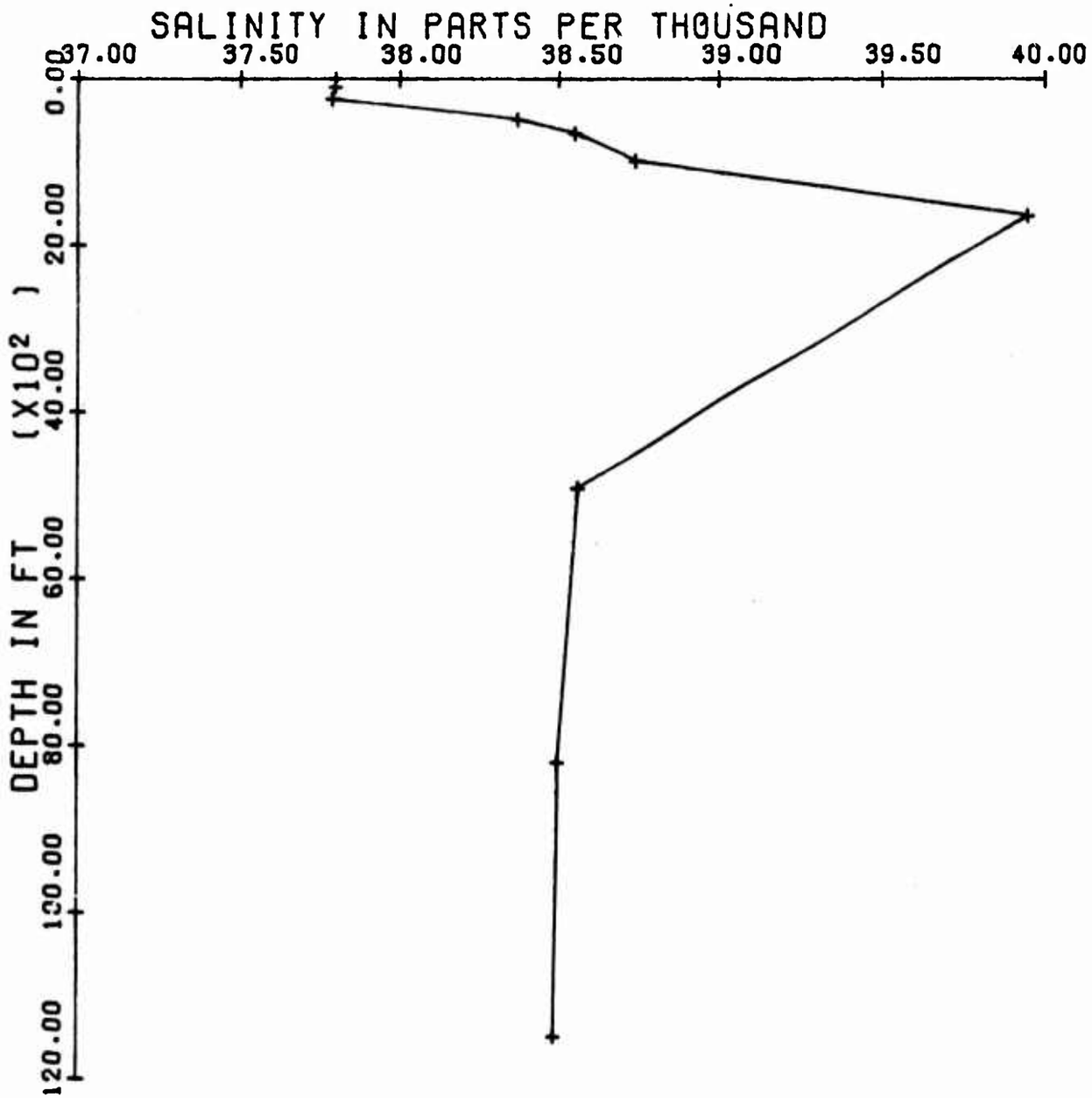


Fig. 11 - Example 2 Salinity-Depth Profile

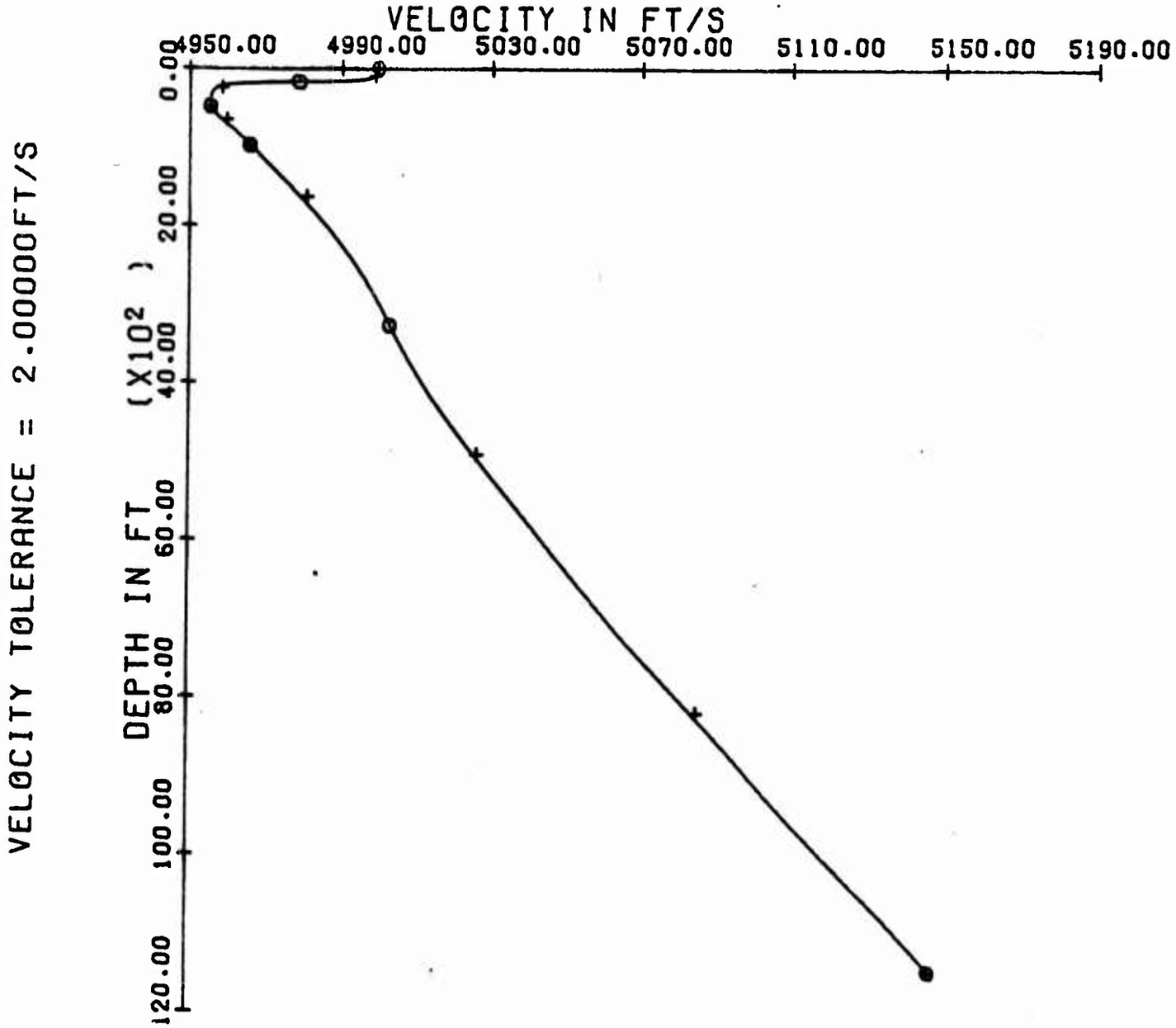


Fig. 12 - Example 2 Velocity-Depth Profile

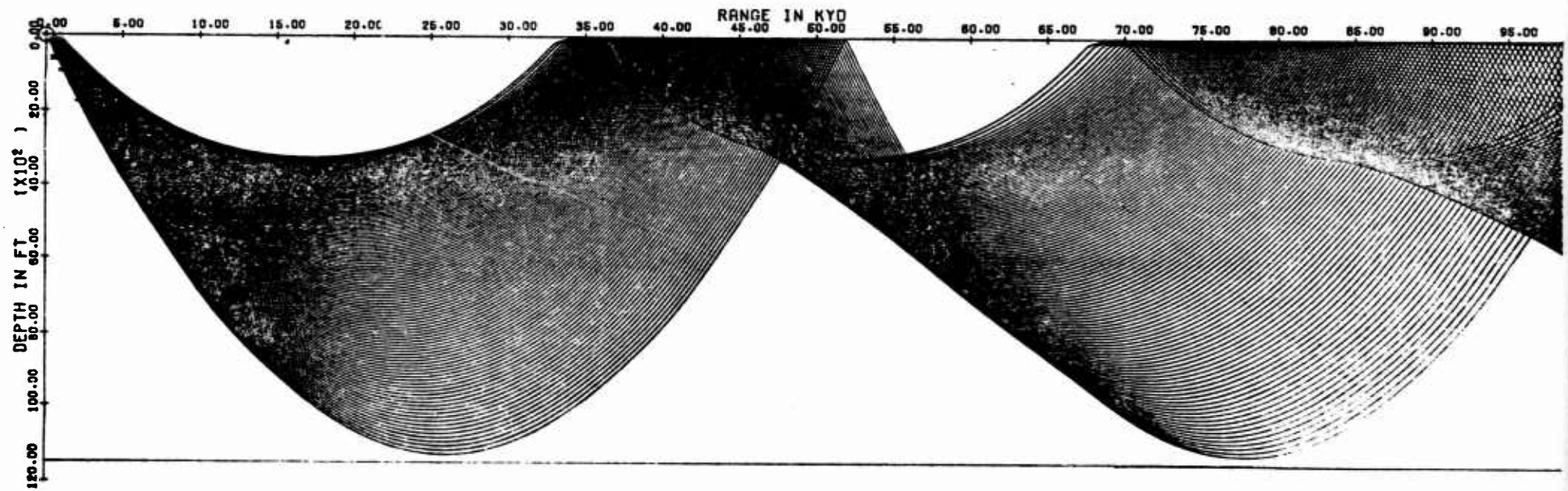


Fig. 13 - Example 2 Ray Plot

APPENDIX A

```
C
C       SUBROUTINE BT CONVERTS A TEMPERATURE PROFILE TO A VELOCITY
C       PROFILE.
C
        SUBROUTINE BT(TP)
C
C       DIMENSION AND COMMON STATEMENTS.
C
         DIMENSION TARGET(1010,3),ANGLES(1010),SONAR(5,2),SURFAC(5),
      1 SP(210,2),BOTTOM(5),BP(210,2),TOLERA(5),VP(210,2),TP(210,3),
      2 FMT(12)
        COMMON  TARGET,ANGLES,SONAR,SURFAC,SP,BOTTOM,BP,TOLERA,VP,
      1  REVMAX,PROCES
        NCARDS = TP(210,1)
C
C       TRANSFER DEPTHS TO VP ARRAY.
C
        DO 10 N=1,NCARDS
        VP(N,1) = TP(N,1)
   10   CONTINUE
C
C       CALCULATE VELOCITY FROM TEMPERATURE, DEPTH, LATITUDE, AND SALINITY.
C
        DO 180 N=1,NCARDS
C
C       CONVERT DEPTH TO METERS.
C
        Z = TP(N,1)*TP(204,1)/TP(204,3)
        D = Z/1000
        VO = 1449.44 + 4.56 * TP(N,2) - 0.046 * TP(N,2) * TP(N,2) + 1.2 *
      1 (TP(N,3) - 35.0) - 0.01 * (TP(N,2) - 18.0) * (TP(N,3) - 35.0)+
      2 Z/61.0
        VA = 0.1 * D * D + 0.0002 * D * D * (TP(N,2) - 18.0)**2 + 0.1 *
      1 D * TP(210,2)/90.0
C
C       TEST TEMPERATURE GREATER THAN OR EQUAL TO 25 DEG.C.
C
        IF ( TP(N,2) - 25.0 )  110,     ,
        VB = 0.00026 * TP(N,2) * (TP(N,2) - 5.0) * (TP(N,2) - 25.0)
        GO TO 120
  110   VB = 0
C
C       TEST DEPTH GREATER THAN 7000 M.
C
  120   IF ( Z - 7000 )  130, 130,
        VC = -0.001 * D * D * (D-4.0) * (D-8.0)
        GO TO 140
  130   VC = 0
C
C       TEST SALINITY LESS THAN 30-/1000.
C
  140   IF ( TP(N,3) - 30.0 )      , 150, 150
        VD = 0.0015 * (1.0-D) * (TP(N,3) - 35.0)**2 + 0.000003 * TP(N,2)
     1 * TP(N,2) * (TP(N,2) - 30.0) * (TP(N,3) - 35.0)
        GO TO 160
  150   VD = 0
  160   VP(N,2) = VO + VA + VB + VC + VD
C
```

```
C       CONVERT VELOCITY TO DESIRED UNITS.
C
        VP(N,2) = VP(N,2) * TP(205,3)/VP(204,2)
  180   CONTINUE
        GO TO 9000
C
C
C
C       BTPLOT PLOTS TEMPERATURE PROFILE AND/OR SALINITY PROFILE.
C       ---------------------------------------------------------
C
        ENTRY BTPLOT(TP)
        IF ( TP(208,1) ) 9000, 9000,      @ TEST Z AXIS
C
C       COMPUTE THE SCALE FACTOR FOR THE DEPTH AXIS.
C
        CALL SCALE(TP(1,1),TP(208,1),NCARDS,1,TP(207,1))
        TP(NCARDS+1,1) = TP(NCARDS+1,1) + TP(NCARDS+2,1) * TP(208,1)
        TP(NCARDS+2,1) = -TP(NCARDS+2,1)
        IF ( TP(208,2) ) 5000, 5000,      @ TEST T AXIS
C
C       PLOT THE DEPTH AXIS IN THE ORIGIINAL UNITS.
C       SET THE VARIABLE FORMAT
C
        FMT(1) = 6H   DEP
        FMT(2) = 6HTH IN
        FMT(3) = TP(205,1)
        CALL AXIS(0.0,0.0,FMT,+18,TP(208,1),90.0,TP(NCARDS+1,1),
     1  TP(NCARDS+2,1),TP(207,1))
        IF ( TP(208,3) )      ,      , 4120 @TEST S AXIS
        CALL SYMBOL(-1.0,1.0,0.14,12HSALINITY =  ,90.0,12)
        CALL NUMBER(999.0,999.0,0.14,TP(1,3),90.0,5)
C
C       PLOT THE TEMPERATURE AXIS IN THE ORIGINAL UNITS.
C       CONVERT TEMPERATURE TO ORIGINAL UNITS.
C       COMPUTE THE SCALE FACTOR.
C
 4120   IF ( TP(204,2) - 0.75 )      ,      , 4140
        DO 4130 N=1,NCARDS
 4130   TP(N,2) = 32.0 + TP(N,2)/TP(204,2)
 4140   CALL SCALE(TP(1,2),TP(208,2),NCARDS,1,TP(207,2))
C
C       SET THE VARIABLE FORMAT.
C
        FMT(1) = 6H TEMPE
        FMT(2) = 6HRATURE
        FMT(3) = 6H IN DE
        FMT(4) = 6HGREES
        FMT(5) = TP(205,2)
        CALL AXIS(0.0,TP(208,1),FMT,+30,TP(208,2),0.0,TP(NCARDS+1,2),
     1  TP(NCARDS+2,2),TP(207,2))
C
C       PLOT THE TEMPERATURE PROFILE.
C
        CALL LINE ( TP(1,2),TP(1,1),NCARDS,1,1,3)
        CALL PLOT (TP(208,2)+5.0,0.0,-3)
C
C       PLOT SALINITY PROFILE.
```

```
C
 5000  IF ( TP(208,3) ) 9000, 9000,     @ TEST S AXIS
C
C       PLOT DEPTH AXIS FOR SALINITY PROFILE.
C       SET THE VARIABLE FORMAT
C
        FMT(1) = 6H   DEP
        FMT(2) = 6HTH IN
        FMT(3) = TP(205,1)
        CALL AXIS (0,0,0.0,FMT,+18,TP(208,1),90.0,TP(NCARDS+1,1),
     1  TP(NCARDS+2,1),TP(207,1))
C
C       PLOT THE SALINITY AXIS
C       COMPUTE THE SCALE FACTOR.
C
        CALL SCALE(TP(1,3),TP(208,3),NCARDS,1,TP(207,3))
C
C       SET THE VARIABLE FORMAT.
C
        FMT(1) = 6HSALINI
        FMT(2) = 6HTY IN
        FMT(3) = 6HPARTS
        FMT(4) = 6HPER TH
        FMT(5) = 6HOUSAND
        CALL AXIS(0.0,TP(208,1),FMT,+30,TP(208,3),0.0,TP(NCARDS+1,3),
     1  TP(NCARDS+2,3),TP(207,3))
C
C       PLOT THE SALINITY PROFILE.
C
        CALL LINE (TP(1,3),TP(1,1),NCARDS,1,1,3)
        CALL PLOT(TP(208,3)+5.0,0.0,-3)
 9000   RETURN
        END
```

```
C       SUBROUTINE  INPUT  FOR CONGRATS.                        CHIC WEINBERG
C       ------------------------------------------------------------------
C
        SUBROUTINE  INPUT
C
C
        DIMENSION  TARGET(1010,3),ANGLES(1010),SONAR(5,2),SURFAC(5),
     1 SP(210,2),BOTTOM(5),BP(210,2),TOLERA(5),VP(210,2),TP(210,3)
        DIMENSION GROUP(11)/6HCOMMENTARGETSONAR SURFACBOTTOMVELOCITHERMA
     1PROCESEND   FREQUEMAXIMU/
        DIMENSION COORD(8)/48HRANGE DEPTH ANGLE LOSS  TOLERAAXES  PROFILP
     1HASE /
        DIMENSION UNITS(2,32)/
     1  1.09361111E-5, 6HCM     ,       1.09361111E-5, 6HCM/S   ,
     2  2.77777777E-5, 6HIN     ,       2.77777777E-5, 6HIN/S   ,
     3  0.33333333E-3, 6HFT     ,       0.33333333E-3, 6HFT/S   ,
     4  1.00000000E-3, 6HYD     ,       1.00000000E-3, 6HYD/S   ,
     5  1.09361111E-3, 6HM      ,       1.09361111E-3, 6HM/S    ,
     6  2.00000000E-3, 6HF      ,       2.00000000E-3, 6HF/S    ,
     7  0.33333333E-0, 6HKFT    ,       0.33333333E-0, 6HKFT/S  ,
     8  1.00000000E-0, 6HKYD    ,       1.00000000E-0, 6HKYD/S  ,
     9  1.09361111E-0, 6HKM     ,       1.09361111E-0, 6HKM/S   ,
     T  1.76000000E-0, 6HMI     ,       1.76000000E-0, 6HMI/S   ,
     1  2.02680000E-0, 6HN MI   ,       2.02680000E-0, 6HKNOTS  ,
     2  1.74532925E-2, 6HDEG    ,       1.74532925E-2, 6HDEG/S  ,
     3  1.00000000E-0, 6HRAD    ,       1.00000000E-0, 6HRAD/S  ,
     4  6.28318531E-0, 6HCPS    ,       6.28318531E+3, 6HKCPS   ,
     5  1.00000000E-3, 6HMS     ,       1.00000000E-0, 6HSEC    ,
     6  1.00000000E-0, 6HC      ,       5.55555555E-1, 6HFAHR   /
        DIMENSION  TEST(12),FMT(12),DATA(2048),REVMAX(4)
        DIMENSION  CMMNT(12)/72H THERE SHOULD BE AT LEAST ONE COMMENT SET
     1,                                                                 /
        DATA  PRINT/6HPRINT /,LINMAX/60/,ICMMNT/0/
        COMMON  TARGET,ANGLES,SONAR,SURFAC,SP,BOTTOM,BP,TOLERA,VP,
     1  REVMAX,PROCES
C
C
C
C       SET INITIAL CONDITIONS.
C       -----------------------
        ANGLES(1010) = 0.0
        TARGET(1010,1) = 0.0
        TARGET(1010,2) = 0.0
        IHEAD = 0
        LINES = LINMAX
        NPRINT = FLD(33,3,PROCES)
        NTAPE1 = FLD(30,3,PROCES)
        NTAPE2 = FLD(27,3,PROCES)
C
C
C
C       CHECK THE GROUP CODE.
C       ---------------------
  100   READ 101, (TEST(J),J=1,9)
  101   FORMAT( 3(A6,A4), 3F10.5 )
        DO 110  I=1,11
        IF( TEST(1).GT.GROUP(I) .OR. TEST(1).LT.GROUP(I) )  GO TO 110
        IGROUP = I
```

```
      GO TO (1000,200,200,200,200,200,200,8000,9000,300,9200), IGROUP
  110 CONTINUE
C
C     THE GROUP CODE IS INCORRECT.
  120 FMT(1) = (+6HGROUP )
  130 PRINT 132, FMT(1)
  132 FORMAT( 10X 14HTHE FOLLOWING , A6, 18HCODE IS INCORRECT. )
  140 PRINT 142, ( TEST(J),J=1,9 )
  142 FORMAT( 24X 6A6, 3F12.5 )
  150 PRINT 152
  152 FORMAT( 10X 28HTHE PROGRAM CANNOT CONTINUE. )
      STOP 6
C
C
C     CHECK THE COORD CODE.
C     ---------------------
  200 DO 210  I=1,8
      IF( TEST(3).GT.COORD(I) .OR. TEST(3).LT.COORD(I) )  GO TO 210
      ICOORD = I
      GO TO (300,300,300,500,300,300,600,500), ICOORD
  210 CONTINUE
C
C     THE COORD CODE IS INCORRECT.
      FMT(1) = (+6HCOORD )
      GO TO 130
C
C
C     CHECK THE UNITS CODE.
C     ---------------------
  300 DO 310  I=1,30
      IF( TEST(5).GT.UNITS(2,I) .OR. TEST(5).LT.UNITS(2,I) )  GO TO 310
      IUNITS = I
      IF( IGROUP.EQ.10 )  GO TO 320
      IF( ICOORD.GE.6 )  GO TO 400
      IF( TEST(9) )  305,315,305
  305 NCARDS = (TEST(8)-TEST(7))/TEST(9) + 1.5
      IF( NCARDS*(1001-NCARDS) )  2100,2100,320
  310 CONTINUE
C
C     THE UNITS CODE IS INCORRECT.
      FMT(1) = (+6HUNITS )
      GO TO 130
C
C     PRINT THE DATA.
  315 TEST(8) = TEST(7)
      NCARDS = 1
  320 IF( LINES.LT.LINMAX-5 )  GO TO 330
      PRINT 322
  322 FORMAT( 1H1 )
      LINES = 1
      GO TO 340
  330 IF( IHEAD.EQ.1 )  GO TO 350
      PRINT 332
  332 FORMAT( // )
      LINES = LINES + 3
  340 PRINT 342
  342 FORMAT( 25X 73HGROUP     COORDINATE   UNITS              INITIAL
     1   FINAL      INCREMENT, / )
```

```
      LINES = LINES + 2
      IHEAD = 1
C
C     SET THE VARIABLE FORMAT.
  350 FMT(1) = (+6H( 24X )
      FMT(2) = (+6H6A6, 3)
      IF( UNITS(1,IUNITS).GT.2.0E-3 )  GO TO 360
      FMT(3) = (+6HF12.2))
      GO TO 370
  360 FMT(3) = (+6HF12.5))
  370 PRINT FMT, (TEST(J),J=1,9)
      LINES = LINES + 1
      TEST(7) = TEST(7) * UNITS(1,IUNITS)
      TEST(8) = TEST(8) * UNITS(1,IUNITS)
      TEST(9) = TEST(9) * UNITS(1,IUNITS)
      GO TO (380,2000,3000,4000,5000,6000,380,380,380,9100,100), IGROUP
C
C     THE CODES ARE INCONSISTENT.
  380 PRINT 382
  382 FORMAT( 10X 33HTHE ABOVE CODES ARE INCONSISTENT. )
      GO TO 150
C
C
C     CHECK THE AXES CARD.
C     --------------------
  400 IF( NTAPE1.EQ.0 )  NTAPE1=1
      IF( IUNITS.GT.4 )  GO TO 420
      IPAPER = 600 - 500 * ((IUNITS-1)/2)
      DO 410 J=1,3
      IF( TEST(J+6) * (100.0*UNITS(1,3)-TEST(J+6)*UNITS(1,IUNITS)) )
     1  420,410,410
  410 CONTINUE
      GO TO (420,420,420,4100,5100,6100,7100,420,420), IGROUP
C
C     THE AXES CARD IS INCORRECT.
  420 PRINT 422
  422 FORMAT( 10X 37HTHE FOLLOWING AXES CARD IS INCORRECT. )
      GO TO 140
C
C
C     READ THE LOSS TABLE.
C     --------------------
  500 IHEAD = 0
      LINES = LINES + 28
      IF( LINES.LT.LINMAX-5 )  GO TO 510
      PRINT 322
      LINES = 25
      GO TO 520
  510 PRINT 332
  520 IF( IGROUP.EQ.4 )  GO TO 540
      IF( IGROUP.NE.5 )  GO TO 120
      IF( ICOORD.EQ.4 )  GO TO 530
      TEST(12) = BPHASE(FREQ)
      GO TO 100
  530 TEST(12) = BLOSS(FREQ)
      GO TO 100
  540 IF( ICOORD.EQ.4 )  GO TO 550
      TEST(12) = SPHASE(FREQ)
```

```
      GO TO 100
  550 TEST(12) = SLOSS(FREQ)
      GO TO 100
C
C
C     CHECK THE NUMBER OF CARDS IN THE PROFILE.
C     -----------------------------------------
  600 NCARDS = TEST(7)
      IF( (NCARDS.GE.2).AND.(200.GE.NCARDS) )  GO TO 610
      PRINT 602, (TEST(J),J=1,4), NCARDS
  602 FORMAT( 10X 27HTHE NUMBER OF CARDS IN THE , 2(A6,A4),
     1  I10, 44H, EXCEEDS 200 CARDS OR IS LESS THAN 2 CARDS. )
      GO TO 150
C
C     PRINT THE HEADING.
  610 IHEAD = 0
      LINES = NCARDS/2 + 10 + LINES
      IF( LINES.LT.LINMAX-1 )  GO TO 620
      PRINT 322
      LINES = NCARDS/2 + 6
      GO TO 630
  620 PRINT 332
  630 PRINT 632, (TEST(J),J=1,4)
  632 FORMAT( 51X 2(A6,A4), /, 51X 17H----------------, / )
C
C
C     CHECK THE UNITS CODE.
C     ---------------------
  700 READ 101, TEST(1),TEST(10),TEST(2),TEST(11),TEST(3),TEST(12)
      J = 1
  710 DO 730 I=1,32
      IF( TEST(J).GT.UNITS(2,I) .OR. TEST(J).LT.UNITS(2,I) )  GO TO 730
      IF( J.GT.1 )  GO TO 720
      IUNITS = I
      J = 2
      GO TO 710
  720 IF (J .GT. 2)  GO TO 725
      JUNITS = I
      J = 3
      IF (IGROUP .EQ. 7)  GO TO 710
      GO TO 740
  725 KUNITS = I
      GO TO 740
  730 CONTINUE
C
C     THE UNITS CODE IS INCORRECT.
      FMT(1) = (+6HUNITS )
      PRINT 132, FMT(1)
      PRINT 142, TEST(1),TEST(3),TEST(2),TEST(4)
      GO TO 150
C
C     SET THE VARIABLE FORMAT.
  740 FMT(1) = (+6H( 2(  )
      FMT(2) = (+6H I15, )
      IF( UNITS(1,IUNITS).GT.2.0E-3 )  GO TO 750
      FMT(3) = (+6HF14.2,)
      GO TO 760
  750 FMT(3) = (+6HF14.5,)
```

```
  760   IF (IGROUP .EQ. 7)  GO TO 763 .
        LUNITS = JUNITS
        GO TO 765
  763   LUNITS = KUNITS
  765   IF ( UNITS(1,LUNITS) .GT. 2.0E-3 )  GO TO 770
        FMT(4) = (+6HF16.2,)
        GO TO 780
  770   FMT(4) = (+6HF16.5,)
  780   FMT(5) = (+6H15X) ))
        GO TO (380,380,380,4200,5200,6200,7200,380,380), IGROUP
C
C
C
C       READ AND WRITE A COMMENT CARD.
C       ------------------------------
 1000   READ 1001, (TEST(J),J=1,12)
 1001   FORMAT( 12A6 )
 1002   FORMAT( 10X 12A6 )
        IF( LINES.LT.LINMAX )  GO TO 1005
        PRINT 322
        LINES = 1
 1005   PRINT 1002, (TEST(J),J=1,12)
        LINES = LINES + 1
        ICMMNT = ICMMNT + 1
        IF( ICMMNT.GT.1 )  GO TO 100
        DO 1010  J=1,12
 1010   CMMNT(J) = TEST(J)
        GO TO 100
C
C
C
C       CONVERT AND STORE THE TARGET DATA.
C       ----------------------------------
 2000   IF( ICOORD.GT.2 )  GO TO 380
        IF( NTAPE2.EQ.0 )  NTAPE2=1
        TARGET(1004,ICOORD) = UNITS(1,IUNITS)
        TARGET(1005,ICOORD) = UNITS(2,IUNITS)
        N = TARGET(1010,ICOORD)
        NCARDS = N + NCARDS
        IF( NCARDS.GT.1000 )  GO TO 2100
        TARGET(1010,ICOORD) = NCARDS
        N = N + 1
        DO 2010  I=N,NCARDS
 2010   TARGET(I,ICOORD) = TEST(7) + (I-N)*TEST(9)
        GO TO 100
C
C       THE NUMBER OF ENTRIES HAS BEEN EXCEEDED.
 2100   PRINT 2102, GROUP(IGROUP), COORD(ICOORD)
 2102   FORMAT( 10X 14HTHE NUMBER OF , A6, 1XA5,
     1  23HS EXCEEDS 1000 ENTRIES. )
        GO TO 150
C
C
C
C       CONVERT AND STORE THE SONAR DATA.
C       ---------------------------------
 3000   IF( ICOORD-3 )  3100,3200,380
 3100   SONAR(1,ICOORD) = TEST(7)
```

```
      SONAR(2,ICOORD) = TEST(8)
      SONAR(3,ICOORD) = TEST(9)
      SONAR(4,ICOORD) = UNITS(1,IUNITS)
      SONAR(5,ICOORD) = UNITS(2,IUNITS)
      GO TO 100
C
C     STORE THE SONAR ANGLE DATA.
 3200 IF( ABS(TEST(7)).GT.1.5707 .OR. TEST(8).GT.1.5707 )  GO TO 3300
      ANGLES(1004) = UNITS(1,IUNITS)
      ANGLES(1005) = UNITS(2,IUNITS)
      N = ANGLES(1010)
      NCARDS = N + NCARDS
      IF( NCARDS.GT.1000 )  GO TO 2100
      ANGLES(1010) = NCARDS
      N = N + 1
      DO 3210  I=N,NCARDS
 3210 ANGLES(I) = TEST(7) + (I-N)*TEST(9)
      GO TO 100
C
C     THE SONAR ANGLES EXCEED THEIR BOUNDS.
 3300 PRINT 3302
 3302 FORMAT(10X50HALL SONAR ANGLES MUST LIE BETWEEN -90 AND +90 DEG.)
      GO TO 150
C
C
C
C     CONVERT AND STORE THE SURFACE DATA.
C     -----------------------------------
 4000 IF( ICOORD.NE.2 )  GO TO 380
      SURFAC(1) = TEST(7)
      SURFAC(2) = TEST(8)
      SURFAC(3) = TEST(9)
      SURFAC(4) = UNITS(1,IUNITS)
      SURFAC(5) = UNITS(2,IUNITS)
      GO TO 100
C
C     STORE THE SURFACE AXES DATA.
 4100 SP(207,1) = 2.777777777E-4/UNITS(1,IUNITS)
      SP(207,2) = SP(207,1)
      SP(208,1) = TEST(7)
      SP(208,2) = TEST(8)
      GO TO 5100
C
C
C     READ AND PRINT THE SURFACE PROFILE.
C     -----------------------------------
 4200 SP(204,1) = UNITS(1,IUNITS)
      SP(205,1) = UNITS(2,IUNITS)
      SP(204,2) = UNITS(1,JUNITS)
      SP(205,2) = UNITS(2,JUNITS)
      SP(210,1) = NCARDS
      SP(210,2) = TEST(5)
      SURFAC(4) = 0.0
      PRINT 4202, SP(205,1),SP(205,2),SP(205,1),SP(205,2)
 4202 FORMAT( 2(12X 16HCARD      RANGE=, A6, 9H   DEPTH=, A6, 11X), / )
      READ 4212, (SP(N,1),SP(N,2),N=1,NCARDS)
 4212 FORMAT( 2F10.5 )
      J = ( NCARDS + 1 ) / 2
```

```
      DO 4220  L=1,J
      N = L + J
      IF( N.LE.NCARDS )  GO TO 4220
      PRINT FMT, L,SP(L,1),SP(L,2)
      GO TO 4230
 4220 PRINT FMT, L,SP(L,1),SP(L,2), N,SP(N,1),SP(N,2)
C
C     CONVERT AND CHECK THE PROFILE.
 4230 DO 4260  N=1,NCARDS
      SP(N,1) = SP(N,1) * SP(204,1)
      SP(N,2) = SP(N,2) * SP(204,2)
C
C     IS THE RANGE INCREASING.
      IF( N.EQ.1 )  GO TO 4260
      IF( SP(N,1).GT.SP(N-1,1) )  GO TO 4260
      NCARDS = N
      GO TO 4270
 4260 CONTINUE
      GO TO 100
C
C     A CARD IS INCORRECT OR OUT OF ORDER.
 4270 PRINT 4272, NCARDS
 4272 FORMAT( 10X 11HCARD NUMBER, I4, 13HIS INCORRECT. )
      GO TO 150
C
C
C
C     CONVERT AND STORE THE BOTTOM DATA.
C     ----------------------------------
 5000 IF( ICOORD.NE.2 )  GO TO 380
      BOTTOM(1) = TEST(7)
      BOTTOM(2) = TEST(8)
      BOTTOM(3) = TEST(9)
      BOTTOM(4) = UNITS(1,IUNITS)
      BOTTOM(5) = UNITS(2,IUNITS)
      GO TO 100
C
C     STORE THE BOTTOM AXES DATA.
 5100 BP(207,1) = 2.777777777E-4/UNITS(1,IUNITS)
      BP(207,2) = BP(207,1)
      BP(208,1) = TEST(7)
      BP(208,2) = TEST(8)
      GO TO 100
C
C
C     READ AND PRINT THE BOTTOM PROFILE.
C     ----------------------------------
 5200 BP(204,1) = UNITS(1,IUNITS)
      BP(205,1) = UNITS(2,IUNITS)
      BP(204,2) = UNITS(1,JUNITS)
      BP(205,2) = UNITS(2,JUNITS)
      BP(210,1) = NCARDS
      BP(210,2) = TEST(5)
      BOTTOM(4) = 0.0
      PRINT 4202, BP(205,1),BP(205,2),BP(205,1),BP(205,2)
      READ 4212, (BP(N,1),BP(N,2),N=1,NCARDS)
      J = ( NCARDS + 1 ) / 2
      DO 5220  L=1,J
```

```
      N = L + J
      IF( N.LE.NCARDS )  GO TO 5220
      PRINT FMT, L,BP(L,1),BP(L,2)
      GO TO 5230
 5220 PRINT FMT, L,BP(L,1),BP(L,2), N,BP(N,1),BP(N,2)
C
C     CONVERT AND CHECK THE PROFILE.
 5230 DO 5260  N=1,NCARDS
      BP(N,1) = BP(N,1) * BP(204,1)
      BP(N,2) = BP(N,2) * BP(204,2)
C
C     IS THE RANGE INCREASING.
      IF( N.EQ.1 )  GO TO 5260
      IF( BP(N,1).GT.BP(N-1,1) )  GO TO 5260
      NCARDS = N
      GO TO 4270
 5260 CONTINUE
      GO TO 100
C
C
C
C     CONVERT AND STORE THE VELOCITY DATA.
C     ------------------------------------
 6000 IF( ICOORD.NE.5 )  GO TO 380
      TOLERA(1) = TEST(7)
      TOLERA(2) = TEST(8)
      TOLERA(3) = TEST(9)
      TOLERA(4) = UNITS(1,IUNITS)
      TOLERA(5) = UNITS(2,IUNITS)
      GO TO 100
C
C     STORE THE VELOCITY AXES DATA.
 6100 VP(207,1) = 2.777777777E-4/UNITS(1,IUNITS)
      VP(207,2) = VP(207,1)
      VP(208,1) = TEST(7)
      VP(208,2) = TEST(8)
      GO TO 100
C
C
C     READ AND PRINT THE VELOCITY PROFILE.
C     ------------------------------------
 6200 VP(204,1) = UNITS(1,IUNITS)
      VP(205,1) = UNITS(2,IUNITS)
      VP(204,2) = UNITS(1,JUNITS)
      VP(205,2) = UNITS(2,JUNITS)
      VP(210,1) = NCARDS
      VP(210,2) = TEST(5)
      PRINT 6202, VP(205,1),VP(205,2),VP(205,1),VP(205,2)
 6202 FORMAT(2(12X 16HCARD      DEPTH-, A6, 10H VELOCITY-, A6, 10X), /)
      READ 4212, (VP(N,1),VP(N,2),N=1,NCARDS)
 6210 J = ( NCARDS + 1 )/2
      DO 6220  L=1,J
      N = L + J
      IF( N.LE.NCARDS )  GO TO 6220
      PRINT FMT, L,VP(L,1),VP(L,2)
      GO TO 6230
 6220 PRINT FMT, L,VP(L,1),VP(L,2), N,VP(N,1),VP(N,2)
C
```

```
C       CONVERT AND CHECK THE PROFILE.
 6230   DO 6260  N=1,NCARDS
        VP(N,1) = VP(N,1) * VP(204,1)
        VP(N,2) = VP(N,2) * VP(204,2)
        IF( VP(N,2).GT.1.55 .AND. 1.77.GT.VP(N,2) )  GO TO 6240
C
C       THE VELOCITY EXCEEDS ITS BOUNDS.
        PRINT 6232, N
 6232   FORMAT( 10X 28HVELOCITY PROFILE CARD NUMBER, I4,
     1  20H EXCEEDS ITS BOUNDS. )
        GO TO 150
C
C       IS THE DEPTH INCREASING.
 6240   IF( N.EQ.1 )  GO TO 6260
        IF( VP(N,1).GT.VP(N-1,1) )  GO TO 6260
        NCARDS = N
        GO TO 4270
 6260   CONTINUE
        GO TO 100
C
C
C
C       CONVERT AND STORE TEMPERATURE DATA.
C       ----------------------------------
C
C
C       STORE THE THERMAL AXES DATA.
 7100   TP(207,1) = 2.777777777E-4/UNITS(1,IUNITS)
        TP(207,2) = TP(207,1)
        TP(207,3) = TP(207,1)
        TP(208,1) = TEST (7)
        TP(208,2) = TEST (8)
        TP(208,3) = TEST (9)
        GO TO 100
C
C       READ AND PRINT THE THERMAL PROFILE.
C       -----------------------------------
C
 7200   VP(204,1) = UNITS(1,IUNITS)
        VP(205,1) = UNITS(2,IUNITS)
        VP(204,2) = UNITS(1,KUNITS)
        VP(205,2) = UNITS(2,KUNITS)
        VP(210,1) = NCARDS
        VP(210,2) = TEST(5)
        TP(204,1) = UNITS(1,IUNITS)
        TP(205,1) = UNITS(2,IUNITS)
        TP(204,2) = UNITS(1,JUNITS)
        TP(205,2) = UNITS(2,JUNITS)
        TP(204,3) = UNITS(1,9)
        TP(205,3) = UNITS(1,10)
        TP(210,1) = NCARDS
        TP(210,2) = TEST(8)
        TP(210,3) = TEST (9)
        PRINT 7202, TP(205,1),TP(205,2),TP(205,1),TP(205,2)
 7202   FORMAT(2(6X,16HCARD      DEPTH-,A6,12HTEMPERATURE-,A6,14HSALINITY
     1-/1000,6X),/)
        READ 7205, (TP(N,1),TP(N,2),TP(N,3),N=1,NCARDS)
 7205   FORMAT(3F10.5)
```

```
C
C       TEST WHICH SALINITY INPUT TO USE.
C
        SAL = 0.0
        DO 7207 I = 1,NCARDS
        IF (  TP(I,3) )  7208,      ,      ,
        SAL = SAL + TP(I,3)
        IF (SAL .GT. 0.0)  GO TO 7215
 7207   CONTINUE
        GO TO 7210
 7208   PRINT 7237, I
        PRINT 7209
 7209   FORMAT (10X,36HNEGATIVE SALINITY IS NOT VALID DATA.)
        GO TO 150
 7210   DO 7212 I = 1,NCARDS
        TP(I,3) = TP(210,3)
 7212   CONTINUE
C
C       PRINT THE TEMPERATURE PROFILE.
C
 7215   J = ( NCARDS + 1 )/2
        DO 7220 L=1,J
        N = L + J
        IF (N .LE. NCARDS)  GO TO 7220
        PRINT 7225, L,TP(L,1),TP(L,2),TP(L,3)
        GO TO 7226
 7220   PRINT 7225, L,TP(L,1),TP(L,2),TP(L,3),N,TP(N,1),TP(N,2),TP(N,3)
 7225   FORMAT(2(6X,I3,6X,F8.2,8X,F7.2,11X,F7.2,10X))
 7226   PRINT 7227, TP(210,2)
 7227   FORMAT(//,45X,12HLATITUDE =  ,F10.5,8H DEGREES,//)
C
C       CONVERT AND CHECK TEMPERATURE PROFILE
C
 7230   DO 7260 N=1,NCARDS
        IF (JUNITS .EQ. 31)  GO TO 7235
        TP(N,2) = (TP(N,2) - 32.) * TP(204,2)
 7235   IF (TP(N,2) .GT.-3.0 .AND. 35.0 .GT. TP(N,2))  GO TO 7250
C
C       THE TEMPERATURE EXCEEDS NEPTUNIAN BOUNDS.
C
        PRINT 7237, N
 7237   FORMAT(10X,31HTEMPERATURE PROFILE CARD NUMBER,I4,19HEXCEEDS ITS B
     1OUNDS.)
C
C       CHECK IF SALINITY IS WITHIN NEPTUNIAN BOUNDS.
C
 7250   IF (SAL .GT. 0.0)  GO TO 7254
        K = N
        IF (K .GT. 1 )  GO TO 7260
        IF (TP(210,3) .GE. 0.0 .AND. 43.0 .GT. TP(210,3))  GO TO 7260
        GO TO 7256
 7254   IF (TP(N,3) .GE. 0.0 .AND. 43.0 .GT. TP(210,3))  GO TO 7260
C
C       THE SALINITY EXCEEDS NEPTUNIAN BOUNDS.
C
 7255   PRINT 7257
        PRINT 7237, N
        GO TO 7260
```

```
 7256   PRINT 7257
 7257   FORMAT(10X,40HSALINITY IS NOT WITHIN NEPTUNIAN BOUNDS.)
 7260   CONTINUE
        CALL BT(TP)
C
C       PRINT THE HEADING
C
        IHEAD = 0
        LINES = NCARDS/2 + 10 + LINES
        IF (LINES .LT. LINMAX - 1)  GO TO 7320
        PRINT 322
        LINES = NCARDS/2 + 6
        GO TO 7330
 7320   PRINT 332
 7330   PRINT 7335
 7335   FORMAT ( 51X,17HVELOCITY PROFILE ,/,51X,17H----------------,/)
C
C       PRINT THE VELOCITY PROFILE.
C
        PRINT 6202, VP(205,1),VP(205,2),VP(205,1),VP(205,2)
        GO TO 6210
C
C
C
C       PROCESS CONGRATS.
C       -----------------
 8000   IF( PRINT.LT.TEST(3) .OR. PRINT.GT.TEST(3) )  GO TO 8010
        NPRINT = 1
        GO TO 8020
 8010   NPRINT = 0
 8020   FLD(27,9,PROCES) = NPRINT + 8 * (NTAPE1 + 8*NTAPE2)
C
C       IS THERE AT LEAST ONE COMMENT CARD.
        IF( ICMMNT.GT.0 )  GO TO 8100
        PRINT 1001, (CMMNT(J),J=1,12)
        LINES = LINES + 1
C
C       INITIALIZE THE PLOTTER TAPE.
 8100   IF( NTAPE1.NE.1 )  GO TO 8200
        CALL  PLOTS( DATA,2048,1 )
        CALL  PLOT(0.0,0.0,IPAPER)
        CALL  PLOT(5.0,0.0,-3)
        CALL  SYMBOL(0.0,0.0,0.14,CMMNT(1),90.0,72)
        CALL  PLOT(5.0,0.0,-3)
        NTAPE1 = 2
C
C       SORT THE TARGET COORDINATES.
 8200   DO 8260  J=1,2
        N = TARGET(1010,J)
        IF( N.LT.2 )  GO TO 8260
        L = 1
 8210   I = L + 1
 8220   IF( TARGET(L,J)-TARGET(I,J) )  8250,8230,8240
 8230   TARGET(I,J) = TARGET(N,J)
        N = N - 1
        GO TO 8250
 8240   TARGET(N+1,J) = TARGET(I,J)
        TARGET(I,J) = TARGET(L,J)
```

```
      TARGET(L,J) = TARGET(N+1,J)
 8250 I = I + 1
      IF( I.LE.N )  GO TO 8220
      L = L + 1
      IF( L.LT.N )  GO TO 8210
      TARGET(1010,J) = N
 8260 CONTINUE
      CALL BTPLOT(TP)
C
C     SET THE MAXIMUM REVERSAL INCREMENT.
      IF( REVMAX(2).GT.REVMAX(1) )  GO TO 8270
      REVMAX(3) = 0.0
      GO TO 8300
 8270 N = TARGET(1010,1)
      REVMAX(3) = (TARGET(N,1)-TARGET(1,1))/(REVMAX(2)-REVMAX(1))
C
C     SORT THE SONAR ANGLES.
 8300 N = ANGLES(1010)
      IF( N.LT.1 )  GO TO 8400
      DO 8305  L=1,N
      IF( ABS(ANGLES(L)).GT.1.0E-4 )  GO TO 8305
      ANGLES(L) = 0.0
 8305 CONTINUE
      IF( N.LT.2 )  GO TO 8400
      L = 1
 8310 I = L + 1
 8320 IF( ANGLES(L)-ANGLES(I) )  8350,8330,8340
 8330 ANGLES(I) = ANGLES(N)
      N = N - 1
      GO TO 8350
 8340 ANGLES(N+1) = ANGLES(I)
      ANGLES(I) = ANGLES(L)
      ANGLES(L) = ANGLES(N+1)
 8350 I = I + 1
      IF( I.LE.N )  GO TO 8320
      L = L + 1
      IF( L.LT.N )  GO TO 8310
      ANGLES(1010) = N
 8400 RETURN
C
C
C
C     TERMINATE CONGRATS.
C     -------------------
 9000 PRINT 9002
 9002 FORMAT( 1H1, 9X 28HCONGRATS HAS BEEN COMPLETED. , /, 1H1 )
 9030 IF( NTAPE2.EQ.0 )  GO TO 9090
      END FILE 2
 9090 STOP 5
C
C
C
C     READ MISCELLANEOUS DATA.
C     ------------------------
C
C     READ THE FREQUENCY.
 9100 TARGET(1008,3) = TEST(7)
      IF( (IUNITS-27)*(IUNITS-28) )  380,9110,380
```

```
 9110   TARGET(1008,1) = ATTEN(TARGET(1008,3))
        PRINT 9112, TARGET(1008,1)
 9112   FORMAT( 24X, 12HATTENUATION , 12A 6HDB/KYD, 6X F12.5 )
        LINES = LINES + 1
        GO TO 100
C
C       READ THE MAXIMUM NUMBER OF REVERSALS.
 9200   REVMAX(1) = TEST(7)
        REVMAX(2) = MAX(TEST(7),TEST(8))
        REVMAX(4) = TEST(9)
        TEST(8) = REVMAX(2)
        IUNITS = 15
        IF( REVMAX(2).LT.201.0 )  GO TO 320
        PRINT 9202
 9202   FORMAT( 10X45HTHE MAXIMUM NUMBER OF REVERSALS EXCEEDS 200.0 )
        GO TO 140
        END
```