NORDA Technical Note 183

Naval Ocean Research
and Development Activity
NSTL Station, Mississippi 39529

A Bathythermograph to Sound Velocity Profile Program for the HP-41CV Calculator, Including a Northern Hemisphere Salinity Profile Library

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ABSTRACT

This technical note documents a program written specifically for the HP-41CV calculator to convert a bathythermograph profile to a sound speed profile. The format of the report follows the guidelines set forth by the Navy Tactical Support Activity, Fleet Mission Program Library.

The program documented herein differs from existing calculator programs used for a similar purpose (Kerr, 1982) in that an archival salinity profile library is included with the program.

Magnetic card copies of the program and salinity profile library may be obtained from the Naval Oceanographic Office, Code 9200.

ACKNOWLEDGMENTS

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NAVY TACTICAL SUPPORT ACTIVITY

FLEET MISSION PROGRAM LIBRARY

PROGRAM SUBMITTAL FORM

I. (U) SUMMARY

IDENTIFICATION NUMBER/MOD _____

A. (U) PROGRAM TYPE:

- ___ TACTICS
- ___ ASW TACTICS
  - ___ SEARCH
  - ___ LOCALIZATION/APPROACH
  - ___ TRACKING/ATTACK
  - ___ DIRECT SUPPORT
- ___ AAW TACTICS
- ___ SURFACE WARFARE TACTICS
- ___ SURVEILLANCE
- ___ COMMUNICATIONS
- ___ SENSOR OPERATIONS
- X ENVIRONMENT
- ___ NAVIGATION
- ___ LOGISTICS
- ___ ENGINEERING
- ___ ADMINISTRATIVE
- ___ OTHER

B. (U) PROGRAM CLASSIFICATION: UNCLASSIFIED

C. (U) PROGRAM TITLE: Bathythermograph→Sound Velocity Profile

D. (U) DATE: EFFECTIVE: 24 November 1982 CANCELLED: _____

E. (U) COMMAND: ORIGINATOR: G. A. Kerr, NORDA Code 323

CONTROL: _____

CONTACT: G. A. Kerr, NORDA Code 323 TEL: A/V 485-4627

F. (U) TACTICAL REFERENCES: None

1. TITLE ( ) _____

REPORT NO. _____ ORIGINATOR _____

DATE _____ *FTL ACC NO* _____

2. TITLE ( ) _____

REPORT NO. _____ ORIGINATOR _____

DATE _____ *FTL ACC NO* _____

G. (U) APPLICATION

EQUIPMENT HP-41CV

SOFTWARE/LANGUAGE HP-41CV

H. (U) STORAGE MEDIA:

- X MAGNETIC CARDS
- ___ MAGNETIC TAPE
- ___ PAPER TAPE
- ___ CASSETTE
- ___ KEYPUNCH CARD
- ___ OTHER

I. (U) PLATFORM:

- X SHORE-BASED PATROL AIRCRAFT
- X CARRIER-BASED ASW AIRCRAFT
- X ROTARY WING AIRCRAFT
- ___ TACTICAL AIRCRAFT
- X SURFACE SHIP
- X SUBMARINE
- ___ SHORE ACTIVITIES
- ___ ALL FLEET UNITS

IDENTIFICATION NUMBER/

II. (U) OPERATING GUIDELINES

A. (U) GENERAL GUIDELINES AND LIMITATIONS

1. When prompted for a salinity profile, "NEW SAL?", the response will be either a yes (Y) or a no (N). If a Y response is given, the program will prompt the user for magnetic cards (CARD). The cards containing the salinity profile to be entered are found in the accompanying library of salinity profiles. If an N response is given, the calculator will use the salinity profile stored from the previous program run.

2. Depth-temperature (BT) data is entered directly into the program as depth (FT) and temperature (°F). The data points may be entered in any order, i.e., depth does not have to be strictly increasing. However, entering data in order of increasing depth will reduce data entry time. If an error is made, simply reenter the same depth as the error and the correct temperature. A maximum of 20 depth-temperature pairs may be entered. The maximum depth which may be entered is 6561 feet. The message "TOO DEEP" will appear if this limit is exceeded. The initial BT data entry portion of the program is ended by entering a negative depth of any number for the temperature.

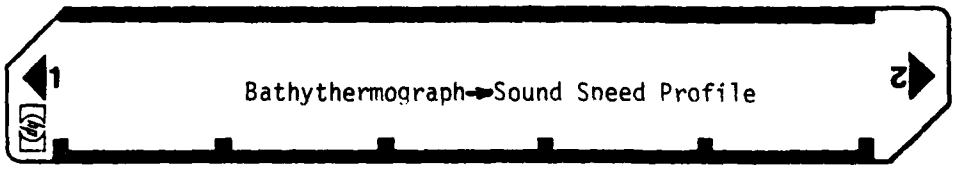
3. Additional corrections can be made to the entered BT data when the program prompts for addition corrections (CORRECTIONS?). A response of yes (Y) will result in the calculator prompting for the depth of the point to be replaced (BAD DEPTH). If the depth entered does not exactly match a depth entered during the initial data entry portion of the program, an error message (D NOT FND) will appear and the program will return with a CORRECTIONS? prompt. If the depth entered matches an initial entry depth then the initial data point is deleted and a prompt for the input of a new data (NEW PT) is generated. New depth-temperature points are entered as in the initial data entry phase. Any number of points may be replaced. If a response of no (N) is made to the CORRECTIONS? prompt the program will proceed to calcualte the sound speed from the existing data set.

4. The sound speed is output in the form depth (FT) and sound speed (FT/sec).

5. The sound speed profile in the form depth (FT) sound speed (FT/sec) can be saved on magnetic cards by responding with a yes (Y) to the prompt "SVP ON CRD." This data can be used in the "Sound Velocity Profile Propagation Loss." program written for the HP41CV.

IDENTIFICATION NUMBER/MOD

II. B. (U) USER INSTRUCTIONS



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Adjust Calculator Memory	153	XEQ	
			ALPHA	
			S	
			I	
			Z	
			E	
			ALPHA	
2	Load Program Cards (6)			
3	Begin Program Execution		XEQ	
			ALPHA	
			B	
			T	
			S	
			S	
			ALPHA	
4	Respond to "NEW SALINITY" Prompt			
	(a) To input new salinity profile		Y R/S	
	or (b) To use previous salinity profile		N R/S	
	If a new salinity profile is to be entered go to step 5, if not go to step 6.			
	NOTE: A salinity profile must be entered for the first application of the program			
5	Respond to "CARD" Prompt			
	Insert magnetic cards as instructed, e.g. side one of the first card, followed by side two of the first card, etc.			

IDENTIFICATION NUMBER/MOD

B. (U) USER INSTRUCTIONS (CONT'D)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
6	Enter Depth	$Df/_{o}FT$	↑		
7	Enter Temperature	T_f/F	R/S		D_F T_F
	Enter first depth temperature point after				
	"DTH TEMP" prompt. Repeat steps 6 and 7 for				
	up to 20 points. Output for each entry is depth (FT) and temperature (^{o}F).				
	To terminate input enter a negative depth any number for temperature.				
	If an incorrect temperature is entered, simply				
	reenter the same depth as the error and the correct temperature.				
	If a 'TOO DEEP' message appears in the display the depth entered was larger than the maximum				
	(6561 ft.) allowed. Go to step 6.				
8	Respond to "CORRECTIONS?" Promot				
	(a) To make corrections		Y	R/S	
	or (b) To skip corrections		N	R/S	
	If corrections are to be made go to step 9, if not go to step 11.				
9	Respond to "BAD DEPTH" Prompt				
	Enter the depth of the depth-temperature point to be replaced.	D_f/FT	R/S		
	If "D NOT FND" message appears in the display the depth entered in step 9 could not be				
	matched with any of those entered in step 6.				
	Go to step 8.				

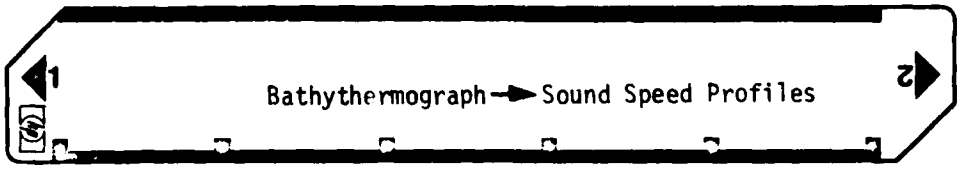
IDENTIFICATION NUMBER/MOD

B. (U) USER INSTRUCTIONS (CONT'D)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
10	Respond to "NEW PT" PROMPT:			
	(a) Enter the new depth	D_f/FT	↑	
	and (b) Enter the new temperature	T_f/^oF	R/S	D_f T_f
	The output for each entry is depth (FT) and Temperature (^oF).			
	Return to Step 8			
11	Sound Speed Profile Output	none		D_f SS_f
	For each depth - temperature point entered a depth (FT) and sound speed (FT/SEC) is output.			
12	Respond to "SSP ON CRD" Prompt			
	(a) To store the sound speed profile on magnetic cards		Y R/S	
	or (b) To skip to the end of the program		N R/S	
	If the sound speed profile is to be stored, go to Step 13.			
13	Insert Blank, Unprotected Magnetic Cards as Requested.			D_f, SS_f
	Output will be of the form depth (FT), Sound Speed (FT/SEC)			
	NOTE: To enter a different set of data points, to Step 3.			

IDENTIFICATION NUMBER/MOD

II. C. (U) EXAMPLE AND IN-FLIGHT PAGES



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Adjust calculator memory	153	XEQ	
			ALPHA	
			S	
			1	
			Z	
			E	
			ALPHA	
2	Load Program Cards (6)			
3	Execute Program		XEQ	
			ALPHA	
			B	
			T	
			S	
			S	
			ALPHA	
	"New Salinity" Prompt			
	Y for new salinity profile			
	N for previously loaded profile			
4	"New Salinity"		Y R/S	
	For a "N" response go to Step 6			
	"CARD" Prompt			
5	Insert new salinity profile cards			
	Depth (Ft)/Temperature (^{O}F)			
	Data may be entered in any order			
6	Depth	0 Ft.	↑	0.0 Ft.
7	Temperature	75.0 ^{O}F	R/S	75.0 ^{O}F
	Repeat Steps 6 and 7 for up to 20 points			

IDENTIFICATION NUMBER/MOD

II. C. (U) EXAMPLE AND IN-FLIGHT PAGES (CONT'D)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
6	Depth	100 Ft.	↑	100.0 Ft
7	Temperature	68.0 °F	R/S	68.0 °F
6	Depth	600 Ft.	↑	600.0 Ft
7	Temperature	52.0 °F	R/S	52.0 °F
	End initial input with a negative depth and any temperature			
6	Depth	-1 Ft.	↑	
7	Temperature	3 °F	R/S	
	"Corrections" Prompt Y to make corrections N to skip corrections and calculate sound speeds For a no (N) response skip to Step 11			
8	"Corrections"		Y R/S	
	"Bad Depth" If the depth entered cannot be found the message "D NOT FND" will appear. Go to Step 8.	100 Ft	R/S	
	"NEW PT." Prompt Enter the new depth (FT) temperature of point			
10	"NEW PT"			
	(a) Depth	120 Ft.	↑	120.0 Ft
	(b) Temperature	67 °F	R/S	67.0 °F
	Steps 8, 9 and 10 may be repeated as many times as necessary to obtain a correct temperature profile.			

IDENTIFICATION NUMBER/MOD

II. C. (U) EXAMPLE AND IN-FLIGHT PAGES (CONT'D)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
	Sound Speed Profile			
11	Sound Speed for up to 20 input depth-temperature points. Output = D (FT) and sound speed (FT/SEC) for each point.			0.0 5015.0 120.0 4988.4 600.0 4912.3
	Note: Your sound speed results will probably differ from those given here because the same salinity profiles were not used.			
	"SSP ON CRD" Prompt Y to store the sound speed profile on cards N to not store and end the program			
12	"SSP ON CRD"		Y R/S	
	Store sound speed profile on cards			
13	Insert blank cards as requested. OUTPUT = D (FT) • Sound Speed (FT/SEC)			0.5015 120.4988 600.4912

IDENTIFICATION NUMBER/MOD

III. (U) PROGRAM DOCUMENTATION

A. (U) DISCUSSION/ANALYSIS

This program generates a sound speed profile from an input temperature profile. The program must be provided with a salinity profile from which interpolated salinities can be determined at input temperature depths.

The major sections within this program identified by beginning labels are:

1. LBL "C" (used to issue data entry instructions). Stores and prints instructions in the print buffer. If a printer is not attached (FLG 55 set) messages throughout the program are held in the display for one PSE.

2. LBL "B" (used to enter, and store depth-temperature points). Points are stored in order of increasing depth. Registers 5 and 6 are used for temporary storage of depth and temperature respectfully. Register 18 is used to store the total number of points entered; and register 17 is used to store the deepest depth entered. If the depth of a newly entered point is larger than the deepest stored depth, then the new point is stored in the next sequential storage register locations. If the depth entered is less than the deepest stored depth, then the point is stored in the appropriate location by depth replacing an existing point in memory. The replaced point is stored in temporary storage locations previously used by the new data point and the "fitting by depth" procedure is repeated until all data points are in the correct order. Flag 3 is clear to indicate the program is in the original data entry made. A maximum of 20 points may be entered.

3. LBL "COR" (used to make final corrections to the entered depth-temperature data). Given the depth of the bad data point, the point is deleted from memory and the points located at deeper depths are moved up one memory location. Storage of correcting data is handled by the same procedures used to store the original data points. Flag 3 is set to indicate the program is in the correction mode.

4. LBL "DSP" (used to print input data points). Accumulates depth and temperature values to the print buffer for printing.

5. LBL "INTR" (used to calculate, through linear interpolation, the salinity at each entered depth). Register 15 is used to store the location of the temperature profile depth (d_T). Register 16 is used to store the location of the salinity profile depth (d_2) deeper than d_T. Register 7 is used to store the location of the salinity profile depth (d_1) shallower than d_T. Register 12 is used to store relative location of the interpolated salinity (S_T). Register 18 is used to store the location of salinity (S_1) corresponding to d_1. Register 19 is used to store the location of the salinity (S_2) corresponding to d_2. ST is found from:

$$ST = \frac{d_T - d_1}{d_2 - d_1}(S_2 - S_1) + S_1$$

IDENTIFICATION NUMBER/MOD

III. (U) PROGRAM DOCUMENTATION

A. (U) DISCUSSION/ANALYSIS (Cont'd)

6. LBL "SSPD" (used to calculate the sound speed from temperature (T), salinity (S), and depth (D).) For each input D the following data are calculated and stored (storage register): T(0), T^2(1), T^3(2), S(3), D(4), and D^2(5). The speed of sound (S) is calculated using Mackenzie's (1981) equation modified for English units. the modified equation is:

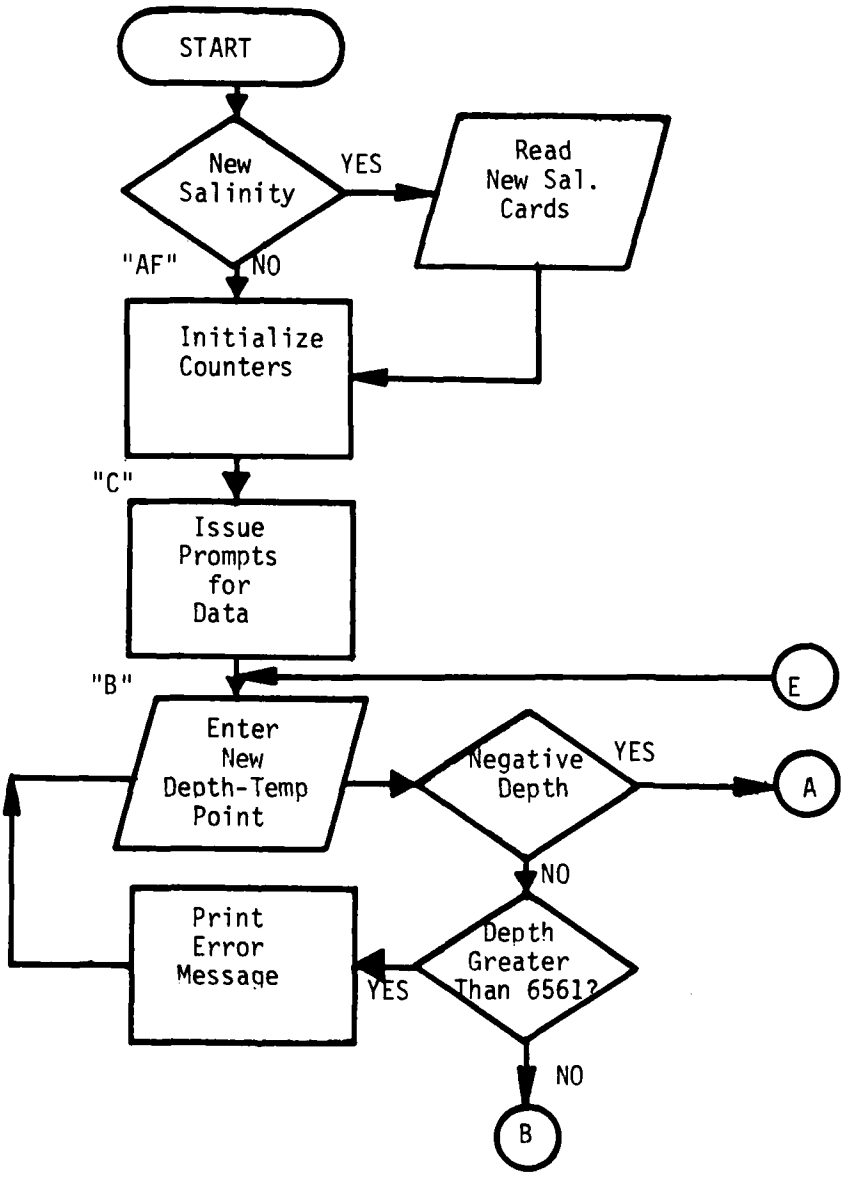
$$S = 3.2808\ (1295.97 + 3.9229T - 2.0278T^2 \times 10^{-2} + 4.071 \times 10^{-5} T^3 + 4.9683 \times 10^{-3} D + 1.5562 \times 10^{-8} D^2 + 1.522\ S - 5.6944 \times 10^{-3}\ TS$$

The $10^{-13}TD^3$ term of the original equation was omitted since this term would be insignificant for the depths considered in the program ($\leq$6561 FT).

IDENTIFICATION NUMBER/MOD

A. DISCUSSION/ANALYSIS (CONT'D)

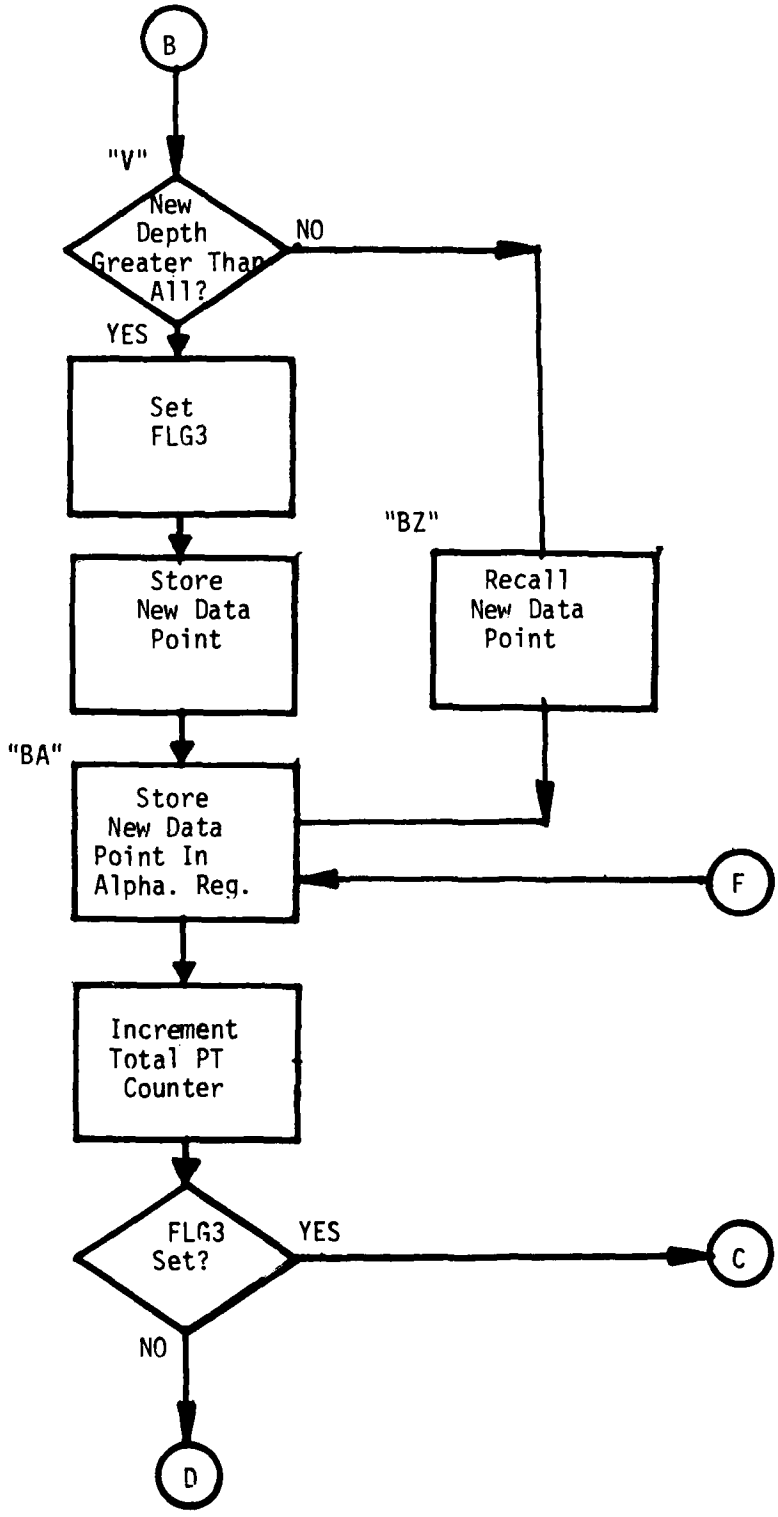
The Flow of the Main Program is as follows:



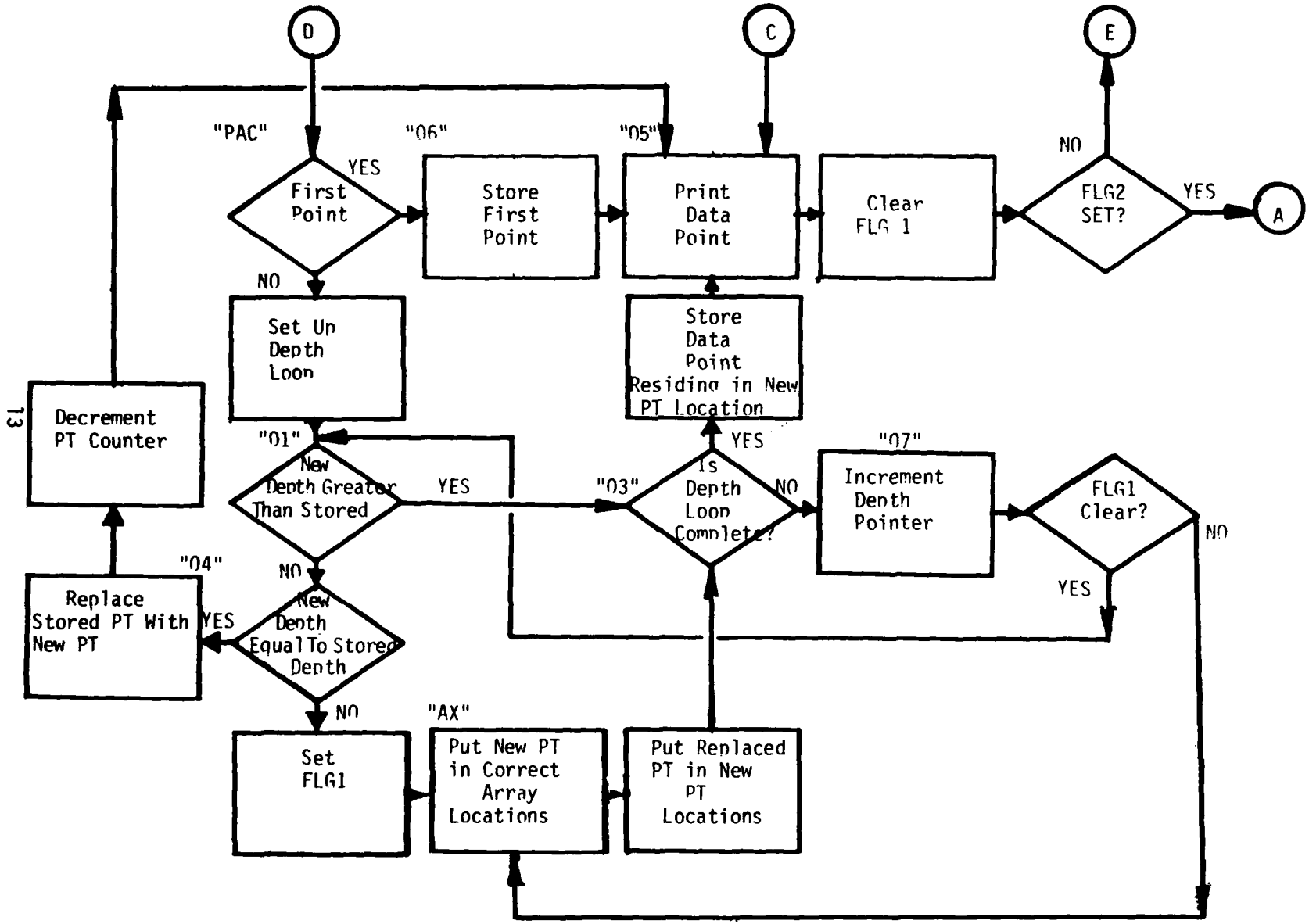
IDENTIFICATION NUMBER/MOD

A. DISCUSSION/ANALYSIS (CONT'D)

Flow of Main Program Cont'd:



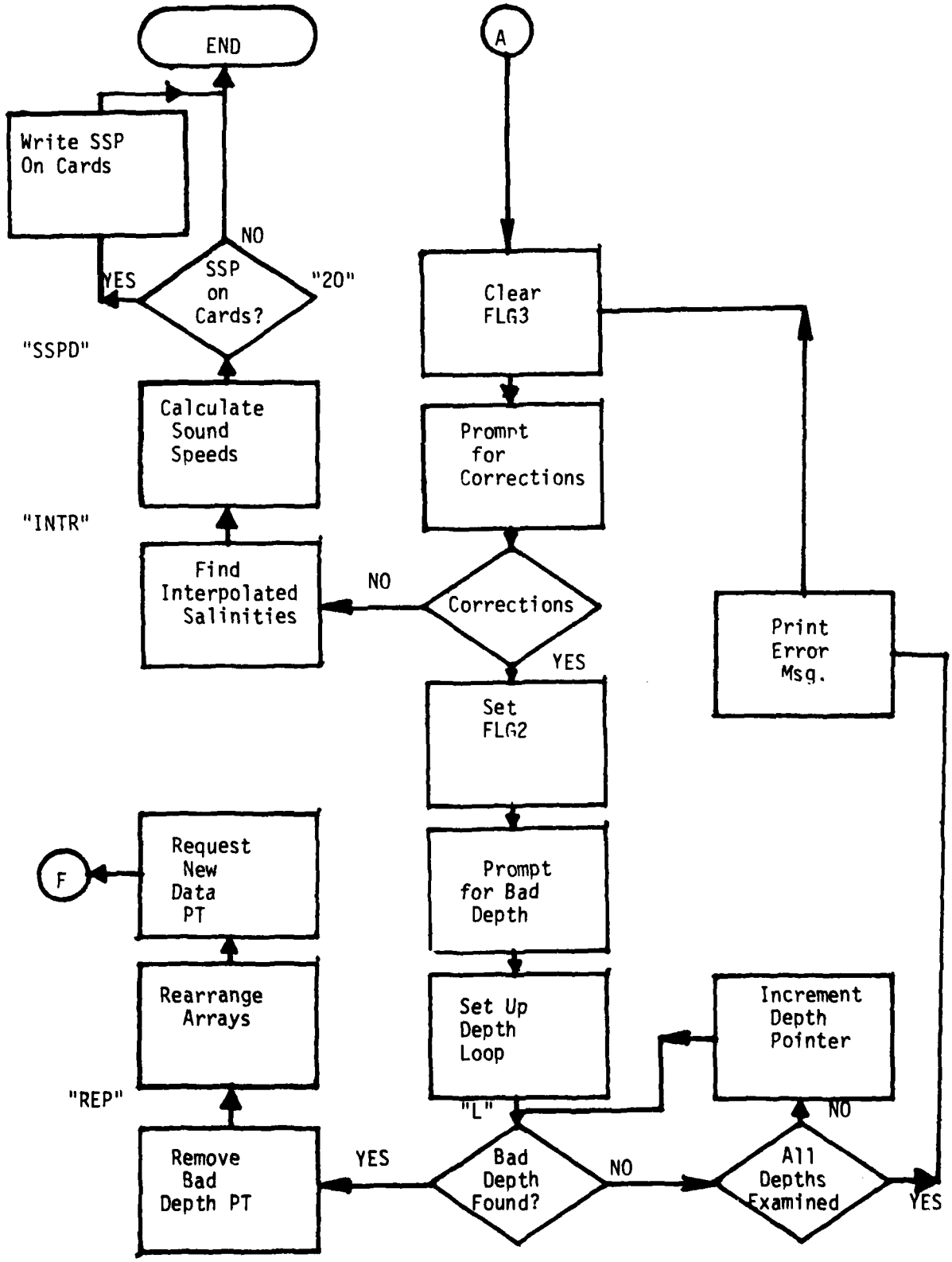
IDENTIFICATION NUMBER/MOD
A. DISCUSSION/ANALYSIS (Cont'd)
Flow of Main Program Cont'd



IDENTIFICATION NUMBER/MOD

A. DISCUSSION/ANALYSIS (CONT'D)

Flow of Main Program Cont'd



IDENTIFICATION NUMBER/MOD

B. (U) REFERENCES

1. Nine-term Equation for Sound Speed in the Oceans, Mackenzie, K. V., The Journal of the Acoustical Society of America, 1981, Vol. 70, Number 3, p. 807-812.

2. An Evaluation of Fleet Mission Program Library Program V10011/B (Bathythermograph Sound Velocity Profile, Kerr, G. A., Naval Ocean Research and Development Activity. Technical Note 192, 1983.

C. (U) PROGRAM DATA

DATA REGISTERS

(0) through (19)	USED
(20) through (30)	BT DEPTH (OUTPUT SSP)
(40) through (59)	BT TEMPERATURE
(60) through (79)	INTERPOLATED SALINITY
(80) through (99)	CALCULATED SOUND SPEED
(100) through (125)	SALINITY PROFILE DEPTH
(126) through (151)	SALINITY PROFILE SALINITY
(152)	NO. OF POINTS IN SAL. PROF.

FLAGS

01) SET WHEN NEW DATA HAS BEEN STORED
02) SET WHEN IN CORRECTION MODE
03) SET WHEN ENTERED DEPTH IS LARGER THAN ALL DEPTHS ENTERED PREVIOUSLY

LABELS

(SUBROUTINES)	(OTHER)	
	01	L
DSP	03 through 09	REP
PAC	20	AX
	30	INTR
	BTSS	BEG
	AF	XAC
	V	AJ
	BZ	INTP
	BA	SSPD
	COR	

IDENTIFICATION NUMBER/MOD _____

D. (U) PROGRAM LISTING

STEP/KEY ENTRY	COMMENT
02 SF 11	
03 FIX 3	
04 "N"	
05 ASTO Y	
06 "NEW SAL ?"	New Salinity Profile Prompt
07 PON	
08 PROMPT	
09 ASTO X	
10 AOFF	
11 R/S	
12 GTO "AF"	
13 CLRG	
14 100.152	Read New Salinity Profile Cards
15 STO X	
16 RTNAX	
17*LBL "AF"	
18 AOFF	
19 20	Initialize Registers
20 STO 11	
21 0	
22 STO 16	
23 STO 19	
24 CLA	
25 CLR	
26*LBL C	
27 "TO ENTER"	
28 AVIEW	
29 FC? 55	
30 PSE	
31 CLA	
32 "TEMP:PROF"	Print Data Entry Instructions
33 AVIEW	
34 FC? 55	
35 PSE	
36 CLA	
37 ADV	
38 "DEPTH :ENTER."	
39 AVIEW	
40 FC? 55	
41 PSE	
42 CLA	
43 "TEMP :RS:"	
44 AVIEW	
45 FC? 55	
46 PSE	
47 CLA	
48 ADV	
49 "IF DONE"	
50 AVIEW	
51 FC? 55	
52 PSE	
53 CLA	
54 "NEG"	
55 CLA	
56 "NEG 0 ENTER"	
57 AVIEW	
58 FC? 55	
59 PSE	
60 CLA	
61 "ANY NO :RS:"	
62 AVIEW	
63 FC? 55	
64 PSE	
65 CLA	
66 ADV	
67 "DTH TEMP"	
68 AVIEW	
69 CLA	
70*LBL E	Enter Depth-Temperature
71 STOP	
72 X=0?	Check for End of Input Data
73 0	
74 X=Y?	
75 GTO "COR"	Make Corrections
76 ADV	Check for Too Large A Depth
77 65E3	
78 X>Y?	
79 GTO "A"	
80 "TOO DEEP"	
81 AVIEW	
82 CLA	
83 GTO E	
84*LBL "A"	
85 SF 03	
86 RCL 12	
87 STO 06	Store Temp.
88 RCL 11	
89 STO 05	Store Depth
90 RCL 11	No. PT Entered
91 RCL 16	Find Deepest Depth Entered
92 +	
93 1	
94 -	
95 STO 17	
96 RCL IND 17	
97 RCL 05	Compare Depth Against Deepest
98 X<=Y?	
99 GTO "BZ"	
100 RCL 17	Store Depth
101 1	
102 +	
103 STO 17	
104 RCL 05	
105 STO IND 17	
106 RCL 17	Store Temperature
107 20	
108 +	
109 STO 17	
110 RCL 06	
111 STO IND 17	

IDENTIFICATION NUMBER/MOD _____

E. (U) PROGRAM LISTING (CONT'D)

STEP/KEY ENTRY	COMMENT
[illegible]	Data Has Been Stored
[illegible]LBL "B2"	
114 RCL 05	Recall Data
115 RCL 06	
116*LBL "BA"	Go Store Point in
117 XEQ "DSP"	Alpha Registers
118 FS? 03	Data in Array?
119 GTO 05	
120 XEQ "PAC"	Place Out of Seq. Data
121 FS? 02	In Correction Mode?
122 GTO "COR"	Go to Corrections
123 RTN	Section
124*LBL "COR"	Beginning of Corrections
125 FC? 55	Section
126 PSE	
127 CF 03	
128 "N"	
129 ASTO Y	
130 "CORRECTIONS?"	Are Corrections Required
131 AON	
132 PROMPT	
133 ASTO X	
134 AOFF	
135 X=Y?	
136 GTO "INTP"	Go Perform Interpolation
137 SF 03	Corrections Being Made
138 "BAD DEPTH"	Enter Depth of
139 PROMPT	Bad Data Point
140 STO 00	
141 RCL 18	Recall Number of Points
142 1000	Entered and Set Up
143 /	Loop
144 1	
145 +	
146 STO 0.	
147 19	Set Up Pointer to Depth
148 STO 02	
149*LBL "L"	Increment Pointer to
150 RCL 02	Depth
151 1	
152 +	
153 STO 02	
154 RCL 00	Recall Bad Depth and
155 RCL IND 02	Array Depth and Compare
156 X=Y?	
157 GTO "REP"	Go Make Replacement
158 ISG 01	All Depths Checked?
159 GTO "L"	Go Get Next Depth
160 "PT NOT FND"	Print Error Message
161 AVIEW	and Return to Correction
162 FC? 55	Beginning
163 PSE	
164 GTO "COR"	
165*LBL "REP"	Beginning of Replacement
166 RCL 02	
167 20	Find Temp.
168 +	Location for
169 STO 04	Bad Depth
170 RCL 02	Replace
171 1	Depth With
172 +	Next Deepest
173 STO 03	
174 RCL IND 03	
175 STO IND 02	
176 RCL 04	Replace Temp.
177 1	With Next
178 +	Deepest
179 STO 05	
180 RCL IND 05	
181 STO IND 04	
182 RCL 02	Increment
183 1	Depth Pointer
184 +	
185 STO 02	
186 RCL 04	Increment
187 1	Temperature
188 -	Pointer
189 STO 04	
190 ISG 01	Enter Array
191 GTO "RE"	Bumped? Go to Rep. Rec
192 RCL 18	
193 1	Decrement No.
194 -	of Pts.
195 STO 18	
196 "NEW PT"	Get Replace-
197 AVIEW	ment Point
198 STOP	
199 GTO "BA"	Put PT. in
200 STOP	Arrays
201*LBL "DSP"	
202 CLA	
203 ARCL Y	
204 ASTO 01	
205 CLA	Store Entered
206 ARCL X	Point in Alph
207 ASTO 02	Registers for
208 CLA	Printing
209 RCL 18	
210 1	
211 +	
212 STO 18	
213 * *	
214 ASTO 04	
215 CLA	
216 RDN	
217 X=Y?	
218 RTN	
219*LBL "PAC"	Place out of Seq Pts
220 STO 05	Store Depth
221 RCL Y	

IDENTIFICATION NUMBER/MOD _____

E. (U) PROGRAM LISTING (CONT'D)

STEP/KEY ENTRY	COMMENT
222 STO 06	Store Temp. to be Placed in Array
223 RCL 16	Find No. of Pts. Entered
224 1	
225 -	
226 ENTER*	
227 x=0?	First Point Treat as First Pt.
228 GTO 06	
229 1 E3	
230 /	Set Up Loop
231 1	
232 +	
233 STO 07	
234 RCL 13	
235*LBL 01	Recall Depth from Array
236 STO 00	
237 RCL IND 00	
238 RCL 05	Recall New Depth and Compare
239 X<>Y?	
240 GTO 03	
241 x=Y?	
242 GTO 04	
243 SF 01	Location for New Data Found
244*LBL "A/"	
245 RCL IND 06	
246 STO 00	Place Depth and Temp. in Arrays and Store Replaced Data in Depth and Temp. Temporary Locations
247 RCL 05	
248 STO IND 06	
249 RCL 00	
250 STO 05	
251 RCL 00	
252 20	
253 +	
254 STO 06	
255 RCL IND 00	
256 STO 00	
257 RCL 06	
258 STO IND 00	
259 RCL 00	
260 STO 06	
261 RCL 00	
262 20	
263 -	
264 STO 00	
265*LBL 03	
266 ISG 07	Have Arrays Been Exhausted?
267 GTO 07	
268 RCL 00	
269 1	
270 +	Store Last Array Points
271 STO 00	
272 RCL 05	
273 STO IND 00	
274 RDN	
275 20	
276 +	
277 STO 05	
278 RCL 00	
279 STO IND 00	
280 GTO 05	
281*LBL 04	For Exact Depth Match Replace Data PT with New PT
282 STO IND 00	
283 RCL Z	
284 20	
285 +	
286 STO 00	
287 RCL 00	
288 STO IND 00	
289 RCL 16	
290 1	
291 -	
292 STO 16	
293*LBL 05	
294 CLA	Print New Point
295 CLX	
296 ARCL 01	
297 ARCL 04	
298 ARCL 02	
299 AVIEW	
300 CF 01	
301 FS? 02	In Correction Mode?
302 GTO "COR"	
303 GTO B	
304*LBL 06	Store First Data Point
305 RCL 05	
306 STO 20	
307 RCL 06	
308 STO 40	
309 GTO 05	
310*LBL 07	Increment Depth Counter Check Mode an Go Accordingl
311 RCL 00	
312 1	
313 +	
314 FS? 01	
315 GTO 01	
316 STO 00	
317 GTO "AX"	
318*LBL "INTR"	
319 ADV	Begin Inter-polation of Salinity Profile for Entered Depth
320 CF 02	
321 CLA	
322 "INTERPOLATED"	
323 AVIEW	
324 CLA	
325 "SALINITY"	
326 AVIEW	
327 0	
328 STO 13	
329 20	
330 STO 15	
331 100	

IDENTIFICATION NUMBER/MOD _____

E. (U) PROGRAM LISTING (CONT'D)

STEP/KEY ENTRY	COMMENT
332 [illegible]	Store Location of First Depth of Sal.Prof.
333*LBL "EEG"	Compare Entered Depths w/ Sal.Prof. Depths
334 RCL IND 16	
335 RCL IND 15	
336 X>Y?	
337 GTO "AJ"	Interp. Possible
338 X=Y?	Exact Match?
339 GTO "XAC"	
340 RCL 16	Decrement Sal. Depth
341 1	
342 -	
343 STO 16	
344 GTO "EEG"	
345*LBL "XAC"	For Exact Match Find Salinity Location and Store
346 RCL 16	
347 26	
348 +	
349 STO 00	
350 RCL IND 00	
351*LBL 00	Find Location for Interpolated Salinity and Store
352 RCL 15	
353 40	
354 +	
355 STO 12	
356 RDN	Store Int. Sal.
357 STO IND 12	
358 RCL 16	Keep Track of the Number of Pts for which Sal. was Calculated
359 RCL 13	
360 1	
361 +	
362 STO 13	
363 X>Y?	Go Calculate Sound Speed If all Depths Have Salinity, if not continue Interp.
364 GTO "SSPD"	
365 RCL 15	
366 1	
367 +	
368 STO 15	
369 GTO "BEG"	
370*LBL "AJ"	Make Sure Entered Depth is Between Salinity Depths
371 RCL 16	
372 1	
373 +	
374 STO 16	
375 RDN	
376 RCL IND 16	
377 X>Y?	
378 GTO "INTP"	Go Perform Interp.
379 GTO "EEG"	Go to Beginning of Proc.
380*LBL "INTP"	
381 RCL 16	
382 1	
383 -	
384 STO 07	
385 RCL IND 07	
386 RDN	
387 RDN	
388 X<>Y	
389 RCL Z	
390 -	
391 RCL Y	
392 RCL T	
393 -	
394 /	
395 RCL 16	Perform Linear Interpolation Between Sal. Profile Depths
396 26	
397 +	
398 STO 08	
399 RCL 07	
400 26	
401 +	
402 STO 15	
403 RDN	
404 RDN	
405 RCL IND 08	
406 RCL IND 15	
407 -	
408 *	
409 RCL IND 19	
410 +	
411 GTO 00	
412*LBL "SSPD"	
413 CLA	Get Ready to Calculate the Sound Speed
414 [illegible]	
415 ARCL 10	
416 CF 29	
417 CLA	
418 "SOUND SPD"	
419 AVIEW	
420 "PROFILE"	
421 AVIEW	
422 CLA	
423 ADV	
424 "DTH SSPD"	
425 AVIEW	
426 CLA	
427 RCL 16	Set Up Loop and Pointer
428 1 EE	
429 /	
430 1	
431 +	
432 STO 05	
433 19	
434 STO 09	
435*LBL 09	
436 CLA	Increment Pointer
437 RCL 09	
438 1	
439 +	
440 STO 09	
441 ARCL IND 09	

IDENTIFICATION NUMBER/MOD _____

E. (U) PROGRAM LISTING (CONT'D)

STEP/KEY ENTRY	COMMENT
442 ARCL 10	
443 RCL IND 09	
444 STO 04	Store Depth
445 RCL IND 09	
446 *	
447 STO 05	Store Depth **2
448 RCL 09	
449 20	
450 +	
451 STO 09	
452 RCL IND 09	
453 STO 00	Store Temperature
454 RCL IND 09	
455 *	
456 STO 01	Store Temp **2
457 RCL IND 09	
458 *	
459 STO 02	
460 RCL 09	
461 20	
462 +	
463 STO 09	
464 RCL IND 09	
465 STO 03	Store Salinity
466 RCL 00	
467 3.9229	
468 *	
469 RCL 01	
470 2.6276 E-2	
471 *	
472 -	
473 RCL 02	
474 4.671 E-5	
475 *	
476 +	
477 RCL 04	
478 4.9683 E-3	Calculate Sound Speed
479 *	
480 +	
481 RCL 05	
482 1.5562 E-8	
483 *	
484 +	
485 RCL 03	
486 1.522	
487 *	
488 +	
489 5.694- E-3	
490 RCL 00	
491 *	
492 RCL 03	
493 *	
494 -	
495 1295.97	
496 +	

STEP/KEY ENTRY	COMMENT
497 3.2666	
498 *	
499 RCL 09	
500 20	
501 +	
502 STO 09	Calculate
503 RCL Y	Card Output
504 STO IND 09	Form for SSP
505 1 E4	Point
506 /	
507 RCL 04	
508 INT	
509 +	
510 STO 11	
511 ARCL IND 09	Print Depth
512 AVIEW	and SS
513 FC? 55	
514 PSE	
515 RCL 09	Store Card
516 60	Format Profile
517 -	Point in Depth
518 STO 09	Locations
519 FIX 4	
520 RCL 11	
521 STO IND 09	
522 FIX 1	Have Sound
523 ISG 00	Speeds Been
524 GTO 99	Calculated for
525*LBL 20	All Depths?
526 ADV	
527 ADV	
528 ADV	SSP on Cards?
529 "N"	
530 ASTO Y	
531 "SSF ON CRD"	
532 AON	
533 PROMPT	
534 ASTO X	
535 AOFF	
536 X=Y?	
537 GTO 30	
538 RCL 10	Outout SSP
539 19	to Cards
540 +	
541 1 E3	
542 /	
543 20	
544 +	
545 STO A	
546 WRTA	
547*LBL 30	End of Progra
548 CLX	
549 RTN	
550 .END.	

Appendix A. HP-41CV BT Sound Speed Profile Program

Areas of Salinity Profile Coverage.

I. Discussion

Contained within this Apendix are figures illustrating the areas of coverage of selected (ICAPS) salinity profiles for the North Atlantic, North Pacific, and North Indian Oceans, and the Mediterranean Sea. The method used to select these representative profiles and listings of the profiles selected may be found in Apendix B.

The profile number to be used in an area of interest corresponds to the number of lines used to crosshatch that area in the figures which follow. Areas without crosshatching are represented by profile zero; areas with single line crosshatching by profile one; etc.

Areas of coverage for the North Atlantic Ocean are seasonally dependent, i.e., a specific area may be represented by a different profile number in each season. Areas of coverage for all other bodies of water are presented on an annual basis. Profile number two in the Mediterranean Sea and profile number four in the North Atlantic Ocean are seasonally dependent, i.e., there is a specific seasonal salinity profile for those areas represeted by these profiles.

To find the appropriate salinity profile, first consult Figure 1 for the N. Atlantic Ocean and Mediterranean Sea, Figure 2 for the N. Pacific Ocean, or Figure 3 for the N. Indian Ocean. These figures contain the reference page numbers to consult for the detailed description of each broad ocean area (and season for the N. Atlantic Ocean). From the referenced page map determine the representative salinity profile number and select the appropriately labeled set (2) of magnetic cards from the salinity profile library.

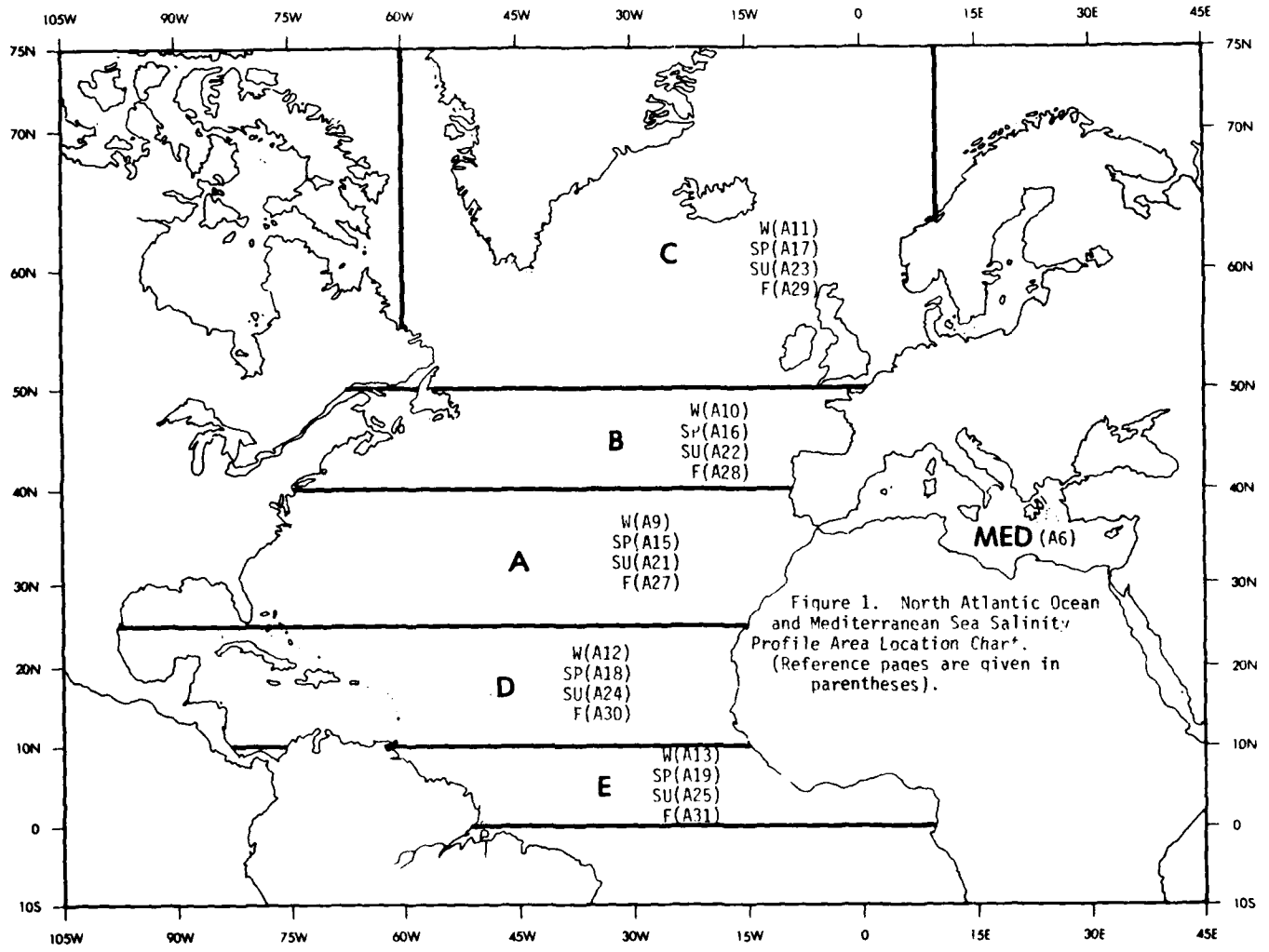


Figure 1. North Atlantic Ocean and Mediterranean Sea Salinity Profile Area Location Chart. (Reference pages are given in parentheses).

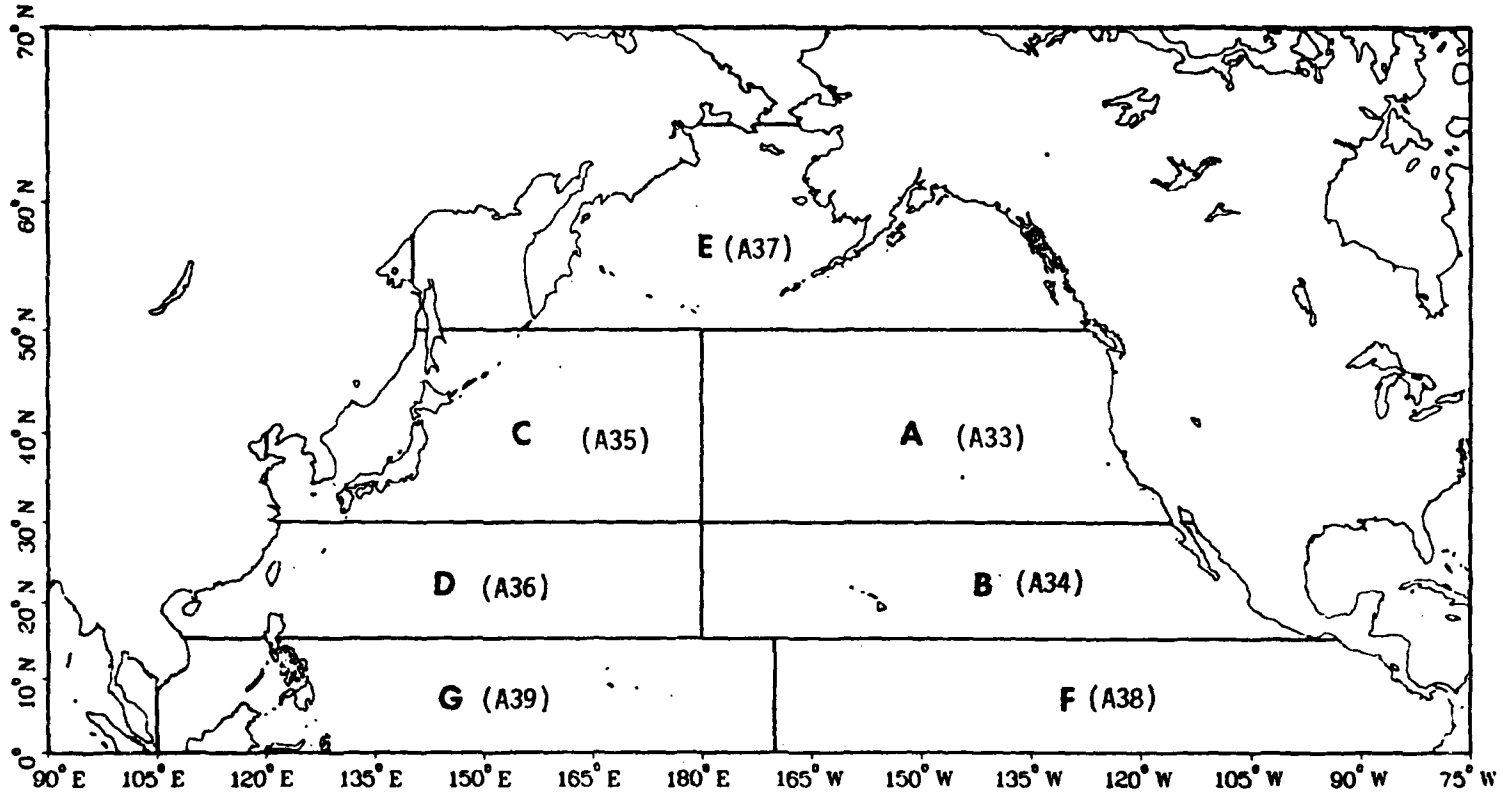


Figure 2. North Pacific Ocean Salinity Profile Area Location Chart. (Reference pages are given in parentheses).

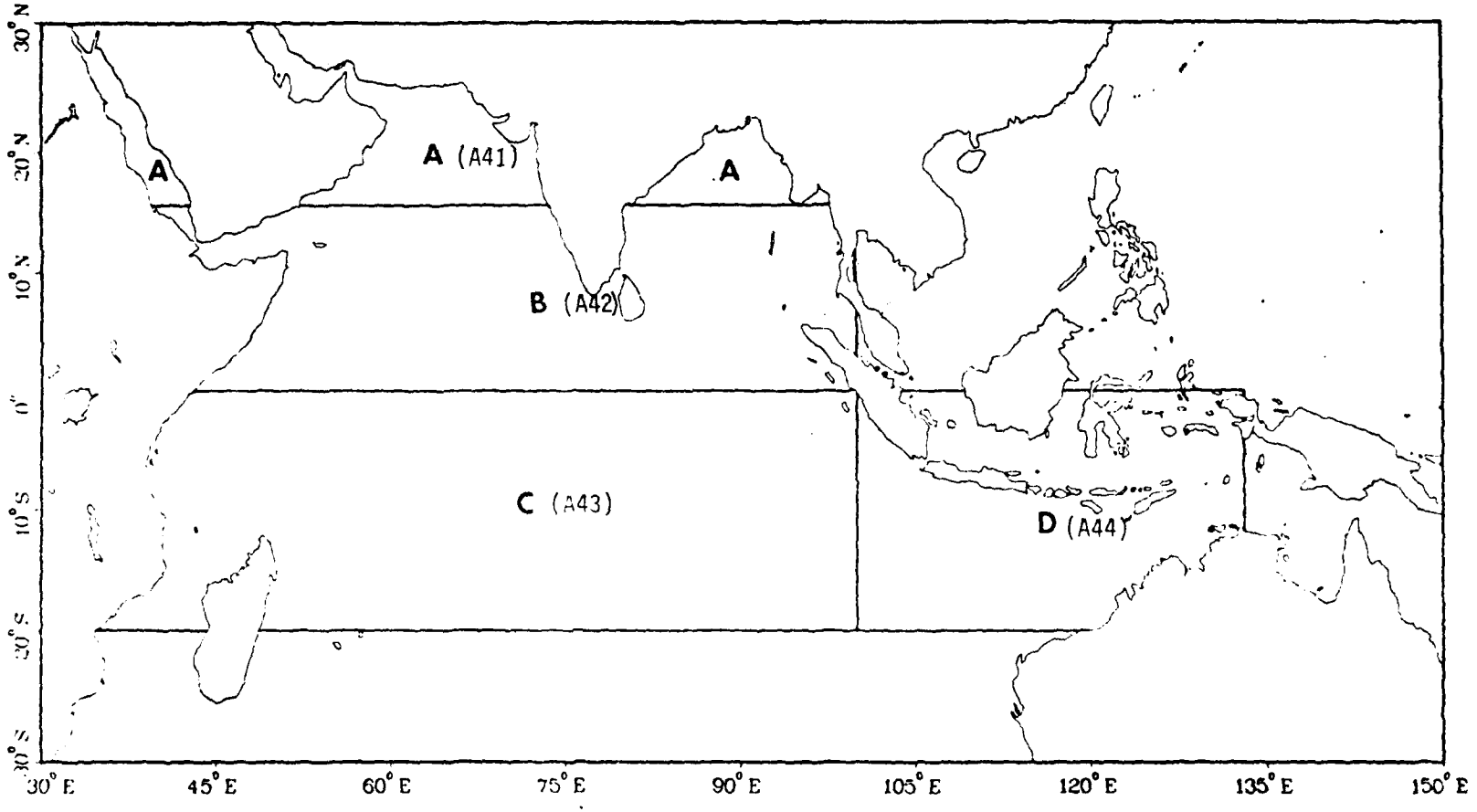
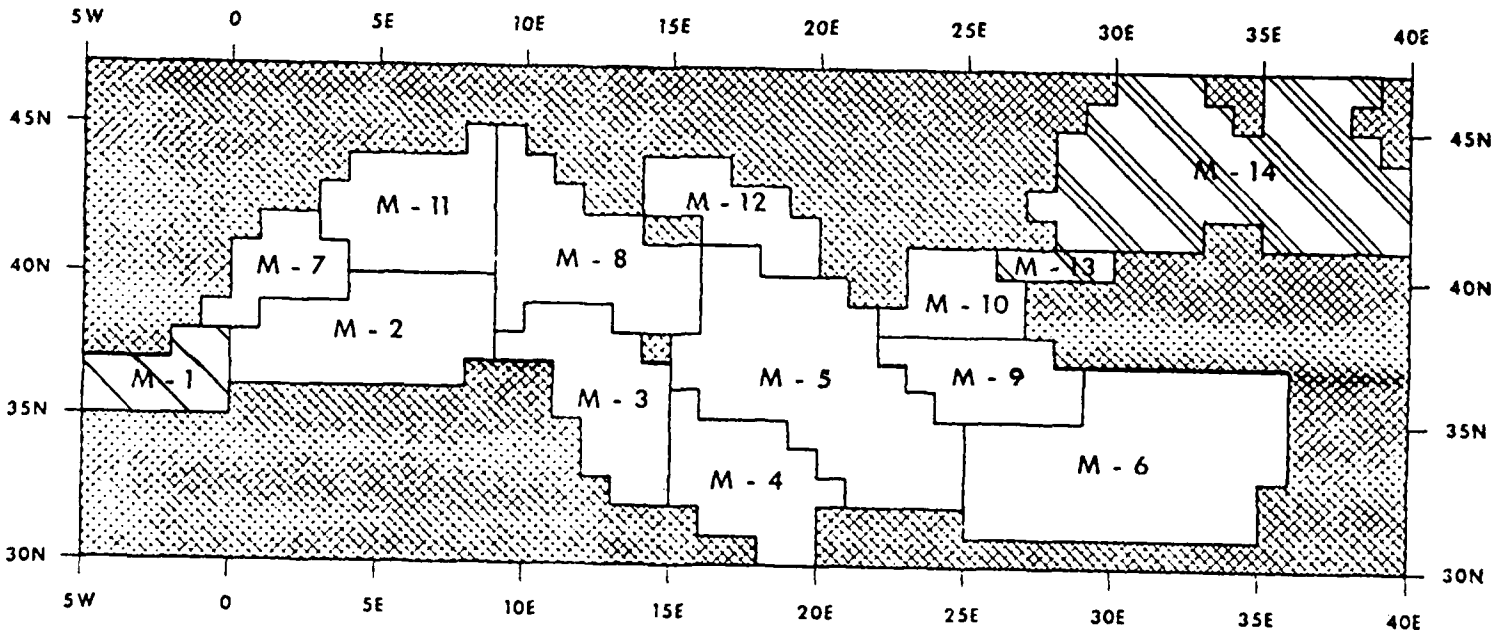


Figure 3. North Indian Ocean Salinity Profile Area Location Chart. (Reference pages are given in parentheses).

MEDITERRANEAN SEA

ALL SEASONS

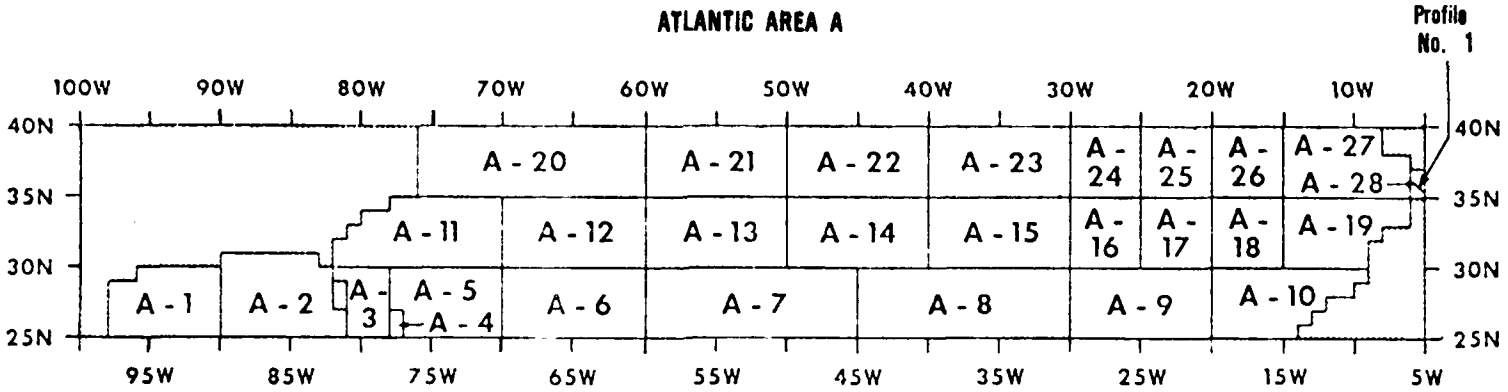
MEDITERRANEAN



NORTH ATLANTIC WINTER

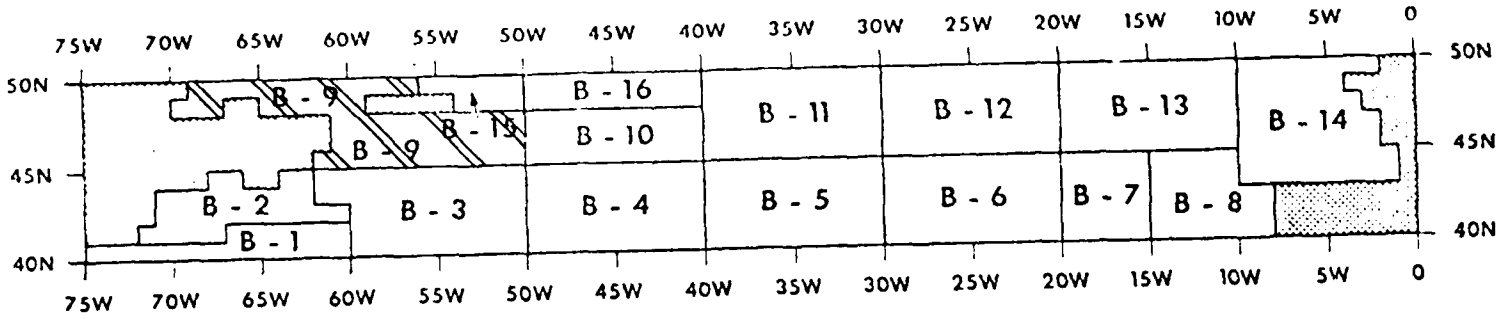
WINTER

ATLANTIC AREA A



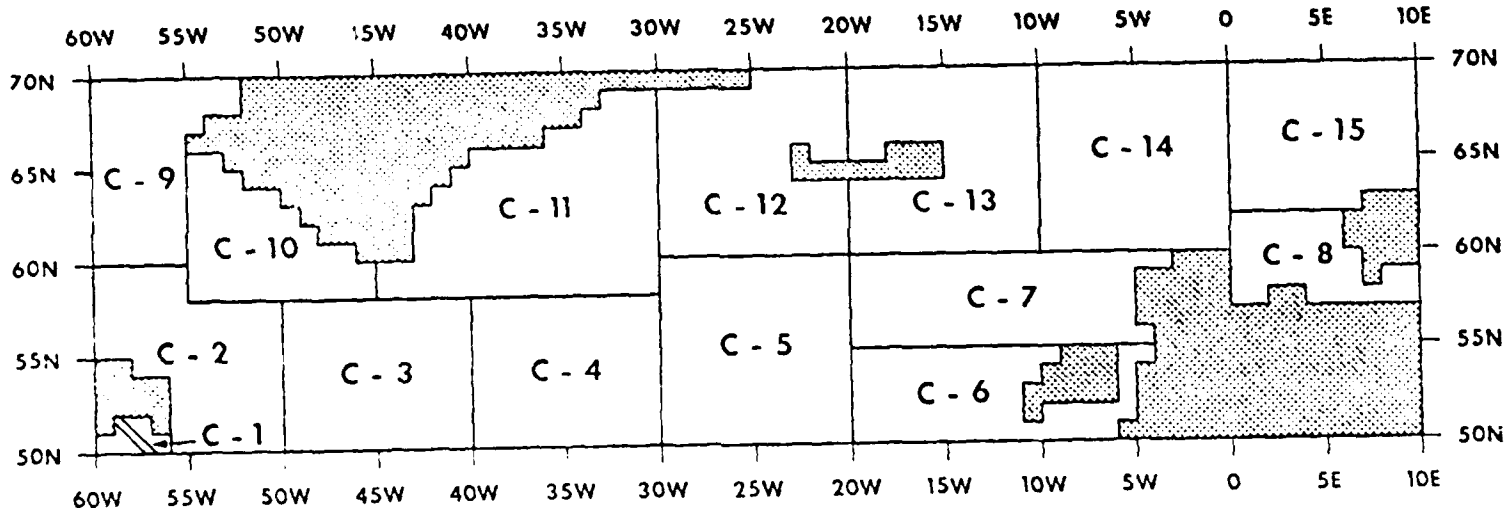
WINTER

ATLANTIC AREA B



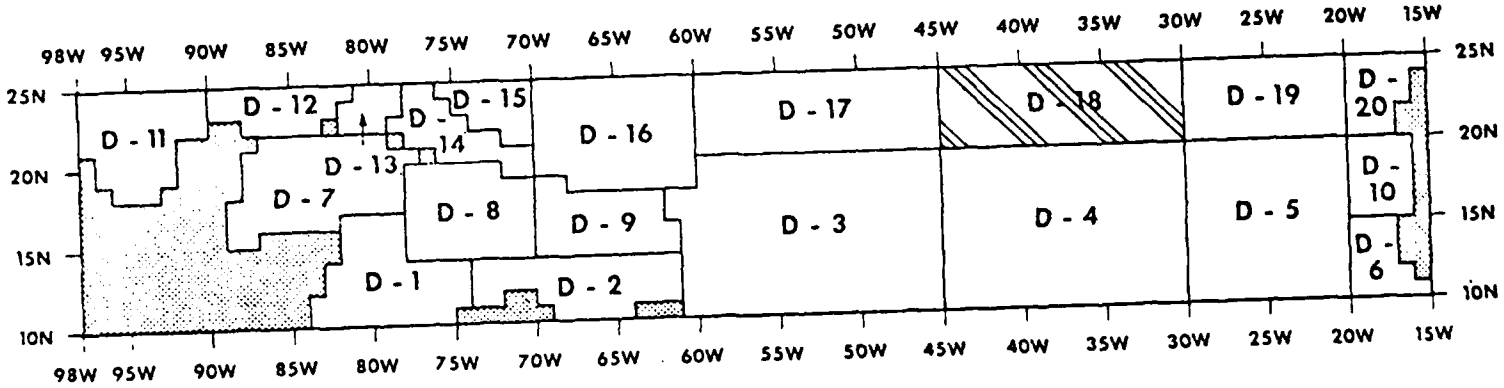
WINTER

ATLANTIC AREA C



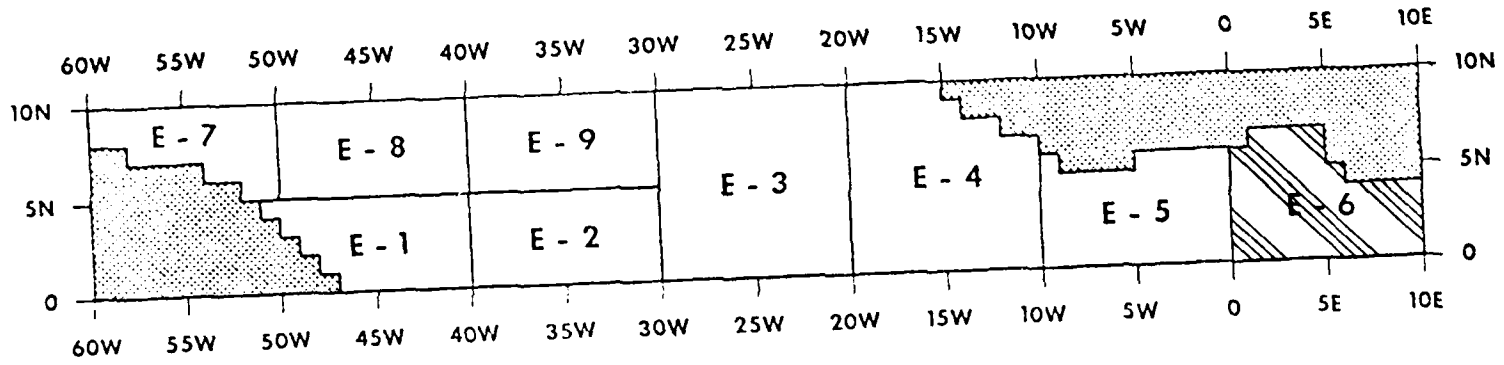
WINTER

ATLANTIC AREA D



WINTER

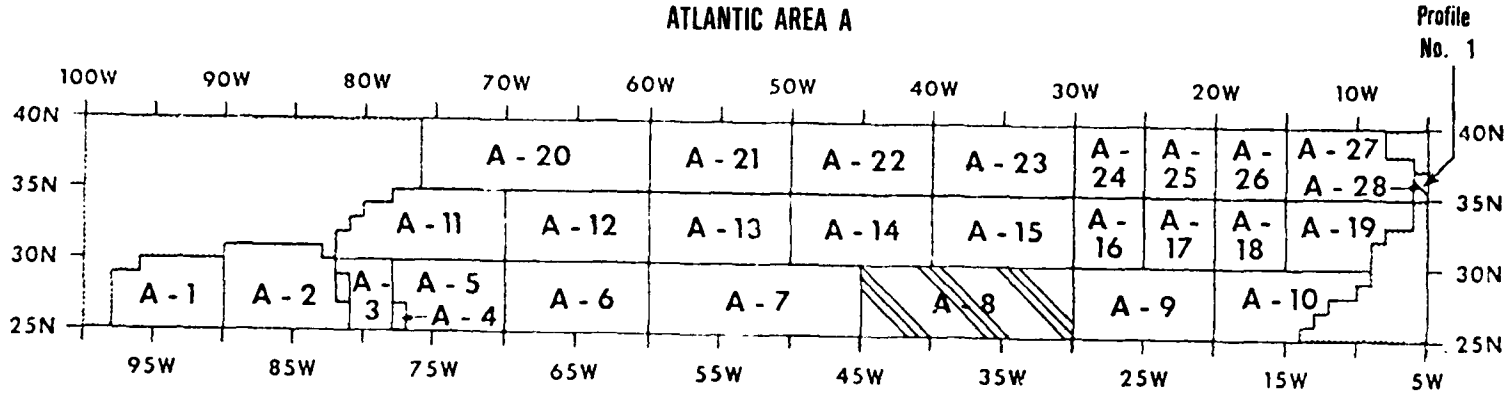
ATLANTIC AREA E



NORTH ATLANTIC SPRING

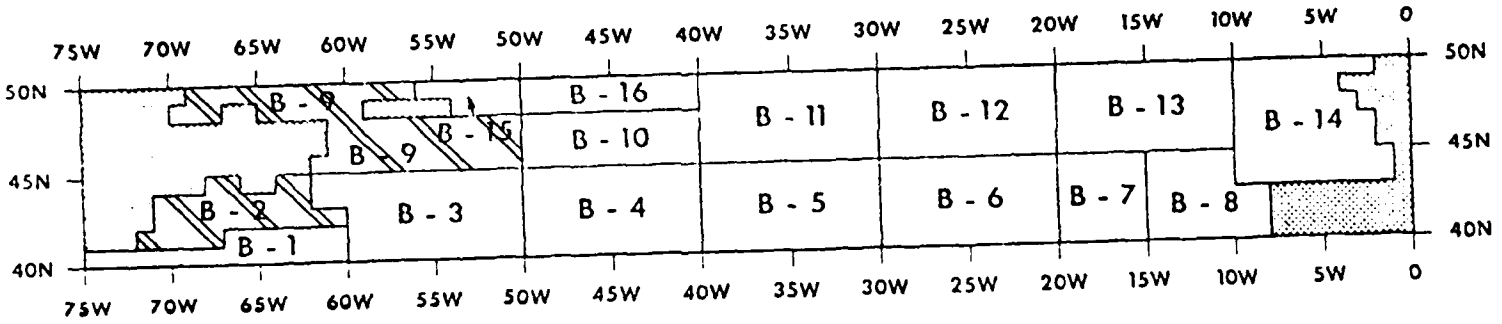
SPRING

ATLANTIC AREA A



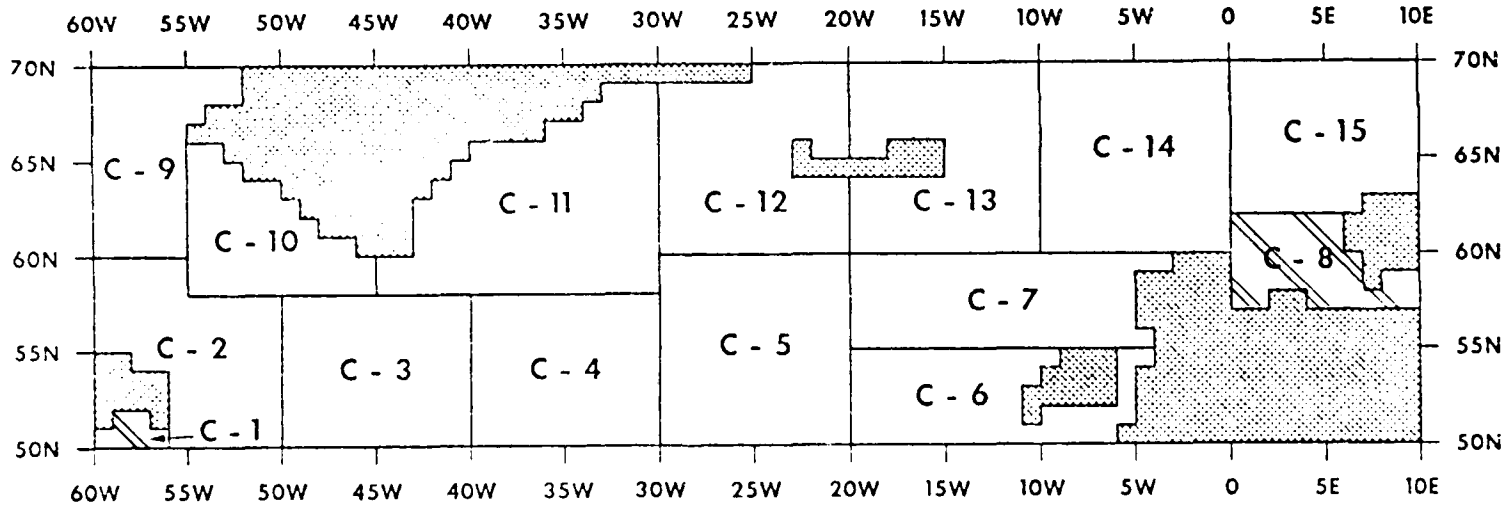
SPRING

ATLANTIC AREA B



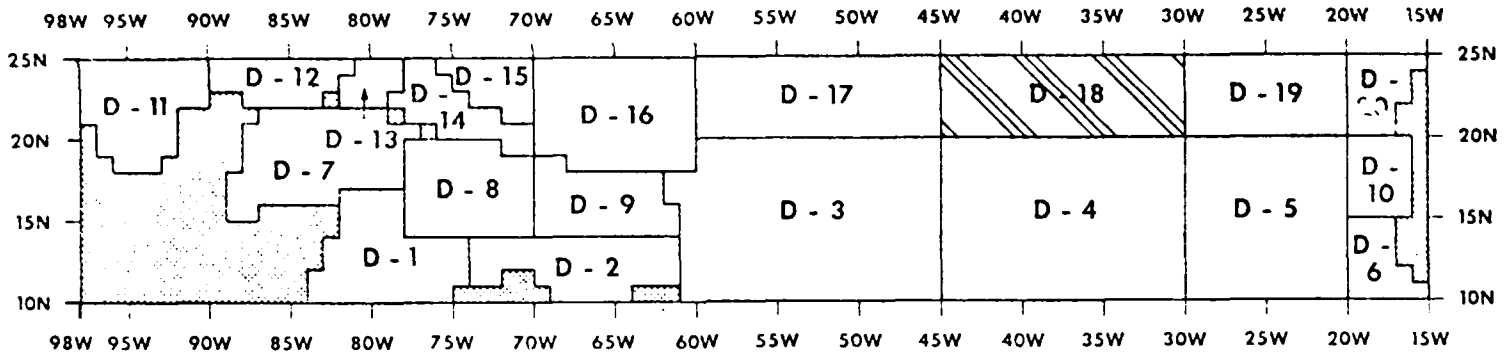
SPRING

ATLANTIC AREA C



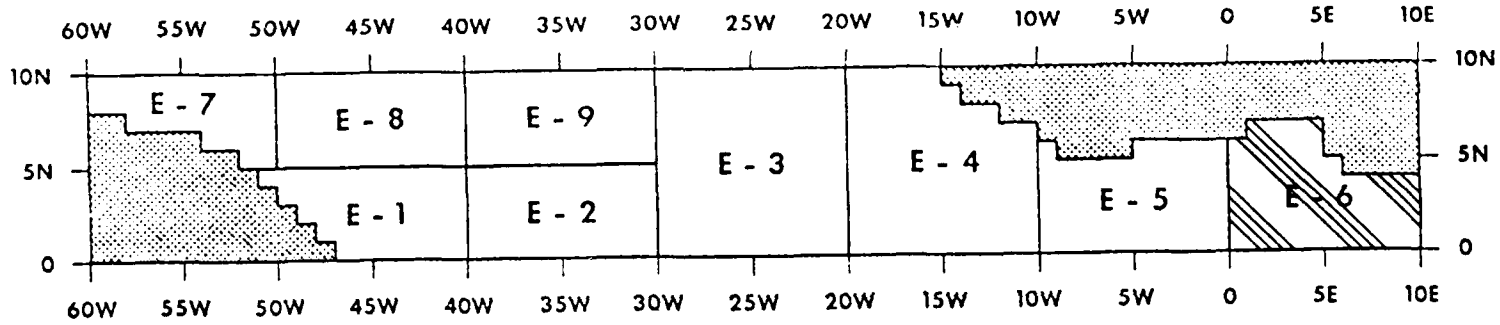
SPRING

ATLANTIC AREA D

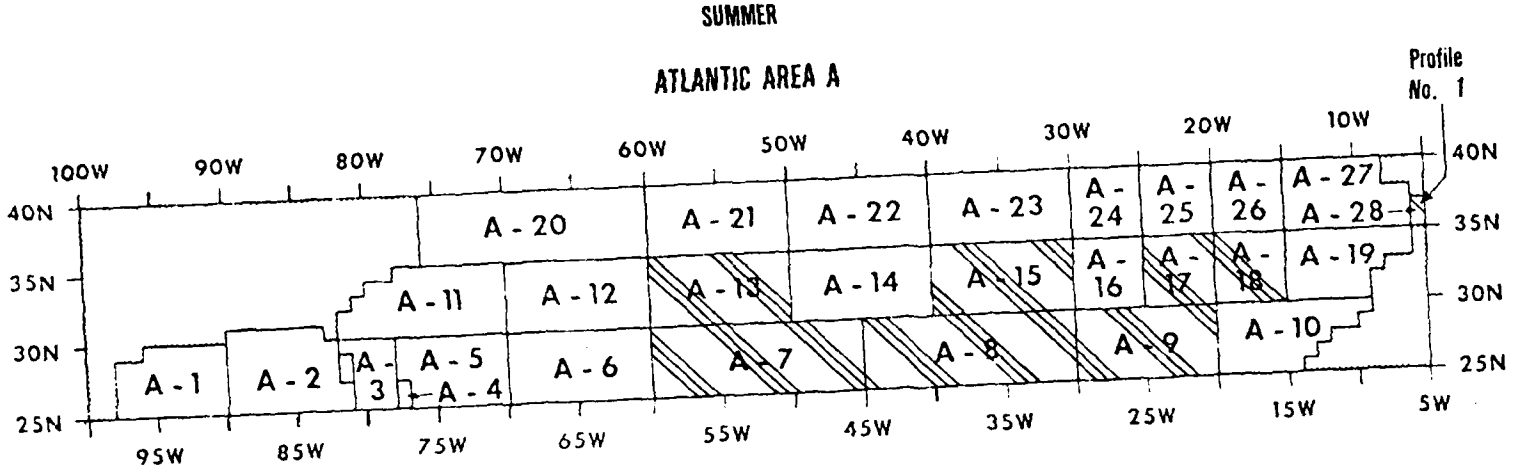


SPRING

ATLANTIC AREA E

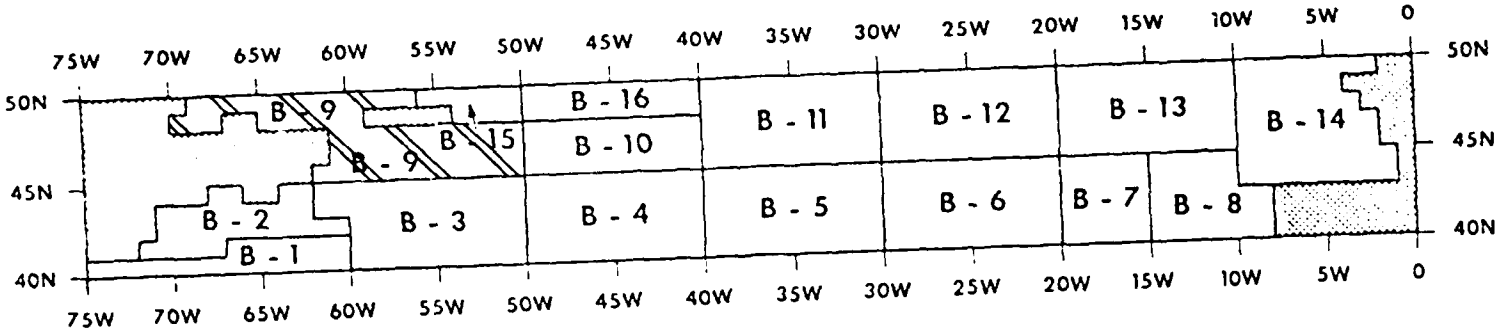


NORTH ATLANTIC SUMMER


SUMMER
ATLANTIC AREA A
Profile No. 1
100W
90W
80W
70W
60W
50W
40W
30W
20W
10W
40N
35N
30N
25N
95W
85W
75W
65W
55W
45W
35W
25W
15W
5W
A - 1
A - 2
A - 3
A - 4
A - 5
A - 6
A - 7
A - 8
A - 9
A - 10
A - 11
A - 12
A - 13
A - 14
A - 15
A - 16
A - 17
A - 18
A - 19
A - 20
A - 21
A - 22
A - 23
A - 24
A - 25
A - 26
A - 27
A - 28

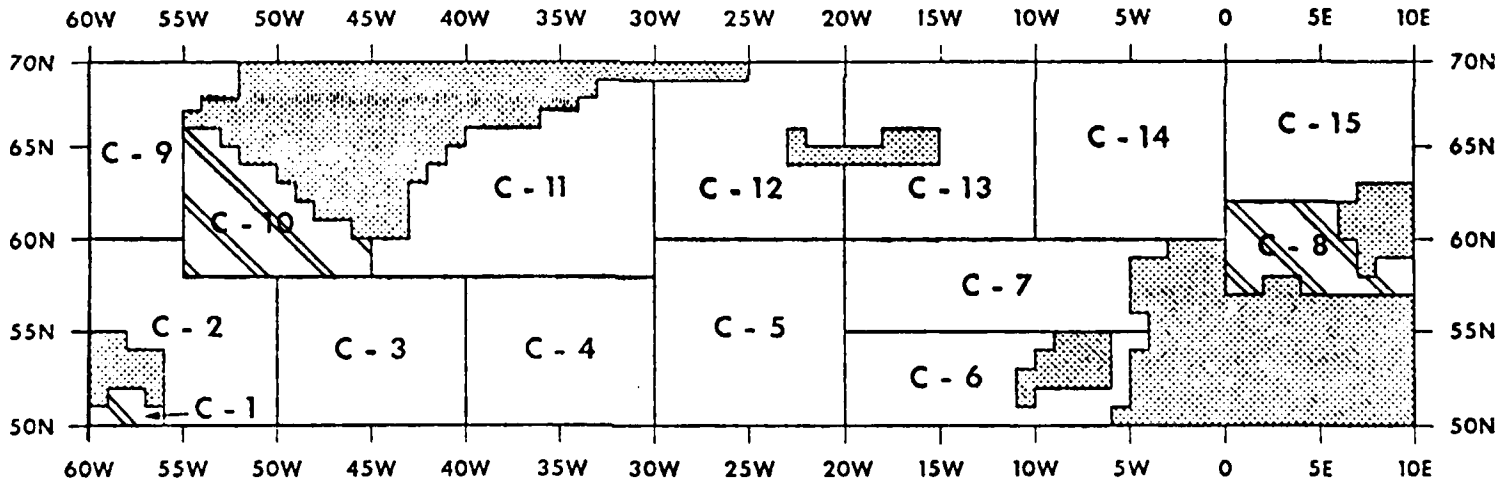
SUMMER

ATLANTIC AREA B



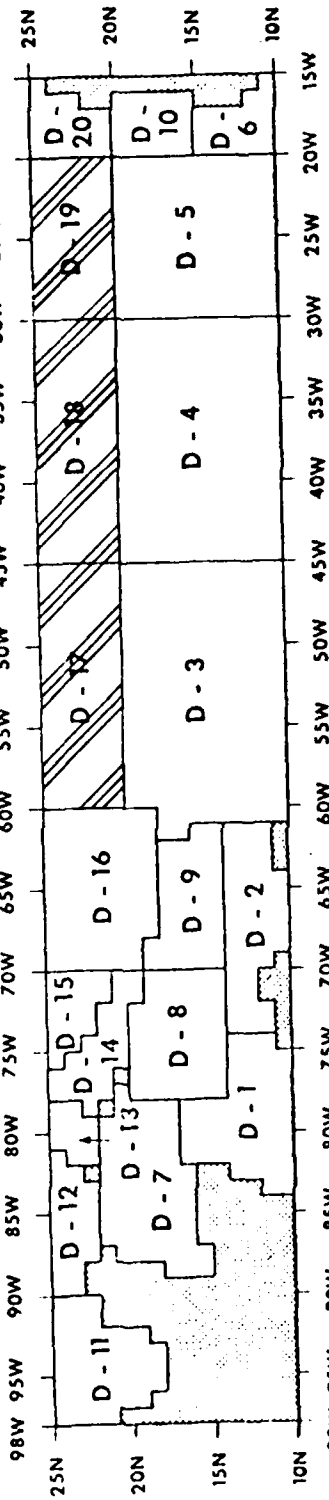
SUMMER

ATLANTIC AREA C



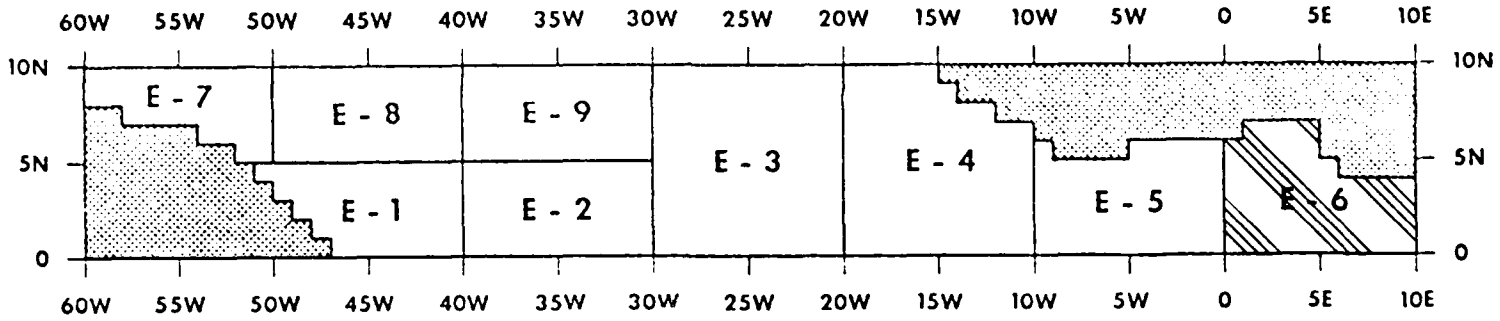
SUMMER

ATLANTIC AREA D



SUMMER

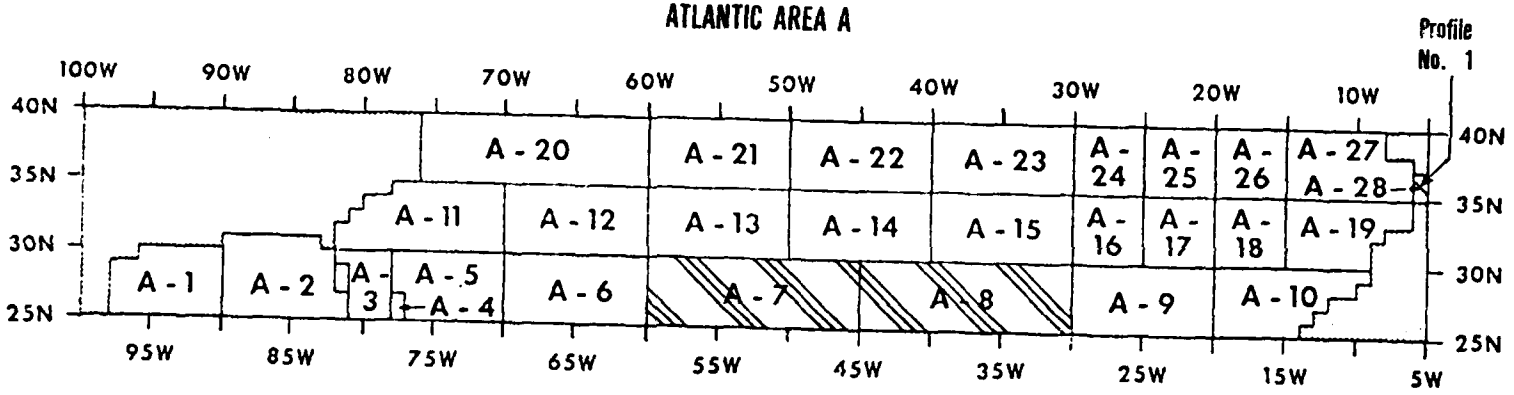
ATLANTIC AREA E



NORTH ATLANTIC FALL

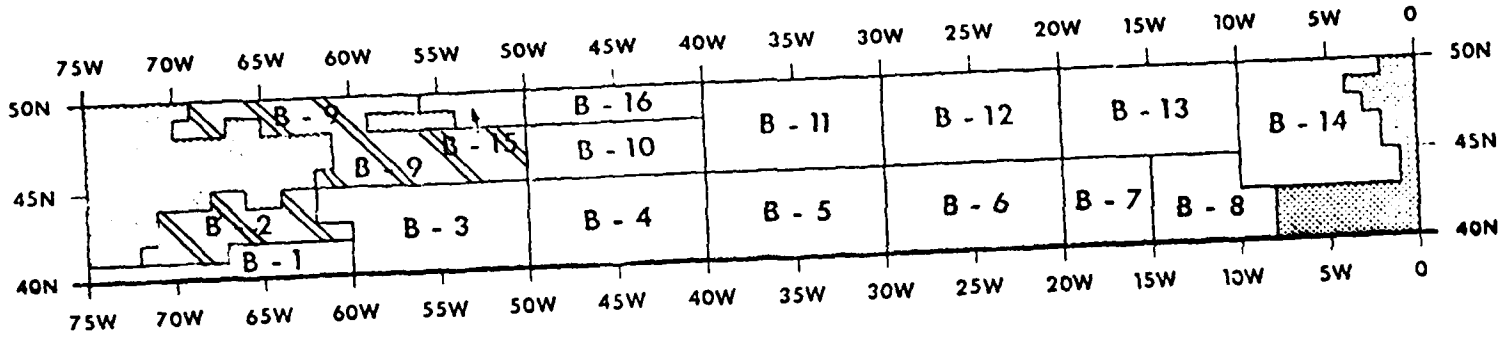
FALL

ATLANTIC AREA A



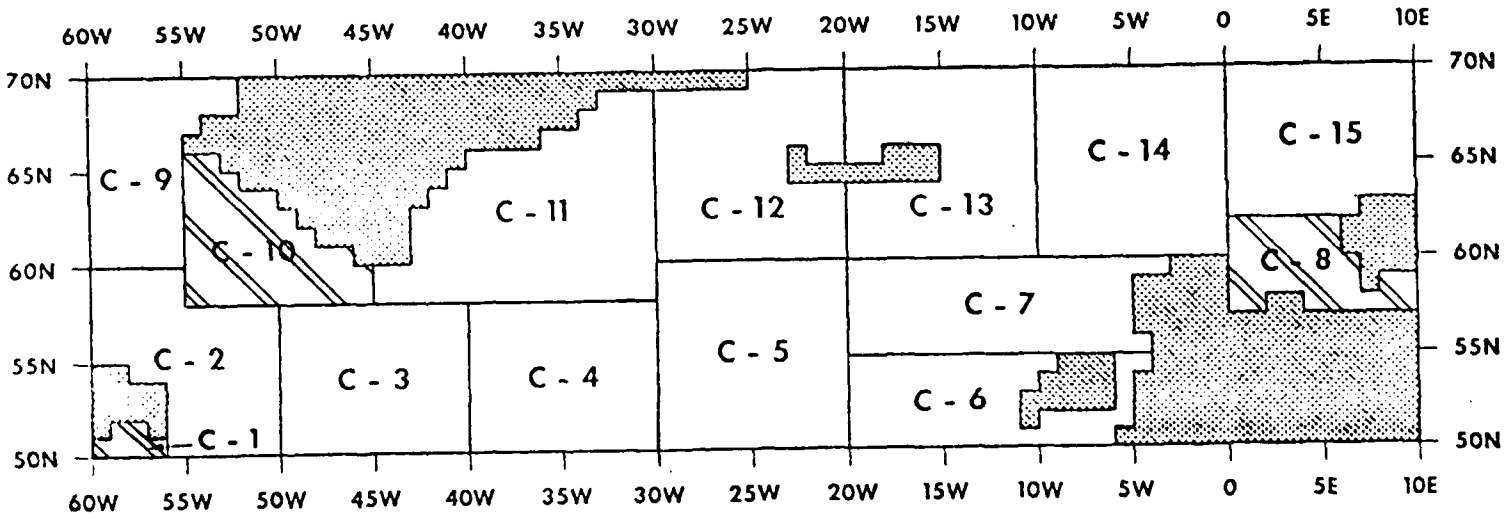
FALL

ATLANTIC AREA B



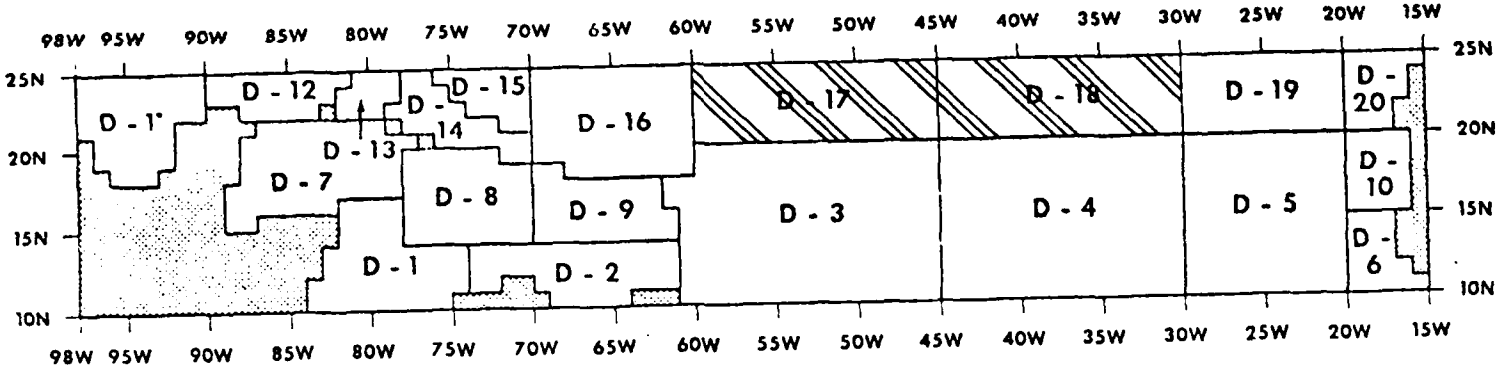
FALL

ATLANTIC AREA C



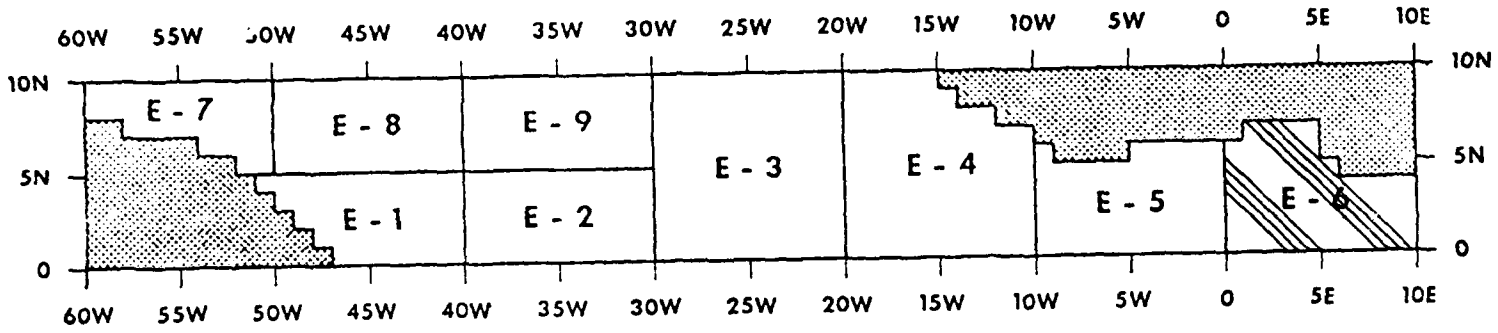
FALL

ATLANTIC AREA D



FALL

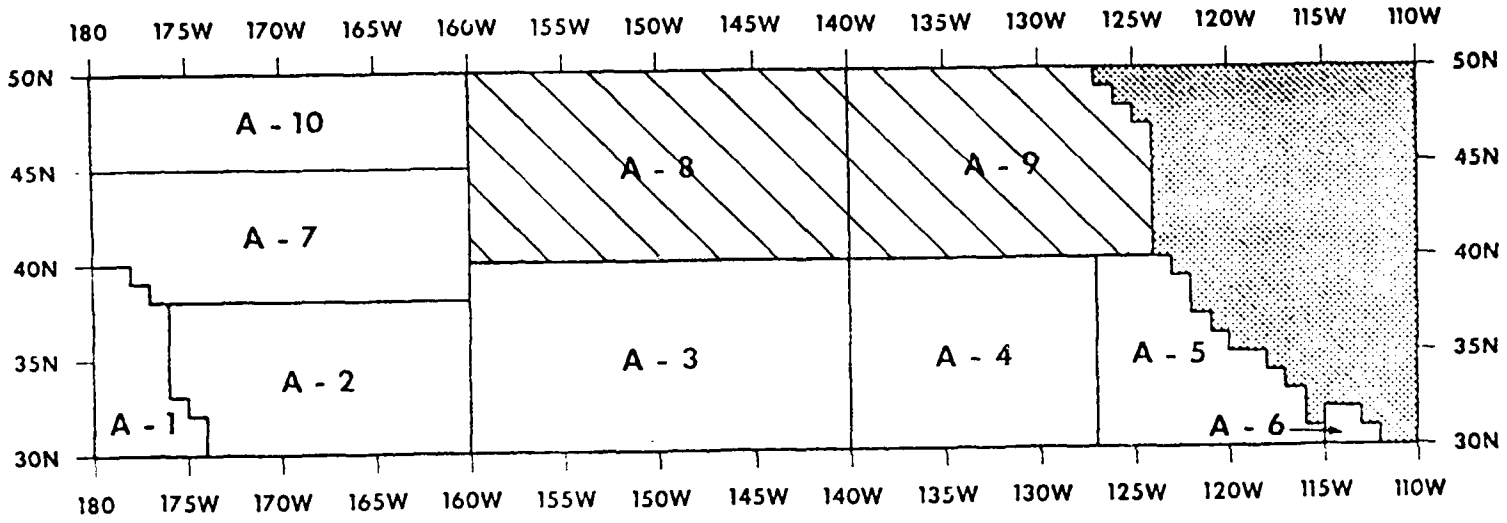
ATLANTIC AREA E



NORTH PACIFIC OCEAN

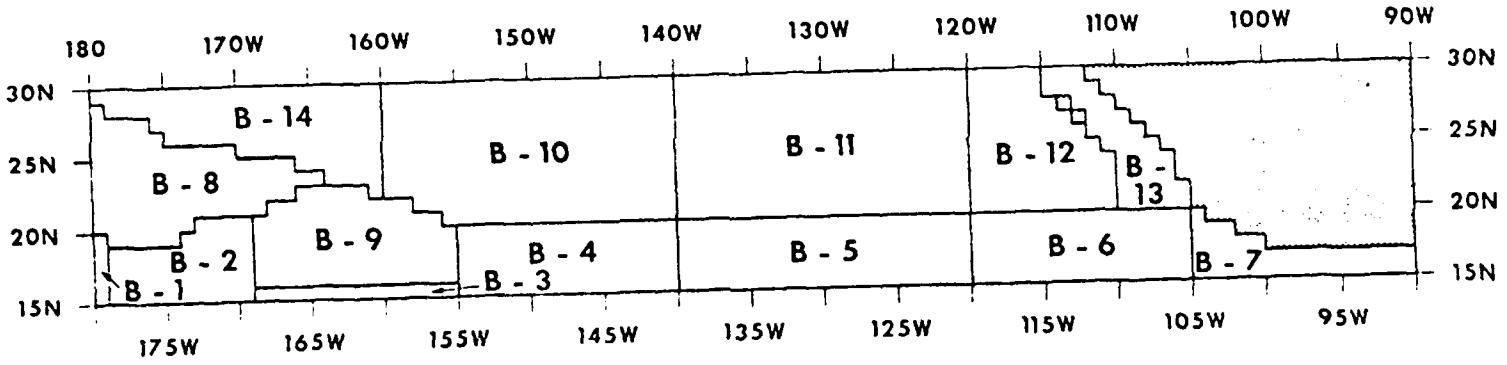
ALL SEASONS

PACIFIC AREA A



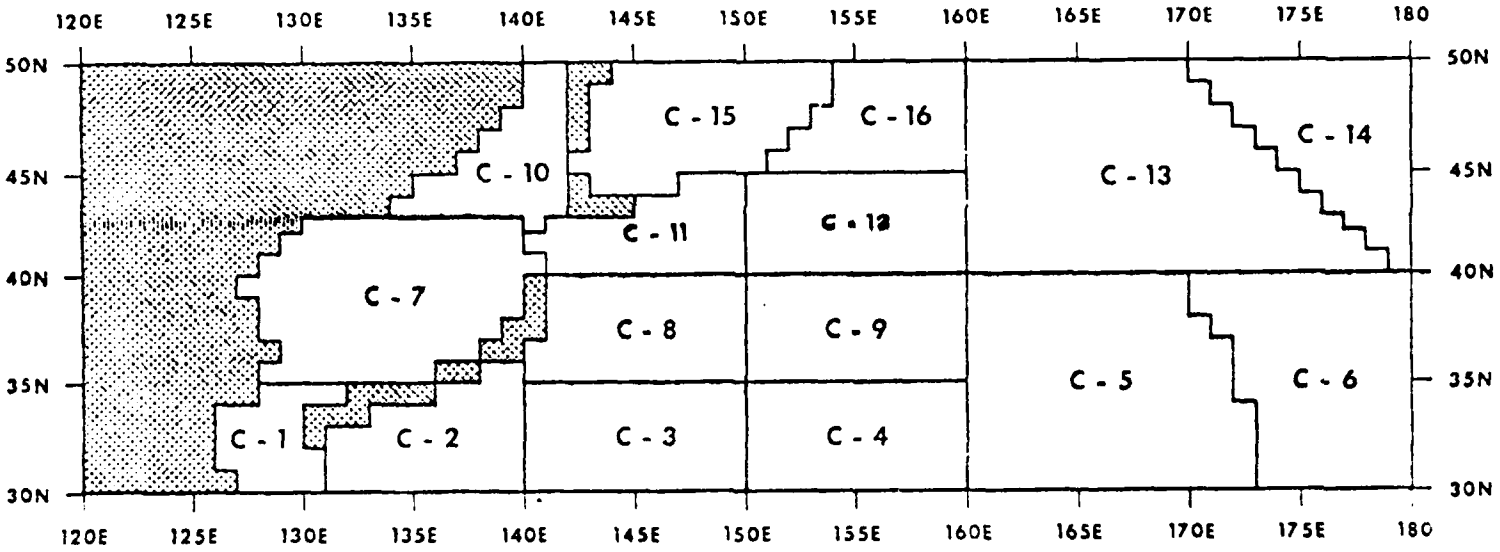
ALL SEASONS

PACIFIC AREA B



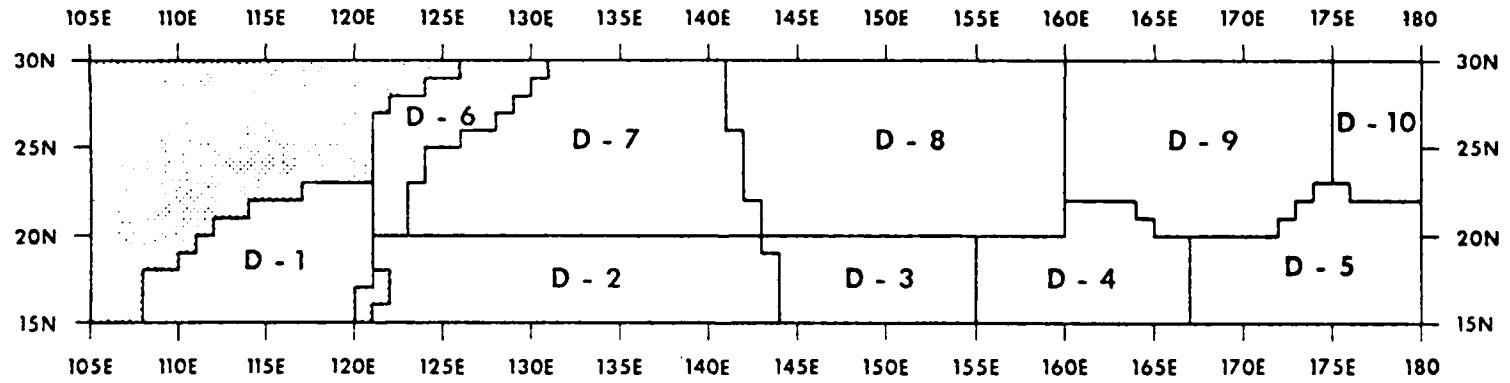
ALL SEAS

PACIFIC AREA C



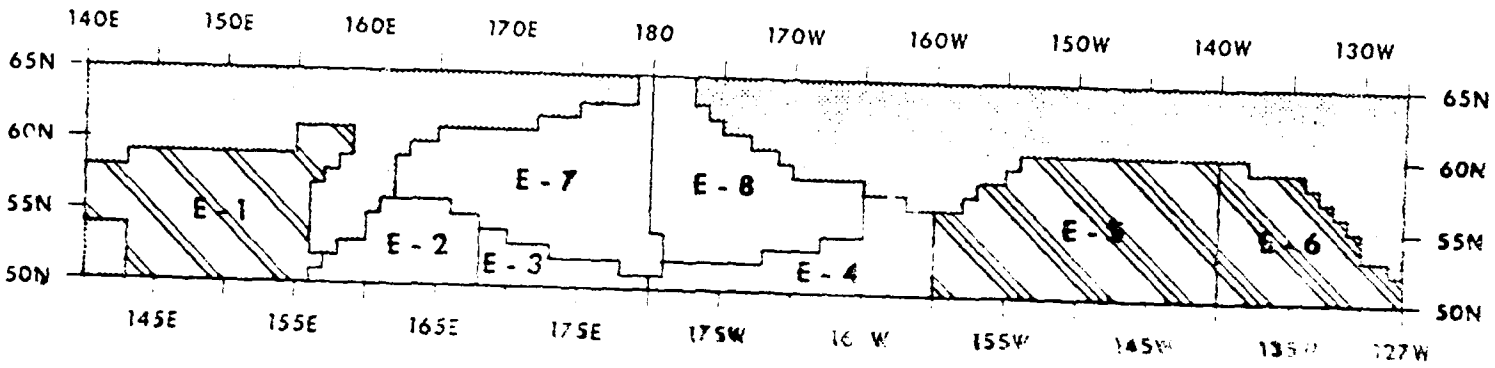
ALL SEASONS

PACIFIC AREA D



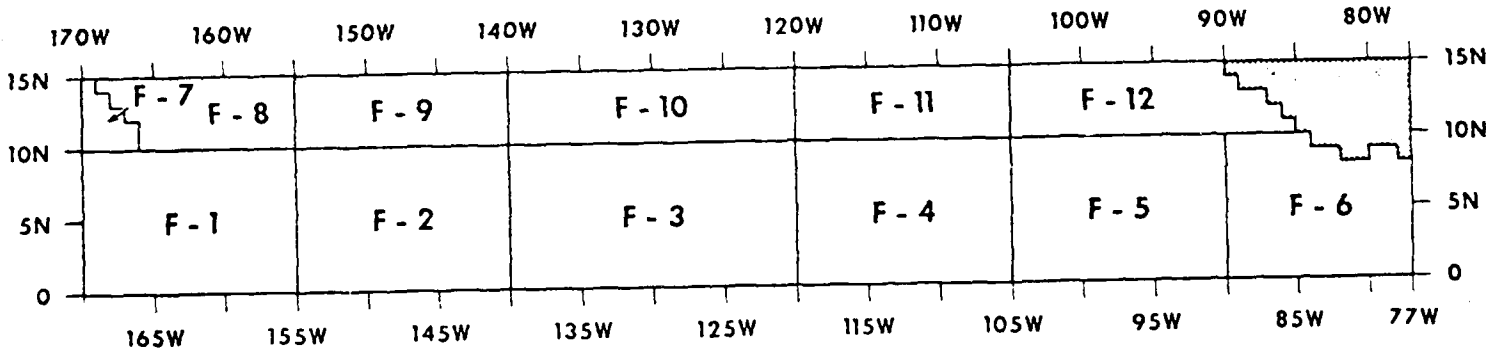
ALL SEASONS

PACIFIC AREA E



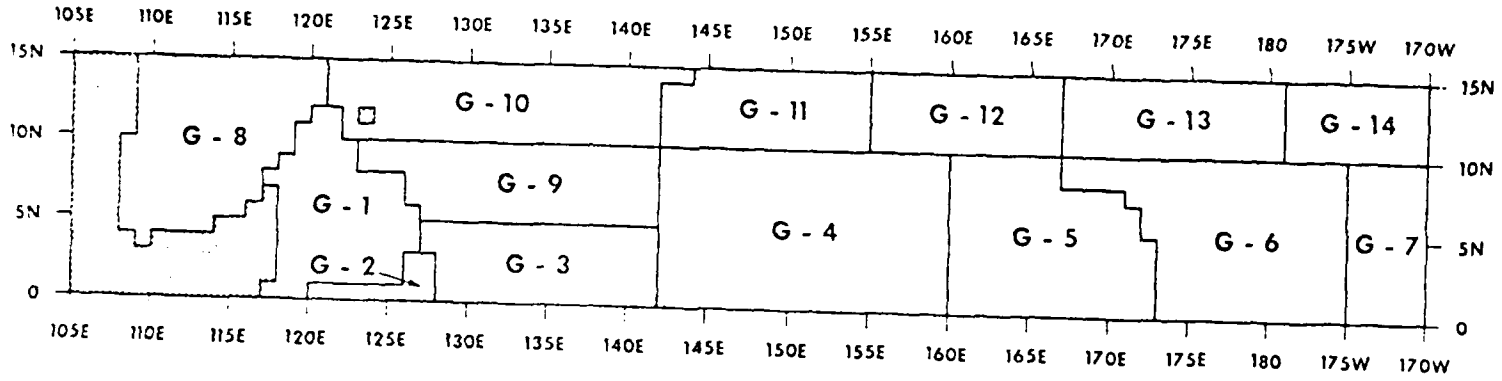
ALL SEASONS

PACIFIC AREA F



ALL SEASONS

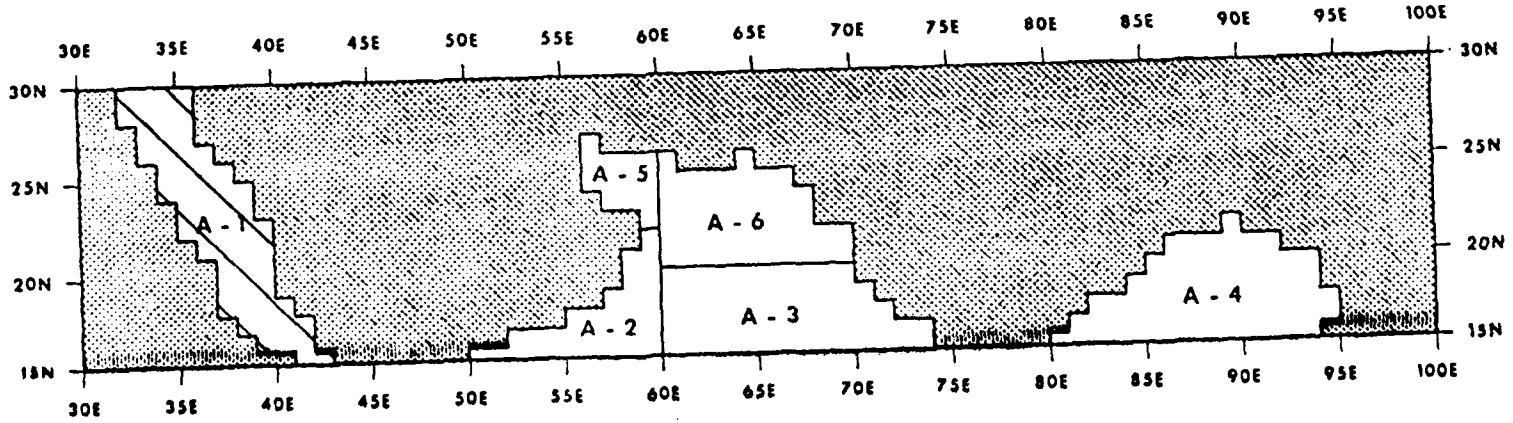
PACIFIC AREA G



NORTH INDIAN OCEAN

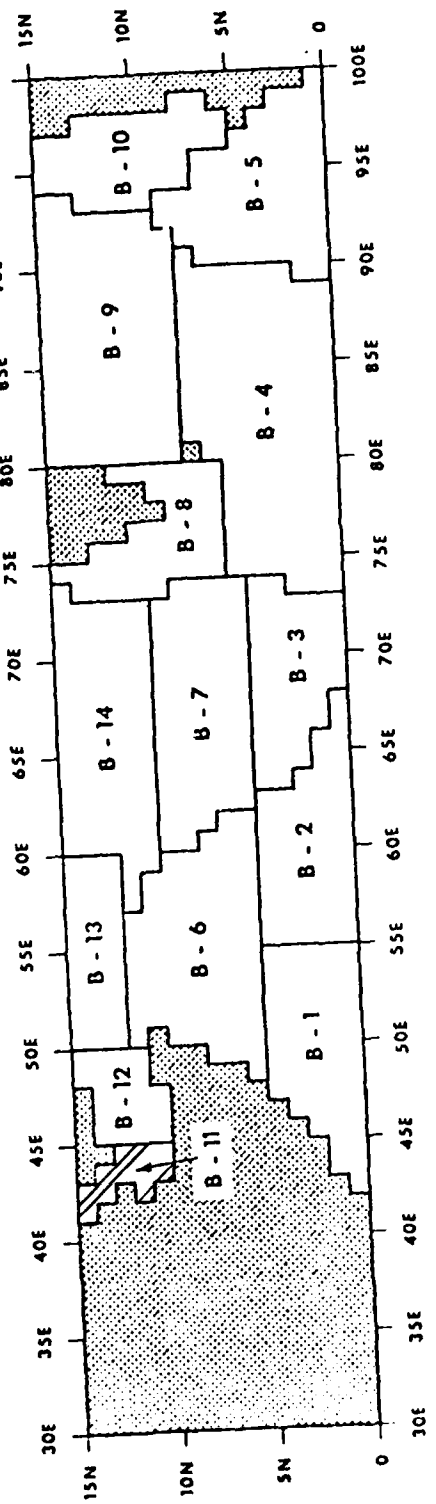
ALL SEASONS

INDIAN AREA A



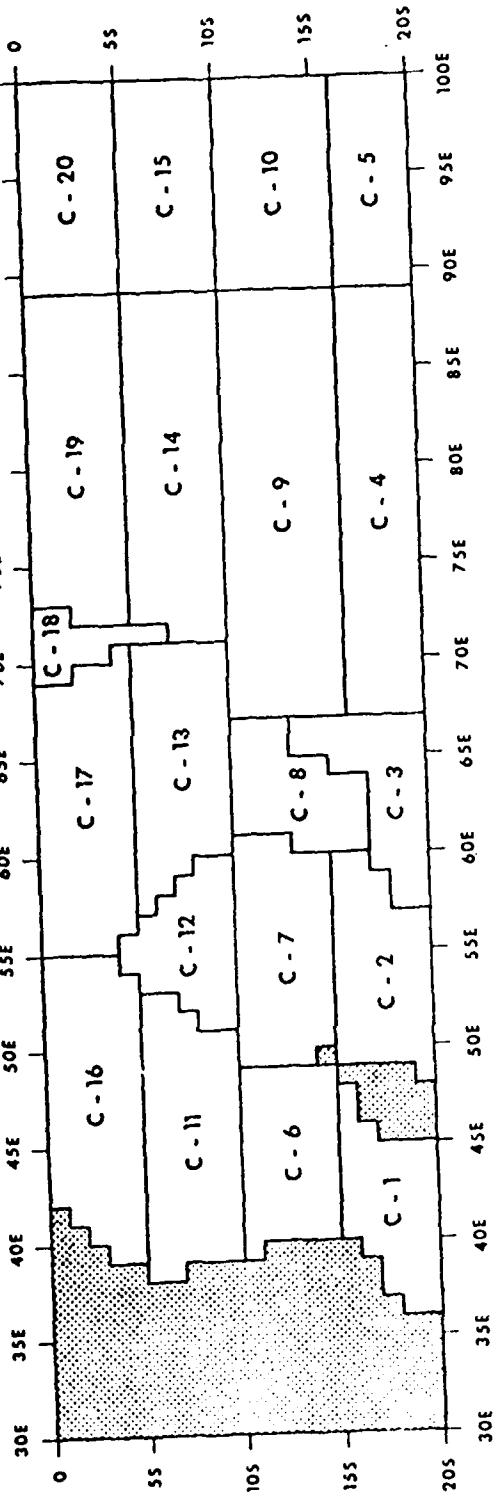
ALL SEASONS

INDIAN AREA B



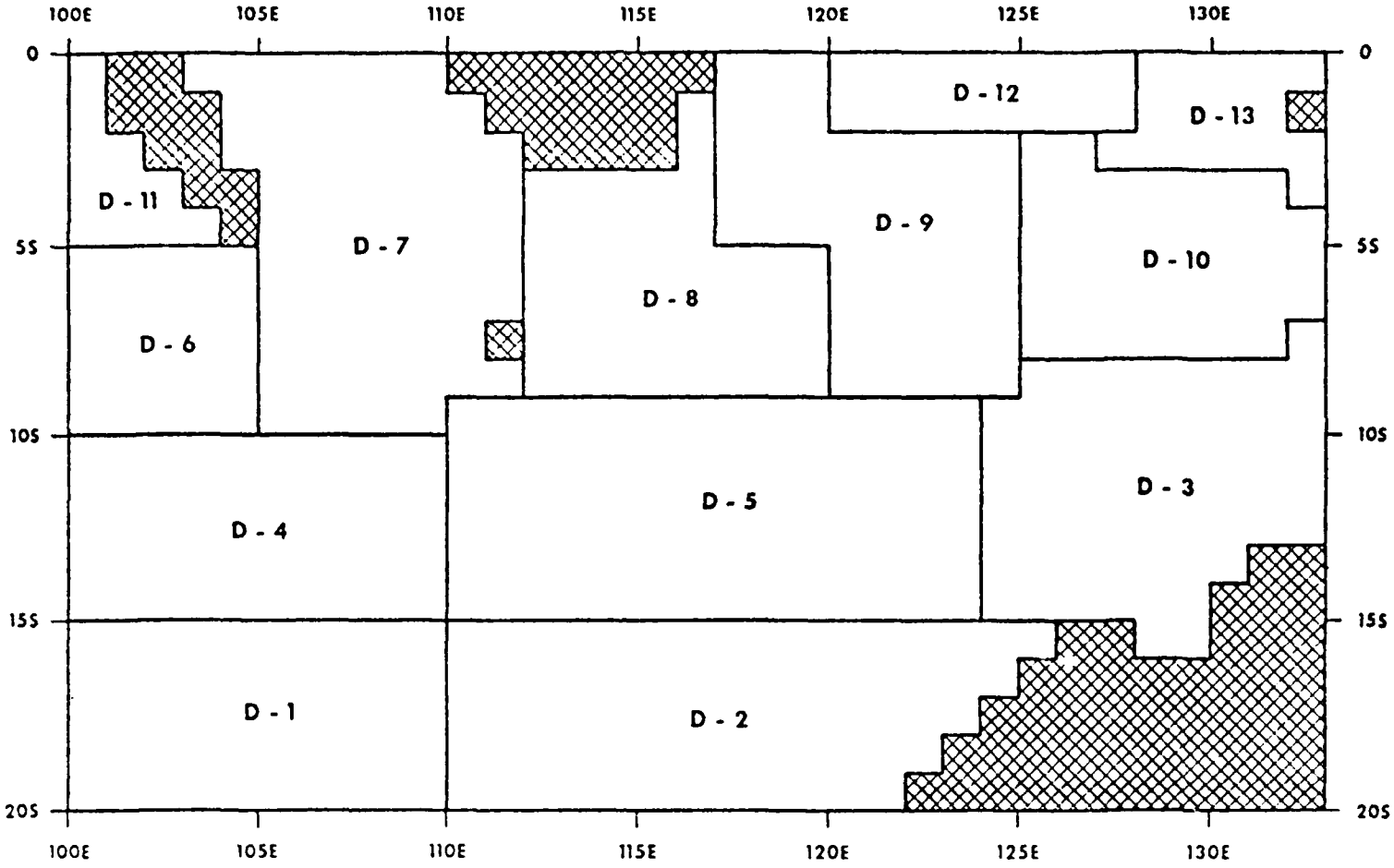
ALL SEASONS

INDIAN AREA C



ALL SEASONS

INDIAN AREA D



Appendix B. Creation of the HP41CV BT to Sound Velocity Program Salinity Profile Data Base

I. Introduction

In order to insure a reasonable sound speed determination from only in-situ temperature versus depth (BT) information, salinity profiles representative of variable oceans had to be determined. Because of funding and time constraints, it was decided to employ the ICAPS water mass data base, which contains representative seasonal salinity profiles for the major oceans of the Northern Hemisphere.

II. Methods

For each season the ICAPS data base contained 401 salinity profiles; 160 in the Atlantic Ocean, 16 in the Mediterranean Sea, 152 in the Pacific Ocean, and 73 in the Indian Ocean. The raw data were received from NAVOCEANO on magnetic tape compatible with the NORDA Cyber computer.

It was decided to compare the salinity value at each standard depth with the corresponding salinity in every profile for each season within each ocean. A maximum allowable salinity difference was selected on the basis of the resulting sound speed difference. If the absolute difference between salinity values exceeded the maximum allowable, a counter was incremented. The analysis results consisted of an NxN symmetric matrix containing the counts of the number of times each salinity profile differed significantly from every other salinity profile for each season and ocean at each standard depth. The total number of standard depth differences detected for each profile was also calculated to aid in interpretation.

If the maximum allowable salinity difference was made too large than all profiles would appear similar. If the maximum allowable salinity difference was made too small then interpretation of the results become difficult. For the final analysis a maximum salinity difference of 2.25 ppt was used in all oceans. This difference resulted in an approximate sound speed difference of 3 m/sec under a constant temperature condition.

From the analysis outlined above, a "best" salinity profile was selected as being that profile which had the lowest difference count of all profiles. All salinity profiles differing from the "best" were examined against each other to determine if any of these could be considered similar. Finally, the frequency of occurence of the selected ICAPS water masses (more than one water mass usually occupied an ICAPS area) were examined to insure that the salinity profiles selected to represent small areas were representative most of the time.

III. Results

A "best" salinity profile was selected in all oceans. For the North Atlantic Ocean, there were four salinity regimes which could not be described by the "best" profile; in the Mediterranean Sea and North Pacific Ocean there were three additional regimes; and in the North Indian Ocean there were two.

Because the differences in salinity at standard depths were small (0.7 ppt) across the seasons, and because of the desire to keep the size of the salinity library as small as possible, in a majority of instances a single salinity profile was chosen to represent the salinity field for all seasons. The annual salinity profile was the seasonal profile which best aproximated (smallest absolute total difference at standard depth) the mean across season profile.

Table 1 lists the salinity values by season for the "best" representative profile for the North Atlantic Ocean. Table 2 through Table 5 lists the salinity values for those profiles differing significantly from the best. Table 6 lists the "best" salinity profile for the Mediterranean Sea; Tables 7 through 9 present the profiles which differed from the "best." Table 10 gives the salinity values for the "best" North Pacific Ocean profiles; Tables 11 through 13 give the salinity profiles which were unlike the "best." Table 14 lists the "best"

salinity profile for the North Indian Ocean; Table 15 and 16 present those which were different. In the tables, an asterisk is used to identify the seasonal profile which was chosen to represent all seasons.

In several instances, the ICAPS salinity profiles selected did not extend to 2000 meters. In these cases, the salinity values at those depths for which information was not available were estimated from neighboring ICAPS areas.

Suggestions for further improvement

The selection of representative salinity profiles was based on a rather large salinity (sound speed) difference of 2.25 ppt (≈3 m/sec). Reducing the allowable salinity difference would increase the size of the profile library to perhaps unmanageable proportions depending on the user's environment. The complete seasonal ICAPS salinity field library would require 3208 magnetic cards. This number could be halved if the standard depths at which salinity values are given were provided in the calculator program and not by the data card.

A better alternative to a complete magnetic card library would be to provide the user with a computer listing of the ICAPS salinity data base from which the user could select profiles in their area of interest. These profiles could then be transferred to a magnetic card, using a creation program, for utilization with the sound speed calculation program.

TABLE 1. NORTH ATLANTIC OCEAN

Library Profile & ICAPS Profile No. 108, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	34.86	34.68	34.39	34.71
10	34.85	34.68	34.46	34.71
20	34.86	34.72	34.57	34.72
30	34.86	34.76	34.67	34.73
50	34.86	34.82	34.83	34.76
75	34.86	34.86	34.90	34.81
100	34.85	34.88	34.92	34.84
125	34.84	34.88	34.92	34.87
150	34.84	34.88	34.92	34.89
200	34.84	34.88	34.89	34.88
250	34.85	34.89	34.89	34.86
300	34.86	34.89	34.88	34.86
400	34.88	34.90	34.89	34.88
500	34.88	34.90	34.90	34.90
600	34.88	34.91	34.91	34.90
700	34.89	34.91	34.92	34.90
1000	34.91	34.91	34.91	34.91
1200	34.91	34.91	34.91	34.91
1500	34.91	34.91	34.91	34.91
2000	34.90	34.90	34.91	34.90

TABLE 2. NORTH ATLANTIC OCEAN

Library Profile 1, ICAPS Profile No. 47, Seasonal Salinities

Depth (m)	Winter	Spring	Summer	Fall*
0	36.53	36.31	36.40	36.40
10	36.52	36.32	36.38	36.39
20	36.51	36.33	36.35	36.39
30	36.52	36.35	36.34	36.39
50	36.58	36.40	36.39	36.41
75	36.66	36.46	36.47	36.44
100	36.82	36.58	36.61	36.55
125	37.04	36.73	36.83	37.00
150	37.26	36.88	37.09	37.30
200	38.00	37.62	37.71	37.66
250	38.30	38.10	38.08	37.98
300	38.39	38.23	38.24	38.22
400	38.45	38.34	38.35	38.37
500	38.46	38.35	38.38	38.39
600	38.48	38.40	38.40	38.40
800	38.46	38.40	38.39	38.40
1000	38.37	38.40	38.39	38.39
1200	38.39	38.41	38.38	38.39
1500	38.39	38.41	38.39	38.40
2000	38.40	38.42	38.40	38.40

TABLE 3. NORTH ATLANTIC OCEAN

Library Profile 2, ICAPS Profile No. 67, Seasonal Salinities

Depth (m)	Winter	Spring	Summer*	Fall
0	32.03	32.33	31.75	32.00
10	32.07	32.39	31.91	32.04
20	32.13	32.46	32.20	32.10
30	32.20	32.55	32.41	32.18
50	32.35	32.81	32.73	32.41
75	32.64	33.27	32.94	32.77
100	33.00	33.61	33.26	33.27
125	33.50	33.94	33.56	33.76
150	33.88	34.23	33.89	34.15
200	34.55	34.75	34.56	34.54
250	34.63	34.78	34.67	34.61
300	34.71	34.80	34.70	34.68
400	34.80	34.85	34.75	34.78
500	34.83	34.86	34.80	34.83
600	34.85	34.81	34/85	34.85
800	34.87	34.81	34.87	34.87
1000	34.87	34.81	34.87	34.87
1200	34.88	34.82	34.88	34.88
1500	34.90	34.84	34.90	34.90
2000	34.93	34.87	34.93	34.93

TABLE 4. NORTH ATLANTIC OCEAN

Library Profile 3, ICAPS Profile No. 147, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	37.09	37.04	37.29	37.29
10	37.09	37.14	37.29	37.28
20	37.09	37.14	37.29	37.28
30	37.09	37.13	37.28	37.27
50	37.09	37.11	37.21	37.26
75	37.09	37.08	37.03	37.07
100	37.05	37.03	36.95	36.93
125	36.93	36.91	37.84	36.81
150	36.83	36.79	36.73	36.70
200	36.63	36.54	36.51	36.52
250	36.42	36.40	36.37	36.38
300	36.25	36.22	36.25	36.25
400	35.95	35.94	36.01	36.00
500	35.72	35.80	35.79	35.77
600	35.52	35.60	35.63	35.59
800	35.21	35.32	35.36	35.30
1000	35.09	35.15	35.22	35.17
1200	35.11	35.11	35.20	35.16
1500	35.10	35.12	35.15	35.13
2000	35.01	35.04	35.02	35.04

TABLE 5. NORTH ATLANTIC OCEAN

Library Profile 4, ICAPS Profile No. 156, Seasonal Salinities

Depth (m)	Winter	Spring	Summer	Fall
0	33.09	32.17	34.00	32.24
10	33.45	32.58	34.11	33.07
20	34.14	33.79	34.37	34.02
30	35.05	35.32	34.97	34.71
50	35.72	35.83	35.70	35.44
75	35.74	35.79	35.72	35.62
100	35.67	35.68	35.63	35.57
125	35.60	35.60	35.56	35.54
150	35.53	35.53	35.50	35.51
200	35.36	35.40	35.36	35.41
250	35.17	35.20	35.16	35.23
300	34.99	35.00	34.99	35.06
400	34.79	34.79	34.80	34.83
500	34.64	34.65	34.68	34.66
600	34.57	34.58	34.62	34.60
800	34.55	34.53	34.55	34.56
1000	34.65	34.64	34.60	34.65
1200	34.80	34.80	34.75	34.79
1500	34.93	34.92	34.92	34.92
2000	34.95	34.95	34.95	34.95

TABLE 6. MEDITERRANEAN SEA

Library Profile 0, ICAPS Profile No. 11, Seasonal Salinities

Depth (m)	Winter	Spring	Summer*	Fall
0	38.94	38.97	39.05	39.12
10	38.94	38.97	39.05	39.11
20	38.94	38.98	39.04	39.13
30	38.94	38.98	39.00	39.10
50	38.94	38.98	38.97	39.01
75	38.96	38.99	38.97	38.95
100	38.96	39.00	38.98	38.98
125	38.96	38.99	38.98	38.99
150	38.96	38.99	38.98	38.99
200	38.96	38.98	38.97	38.98
250	38.95	38.96	38.96	38.96
300	38.94	38.93	38.94	38.94
400	38.90	38.90	38.90	38.89
500	38.86	38.86	38.86	38.86
600	38.83	38.83	38.83	38.83
800	38.80	38.80	38.80	38.80
1000	38.79	38.78	38.79	38.81
1200	38.81	38.79	38.77	38.81
1500	38.81	38.78	38.72	38.82
2000	38.81	38.74	38.70	38.81

TABLE 7. MEDITERRANEAN SEA

Library Profile 1, ICAPS Profile No. 2, Seasonal Salinities

Depth (m)	Winter	Spring	Summer*	Fall
0	36.53	36.31	36.40	36.40
10	36.52	36.32	36.38	36.39
20	36.51	36.33	36.35	36.39
30	36.52	36.35	36.34	36.39
50	36.58	36.40	36.39	36.41
75	36.66	36.46	36.47	36.44
100	36.82	36.58	36.61	36.55
125	37.04	36.73	36.83	37.00
150	37.26	36.88	37.09	37.30
200	38.00	37.62	37.71	37.66
250	38.30	38.10	38.08	37.98
300	38.39	38.23	38.24	38.22
400	38.45	38.34	38.35	38.37
500	38.46	38.35	38.38	38.39
600	38.48	38.40	38.40	38.40
800	38.46	38.40	38.39	38.40
1000	38.37	38.40	38.39	38.39
1200	38.39	38.41	38.38	38.39
1500	38.39	38.41	38.39	38.40
2000	38.40	38.42	38.40	38.40

TABLE 8. MEDITERRANEAN SEA

Library Profile 2, ICAPS Profile No. 15, Seasonal Salinities

Depth (m)	Winter	Spring	Summer	Fall
0	22.00	23.00	21.26	26.16
10	26.00	27.00	22.14	26.44
20	30.00	31.00	28.63	30.94
30	34.00	35.00	37.24	35.82
50	38.40	38.45	38.45	38.53
75	38.55	38.50	38.54	38.56
100	38.55	38.55	38.55	38.57
125	38.55	38.55	38.55	38.57
150	38.54	38.54	38.55	38.57
200	38.54	38.53	38.54	38.56
250	38.53	38.52	38.53	38.54
300	38.53	38.52	38.52	38.54
400	38.52	38.52	38.52	38.53
500	38.52	38.52	38.52	38.53
600	38.52	38.52	38.51	38.52
800	38.51	38.52	38.53	38.53
1000	38.50	38.51	38.51	38.51
1200	38.49	38.49	38.49	38.50
1500	38.48	38.48	38.48	38.48
2000	38.45	38.45	38.45	38.45

TABLE 9. MEDITERRANEAN SEA

Library Profile 3, ICAPS Profile No. 16, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	18.26	17.97	17.87	17.95
10	18.30	18.08	18.00	18.08
20	18.32	18.19	18.13	18.13
30	18.39	18.27	18.23	18.21
50	18.66	18.49	18.46	18.53
75	19.30	19.13	19.28	19.37
100	19.98	19.80	20.02	20.09
125	20.44	20.35	20.57	20.58
150	20.78	20.71	20.93	20.89
200	21.24	21.21	21.34	21.28
250	21.47	21.47	21.56	21.48
300	21.63	21.65	21.71	21.61
400	21.85	21.86	21.90	21.83
500	21.96	22.00	22.03	21.98
600	21.85	22.07	22.13	21.95
800	21.98	22.20	22.23	22.08
1000	22.23	22.30	22.26	22.12
1200	22.23	22.36	22.30	22.13
1500	22.36	22.35	22.31	22.30
2000	22.33	22.34	22.34	22.34

TABLE 10. NORTH PACIFIC OCEAN

Library Profile 0, ICAPS Profile No. 68, Seasonal Salinities

Depth (m)	Winter*	Spring	Summer	Fall
0	34.23	33.97	33.83	34.03
10	34.10	33.97	33.96	34.01
20	34.10	33.98	34.03	34.00
30	34.10	33.99	34.09	34.03
50	34.11	34.01	34.20	34.11
75	34.12	34.06	34.23	34.15
100	34.12	34.08	34.22	34.21
125	34.12	34.08	34.17	34.16
150	34.12	34.07	34.13	34.13
200	34.07	34.05	34.06	34.08
250	34.04	34.04	34.04	34.04
300	34.04	34.04	34.03	34.01
400	34.03	34.05	34.04	34.00
500	34.04	34.07	34.05	34.00
600	34.05	34.06	34.09	34.05
800	34.07	34.04	34.10	34.10
1000	34.09	34.04	34.10	34.10
1200	34.10	34.05	34.10	34.10
1500	34.09	34.06	34.09	34.08
2000	34.08	34.08	34.08	34.08

TABLE 11. NORTH PACIFIC OCEAN

Library Profile 1, ICAPS Profile No. 14, Seasonal Salinities

Depth (m)	Winter	Spring	Summer	Fall*
0	32.48	32.24	32.14	32.36
10	32.49	32.28	32.20	32.36
20	32.51	32.41	32.39	32.39
30	32.53	32.49	32.52	32.44
50	32.58	32.59	32.68	32.65
75	32.82	32.82	32.86	32.94
100	33.21	33.19	33.12	33.23
125	33.52	33.50	33.41	33.48
150	33.72	33.71	33.64	33.68
200	33.89	33.89	33.87	33.88
250	33.94	33.94	33.93	33.93
300	33.97	33.97	33.96	33.96
400	34.03	34.03	34.03	34.02
500	34.10	34.11	34.10	34.09
600	34.18	34.18	34.18	34.17
800	34.30	34.31	34.30	34.30
1000	34.39	34.40	34.39	34.39
1200	34.45	34.45	34.45	34.45
1500	34.52	34.52	34.51	34.52
2000	34.59	34.59	34.59	34.59

TABLE 12. NORTH PACIFIC OCEAN

Library Profile 2, ICAPS Profile No. 99, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	33.06	32.78	32.50	32.33
10	33.04	32.79	32.55	32.33
20	33.05	32.84	32.68	32.37
30	33.07	32.89	32.79	32.58
50	33.10	32.98	32.92	32.84
75	33.14	33.04	33.02	32.99
100	33.17	33.13	33 10	33.08
125	33.25	33.22	33.19	33.19
150		33.29	33.26	33.26
200	33.50	33.38	33.35	33.35
250	33.60	33.45	33.41	33.40
300	33.65	33.51	33.47	33.46
400	33.66	33.63	33.59	33.59
500	33.70	33.75	33.74	33.71
600	33.85	33.90	33.94	33.89
800	34.15	34.14	34.21	34.14
1000	34.30	34.32	34.35	34.32
1200	34.42	34.44	34.43	34.44
1500	34.50	34.50		
2000		34.54		

TABLE 13. NORTH PACIFIC OCEAN

Library Profile 3, ICAPS Profile No. 104, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	32.18	32.00	31.96	31.88
10	32.19	32.04	32.01	31.92
20	32.22	32.11	32.12	31.99
30	32.25	32.18	32.24	32.08
50	32.33	32.31	32.45	32.32
75	32.50	32.51	32.66	32.62
100	32.82	32.81	32.90	32.93
125	33.16	33.13	33.22	33.23
150	33.39	33.37	33.49	33.46
200	33.63	33.62	33.74	33.69
250	33.74	33.73	33.82	33.79
300	33.81	33.81	33.88	33.84
400	33.97	33.96	33.98	33.95
500	34.07	34.06	34.07	34.05
600	34.16	34.16	34.14	34.14
800	34.28	34.29	34.27	34.28
1000	34.36	34.37	34.34	34.37
1200	34.43	34.43	34.40	34.44
1500	34.51	34.51	34.50	34.52
2000	34.59	34.58	34.58	34.57

TABLE 14. NORTH INDIAN OCEAN

Library Profile 0, ICAPS Profile No. 13, Seasonal Salinities

Depth (m)	Winter	Spring	Summer*	Fall
0	34.41	34.43	34.43	34.41
10	34.40	34.43	34.43	34.40
20	34.48	34.43	34.43	34.48
30	34.63	34.46	34.46	34.63
50	34.82	34.65	34.65	34.82
75	35.10	34.91	34.91	35.10
100	35.12	35.09	35.09	35.12
125	35.04	35.14	35.14	35.04
150	35.01	35.13	35.13	35.01
200	35.03	35.07	35.07	35.03
250	35.08	35.06	35.06	35.08
300	35.08	35.05	35.05	35.08
400	35.06	35.03	35.03	35.06
500	35.05	35.02	35.02	35.05
600	35.03	35.01	35.01	35.03
800	34.99	34.98	34.98	34.99
1000	34.94	34.93	34.93	34.94
1200	34.90	34.89	34.89	34.90
1500	34.85	34.84	34.84	34.85
2000	34.78	34.77	34.77	34.78

TABLE 15. NORTH INDIAN OCEAN

Library Profile 1, ICAPS Profile No. 1, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	39.02	38.76	38.76	39.02
10	39.01	38.76	38.76	39.01
20	39.02	38.83	38.83	39.02
30	39.08	38.89	38.89	39.08
50	39.21	39.01	39.01	39.21
75	39.54	39.48	39.48	39.54
100	39.98	40.03	40.03	39.98
125	40.22	40.29	40.29	40.22
150	40.35	40.42	40.42	40.35
200	40.45	40.50	40.50	40.45
250	40.49	40.54	40.54	40.49
300	40.51	40.57	40.57	40.51
400	40.54	40.58	40.58	40.54
500	40.56	40.61	40.61	40.56
600	40.56	40.61	40.61	40.56
800	40.57	40.63	40.63	40.57
1000	40.58	40.65	40.65	40.58
1200	40.60	40.63	40.63	40.60
1500	40.60	40.65	40.65	40.60
2000	40.70	40.66	40.66	40.70

TABLE 16. NORTH INDIAN OCEAN

Library Profile 2, ICAPS Profile No. 23, Seasonal Salinities

Depth (m)	Winter	Spring*	Summer	Fall
0	36.25	36.51	36.51	36.25
10	36.22	36.46	36.46	36.22
20	36.20	36.32	36.32	36.20
30	36.22	36.24	36.24	36.22
50	36.18	36.06	36.06	36.18
75	36.10	35.97	35.97	36.10
100	35.80	35.91	35.91	35.80
125	35.75	35.90	35.90	35.75
150	35.70	35.89	35.89	35.70
200	35.67	35.87	35.87	35.67
250	35.80	36.19	36.19	35.80
300	36.05	36.54	36.54	36.05
400	36.35	37.07	37.07	36.35
500	36.61	37.12	37.12	36.61
600	36.93	37.18	37.18	36.93
800	37.22	37.25	37.25	37.22
1000	37.35	37.45	37.45	37.35
1200	37.34	37.51	37.51	37.34
1500	37.30	37.50	37.50	37.30
2000		37.25		

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This technical note documents a program written specifically for the HP-41CV calculator to convert a bathythermograph profile to a sound speed profile. The format of the report follows the guidelines set forth by the Navy Tactical Support Activity, Fleet Mission Program Library.

The program documented herein differs from existing calculator programs used for a similar purpose (Kerr, 1983) in that an archival salinity profile library is included with the program.

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Magnetic card copies of the program and salinity profile library may be obtained from the Naval Oceanographic Office, Code 9200.