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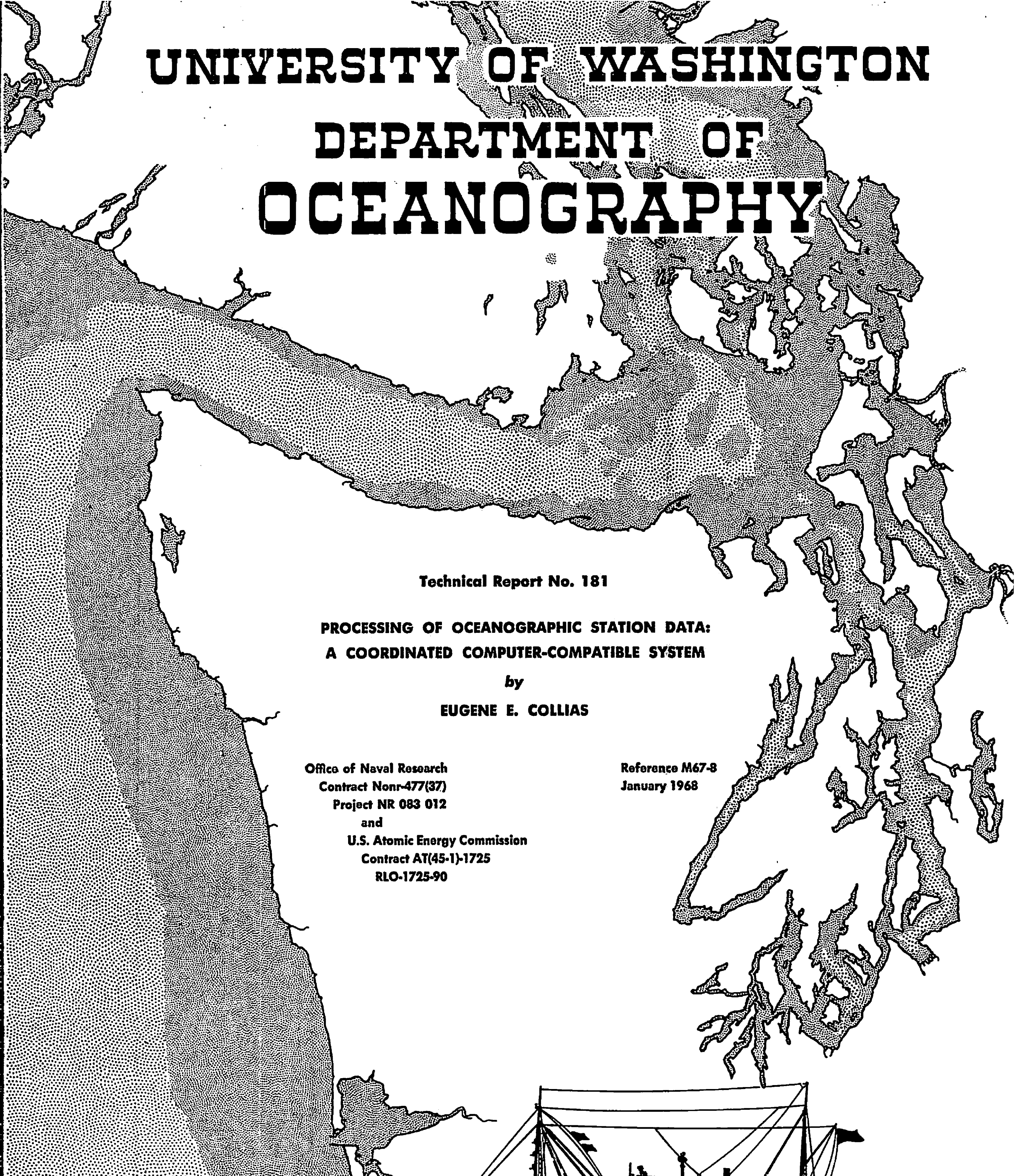

Technical Report No. 181

**PROCESSING OF OCEANOGRAPHIC STATION DATA:
A COORDINATED COMPUTER-COMPATIBLE SYSTEM**

by

EUGENE E. COLLIAS

Office of Naval Research
Contract Nonr-477(37)
Project NR 083 012
and
U.S. Atomic Energy Commission
Contract AT(45-1)-1725
RLO-1725-90

Reference M67-8
January 1968

SEATTLE, WASHINGTON 98105

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Eugene E. Collias

RICHARD H. FLEMING
Chairman

FRANCIS A. RICHARDS
Principal Investigator, ONR

CLIFFORD A. BARNES
Principal Investigator, AEC

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ABSTRACT

A coordinated computer-compatible system has been developed to eliminate most of the hand calculations involved in processing oceanographic data taken at a hydrographic (water-sampling) station. A special field-log form is used at the time the oceanographic station is occupied so that machine processing of the data is expedited. These data are first punched either on paper tape using a Friden Flexowriter or on Hollerith (IBM) cards and then submitted to a computer to make selected computations.

The computer program uses only uncorrected readings from the meter wheel, estimated wire length, reversing thermometers, salinity, oxygen, and other chemical determinations. The final results are printed, and other output options may be selected such as punched cards, magnetic tape, or both. Output formats for punched cards are essentially those used by the National Oceanographic Data Center. Many error checks and quality control evaluations are incorporated into the program.

The program is written in FORTRAN-II and FAP especially for the IBM-7094-7040 Direct Couple System. An average of 2.5 sec of computer time is required for a station of 12 sampling depths.

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1. INTRODUCTION

1.1. *Purpose*

The purpose of this comprehensive computer-compatible system for the processing of physical and chemical oceanographic station data is to eliminate most of the hand computations involved in reducing the observed values to a usable form for further analyses. From the actual physical and chemical readings obtained at an oceanographic station, the computer program is designed to calculate such quantities as corrected water temperature, salinity, density as sigma-*t*, several values for representing oxygen concentration, relative humidity, wire-angle depth, and thermometric depth. The system has been designed with flexibility in mind. Inputs may appear in different forms, and outputs may be produced in several desired formats.

1.2. *Background*

Many attempts have been made to eliminate the need for hand computations of data taken at oceanographic stations where water samples are obtained (i.e., hydrographic stations). Prior to the development of high-speed electronic computers, reversing thermometer corrections were made by means of various nomograms as developed by Tully (1937) and by LaFond (1951), or by specially designed slide rules (Culbertson, 1955), or by hand calculator. Salinity values were derived by means of tables whether the determinations were performed by titration (Oxner, 1920) or by conductivity bridge or salinometer (Paquette, 1958). Values of density as sigma-*t* were computed by double interpolation from Knudsen's tables (Knudsen et al., 1901) or tables derived from this work. Oxygen saturation values were obtained from tables developed from the work of either Whipple and Whipple (1911) or Truesdale and Gameson (1957) or by nomograms derived from these works (Tully, 1949; Richards and Corwin, 1956). Because each of these quantities is based upon an explicit mathematical expression, it was easy to develop a program to perform the computations by means of a high-speed digital electronic computer.

Many groups (Dinger, 1964) have prepared computer programs to perform calculations of density and other values from reduced oceanographic station data. There have been some attempts to correct reversing thermometers by electronic computer. But until recently there have been no attempts to design a system that would perform all of these computations from the basic observed (or raw) station data.

During the summer of 1963, a first attempt to develop such a comprehensive computer program was made and proved to be successful. Since then the program and system have been revised several times and a Friden Flexowriter has been incorporated into it.

1.3. *The System*

The system (Fig. 1.1) is designed so that after all the basic observed data have been recorded on the field log (section 2.1), the data are transcribed onto punched paper tape, using a Friden Flexowriter on board ship, as soon as practicable after the station is occupied. This procedure permits proofreading and a first screening for any errors or omissions shortly after the station is occupied. Any errors are corrected, and comments may be written on the tape after each station to explain any unusual events. Upon return to the home laboratory, the punched paper tape is converted to Hollerith cards using a suitable computer program (section 5.2). If no Flexowriter is available, the field logs must be carefully checked for errors, the data must be keypunched onto cards, and the cards must be verified.

After all cards from a cruise have been punched and verified, they are submitted to a proofreading program (section 5.4) for a further scan for errors and for the preparation of a thermometer deck (section 2.2.7). Any errors are corrected and additional comment cards are prepared if necessary. Then the corrected cards are processed by the main program SYNØP (section 4) for correction of thermometers and calculation of various parameters. The output from this program is in the form of a printed page giving all the computed results, plus punched-card output based on the NODC offshore format (National Oceanographic Data Center, 1962) and a magnetic tape if desired. The data are now ready for further analysis by the person or group that obtained the original data. After further checking of the data, computation of the actual sampling depths for samples deeper than 200 m, addition of any special chemistry

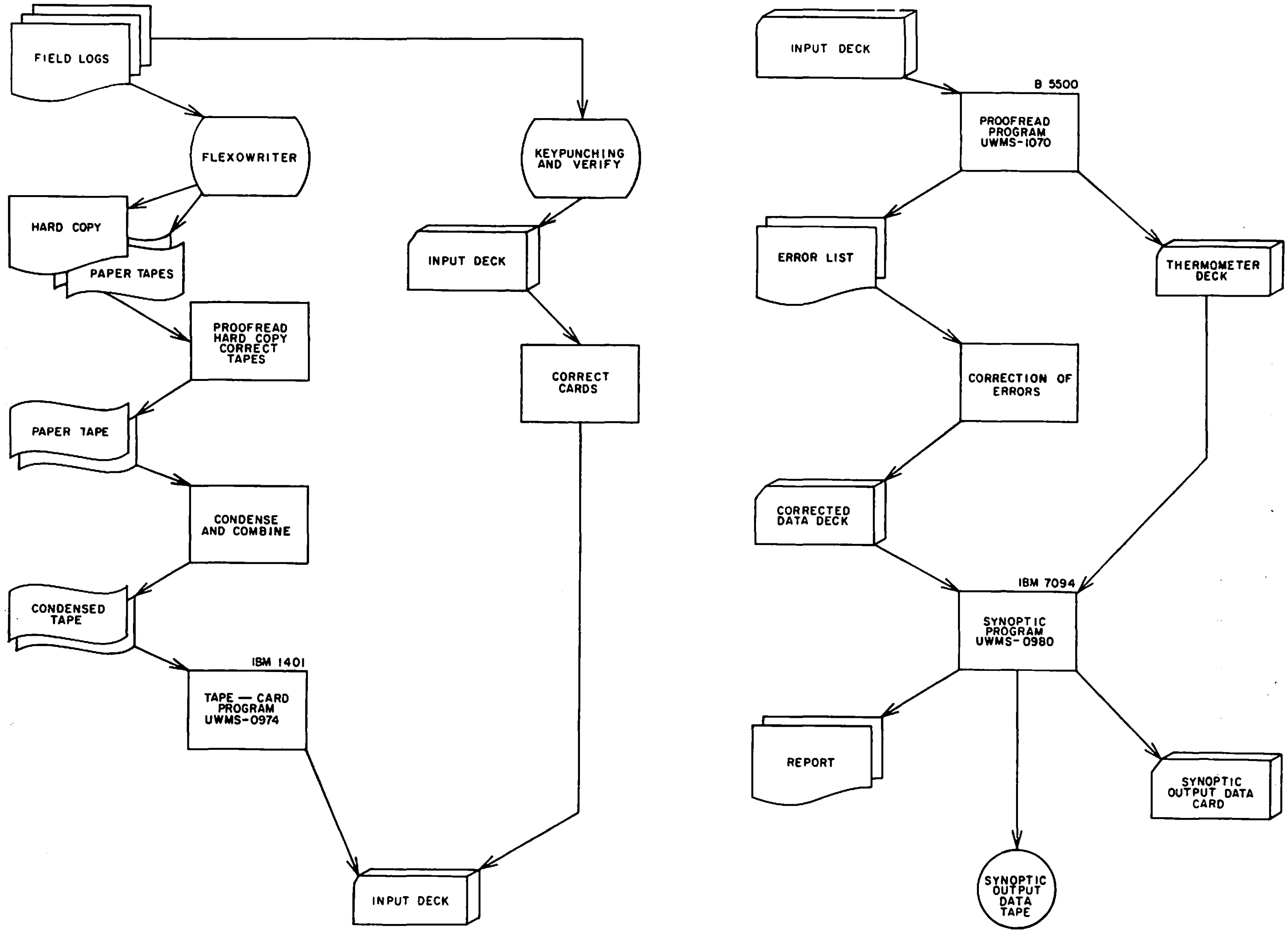

Fig. 1.1. Flow chart of the system.

values,[1] computation of interpolated values, computations of dynamic heights, and the addition of any biological data, a data report is prepared for publication using a final computer program.

Details of the entire system are presented in the following sections of this report.

[1]Such as phosphate, nitrate, *p*H, silicates, etc.

2. INPUT

2.1. *Field Log*

Success with any system of processing oceanographic data demands that some type of a field log be properly prepared at the time of observation. Only then will the final results be a correct representation of the original data. It must be realized, however, that errors not obvious at the time of sampling may be present in the original data. Also, any inherent experimental errors will be present in the final output.

The field log used with this system (Fig. 2.1) is similar to field logs used by other institutions to record the basic physical and chemical data obtained at a hydrographic station. However, the number of digits placed in any data column and the location of the data fields are closely controlled. This field log permits direct transcription of the data onto punched paper tape with a Friden Flexowriter or onto punched Hollerith cards without further conversion or modification of the basic format. (See section 5 for more details.)

Five data areas are provided on the field log, of which three are used for machine coding[2] and the other two are used for necessary information pertaining to work performed while the oceanographic station is being occupied. The first block of data, the master card information, is recorded on the upper two lines of the field log. The second type of data constitutes the parameter card and appears on the third line of the log. The information for the third set of data is recorded in the body of the log and is used to punch the detail-A cards. These three types of data cards plus three other types are necessary as input for the program SYNØP (section 4).

2.2. *Format of Cards*

2.2.1. *Introduction:* The basic input to the computer consists of punched Hollerith cards and wherever possible the information is coded as recommended by the National Oceanographic Data Center (1962). Card input was selected because of the ease of editing and correcting any errors.

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[2]Small numbers are printed on the field log to indicate the column number on a Hollerith card into which the data are to be punched.

FORM NO. UW-DO-HS-4X (REVISED 1 NOVEMBER 1963)

OCEANOGRAPHIC FIELD LOG — UNIVERSITY OF WASHINGTON — DEPARTMENT OF OCEANOGRAPHY

Page 1 of 1 for this station

CRUISE & STATION NO.	STATION NAME	VESSEL	LOCAL DATE
ØA-78 17	Tabcok Point	ØNAR	25 II 66

Master Card

Country (1–2)	Ship (3–4)	Latitude N (5–9)	Longitude W (10–15)	Marsden Square or area (16–18)	Date — Year (19–20)	Month (21–22)	Day (23–24)	Hour (25–27)	Tide Ht, Time zone (28–33)	Sonic depth 106 fm, m (34–37)	Max. Samp. Depth (38–39)	40
31	ØA	47°44.8'	122°49.9'	DAB	66	02	25	07.5	113H08	0194	02	

41	Water Color (42–43)	Water Transp. (44–45)	Waves Dir. (46–47)	H/A (48)	Pw (49)	Wind Dir. (50–51)	Wind Speed (52–53)	Barometer ____ in. mbs (54–56)	Air temperature Dry, °C (57–59)	Wet, °C (60–62)	Weather (63–64)	Cloud Typ (65)	Cloud Am (66)	Visib. (67)	Special observations (68–73)	Cruise no. (74–76)	Station no. (77–79)	Control (80)
		09	17	2	2	17	15	14.6	07.0	06.4	X5	5	8	6		078	017	J

Time based on ________ zone

Cast	Wire angle	Start	Down	Mess.	Begin Haul	Finish
1	6	0706	0706	0710	0712	0715
2	6	0717	0728	0735	0737	0745

Trip felt? yes yes | Winch card? ok | Thermo. reading time: 0800
BT slide no: 17 | Sal. in case no: Ø-9 | Thermo read by: EEC

Parameter Card

Cast (5)	Mess. time of cast (local time) (6–9)	Last applicable depth (10–13)	Wire angle (14–15)	Final "down" reading on meter wheel (16–19)	Salinometer no. (20–21)	Oxygen titer (22–25)	Cast (26)	Mess. time of cast (local time) (27–30)	Last applicable depth (31–34)	Wire angle (35–36)	Final "down" reading on meter wheel (37–40)	Salinometer no. (41–42)	Oxygen titer (43–46)	Meter wheel factor (65–68)	Sp. ch. (69)	Time zone (70–71)	Card No. (72)	Card of (73)	Control (80)
1	0710	0194	06	0197	02	13.83	2	0735	0180	06	0183	02	13.83	1.000	0	08	1	1	K

OBSERVERS: Collias - Van Olphen

SPECIAL OBSERVATIONS: none

Detail and parameter cards: Auto-duplicate col. 3-4, 74-79 from master card

Detail Card - A

Cast (5)	Meter wheel (6–9)	Est. depth (wire L) (10–13)	Slippage (14–15)	Rev. bott. no. (16–17)	Left Thermometer No. (18–23)	Left T (24–27)	Left t (28–30)	Left Corrected temp.	Middle Thermometer No. (31–36)	Middle T (37–40)	Middle t (41–43)	Middle Corrected temp.	Right Thermometer No. (44–49)	Right T (50–53)	Right t (54–56)	Salinity Bottle no.	Salinity Reading (57–61)	Oxygen Bottle no.	Oxygen Reading (62–65)	Special chem. bott. no. (66–69)	Remarks	Control (80)
2	0180	0000	00	01	0Y6801	07.90	08.0	.	654330	07.87	07.7	.		.	.	194	540.04	167	16.30		Submarine	L
	0175	0005		02	0Y7566	07.86	07.8	.	654119	07.85	07.8	.		.	.	195	539.82	168	16.29		in area	L
	0170	0010		03	0Y6340	08.52	07.9	.	0Y6782	08.50	07.8	.		.	.	196	580.98	169	13.09			L
	0165	0015		04	0Y7544	08.50	08.0	.	0Y6394	08.56	07.9	.		.	.	197	583.92	170	12.33			L
	0160	0020		05	0Y6341	08.55	07.8	.	654319	08.50	07.9	.		.	.	198	585.90	171	12.10			L
	0150	0030		06	009984	08.65	07.8	.	014037	08.61	08.1	.		.	.	199	589.20	172	11.77			L
	0140	0040		07	643967	08.76	07.8	.	014033	08.75	07.9	.		.	.	200	591.80	173	11.39			L
	0120	0060		08	014186	08.89	07.8	.	014336	08.93	08.1	.		.	.	201	594.00	174	11.43			L
	0100	0080		09	014175	09.10	08.0	.	014250	09.11	07.8	.	013522	10.00	08.1	202	596.83	175	10.71			L
	0080	0100		10	654117	09.60	08.0	.	014183	09.55	07.8	.	013559	10.64	08.3	203	601.41	176	09.17			L
	0060	0120		11	0Y6028	09.87	08.1	.	014177	09.74	07.8	.	013564	11.08	08.3	204	603.46	177	08.55			L
	0040	0140		12	0Y5624	09.88	08.3	.	014174	09.81	08.0	.	014075	11.35	08.3	205	604.86	178	08.19			L
	0020	0160		13	014182	09.92	08.3	.	654333	09.55	08.0	.	014079	11.72	08.4	206	606.43	179	07.12			L
	0000	0180		14	643968	10.07	07.2	.	654116	10.09	08.3	.	014884	11.95	08.8	207	607.57	180	05.69			L
1	0020	0174	00	01	0Y6801	10.06	08.5	.	654330	10.02	08.1	.		.	.	208	607.16	181	06.54		Weight on	L
	0010	0184		02	0Y7566	10.13	08.4	.	654119	10.11	08.1	.		.	.	209	607.83	182	05.14		bottom	L
	0000	0194		03	0Y6340	10.15	08.3	.	0Y6782	10.12	08.3	.		.	.	210	607.77	183	05.09			L

Temp. corrected by _____

Use red → | Cruise ØA 78 | Station no. 17

Fig. 2.1. Oceanographic field log for use with SYNØP (67 percent of original size).

Six types of card formats are used as input to the main program SYNØP. Three of the six formats are on special printed cards to aid in reading the data and for making corrections.

2.2.2. *Master card:* The master card (Fig. 2.2) contains information concerning when and where the station was occupied, the meterological conditions at that time, and other pertinent information. Table 2.1 presents the format of this card. Only one master card is prepared for each station unless certain restrictions are exceeded as stated in section 4.2.

2.2.3. *Parameter card:* The parameter card (Fig. 2.3) states the constants necessary for the computer to make calculations of sampling depth, salinity, oxygen, and other values. Data for two casts can be punched into each card; hence several parameter cards may be needed for one station. The format and coding instructions are found in Table 2.2.

2.2.4. *Detail-A card:* The detail-A card (Fig. 2.4) contains observed data such as estimated depth, meter-wheel reading, uncorrected reversing thermometer readings, salinometer reading, oxygen-titration values, etc., for each sampling depth. One card for each depth is prepared as listed in Table 2.3.

2.2.5. *Comment card:* Frequently it is desirable to insert remarks as to what happened during a cast or station so that anyone working with the data will know the circumstances under which the station was occupied. Up to 20 comment cards per station may be punched according to the format in Table 2.4.

2.2.6. *Cruise parameter card:* One cruise parameter card is punched for each cruise, and it must be the first card of the data for each cruise. This card specifies the meter-wheel type used, the distance from the point of attaching the reversing bottles on the hydrographic wire to the surface of the water (referred to as distance above water), and the type of output options desired other than printed copy. The format is specified in Table 2.5.

2.2.7. *Thermometer-correction cards:* The thermometer-correction cards specify the serial number of the reversing thermometer, the type

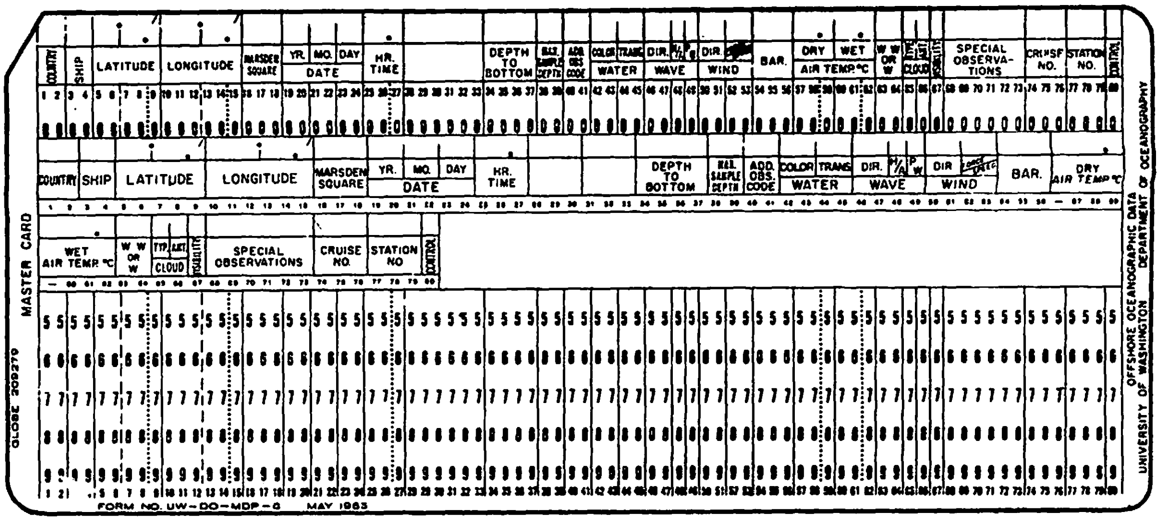

Fig. 2.2. Master card.

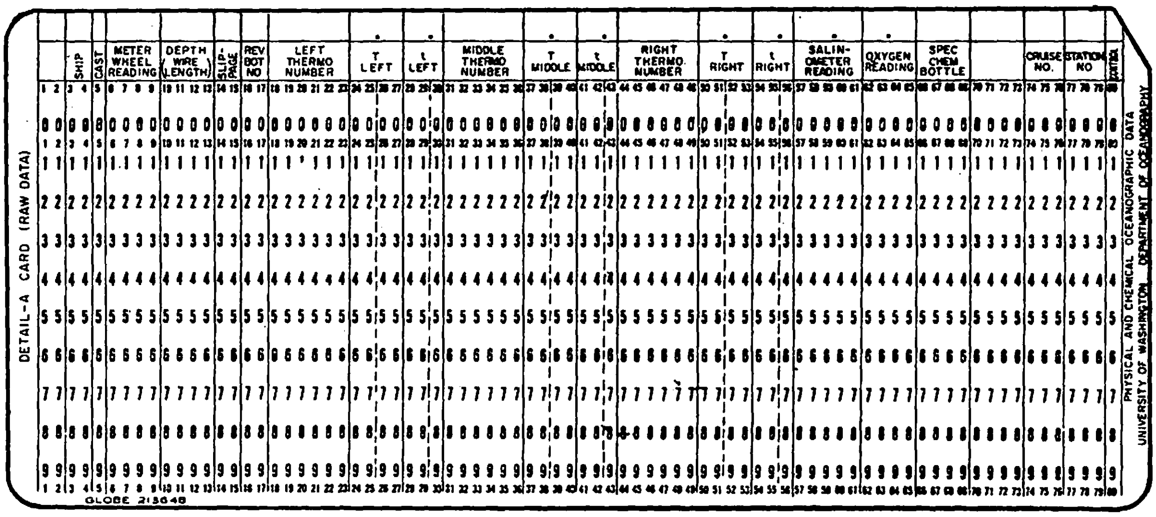

Fig. 2.3. Parameter card.

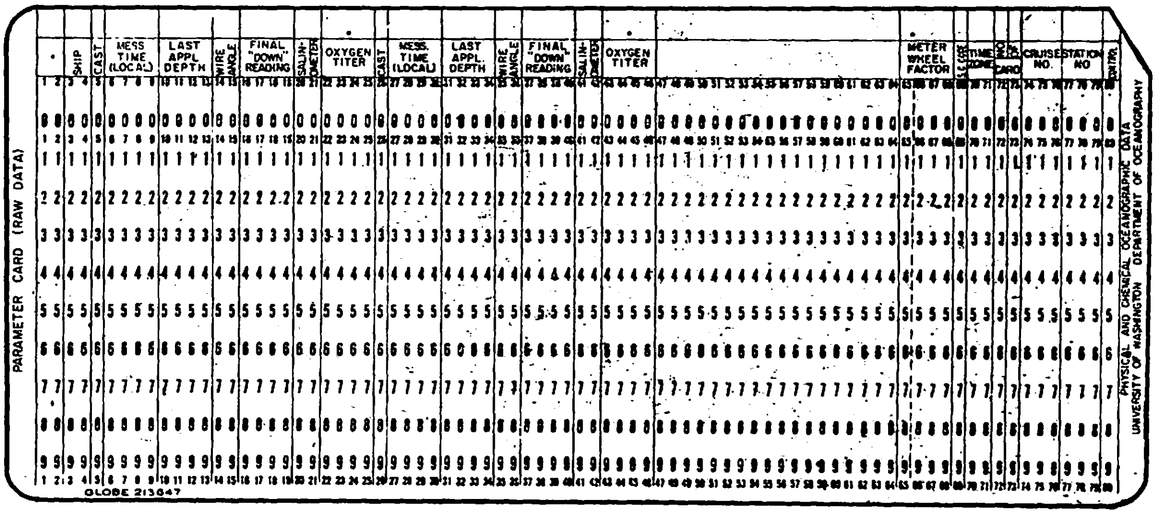

Fig. 2.4. Detail-A card. (Combined Figs. 2.2, 2.3, and 2.4 are 80 percent of original size.)

(i.e., protected or unprotected), the pressure coefficient if unprotected, and the index correction at several readings of the main thermometer. A total of 15 index corrections per thermometer may be required with two cards per thermometer. A maximum of 300 thermometers is permitted. The format of these cards is given in Table 2.6.

2.3. *Using the Flexowriter*

The Friden Programamatic Flexowriter (Model SPD) provides a convenient method for completing the preliminary phases of machine data processing while aboard ship. By its use, the data obtained are transcribed onto tapes which, when corrected and combined into a single *cruise tape*, may be submitted to a computer for the preparation of punched cards.

Immediately upon the completion of the field log, the data are transcribed onto paper tape.[3] The observer obtains a hard copy[4] of the data and a *full tape*[5] simultaneously. After all the data for one station have been typed, the operator proofreads the hard copy and makes any necessary corrections to the full tape. At the same time he scans the data for obvious errors and/or omissions and either corrects them or writes a comment at the end of the cast or station to explain any discrepancies or irregularities.

The transcription of the data from the field log is facilitated by the use of a number of *program tapes* for the Flexowriter. The *master card program tape*, the *parameter card program tape*, and several *detail program tapes* (i.e., one for each deep-sea reversing bottle or the detail-A card information) are prepared at the beginning of each cruise. To facilitate the preparation of these tapes a *meta-master tape* is used. This tape is prepared before the start of the cruise and provides all

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[3]The coding of the paper tape is the IBM 8-level BCD paper tape code.

[4]A hard copy is a typewritten page containing the data just typed onto the paper tape.

[5]The *full tape* contains the information just typed, plus column headings and control information for preparation of the condensed tape.

necessary Flexowriter and computer control information and headings. Instructions for using these tapes are available from the author upon request.

After the full tape for each station has been corrected, a *condensed tape* is prepared. This tape has no headings, all the spaces between data fields found on the hard copy are eliminated, and control characters for the tape-to-card program are inserted at the correct points.

An example of the hard copy obtained by the Flexowriter is shown in Fig. 2.5 and gives the same data as shown on the original field log of Fig. 2.1. The condensed version of these data is shown in Fig. 2.6. After the cruise has been completed and all condensed tapes have been prepared, a final punched tape is made by combining the condensed tapes into one continuous cruise tape without breaks between stations. This cruise tape is then submitted to a computer for preparation of punched cards.

OA CRUISE 78 STATION 017

Country 31 Ship oa Lat 47448 Long 122499 Mars Sq/Area dab Date 66/02/25 Hour 075
Depth 0194 Water Color Trans 09 Wave Dir 17 Ht Prd 2 Wind Dir 17 Spd 15 Baro 146
Temp Dry 070 Wet 064 Wea x5 Cloud Type 5 Amt 8 Vis 6 Cruise 078 Station 017 j

Cast 1	Mess 0710	Last Depth 0194	WA 06	Final Down MW 0197	Salinom. No. 02	Oxy Titer 1383		
2	0735	0180	06	0183	02	1383		
MW Factor 1000	Spec Chem Code 0	Time Zone 08	Card 1 of 1					k

Cst	Mtr Whl	Est Dpth	Slp	Rev Bot	Left Thermo	T m	T a	Mid Thermo	T m	T a	Right Thermo	T m	T a	Sal Rdng	Oxy Rdng	Spec Chem	
2	0180	0000	00	01	Oy6801	0790	080	654330	0787	077				54004	1630		1
2	0175	0005	00	02	Oy7566	0786	078	654119	0785	078				53982	1629		1
2	0170	0010	00	03	Oy6340	0852	079	Oy6782	0850	078				58098	1309		1
2	0165	0015	00	04	Oy7544	0850	080	Oy6394	0856	079				58392	1233		1
2	0160	0020	00	05	Oy6341	0855	078	654319	0850	079				58590	1210		1
2	0150	0030	00	06	009984	0865	078	014037	0861	081				58920	1177		1
2	0140	0040	00	07	643967	0876	078	014033	0875	079				59180	1139		1
2	0120	0060	00	08	014186	0889	078	014336	0893	081				59400	1143		1
2	0100	0080	00	09	014175	0910	080	014250	0911	078	013522	1000	081	59683	1071		1
2	0080	0100	00	10	654117	0960	080	014183	0955	078	013559	1064	083	60141	0917		1
2	0060	0120	00	11	Oy6028	0987	081	014177	0974	078	013564	1108	083	60346	0855		1
2	0040	0140	00	12	Oy5624	0988	083	014174	0981	080	014075	1135	083	60486	0819		1
2	0020	0160	00	13	014182	0992	083	654333	0955	080	014079	1172	084	60643	0712		1
2	0000	0180	00	14	643968	1007	072	654116	1009	083	014864	1195	088	60757	0569		1
1	0020	0174	00	01	Oy6801	1006	085	654330	1002	081				60716	0654		1
1	0010	0184	00	02	Oy7566	1013	084	654119	1011	081				60783	0514		1
1	0000	0194	00	03	Oy6340	1015	083	Oy6782	1012	083				60777	0509		1

Fig. 2.5. Hard copy from Flexowriter (88 percent of original size).

```
31oa47448122499dab6602250750194   091721715146070064x5586078017j

107100194060197021383207350180060183021383
100000811k
20180000000010y680107900806543300787077                 540041630     1
20175000500020y756607860786541190785078                 539821629     1
20170001000030y634008520790y67820850078                 580981309     1
20165001500040y754408500800y63940856079                 583921233     1
20160002000050y634108550786543190850079                 585901210     1
201500030000600998408650780140370861081                 589201177     1
201400040000764396708760780140330875079                 591801139     1
201200060000801418608890780143360893081                 594001143     1
2010000800009014175091008001425009110780135221000081596831071     1
2008001000010654117096008001418309550780135591064083601410917     1
200600120001 10y6028098708101417709740780135641108083603460855     1
20040014000120y5624098808301417409810800140751135083604860819     1
2002001600013014182099208365433309550800140791172084606430712     1
2000001800014643968100707265411610090830148641195088607570569     1
10020017400010y680110060856543301002081                 607160654     1
10010018400020y756610130846541191011081                 607830514     1
10000019400030y634010150830y67821012083                 607770509     1
```

Fig. 2.6. Condensed data from Flexowriter (actual size).

TABLE 2.1

MASTER CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
1	1-2	2	Country, indicating which nation is operating the ship or conducting the cruise	XX	Found in NODC table 1*
2	3-4	2	Ship code	XX	Supplied by NODC
3	5-9	5	Latitude to the nearest 0.1 minute whenever possible	XX°XX.X'	If in the southern hemisphere, an 11-overpunch is put in col. 8
4	10-15	6	Longitude to the nearest 0.1 minute whenever possible	XXX°XX.X'	If in the eastern hemisphere, an 11-overpunch is put in col. 14
5	16-18	3	Marsden square or a mnenomic area code	AAA	
6	19-24	6	Year, month, and day based upon Greenwich mean time unless otherwise stated in col. 32-33	YYMMDD	Two digits each for year and month
7	25-27	3	Hour to the nearest tenth based upon Greenwich mean time unless otherwise stated	HH.H	
8†	28-30	2	Predicted tide height in feet above mean higher high water or other datum	TT.T	If negative, an 11-overpunch is put in col. 28
9†	31	1	Tide stage: H = high stand, L = low stand, R = rising, F = falling	A	
10†	32-33	2	Time zone on which hour (Field 7) is based	XX	00 = GMT
11	34-37	4	Sonic depth of water from surface to bottom in meters	XXXX	

(continued)

TABLE 2.1 (continued)

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
12	38-39	2	Maximum sampling depth in hundreds of meters	XX	
13	40-41	2	Additional observations		
14	42-43	2	Water color as determined by the Forel-Uhl scale	XX	
15	44-45	2	Transparency of the water based upon a Secchi disk reading recorded to the nearest meter	XX	
16	46-47	2	Wave direction	XX	Coding in NODC table 36*
17	48	1	Wave height or amount if direction is blank	X	Coding in NODC table 38*
18	49-50	1	Wave period	X	Coding in NODC table 39*
19	50-51	2	Direction from which the wind is blowing	XX	Coding in NODC table 36*
20	52-53	2	Wind speed in knots	XX	
21	54-56	3	Barometric pressure in millibars to the nearest tens, units, and tenths only (i.e., leave off the 9 for 900 plus or the 10 for 1000 plus)	XX.X	
22	57-59	3	Dry bulb air temperature as determined by a psychrometer, in degrees Celsius	XX.X	
23	60-62	3	Wet bulb air temperature as determined by a psychrometer, reported in degrees Celsius	XX.X	
24	63-64	2	Weather code (if present weather code is used put the letter X in col. 63)	XX	Coding in NODC table 64*

(continued)

TABLE 2.1 (continued)

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
25	65	1	Cloud type (if clear, leave blank)	X	Coding in NODC table 68*
26	66	1	Cloud amount in octas of cloud cover	X	Coding in NODC table 69*
27	67	1	Visibility	X	Coding in NODC table 70*
28	68-73	6	Special observations	AAAAAA	Coded by observer
29†	74-76	3	Cruise number	AAA	Alphameric field
30†	77-79	3	Station number	AAA	Alphameric field
31†	80	1	Always the letter "J"	A	

*Tables are found in NODC Pub M-2 (1962).

†Deviations from NODC format.

TABLE 2.2

PARAMETER CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal placement	Remarks
1	1-2	2	Country code or left blank	AA	Ignored by computer programs
2	3-4	2	Ship code	AA	Duplicated from master card
3	5	1	Cast number	I	An integer from 1 to 9, must not be 0 or blank
4	6-9	4	Messenger time of cast in local time	XXXX	
5	10-13	4	Last applicable depth for chemical analysis	XXXX	Used by SYNØP when chemical analyses changed in middle of cast
6	14-15	2	Wire angle	XX	Left blank if not measured
7	16-19	4	Final "down" reading on meter wheel	XXXX	Actual reading of meter wheel when cast is down
8	20-21	2	Salinometer number (valid numbers in existing program are 2, 4, 11, and 22, but must be changed by any other used to conform with his own salinometers)	XX	If salinity is entered onto detail-A cards, code is 88; if chlorinity was determined by titration, code is 99

(continued)

TABLE 2.2 (continued)

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
9	22-25	4	Oxygen titer—average number of milliliters of sodium thiosulfate required to standardize against 10.00 ml of 0.0100 *N* potassium biiodate	XX.XX	Code as 0000 if oxygen values in detail-A cards are in mg atoms/liter, or 0001 if entered as ml/liter, or left blank if no oxygens determined.
10-16	26-46	21	Same as Fields 3-9 for another cast		
17	47-64	18	Not used		
18	65-68	4	Meter-wheel factor (actual diameter of meter wheel divided by theoretical diameter)	X.XXX X	Must be numeric and not blank
19	69	1	Special chemistry	X	0 = no special chemistry 1 = phosphate samples only 2 = frozen samples collected 3 = phosphates and frozen samples
20	70-71	2	Time zone on which messenger time is based	XX	Negative zone indicated by minus overpunch in col. 71
21	72-73	2	Parameter card number X of Y for this station	XY	
22	74-76	3	Cruise number	XXX	Duplicated from master card
23	77-79	3	Station number	XXX	Duplicated from master card
24	80	1	Always the letter "K"	X	

TABLE 2.3

DETAIL-A CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
1	1-2	2	Country code or blank	XX	Ignored by computer programs
2	3-4	2	Ship code	XX	Duplicated from master card
3	5	1	Cast number	X	Must agree with that on parameter card
4	6-9	4	Meter-wheel reading	XXXX	Must be numeric
5	10-13	4	Estimated depth	XXXX	Must be numeric
6	14-15	2	Slippage—difference between down and up readings of meter wheel	XX	Numeric or blank
7	16-17	2	Deep-sea reversing bottle number	AA	May be alphabetic or numeric
8-10	18-30	13	Left reversing thermometer data:		
			18-23 Serial number of thermometer	AAAAAA	Alphameric but no blanks permitted
			24-27 Main thermometer reading	XX.XX	Malfunction coded as 8888
			28-30 Auxiliary thermometer reading	XX.X	
11-13	31-43	13	Middle reversing thermometer data:		
			31-36 Serial number	AAAAAA	
			37-40 Main thermometer reading	XX.XX	
			41-43 Auxiliary thermometer reading	XX.X	

(continued)

TABLE 2.3 (continued)

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
14-16	44-56	13	Right reversing thermometer data:		
			44-49 Serial number	AAAAAA	
			50-53 Main thermometer reading	XX.XX	
			54-56 Auxiliary reading	XX.X	
17	57-61	5	Salinometer reading in ohms	XXX.XX	Actual salinity or titration value may be entered
18	62-65	4	Milliliters of sodium thiosulfate used to titrate sample	XX.XX	Blank if no oxygen sample; oxygen may be entered as mg atoms/liter or ml/liter if coded in parameter card
19	66-69	4	Special chemistry bottle number	AAAA	Alphameric field
20	70-73	4	Not used at present	blank	
21	74-76	3	Cruise designator	AAA	Duplicated from master card
22	77-79	3	Station number	AAA	Duplicated from master card
23	80	1	Always the letter "L"		

TABLE 2.4

COMMENT CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
1	1-2	2	Country code or left blank	XX	Ignored by computer programs
2	3-4	2	Ship code	XX	Duplicated from master card
3	5	1	Cast number	X	Must not be 0 or blank
4	6-71	66	The comment		Any legal Hollerith code permitted
5	72-73	2	Not used		
6	74-76	3	Cruise designator	AAA	Duplicated from master card
7	77-79	3	Station number	AAA	Duplicated from master card
8	80	1	Always the letter "N"		

TABLE 2.5

CRUISE PARAMETER CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
1	1-2	2	Country code or blank	AA	Ignored by computer programs
2	3-4	2	Ship code	AA	Must be same on all cards for the cruise
3	5-12	8	Not used		
4	13-14	2	Distance from hydro-platform to water surface in meters	XX	
5	15	1	Meter-wheel use	X	1 = reading increases as wire is paid out 2 = reading decreases as wire is paid out
6	16-18	3	YES if detail and auxiliary cards are to be punched	AAA	Leave blank if this option is not wanted
7	19-21	3	YES if auxiliary tape is to be written	AAA	Leave blank if this option is not wanted
8	22-24	3	YES if special chemistry bottle numbers are to be punched in output detail cards col. 70-73	AAA	Leave blank if this option is not wanted
9	25-79	55	Leave blank		
10	80	1	Always the letter "M"		

TABLE 2.6

THERMOMETER CORRECTION CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
A. Card type one					
1	1	1	Not used		
2	2-7	6	Serial number of deep-sea reversing thermometer	AAAAAA	Must be six digits or letters
3	8	1	Type of thermometer	A	P = protected U = unprotected
4	9-11	3	V_o — Volume of small bulb in °C	XXX	
5	12-15	4	K — the relative expansion of glass and mercury as specified by manufacturer	XXXX	
6	16-20	5	Q — the pressure coefficient of an unprotected thermometer	.XXXXX	
7-16	21-70		Ten correction terms as		
			21-22 Temperature in °C	XX	
			23 Sign or correction term	+ -	
			24-25 Correction term in hundredths °C	XX	
			etc.		
17	71-74	3	Left blank		Ignored by program
18	75-76	2	Month calibrated		
19	77-78	2	Year calibrated		
20	79-80	2	Left blank		

(continued)

TABLE 2.6 (continued)

Field No.	Card columns	Field width	Information	Decimal placement	Remarks
B. Card type two — continuation card					
1	1	1	Not used		
2	2-7	6	Serial number of thermometer	AAAAAA	
3	8	1	Not used		
4	9-11	3	999		
5	12-20	9	Not used		
6-10	21-45	25	Correction terms Five more terms as Fields 7-16 of card number one		
11	46-80	35	Not used		

3. OUTPUT

3.1. *The Printed Page*

The output of the main program SYNØP (section 4) may be in several forms. The printed page is always obtained, with the punched-card output, or auxiliary tape, or both, being selected by setting options in the cruise parameter card (section 2.2.6). The printed page (Fig. 3.1) contains four areas of information. The first area is the station header data, which includes all the information on the master card arranged in a convenient manner. This arrangement may be in one of two formats depending on whether tide height and stage were included on the master card (i.e., if columns 28-33 of the master card were punched). The difference in these formats is simply the inclusion of tide height and time zone on which the station time is based. The second area is a transcription of the parameter card (section 2.2.3) and includes the calculated oxygen titer (section 4.3). This portion is repeated once for each card. Comment cards are written immediately after the parameter card data; the detail-A data are listed in the fourth area. The number of lines for each reversing bottle may vary from one to seven depending upon the number of thermometers and whether the protected thermometers agreed within 0.06°C or closer. If they did not meet this test, one line for each thermometer or combination of thermometers is printed and one card for each thermometer or combination will be punched. By printing and/or punching all related data for each thermometer, it is possible for the observer to select the best fit when there is a disagreement in temperature. At the end of each printed page any comments made by the program (such as missing thermometers or incorrect thermometer numbers, errors in the data that SYNØP has picked up, etc.) are printed. Each station begins a new page.

The arrangement of the printout of depths within a station is by cast and in order of the maximum sampling depth on each cast. If two casts have the same maximum sampling depth, they are printed in sequence by cast number.

3.2. *Punched Cards*

3.2.1. *Output detail cards:* Punched cards may or may not be obtained depending upon the option set in the cruise parameter card

CBSERVED VALUES CA 078-017 AREA CODF OAB

DATE(+08) 66/02/25 HP(+C8) 7.5 LAT 47-44.8N LCNG 122-49.9W SUG 0194 WEA X5 WVEL 15 DIR 17 VIS 6
BA 14.6 CL 5 AMT 8 DRY 7.0 WET 6.4 RELHU 92 WAV DIR 17 HT 2 PD 0 COLOR 4 SECOI 09 WA 06,06
TIDE HT 11.0 STG R

OA078 STATION 017 CAST 2 MESS.TIME GMT 1535 LOCAL(+08) 0735 WIRE ANGLE 06 LAST APPL. DEPTH 0180 FINAL MW 0183
SALINOMETER NO. 2 OXY TITER 13.83 OXY CONSTANT 0.4080 SP.CHEM. 0 MW FACTOR 1.000 CARD NO.1 OF 1

REV BOTTLE NO	LEFT T	MIDDLE T	RIGHT T	WIRE ANGLE DEPTH	THERM DEPTH (Z)	CALC (L-Z)	WIRE LENGTH (L)	L-Z FROM CURVE	ACCEPTED DEPTH	AVE T	SAL	SIGMA-T	---- O X Y G E N ---- ML/L	MGA/L	AOU	SATN	SP.CHEM BOTTLE NO	PO4	NO3	SIO3
01	7.85	7.E7		0			0			7.86	27.626	21.54	6.65	0.594	0.011	98				
02	7.81	7.E5		5			5			7.83	27.616	21.54	6.65	0.594	0.012	99				
03	8.51	8.50		10			10			8.50	29.491	22.91	5.34	0.477	0.111	81				
04	6.49	8.50		15			15			9.49	29.625	23.02	5.03	0.449	0.138	76				
05	8.52	8.51		20			20			8.52	29.716	23.08	4.94	0.441	0.146	75				
06	8.67	8.C3		3C			30			8.67L	29.867	23.18	4.80	0.429	0.155	73				
										8.03M		23.27			0.164	72				
07	8.79	8.29		40			40			8.79L	29.986	23.26	4.65	0.415	0.167	71				
										8.29M		23.33			0.174	70				
08	8.95	8.94		6C			60			8.94	30.087	23.31	4.66	0.417	0.163	72				
09	9.12	9.15	9.95U	80	79	1	80			9.13	30.217	23.38	4.37	0.390	0.186	68				
10	9.63	9.63	N I T	99			100			9.63	30.422	23.47	3.74	0.334	0.235	59				
11	9.77	9.79	11.07U	119	118	2	120			9.78	30.516	23.52	3.49	0.312	0.255	55				
12	9.P4	9.E5	11.35U	139	135	5	140			9.84	30.581	23.56	3.34	0.298	0.267	53				
13	9.99	9.57	11.72U	155	154	6	160			9.99L	30.653	23.59	2.91	0.259	0.304	46				
			11.71U		190	-30				9.57M		23.66			0.310	46				
14	10.14	10.10	11.95U	179	174-	6	180			10.12	30.706	23.61	2.32	0.207	0.355	37				

OA078 STATION 017 CAST 1 MESS.TIME GMT 1510 LOCAL(+08) 0710 WIRE ANGLE 06 LAST APPL. DEPTH 0194 FINAL MW 0197
SALINOMETER NO. 2 OXY TITER 13.83 OXY CONSTANT 0.4080 SP.CHEM. 0 MW FACTOR 1.000 CARD NO.1 OF 1

REV BOTTLE NO	LEFT T	MIDDLE T	RIGHT T	WIRE ANGLE DEPTH	THERM DEPTH (Z)	CALC (L-Z)	WIRE LENGTH (L)	L-Z FROM CURVE	ACCEPTED DEPTH	AVE T	SAL	SIGMA-T	---- O X Y G E N ---- ML/L	MGA/L	AOU	SATN	SP.CHEM BOTTLE NO	PO4	NO3	SIO3
01	10.05	10.06		173			174			10.05	30.687	23.60	2.67	0.238	0.324	42				
02	10.09	10.15		183			184			10.12	30.717	23.62	2.10	0.187	0.375	33				
03	10.16	10.15		193			194			10.15	30.715	23.61	2.08	0.185	0.376	33				

N I T - THERMOMETERS NOT FOUND IN TABLE FOR STATION 017
013555 AT DEPTH 0100

Fig. 3.1. Printed output from SYNØP (49 percent of original size).

(section 2.2.6) or by deletion under program control (section 4.3). The "output detail cards" are in essentially the same format as that used by NODC and are shown in Fig. 3.2 and explained in Table 3.1.

3.2.2. *Auxiliary output card:* The auxiliary output card is used to supply information in preparing the header information in the final data report presentation, but this information does not appear on the master card. The format of this card is described in Table 3.2.

3.3. *Auxiliary Output Tape*

When the auxiliary output tape option is set on the cruise parameter card (section 2.2.6), the tape produced is in card-image form and consists of one auxiliary card, the required number of detail cards, and a final card image with the letter X in column 80 for each station. At the end of all the data, a card image with the letter Z in column 80 and an end-of-file mark are generated. The auxiliary card format is identical to that described in Table 3.2 but the detail cards differ from that stated in Table 3.1 as follows:

Field No.	Card columns	Changes
8	28-31	Wire-angle depth for all samples rather than corrected sampling depth
21	66-69	Wire length rather than silicate or a blank
22	70-73	Thermometric depth rather than special chemistry bottle number

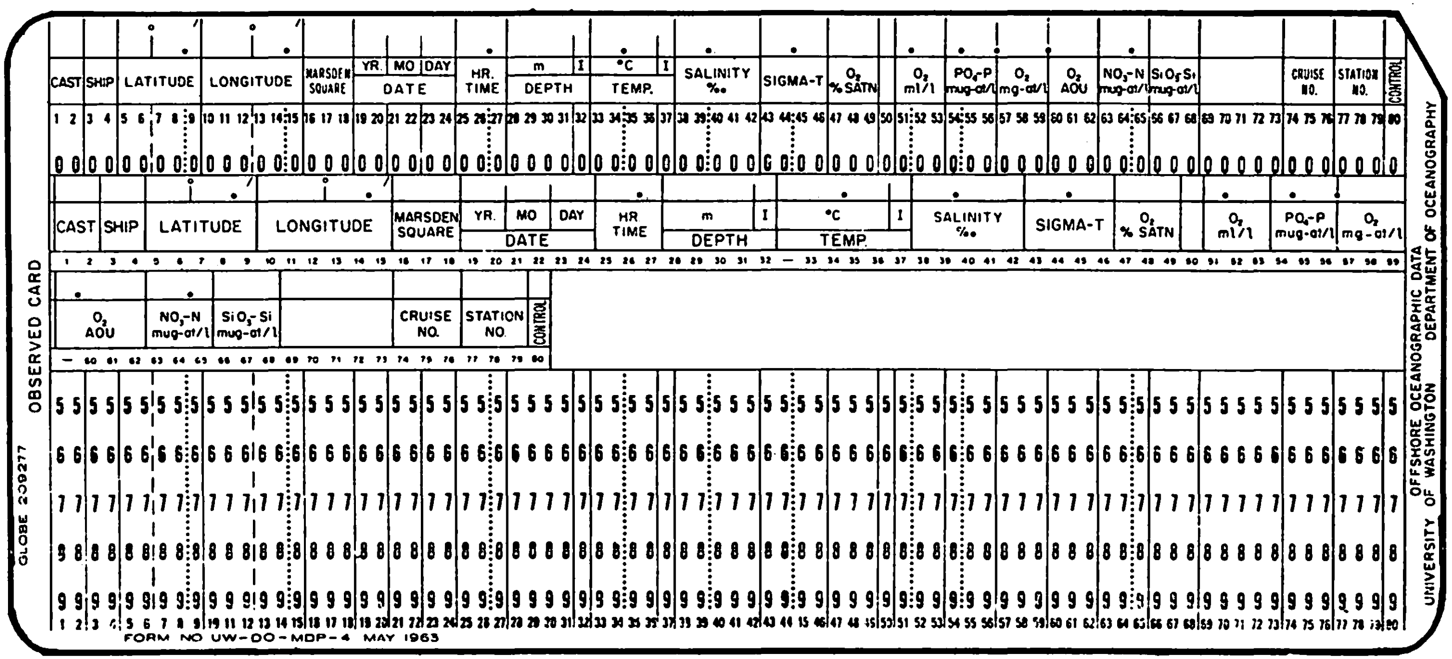

Fig. 3.2. Output detail card (actual size).

TABLE 3.1

OUTPUT DETAIL CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
1	1-2	2	Cast number	XX	
2	3-4	2	Ship code	XX	Duplicated from master card
3	5-9	5	Latitude to nearest 0.1 minute	XX-XX.X	South latitude indicated by X-overpunch in col. 8
4	10-15	6	Longitude to nearest 0.1 minute	XXX-XX.X	East longitude indicated by X-overpunch in col. 14
5	16-18	3	Marsden square or area code	AAA	
6	19-24	6	Date	YYMMDD	Duplicated from master card
7	25-27	3	Time of cast in GMT	XXX	See section 4.3
8	28-31	4	Corrected depth of sample in meters	XXXX	
9	32	1	Error code established by NODC	X	Left blank by program SYNØP
10	33-36	4	Temperature of water in °C	XX.XX	
11	37	1	Error code established by NODC	X	Left blank by program SYNØP
12	38-42	5	Salinity in parts per thousand	XX.XXX	
13	43-46	4	Density as sigma-*t*	XX.XX	
14	47-49	3	Percentage oxygen saturation	XXX	Change from NODC format

(continued)

TABLE 3.1 (continued)

Field No.	Card columns	Field width	Information	Decimal place-ment	Remarks
15	50	1	Not used at present		
16	51-53	3	Oxygen concentration in ml/liter	X.XX	If more than 10 ml/liter, put 12-overpunch in col. 51
17	54-56	3	Phosphate in µg-atoms/liter	X.XX	Inserted by hand
18	57-59	3	Oxygen concentration in mg-atoms/liter	.XXX	Deviation from NODC format
19	60-62	3	Apparent oxygen utilization	.XXX	Deviation from NODC format (see section 4.3)
20	63-65	3	Nitrate-nitrogen in µg-atoms/liter	XX.X	Inserted by hand
21	66-68	3	Silicate-silicion in µg-atoms/liter	XXX	Inserted by hand
22	69-73	5	Option: special chemistry bottle number or blank	XXXXX	Set by option in cruise parameter card (section 2.2.6)
23	74-76	3	Cruise designator	AAA	Duplicated from master card
24	77-79	3	Station number	AAA	Duplicated from master card
25	80	1	Always blank	B	

TABLE 3.2

AUXILIARY OUTPUT CARD FORMAT

Field No.	Card columns	Field width	Information	Decimal placement	Remarks
1	1-3	3	Blank		
2	4-5	2	Relative humidity in percent	XX	
3	6-9	4	Blank		
4	10-27	18	Wire angle of casts in increasing order, nine values in two column fields	XX.XX. etc.	
5	28-69	42	Blank		
6	70-71	2	Maximum sampling depth	XX	
7	72-73	2	Blank		
8	74-76	3	Cruise designator	XXX	Duplicated from master card
9	77-79	3	Station number	XXX	Duplicated from master card
10	80	1	Always the letter "K"	A	

4. THE PROGRAM "SYNØP"

4.1. *General Information*

The oceanographic station data processing program (SYNØP) uses for input the master cards, parameter cards, and detail-A cards for the various stations, plus the other three cards described in section 2.2 Output is provided in several formats as described in section 3. The main program was written in FORTRAN-II for the IBM 7094 computer and occupies 12,614 memory locations. The associated subroutines require another 12,960 locations, and the common storage area occupies 2108 cells for a total of 27,682 cells. In addition to these storage requirements, the computer monitor program requires at least another 2000 locations so that a 32K memory is necessary if the program is used as presented in this report. For a computer with a smaller memory, the program may be rewritten as a two- or three-pass program or many of the options may be eliminated. Seven subroutines are required as listed in Table 4.1. Sense lights 1 and 2 are used in the program as logical switches. Sense switches are not used, nor are the divide check and overflow indicators used.

4.2. *Restrictions*

Restrictions imposed by storage requirements are: (1) the thermometer correction deck is limited to 300 thermometers with a maximum of 15 index corrections each, (2) a station may have no more than (a) nine casts, or (b) 40 detail-A cards, or (c) 20 comment cards. If a station exceeds these limits, it may be processed by duplicating the master card and splitting the casts in an appropriate manner.

4.3. *Main Program*

Basically, the main program of SYNØP sets up a table of thermometer corrections, sets output options, and then processes the oceanographic stations one at a time until an end-of-data card is found. A summary of the data submitted for the run is printed before control of the computer is returned to monitor. A flow chart describing the main features of SYNØP is shown in Fig. 4.1. Many of the various tests and branches are

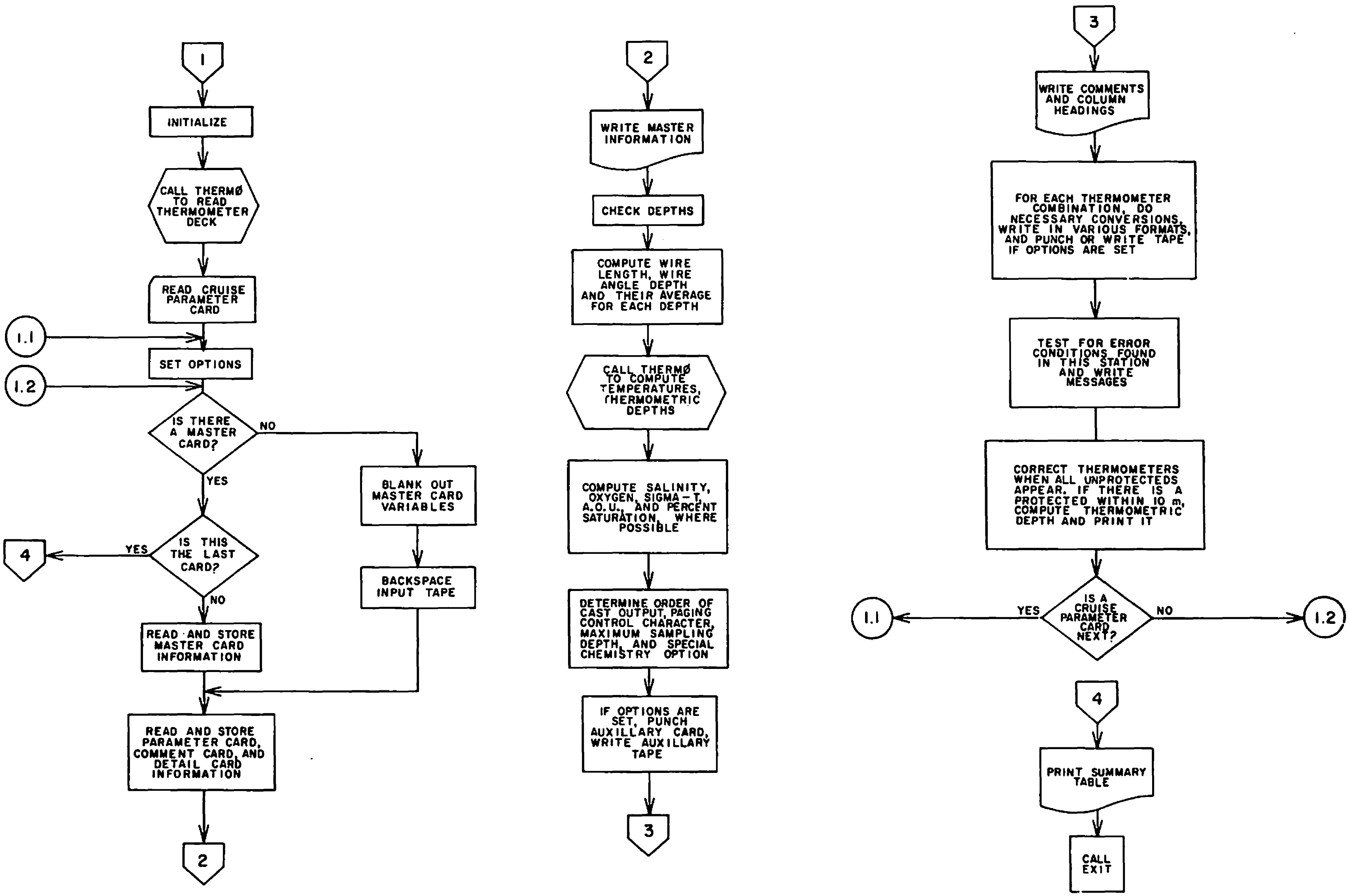

Fig. 4.1. Flow chart of SYNØP.

not indicated but can be determined by consulting the program listing (Appendix 3). The order in which the cards are presented to the computer is given in section 5.5.

The program SYNØP begins by initializing selected memory locations and then calls upon subroutine THERMØ to read, set up, and print the thermometer-correction table. A cruise parameter card (section 2.2.6) is read to set the output options and to set the necessary constants for the depth calculations. If the cruise parameter card is missing and if the ship code on the first data card is "TT"[6] the correct constants for depth calculation will be set by the program, but only the printed output will be obtained. If the ship code is not "TT" error message number 3 will be printed.[7,8]

The master card for each station is processed first, conversions of selected fields are made, and the relative humidity (R_h) is computed from the dry bulb reading (t_d) and wet bulb reading (t_w) by equations (4.1) to (4.5).

$$T_d = 1 + t_d/273.2 \tag{4.1}$$

$$T_w = 1 + t_w/273.2 \tag{4.2}$$

$$T_1 = \exp\,(25.22)(1/T_d - 1/T_w) \tag{4.3}$$

$$T_2 = \exp\,(25.22)(1/T_d - 1) \tag{4.4}$$

$$R_h = [(T_d/T_w)^{5.31}T_1 - 10.16(2.02 + 0.927T_d) \times (T_2)(T_d - T_w)T_d^{5.31}]100 \tag{4.5}$$

If no master card is present, SYNØP will expect a parameter card to be next in order. If this is not the case, error messages will be set and that station will be bypassed.

---

[6]"TT" refers to the RV *Thomas G. Thompson*.

[7]Error messages are listed in Appendix 12.

[8]This feature must be changed by the user to fit his requirements.

Because the parameter, detail-A, and comment cards may appear in any order within the station, they are all read for a given station before any major computations are performed. The cast numbers on the parameter cards are checked against those in the detail cards and if a cast number is missing, error message number 4 is set and the entire station is bypassed. Otherwise, the cast time is converted to Greenwich mean time (GMT) in hours and the oxygen titer factor (O_f) is computed by equation (4.6) using the oxygen titer (O_e) listed for each cast (Table 2.2, Fields 9 and 16).

$$O_f = 0.504/O_e \tag{4.6}$$

The program SYNØP assumes that the Winkler method as described by Thompson and Robinson (1939) was used for the oxygen determination and that 250-ml sample bottles were used. If the messenger time of any cast is numerically less than the messenger time of the first cast, 24.0 hr are added to it, since the date on all casts will be the same. Data from the parameter cards are stored by cast number. At this point, the station header information is printed if a master card is present. A test is made to determine if tide and time-zone information is present; if so, the station heading is slightly modified as stated in section 3.1.

After a complete station is read into memory, each estimated depth listed in the detail-A cards is checked for correctness by Algorithm 1.

ALGORITHM 1

CHECKING FOR ERROR IN WIRE LENGTH

(a) If the meter-wheel type (Table 2.5, Field 5) is 1, the meter-wheel reading (M_r) plus the estimated depth (L_e) plus the distance from the hydrographic platform to the water surface must equal the final down reading, or:

(b) If the meter-wheel type is 2, the meter-wheel reading minus the estimated depth minus the distance from the hydrographic platform to the water surface must equal the final down reading.

Each depth that does not meet this test is flagged with an asterisk (*) and error message number 17 is set. Next, the true wire length (L_t), wire-angle length (L_w), and the average of these two values (L_a) are computed from equations (4.7), (4.8), and (4.9), respectively.

$$L_t = (L_e + S)(M_r) \quad (4.7)$$

$$L_w = L_t \cos \Theta \quad (4.8)$$

$$L_a = (L_t + L_w)(0.5) \quad (4.9)$$

where Θ is the wire angle and S is the slippage (Table 2.3, Field 6).

After the depths have been checked, subroutine THERMØ is called once for each station to compute the corrected water temperature and thermometric depths. Details of this subroutine are presented in section 4.4. After control is returned to the main program, salinity and oxygen computations are performed. Valid salinometer numbers in the current program are 2, 4, 11, and 22, but these must be modified by any other user. If the salinometer number listed in the parameter card (Table 2.2, Fields 8 and 16) is coded 88, the input is converted directly to salinity. If the salinometer number is blank and there are salinities to be computed on that cast, the salinometer number from the previous computations is used, if it is a valid number, and error message number 12 is set. Salinities by salinometer are computed according to equations (4.10) and (4.11).

$$R = r + \Delta r \quad (4.10)$$

$$S = A + BR + CR^2 \quad (4.11)$$

where r is the salinometer reading and Δr is a resistance correction dependent upon the value of r.

If oxygen values are to be computed on a cast and the corresponding titer value is missing, no oxygens are computed and error message number 13 is set. Normally oxygen values are entered as burette readings (O_b) and computed by equation (4.12) in terms of milligram atoms per liter (O_a) and by equation (4.13) in terms of milliliters per liter (O_m) by equation (4.13).

$$O_a = O_f \, O_b \quad (4.12)$$

$$O_m = 11.159 \, O_a \quad (4.13)$$

However, oxygen values may be entered directly as either milligram atoms per liter or as milliliters per liter by appropriate coding of the oxygen titer in the parameter card (Table 2.2, Fields 9 and 16).

If both temperature and salinity data are present for a given depth, the density as sigma-*t* (σ_t) is computed by equations (4.14) through (4.18).

$$\Sigma_t = -\{T[T(T + 275.04) - 2236.8396] + 4482.8332\} \div [503.57(T + 67.26)] \qquad (4.14)$$

$$A_t = 1 - \{T[T(1.0843 \times 10^3\ T - 9.8185 \times 10^{-2}) + 4.7867]\} \times 10^{-3} \qquad (4.15)$$

$$B_t = \{T[T(1.667 \times 10^{-2}T - 0.8164) + 18.030]\} \times 10^{-6} \qquad (4.16)$$

$$\sigma_o = \{S[S(6.768 \times 10^{-6}S - 4.82496 \times 10^{-4}) + 0.81487658]\} - 9.344586 \times 10^{-2} \qquad (4.17)$$

and

$$\sigma_t = \Sigma_t + A_t\sigma_o + B_t\sigma_o{}^2 + 0.1324\ A_t - (0.1324)^2\ B_t \qquad (4.18)$$

where S is the salinity for the given depth and T is the specified temperature. If more than one temperature is returned by subroutine THERMØ, a sigma-*t* value will be calculated for each temperature.

Finally, if temperature, salinity, and oxygen values are present for a given depth, the percent saturation of oxygen (O_p) and apparent oxygen utilization (*AOU*) are computed according to equations (4.19) through (4.21) (based upon the work of Truesdale and Gameson, 1957).

$$C' = 0.88506 - 0.02464T + 0.0004821T^2 - 0.000004038T^3 - S(0.005256 - 0.000160T + 0.000002338T^2) \qquad (4.19)$$

where C' is the solubility of oxygen at a given temperature (T) and salinity (S) and at atmospheric pressure.

$$O_s = 100(O_a/C') \qquad (4.20)$$

$$AOU = C' - O_a \qquad (4.21)$$

The next section of SYNØP sets printer control characters in an attempt to print an entire cast on one page. If two casts can be printed on one page without continuing onto another page, they will be. The number of lines to be printed per station is determined by Algorithm 2.

ALGORITHM 2

NUMBER OF LINES TO BE PRINTED

Number of lines = 10 lines per station for header information
+ 11 lines per cast for cast information
+ 2.2 lines per depth
+ 1.1 lines per comment card.

If the total number of lines exceeds 59, the station will be printed on two or more pages.

This algorithm may occasionally fail if many of the correction temperatures fall outside the acceptable limits. Then the maximum sampling depth is found and the auxiliary card (see section 3.2.2) is prepared for punching. The station data are printed one cast at a time, as stated in section 3.1. The parameter card information and any comment cards for the cast are printed first, followed by column headings for the oceanographic information. The information from each depth is printed and the process is repeated for all casts of the station. Any error messages pertaining to the station are printed along with a list of thermometer numbers that could not be found in the thermometer deck. If there are any depths at which only unprotected thermometers were placed, the program will calculate depths if there are protected thermometers within 10 m of this bottle. This information is printed out at the end of the error messages. If cards are punched or an auxiliary tape is to be prepared or both, this is done at the same time the printed output is written.

After all the stations have been processed, a summary table is printed and the proper ending is put on the auxiliary tape.

4.4. *Subroutine THERMØ*

Subroutine THERMØ is used to store and print the thermometer correction table, to correct the reversing thermometer readings, and to compute the thermometric depths if unprotected thermometers were present. The first time THERMØ is called by SYNØP, the thermometer correction table is entered into storage. The first card of the table is used to identify the thermometer table and the set of data with which it is to be used. The last card of the table must be blank to signal the end of the thermometer corrections. Any errors in the thermometer deck arrangement will cause error message 2 to be printed. The program will be terminated and control will be returned to monitor.

After all the data for a given station have been read by SYNØP, control is transferred to THERMØ. Subroutine THERMØ begins by examining each of the three thermometer positions (left, middle, and right) to determine if the thermometers present were of the protected or unprotected type, or if a malfunction occurred. A value of N is assigned for each position as follows:

N = 0 for thermometer absent or malfunctioned

N = 1 for protected type

N = 2 for unprotected type

A value of NBASE is calculated by equation (4.22), which will have a value from 0 to 26 and represents one of the 27 combinations of thermometers listed in Table 4.2.

$$\text{NBASE} = 9N_l + 3N_m + N_r \tag{4.22}$$

where N_l is the value of N for the left thermometer, N_m for the middle thermometer, and N_r for the right thermometer.

The equations used by THERMØ to correct the reversing thermometers are those developed by Sverdrup (1947). For the protected thermometer the equation is

$$T_w = T' + I + \frac{(T' - t)(T' + V_o)}{K - (T' - t) - (T' + V_o)} \tag{4.23}$$

and for the unprotected thermometer the equation is

$$T_u = T' + I + \frac{(T_w - t)(T' + V_o)}{K - (T_w - t)} \qquad (4.24)$$

The thermometric depth (Z) is calculated as

$$Z = (T_u - T_w)/(Q\rho_m) \qquad (4.25)$$

where T_w is the "true" water temperature, T' is the uncorrected reading of the main thermometer, t is the reading of the auxiliary thermometer, I is the index correction, V_o is the volume of the small bulb, K is a constant depending upon the type of glass used in the thermometer, Q is the pressure coefficient of the unprotected thermometer, and ρ_m is the mean integrated density of the water from surface to the depth in question. For this subroutine the ρ_m values used were based upon the data taken off the coast of Washington and Oregon and are presented in Table 4.3. This table is valid only for this area and must be changed for other areas of the world. This is accomplished by changing the *in situ* density table.

The nature of the data returned to the main program SYNØP by subroutine THERMØ depends upon the case represented by the value of NBASE. Each of the 27 cases is treated separately as follows:

Case 0: In this case there are no reversing thermometers or all thermometers have malfunctioned. No temperatures are computed.

Cases 1, 3, 9: One protected thermometer is present, so only one corrected temperature is returned.

Cases 4, 10, and 12: The two protected thermometers are corrected and the results are rounded to the nearest 0.01°C. If the difference between the two temperatures is less than or equal to 0.06°C, the average value is returned; otherwise, each value is returned to be used in separate calculations of sigma-t, *AOU*, and oxygen saturation values.

Case 13: All three protected thermometers are corrected and the results are rounded to the nearest 0.01°C. One, two, three, or six temperatures $[T_a(x)]$ are returned to the main program depending upon the values of the corrected temperatures (T_l, T_m, and T_r) as follows:

(1) $|T_l - T_m| \leq 0.06$, $|T_l - T_r| \leq 0.06$, $|T_m - T_r| \leq 0.6$

$$\left.\begin{array}{l} |T_l - T_m| \leq 0.06 \\ |T_l - T_r| \leq 0.06 \\ |T_m - T_r| \leq 0.6 \end{array}\right\} \quad T_a(1) = (T_l + T_m + T_r)/3$$

(2)

$$\left.\begin{array}{l} |T_l - T_m| \leq 0.06 \\ |T_l - T_r| > 0.06 \\ |T_m - T_r| > 0.06 \end{array}\right\} \quad \left\{\begin{array}{l} T_a(1) = (T_l + T_m)/2 \\ T_a(2) = T_r \end{array}\right.$$

(3)

$$\left.\begin{array}{l} |T_l - T_m| > 0.06 \\ |T_l - T_r| > 0.06 \\ |T_m - T_r| > 0.06 \end{array}\right\} \quad \left\{\begin{array}{l} T_a(1) = T_l \\ T_a(2) = T_m \\ T_a(3) = T_r \end{array}\right.$$

(4)

$$\left.\begin{array}{l} |T_l - T_m| \leq 0.06 \\ |T_l - T_r| > 0.06 \\ |T_m - T_r| \leq 0.06 \end{array}\right\} \quad \left\{\begin{array}{l} T_a(1) = (T_l + T_m)/2 \\ T_a(2) = (T_m + T_r)/2 \\ T_a(3) = T_l \\ T_a(4) = T_m \\ T_a(5) = T_r \\ T_a(6) = (T_l + T_m + T_r)/3 \end{array}\right.$$

Cases 5, 7, 11, 15, 19, and 21: The protected thermometer is corrected, the unprotected thermometer is corrected, and the thermometric depth is computed. All three values are returned.

Cases 14, 16, and 22: If the corrected temperatures from the two protected thermometers agree within 0.06°C, the average value is used to correct the unprotected thermometer and to obtain the thermometric depth. Otherwise, the unprotected thermometer is corrected for each protected thermometer and a corresponding thermometric depth is computed. These values and each value of the protected thermometer are returned.

Cases 17, 23, and 25: The protected thermometer is corrected, and then the unprotected thermometers are corrected and the two thermometric depths are computed and returned to the main program.

Cases 2, 6, 8, 20, 24, and 26: Each of these types involves only unprotected thermometers, and since a "true" water temperature is needed to correct an unprotected thermometer, THERMØ simply returns to the main program, without any computations. After all possible temperatures for the station have been computed, the main program SYNØP tests to see if a thermometric depth can be computed for these cases. In order to have a thermometric depth computed, there must be a "true" water temperature within 10 m and on the same cast. The program checks for these conditions for only two depths on either side of the one in question. For this reason, it is best to have the detail-A cards separated by cast and in order of depth within each cast.

After all thermometers have been corrected on the station, control is returned to the main program.

TABLE 4.1

SUBROUTINES REQUIRED BY SYNØP

Subroutine name	UWMS* number	Memory locations	Programing language(s)	Description in:
THERMØ	0980	12,725	FORTRAN-II	Section 4.4 & Appendix 4
BIDE	0950	97	FAP	Appendix 5
DEBI	0948	115	FAP	Appendix 6
RDBUF	0933	8	FAP	Appendix 7
EXØR	0945	4	FAP	Appendix 8
BLANK	0941	6	FAP	Appendix 9
XRND	0944	5	FAP	Appendix 10

*UWMS = University of Washington, Department of Oceanography, Applied Mathematics Section.

TABLE 4.2

POSSIBLE ARRANGEMENTS OF THREE REVERSING THERMOMETERS

Thermometer combinations			Value of NBASE
Left	Middle	Right	
*	*	*	0
*	*	P	1
*	*	U	2
*	P	*	3
*	P	P	4
*	P	U	5
*	U	*	6
*	U	P	7
*	U	U	8
P	*	*	9
P	*	P	10
P	*	U	11
P	P	*	12
P	P	P	13
P	P	U	14
P	U	*	15
P	U	P	16
P	U	U	17
U	*	*	18
U	*	P	19
U	*	U	20
U	P	*	21
U	P	P	22
U	P	U	23
U	U	*	24
U	U	P	25
U	U	U	26

* = absent or malfunction

U = unprotected

P = protected

TABLE 4.3

MEAN INTEGRATED DENSITIES (ρ_m) FOR THE NORTHEAST PACIFIC OCEAN

Depth (m)	ρ_m
0	1.0242
100	1.0253
200	1.0261
300	1.0267
500	1.0275
700	1.0282
1,000	1.0291
1,500	1.0305
2,000	1.0318
2,500	1.0330
3,000	1.0344
3,500	1.0355
4,000	1.0366
10,000	1.0510

5. USE OF THE SYSTEM

5.1. *Field Use*

Proper preparation of the field log (section 2.1 and Fig. 2.1) while aboard ship will considerably reduce the amount of handwork involved in processing the oceanographic data collected at a station. This requires some extra care by the observer; he must be neat and print all values legibly. When numbers are recorded in the various fields, it is necessary to fill in as many digits as are called for in that field. This means that some numbers must be prefixed by one or more zeros. Thus, a depth of 5 m will be recorded as 0005 not 5, and a temperature of 7.86°C will be recorded as 0786 not 786. The required number of digits in each field is listed in Tables 2.1, 2.2, and 2.3. Also note that, by data processing convention, the number zero is represented by 0 and the letter "O" by Ø; this is contrary to the standard military and radiotelegraphic usage of these symbols.

At the completion of each station, the scientist in charge of that station must go over the field log, fill in any missing information, perform any necessary conversion of units, and check to see that all entries have been made. The time to obtain any missing information is while the events are fresh in the observer's mind. A delay of only one hour may create a problem in reconstruction of events. It is good practice to have one person of the scientific party assigned to make a final check of all field logs. Any pertinent remarks must be written down at this time even if it requires using the reverse side of the log for a longer explanation.

If a Flexowriter is aboard ship, the full tape (section 2.3) is prepared at this time. After the final oceanographic station has been completed, the condensed cruise tape is prepared. Thus by the time the ship has arrived in port the oceanographic data are ready for processing.

5.2. *Paper Tape-to-Card Conversion*

After the cruise tape (section 2.3) has been prepared, the information is converted to punched cards by use of the IBM 1401 computer. The program reads the tape and converts the data into master, parameter, and detail-A cards. Because the condensed tape does not have all the information for the detail-A cards, this information is derived from the appropriate master card and transferred to the proper card column. A listing of this program is given in Appendix 1.

Only one type of printed card may be punched by the IBM 1401, so all of the output is put onto detail-A cards. The output deck is then sorted on column 80 and the master and parameter cards are reproduced onto the appropriate printed format. Finally the deck is reassembled by sorting by station number and cruise number if more than one cruise was processed. The order of the cards in this sort is master card first, followed by the parameter cards, detail-A cards, and any comment cards. The deck may be rearranged at this time if so desired.

5.3. *Keypunching the Input Cards*

If for some reason the data were not punched onto paper tape, the data must be keypunched onto the appropriate card format. When this is done, it is desirable to have the cards verified to reduce the number of errors due to keypunching.

5.4. *Proofread Program*

After the data cards have been prepared according to section 5.2 or 5.3, the data are submitted to the proofread program. This program was written for the Burroughs B5500, coded in ALGOL, and is listed in Appendix 2.

The first section of the program reads the thermometer master deck, stores all thermometer numbers in a table in memory, and writes all the card images onto a scratch file. Then the data for one complete station are read and stored one card column per word. The data cards are checked in separate routines depending upon the type of card (i.e., master, etc.). Each error as listed in Table 5.1 is flagged with a special code, and cards with errors are printed along with appropriate error indicators. At the end of each station, all cast numbers from parameter cards and detail cards are compared, and indications of any mismatches are printed. When all stations have been processed, the thermometer file is read and cards are punched for those thermometer numbers that appear in the data deck. Separate listings are made for both valid and invalid thermometer numbers, showing the number of times each thermometer was used and the first station on which it was used.

The deck makeup for submitting this program to the Burroughs B5500 is as follows:

1. Control cards:
    ?COMPILE card
    ?DATA card
2. Source deck for PRUF
3. ?DATA THERMOMSTRCD
4. Thermometer master deck (section 2.2.7)
5. ?DATA CRUISEDATA
6. Data cards for one station
7. Repeat (6) as often as necessary
8. ?END card

The printed output will consist of a page containing a list of the error codes and their explanations. If there are any errors, each card in error will generate two lines of printout; the first one is a card image and the second is the error indicator. The error list is followed by a listing of valid thermometers, and then the list of invalid thermometers. The last line of print contains the beginning and ending times for processing the data, and the I/O channel times. The punched output will be a copy of the thermometer corrections used by this set of data.

5.5. *Submitting SYNØP to the Computer*

The method of submitting SYNØP to the computer will vary with computer systems but basically the procedure is similar. The method described in this section is specifically for the IBM 7040-7094 Direct Couple System (DCS). The DCS requires an estimate of both the number of lines to be written (sum of lines printed, punched, and put onto tape) and of the maximum 7094 computer time to be used.

The computer time estimate is obtained by dividing the total number of cards submitted by 300, adding two, and rounding to the next highest minute. The line estimate is obtained as follows:

(A) For the printed page, add:
   (1) the number of stations multiplied by 10, to
   (2) the total number of cast times 11, to
   (3) the total number of sampling depths times 2.2, to
   (4) the total number of comment times 1.1.

(B) For punched cards (if option is set), add
   (1) the number of stations times 1.1, to
   (2) the total number of sampling depths times 1.3.

(C) For magnetic tape output (if option is set), use the same count as for punched cards.

(D) If source program decks are used rather than binary program decks, multiply the number of source cards by 2.

(E) Sum the values obtained in (A), (B), (C), and (D), add 1000, and round to the next highest thousand.

After the line count and time estimate have been calculated, the various control and program cards are arranged in the order as given in Table 5.2. This completed card deck is then ready for submission to the computer.

5.6. *Correcting the Output of SYNØP*

After the printed output is obtained, the scientist preparing the data scans for errors as listed at the bottom of each station. Any thermometer values that differed by more than 0.06°C must be reconciled as well as other possible errors. If the sampling depth was greater than 200 m, the L - Z curves are plotted in the usual manner (LaFond, 1951), and the accepted sampling depths are determined and posted in the proper column of the printout. If any special chemistry determinations were performed, the results are posted in the proper column.

Next the output cards are corrected as necessary. Further checks are made on these cards and the results of the various parameters are plotted to check internal consistency and for spacial consistency. When all obvious errors are corrected, the output cards are ready for use by any interested party. These data may be used to compute values of various parameters at standard depths, for dynamic height calculation, etc. Finally the data may be put into report form by the use of various mechanical printers such as the IBM 407 accounting machine or by special computer programs.

TABLE 5.1

EDITS MADE AND ERRORS FLAGGED BY PROOFREAD PROGRAM

On all cards	
Col. 80	must be J, K, L, or N
Col. 74-79	must be nonblank
For master cards	
Col. 1-8	must be nonblank
Col. 10-14	must be nonblank
Col. 16-277	must be nonblank
For parameter cards	
Col. 1-2	must be either blank or numeric
Col. 5-37	must be either blank or numeric
Col. 5-25	must be all blank or all nonblank
Col. 26-46	must be all blank or all nonblank
Col. 65-73	must be nonblank except for col. 69
For detail-A cards	
Col. 5	must be 1 through 9
Col. 6-15	must be nonblank
Col. 16-17	may not both be blank
Thermometer numbers must be valid	
If $T \neq 8888$ or blank, then t must be nonblank	
Cast number must appear in a parameter card	

TABLE 5.2

ORDER OF CARDS TO BE SUBMITTED TO COMPUTER FOR SYNØP

(1) Control cards

  (a) $JØB card
  (b) $ID card
  (c) $IØBASE card
  (d) $EXECUTE FMS card
  (e) *XEQ

(2) SYNØP source or binary cards

(3) THERMØ source or binary cards

(4) SUBRØUTINES as listed in Table 4.1

(5) *DATA card

(6) Cruise parameter card (section 2.2.6) (one per cruise)

(7) Data cards for one station

  (a) Master cards
  (b) Parameter cards
  (c) Detail-A cards
  (d) Remarks cards

(8) Repeat (6-7) as often as needed

(9) $EØF

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Many constructive suggestions were made by Cuthbert Love and William Walker, who were in the Department of Oceanography Data Analysis Section. Mr. Walker prepared all the programing associated with the use of the Flexowriter.

The tape-to-card program (Appendix 1) was written by Mr. M. M. Marshall.

The proofread program (Appendix 2) was originally written by Mr. Walker and modified for the Burrows 5500 by Hella MacIntosh.

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APPENDIX 1 Program to convert Flexowriter paper tape to cards

```
00000*                    DATA TAPE PUNCH 1                                        *
00000*              UWMS- 974
00000*
00000*              UNIVERSITY OF WASHINGTON
00000*              DEPARTMENT OF OCEANOGRAPHY
00000*              SEATTLE, WASHINGTON  98105
00000*
00000*              PROGRAMMED BY..  MORITZ M. MARSHALL
00000*
00000*****************************************************************
00000*                                                                 *
00000*         PUNCHES DETAIL-A, MASTER AND PARAMETER CARDS FROM       *
00000*              FLEXOWRITER TAPE.                                  *
00000*                                                                 *
00000*         SWITCHES                                                *
00000*              ALL OFF.                                           *
00000*                                                                 *
00000*         BOARD                                                   *
00000*              EOL IS WIRED TO EOR.                               *
00000*              =   IS WIRED TO PARITY ERROR.                      *
00000*                                                                 *
00000*         HALTS                                                   *
00000*              888 READY PAPER TAPE READER.                       *
00000*              999 END OF JOB.                                    *
00000*                    TO START ANOTHER TAPE                        *
00000*                    TURN SWITCH G ON AND                         *
00000*                    PRESS START.                                 *
00000*                                                                 *
00000*****************************************************************
0103 START     B    READY
0104 GO        RT   (P1,INPUT
0105           RT   (P1,INPUT
0106           RT   (P1,INPUT
0107           B    READY
0108           RT   (P1,INPUT
0109           B    MASTER
0112 RTMR      B    READY
0113           RT   (P1,INPUT
```

```
0114              RT     (P1,INPUT
0115              SBR    NOP 3
0116              B      PARAM
0117 NOP          NOP    000
0120 RIDE         B      READY
0121              RT     (P1,INPUT
0122              B      DETAIL
0201 MASTER       SW     101,134
0202              SW     142,174
0203              MLC    INPUT 26,127
0204              MLC    INPUT 30,137
0205              MLC    INPUT 56,167
0206              MLC    INPUT 63,180
0207              MLC    104,SAVE1
0208              MLC    179,SAVE2
0209              P
0210              CS     180
0211              B      RTMR
0213 PARAM        SW     105,126
0214              SW     165,180
0215              MLC    SAVE1,104
0216              MLC    SAVE2,179
0217              MLC    INPUT 20,125
0218              C      NOP 3,ZAP
0219              BU     FORMB
0222 FORMA        B      READY
0223              RT     (P1,INPUT
0224              MLC    INPUT 8,173
0225              MLC    INPUT 9,180
0226              P
0227              CS     180
0228              B      RIDE
0301 FORMB        MLC    INPUT 41,146
0304              B      READY
0305              RT     (P1,INPUT
0306              MLC    INPUT 8,173
0307              MLC    INPUT 9,180
0308              P
0309              CS     180
0310              B      RIDE
0312 DETAIL       MLC    SAVE1,104
0313              MLC    SAVE2,179
0314              SW     105,180
```

```
0315          MLC   INPUT 64,169
0316          MLC   INPUT 65,180
0317          P
0318          CS    180
0319          B     READY
0320          RT    (P1,INPUT
0321          SBR   NOP 3
0322          C     NOP 3,ZIP
0323          BU    DETAIL
0324          B     READY
0325          RT    (P1,INPUT
0401          SBR   NOP 3
0402          C     NOP 3,ZIP
0403          BU    PARAM
0404          B     READY
0405          RT    (P1,INPUT
0406          SBR   NOP 3
0407          C     NOP 3,ZIP
0408          BU    MASTER
0409          CS    180
0410          P
0411 EOJ      H     999,999
0412          BSS   START,G
0413          B     EOJ
0416 READY    SBR   OUT 3
0417          CS    GMWM-1
0418          CS
0419          CHAIN28
0420 BIN      BIN   OUT,2
0421          H     888,888
0422          B     BIN
0423 OUT      B     0
0424 SAVE1    DCW   =2
0425 SAVE2    DCW   =6
0426 ZIP      DCW   -Z01-
0427 ZAP      DCW   -Z22-
0428          ORG   1000
0429 INPUT    DA    1X2999
0430 GMWM     DCW   -)-
99999         END   START
```

APPENDIX 2 Proofread program

Program to proofread detail-A, master, and
parameter cards and prepare a thermometer deck

```
BEGIN COMMENT

      PROOFREAD

      UWMS-1070

      UNIVERSITY OF WASHINGTON
      DEPARTMENT OF OCEANOGRAPHY
      SEATTLE, WASHINGTON  98105

      ORIGINATED BY:  JACK BECK       SEPTEMBER 1966
      PROGRAMMED BY:  H. MACINTOSH    OCTOBER 1966

      WRITTEN IN ALGOL FOR BURROUGHS B5500

      BASED ON PROGRAM UWMS-1038  (1401)

             THIS PROGRAM READS CRUISE DATA AND CHECKS VARIOUS COLUMNS
             FOR ERRONEOUS CODES AND PUNCHES.  CARDS WITH ERRORS ARE
             PRINTED AND THE ERRORS ARE FLAGGED.

INTEGER     I,J,CARDCNT,THCOUNT,PCST,DCST,K,LINECOUNT,P ,D ;
INTEGER     GDCOUNT,NGCOUNT,PTA,ITA;
INTEGER ARRAY  GDTALLY[0:200], NGTALLY[0:200], THFLAG[0:800] ;
ALPHA STATION,LASTSTATION  ;
ALPHA THERMOMETER ;
SAVE ALPHA ARRAY THLIST[0:800], COL[0:80], CARD[0:100,0:80], TH[0:14],
                 ERRCOL[0:80], PCASTNO[0:20], DCASTNO[0:20] ;
ALPHA ARRAY NGLIST[0:200],NGSTAT[0:200],GDLIST[0:200],GDSTAT[0:200] ;
BOOLEAN  ERRSW , NEW,NEWD ;
FILE  IN   THERMOMSTRCD (2,10) ;
FILE  IN   CRUISEDATA   (2,10) ;
FILE       THERMOTAPE DISK SERIAL [1:800] (2,10,30) ;
FILE OUT   THERMOPUNCH 0(2,10) ;
FILE OUT   PRINTOUT    4(2,17) ;
FORMAT  TITLE ("  COUNTRY  SHIP  CST  COLS 06-15   COLUMNS   16-30",X3,
              "COLUMNS 31-43   COLUMNS 44-56   COLUMNS 57 THRU73",X2,
              "CRUISE STATION  CNTRL"// );
FORMAT  THERMOFMT (A1,A6,A1,A3,11A6,A3) ;
FORMAT  DATAFMT   (80A1) ;
FORMAT  LINEFMT   (X4,2A1,X6,2A1,X4,A1,X3,10A1,X3,15A1,X3,13A1,X3,13A1,
                   X3,17A1,X4,3A1,X4,3A1,X6,A1));
FORMAT PCSTFMT("PARAMETER CAST NUMBER ",A1," NOT ON DETAIL CARDS FOR ",
              "CRUISE AND STATION ",3A1,"-",3A1 //) ;
FORMAT DCSTFMT("DETAIL CAST NUMBER ",A1," NOT ON PARAMETER CARDS FOR ",
              "CRUISE AND STATION ",3A1,"-",3A1 //) ;
FORMAT THLISTFMT (A10,T10,A10) ;
FORMAT NGTITLE ("INVALID THERMOMETERS " //) ;
FORMAT OKTITLE ("VALID THERMOMETERS USED IN THIS RUN " //) ;
FORMAT THTITLE   ("    THERMO     COUNT    STATION"// );
FORMAT TIMEFMT (//"BEG,END PROC",2I8,"  BEG,END I/O",2I8 );
FORMAT EXPLAIN ("ERROR CODES AND THEIR EXPLANATIONS:" //
                " * - THIS COLUMN SHOULD NOT BE BLANK " /
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                    " # - CONTROL PUNCH INVALID: NOT J,K,L OR N" /
                    " @ - CAST NUMBER INVALID: NOT 1-9" /
                    " % - PARAMETER CARD FOR THIS CAST EITHER" ,
                        " OUT OF ORDER OR MISSING " /
                    " ",""",". - THIS COLUMN SHOULD NOT BE ALPHA " /
                    " ← - INVALID THERMOMETER NUMBER" /
                    " : - SALINITY ≥ 800 OR OXYGEN ≥ 30" / ) ;
LIST  THCARD (TH[0],THERMOMETER, FOR I ←1 STEP 1 UNTIL 14 DO TH[I]) ;
LIST  DATACD (FOR I ← 1 STEP 1 UNTIL 60 DO COL[I]) ;
LIST  LINEIN (FOR J ← 1 STEP 1 UNTIL 80 DO CARD[I,J]);
LIST  LINERR (FOR J ← 1 STEP 1 UNTIL 80 DO ERRCOL[J]);
LIST THLISTOUT ( GDLIST[J], GDTALLY[J], GDSTAT[J] ) ;
LIST NGLISTOUT (NGLIST[J], NGTALLY[J], NGSTAT[J] ) ;



          COMMENT   THIS PROCEDURE READS THERMO MASTER DECK,
                    WRITES IT ON DISK, AND CREATES A TABLE
                    OF ALL THERMO NUMBERS IN THE DECK;

PROCEDURE  PROCESSTHERMOMASTERS ;
BEGIN
      LABEL THEND ;
      FOR THCOUNT ← 1 STEP 1 WHILE TRUE  DO
      BEGIN READ (THERMOMSTRCD,THERMOFMT,THCARD) [THEND] ;
            WRITE(THERMOTAPE  ,THERMOFMT,THCARD) ;
            THLIST[THCOUNT] ← THERMOMETER ;
      END;
THEND:REWIND(THERMOTAPE) ;
      CLOSE ( THERMOMSTRCD,RELEASE ) ;
      WHEN (1) ;
END;


          COMMENT   THIS PROCEDURE PROCESSES MASTER CARDS ONLY  ;

PROCEDURE PROCESSMASTERCARD ;
BEGIN
      FOR J ← 1 STEP 1 UNTIL 8, 10 STEP 1 UNTIL 14, 16 STEP 1 UNTIL 27
      DO IF CARD[I,J] = " " THEN
         BEGIN ERRSW ← TRUE ;
               ERRCOL[J] ← "*"
         END;
END PROCESSING MASTER CARD ;


          COMMENT   THIS PROCEDURE HANDLES ALL PARAMETER CARDS ;

PROCEDURE PROCESSPARAMCARD ;
BEGIN
      BOOLEAN NONBLANKS ;
      FOR J ← 1,2,5 STEP 1 UNTIL 73  DO
            IF CARD[I,J] ≠" " AND CARD[I,J] > "9" THEN
            BEGIN ERRSW ← TRUE ;
                  ERRCOL[J] ← """
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            END ;
        NONBLANKS ← FALSE ;
        FOR J ← 5 STEP 1 UNTIL 25 DO
            IF CARD[I,J] ≠ " " THEN NONBLANKS ← TRUE ;
        IF NONBLANKS THEN
        BEGIN FOR J ← 5 STEP 1 UNTIL 25 DO
            IF CARD[I,J] = " " THEN
            BEGIN ERRSW ← TRUE ;
                ERRCOL[J] ← "*"
            END;
            PCST ← PCST+1 ;
            PCASTNO[PCST] ← CARD[I,5] ;
        END ;
        NONBLANKS ← FALSE ;
        FOR J ← 26 STEP 1 UNTIL 46 DO
            IF CARD[I,J] ≠ " " THEN NONBLANKS ← TRUE;
        IF NONBLANKS THEN
        BEGIN FOR J ← 26 STEP 1 UNTIL 46 DO
            IF CARD[I,J] = " " THEN
            BEGIN ERRSW ← TRUE ;
                ERRCOL[J] ← "*"
            END ;
            PCST ← PCST+1;
            PCASTNO[PCST] ← CARD[I,26] ;
        END;
        FOR J ← 65 STEP 1 UNTIL 68, 70 STEP 1 UNTIL 73 DO
            IF CARD[I,J] = " " THEN
            BEGIN ERRSW ← TRUE ;
                ERRCOL[J] ← "*"
            END;
END PROCESSING PARAMETER CARD ;


        COMMENT   THIS PROCEDURE HANDLES ALL DETAIL CARDS ;

PROCEDURE PROCESSDETAILCARD ;
BEGIN BOOLEAN GOOD ;  ALPHA TA,TB,LEFTNO,MIDDLENO,RIGHTNO ;
LABEL CKLFT,CKMID,CKRIT ;
        GOOD ← FALSE;
        IF CARD[I,5] < "1" OR CARD[I,5] > "9" THEN
        BEGIN ERRSW ← TRUE ;
            ERRCOL[5] ← "@"
        END ELSE
        BEGIN FOR P ← 1 STEP 1 UNTIL PCST  DO
            IF CARD[I,5] = PCASTNO[P] THEN GOOD ← TRUE ;
            IF NOT GOOD THEN
            BEGIN ERRSW ← TRUE ;
                ERRCOL[5] ← "%"
            END ;
            NEWD ← TRUE ;
            FOR D ← 1 STEP 1 UNTIL DCST  DO
                IF DCASTNO[D] = CARD[I,5] THEN NEWD ← FALSE ;
            IF NEWD THEN
            BEGIN DCST ← DCST + 1 ;
                DCASTNO[DCST] ← CARD[I,5]
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      END;
   END ;
   FOR J ← 6 STEP 1 UNTIL 13 DO
        IF CARD[I,J] = " " THEN
        BEGIN ERRSW ← TRUE ;
              ERRCOL[J] ←"*"
        END ;
   IF CARD[I,16] = " " AND CARD[I,17] = " " THEN
        BEGIN ERRSW ← TRUE ;
              ERRCOL[16] ← ERRCOL[17] ← "*"
        END ;

   GOOD ← FALSE ;
   LEFTNO ← 0 & CARD[I,18][12:42:6] & CARD[I,19][18:42:6]
              & CARD[I,20][24:42:6] & CARD[I,21][30:42:6]
              & CARD[I,22][36:42:6] & CARD[I,23][42:42:6] ;
   IF LEFTNO ≠ "      " THEN
   BEGIN FOR J ← 1 STEP 1 UNTIL GDCOUNT  DO
         IF    LEFTNO   = GDLIST[J]
         THEN BEGIN GOOD ← TRUE ;
                    GDTALLY[J] ← GDTALLY[J] +1 ;
                    GO TO CKLFT ;
              END ;
         FOR J ← 1 STEP 1 UNTIL THCOUNT  DO
         IF    LEFTNO   = THLIST[J]
         THEN BEGIN GOOD ← TRUE ;
                    GDCOUNT ← GDCOUNT +1 ;
                    GDLIST[GDCOUNT] ← LEFTNO ;
                    GDTALLY[GDCOUNT] ← 1 ;
                    GDSTAT[GDCOUNT] ← LASTSTATION ;
                    THFLAG[J] ← 99 ;
                    GO TO CKLFT ;
              END ;
   CKLFT:IF NOT GOOD THEN
               BEGIN ERRSW ← TRUE ; NEW ← TRUE ;
                     IF NGCOUNT > 0
                     THEN FOR J ← 1 STEP 1 UNTIL NGCOUNT  DO
                          IF LEFTNO = NGLIST[J]
                          THEN BEGIN NEW ← FALSE ;
                                     NGTALLY[J] ← NGTALLY[J] + 1
                               END ;
                     IF NEW
                          THEN BEGIN NGCOUNT ← NGCOUNT + 1 ;
                                     NGLIST[NGCOUNT] ← LEFTNO ;
                                     NGSTAT[NGCOUNT] ← LASTSTATION ;
                                     NGTALLY[NGCOUNT] ← 1
                               END ;
                     ERRCOL[18] ← "*"
               END;
         TA ←0 & CARD[I,24][24:42:6] & CARD[I,25][30:42:6]
               & CARD[I,26][36:42:6] & CARD[I,27][42:42:6] ;
         TB ←0 & CARD[I,28][30:42:6] & CARD[I,29][36:42:6]
               & CARD[I,30][42:42:6] ;
         IF TA ≠ "8888" AND TA ≠ "    " AND TB = "   " THEN
         BEGIN ERRSW ← TRUE ;
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            ERRCOL[28] ← ERRCOL[29] ← ERRCOL[30] ← "*";
      END ;
END ;

GOOD ← FALSE ;
MIDDLENO ← 0 & CARD[I,31][12:42:6] & CARD[I,32][18:42:6]
             & CARD[I,33][24:42:6] & CARD[I,34][30:42:6]
             & CARD[I,35][36:42:6] & CARD[I,36][42:42:6] ;
IF MIDDLENO ≠ "       " THEN
BEGIN FOR J ← 1 STEP 1 UNTIL GDCOUNT  DO
      IF   MIDDLENO = GDLIST[J]
      THEN BEGIN GOOD ← TRUE ;
                 GDTALLY[J] ← GDTALLY[J] +1 ;
                 GO TO CKMID ;
           END ;
      FOR J ← 1 STEP 1 UNTIL THCOUNT  DO
      IF   MIDDLENO = THLIST[J]
      THEN BEGIN GOOD ← TRUE ;
                 GDCOUNT ← GDCOUNT +1 ;
                 GDLIST[GDCOUNT] ← MIDDLENO ;
                 GDTALLY[GDCOUNT] ← 1 ;
                 GDSTAT[GDCOUNT] ← LASTSTATION ;
                 THFLAG[J] ← 99 ;
                 GO TO CKMID ;
           END ;
CKMID:IF NOT GOOD THEN
            BEGIN ERRSW ← TRUE ; NEW ← TRUE ;
                  IF NGCOUNT > 0
                  THEN FOR J ← 1 STEP 1 UNTIL NGCOUNT  DO
                       IF MIDDLENO = NGLIST[J]
                       THEN BEGIN NEW ← FALSE ;
                                  NGTALLY[J] ← NGTALLY[J] + 1 ;
                            END ;
                  IF NEW
                       THEN BEGIN NGCOUNT ← NGCOUNT + 1 ;
                                  NGLIST[NGCOUNT] ← MIDDLENO ;
                                  NGSTAT[NGCOUNT] ← LASTSTATION ;
                                  NGTALLY[NGCOUNT] ← 1
                            END ;
                  ERRCOL[31] ← "←"
            END ;
      TA ← 0 & CARD[I,37][24:42:6] & CARD[I,38][30:42:6]
             & CARD[I,39][36:42:6] & CARD[I,40][42:42:6] ;
      TB ← 0 & CARD[I,41][30:42:6] & CARD[I,42][36:42:6]
             & CARD[I,43][42:42:6] ;
      IF TA ≠ "8868" AND TA ≠ "    " AND TB = "   " THEN
      BEGIN ERRSW ← TRUE ;
            ERRCOL[41] ← ERRCOL[42] ← ERRCOL[43] ← "*";
      END ;
END ;

GOOD ← FALSE ;
RIGHTNO ← 0 & CARD[I,44][12:42:6] & CARD[I,45][18:42:6]
            & CARD[I,46][24:42:6] & CARD[I,47][30:42:6]
            & CARD[I,48][36:42:6] & CARD[I,49][42:42:6] ;
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```
IF RIGHTNO ≠ "        " THEN
BEGIN FOR J ← 1 STEP 1 UNTIL GDCOUNT  DO
      IF    RIGHTNO  = GDLIST[J]
      THEN BEGIN GOOD ← TRUE ;
                 GDTALLY[J] ← GDTALLY[J] +1 ;
                 GO TO CKRIT ;
           END ;
      FOR J ← 1 STEP 1 UNTIL THCOUNT  DO
      IF    RIGHTNO = THLIST[J]
      THEN BEGIN GOOD ← TRUE ;
                 GDCOUNT ← GDCOUNT +1 ;
                 GDLIST[GDCOUNT] ← RIGHTNO ;
                 GDTALLY[GDCOUNT] ← 1 ;
                 GDSTAT[GDCOUNT] ← LASTSTATION ;
                 THFLAG[J] ← 99 ;
                 GO TO CKRIT ;
           END ;
CKRIT:IF NOT GOOD THEN
            BEGIN ERRSW ← TRUE ; NEW ← TRUE ;
                  ERRCOL[44] ← "←" ;
                  IF NGCOUNT > 0
                  THEN FOR J ← 1 STEP 1 UNTIL NGCOUNT  DO
                       IF RIGHTNO  = NGLIST[J]
                       THEN BEGIN NEW ← FALSE ;
                                  NGTALLY[J] ← NGTALLY[J] + 1 ;
                            END ;
                  IF NEW
                       THEN BEGIN NGCOUNT ← NGCOUNT + 1 ;
                                  NGLIST[NGCOUNT] ← RIGHTNO ;
                                  NGSTAT[NGCOUNT] ← LASTSTATION ;
                                  NGTALLY[NGCOUNT] ← 1
                            END ;
            END ;
      TA ← 0 & CARD[I,50][24:42:6] & CARD[I,51][30:42:6]
             & CARD[I,52][36:42:6] & CARD[I,53][42:42:6] ;
      TB ← 0 & CARD[I,54][30:42:6] & CARD[I,55][36:42:6]
             & CARD[I,56][42:42:6] ;
      IF TA ≠ "8888" AND TA ≠ "    " AND TB = "   " THEN
      BEGIN ERRSW ← TRUE ;
            ERRCOL[54] ← ERRCOL[55] ← ERRCOL[56] ← "*";
      END ;
END ;
IF CARD[I,57] > "7" AND CARD[I,57] ≠ " "  THEN
BEGIN ERRSW ← TRUE ;
      ERRCOL[57] ← ":"
END ;
IF CARD[I,62] > "2" AND CARD[I,62] ≠ " "  THEN
BEGIN ERRSW ← TRUE ;
      ERRCOL[62] ← ":"
END ;
END PROCESSING THIS DETAIL CARD ;


     COMMENT   THIS PROCEDURE HANDLES ALL COMMENT CARDS ;
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```
PROCEDURE PROCESSCOMMENTCARD ;

BEGIN
      BOOLEAN GOOD ;
      GOOD ← FALSE ;
      IF CARD[I,5] <"1"OR CARD[I,5] >"9" THEN
      BEGIN ERRSW ← TRUE ;
            ERRCOL[5] ← "@"
      END  ELSE
      BEGIN FOR P ← 1 STEP 1 UNTIL PCST  DO
            IF CARD[I,5] = PCASTNO[P] THEN GOOD ← TRUE ;
            IF NOT GOOD THEN
            BEGIN ERRSW ← TRUE ;
                  ERRCOL[5] ← "%"
            END ;
      END ;
END PROCESSING THIS COMMENT CARD ;


           COMMENT   THIS PROCEDURE HANDLES CARDS WITH ERRORS ;

PROCEDURE PROCESSBADCARD ;
BEGIN
      IF LINECOUNT = 17 THEN
      BEGIN LINECOUNT ← 0 ;
            WRITE(PRINTOUT[PAGE]) ; WRITE(PRINTOUT,TITLE) ;
      END ;
      WRITE(PRINTOUT ,LINEFMT, LINEIN ) ;
      WRITE(PRINTOUT[DBL], LINEFMT, LINERR );
      LINECOUNT ← LINECOUNT +1 ;
END PROCESSING ERROR CARD ;


           COMMENT   THIS PROCEDURE EDITS THE LIST OF CAST NUMBERS;

PROCEDURE EDITCASTLIST ;
BEGIN
      BOOLEAN  PCASTOK,DCASTOK ;
      PCASTOK ← DCASTOK ← FALSE ;
      FOR P ← 1 STEP 1 UNTIL PCST  DO
      BEGIN FOR D ← 1 STEP 1 UNTIL DCST DO
            IF PCASTNO[P] = DCASTNO[D] THEN  PCASTOK ← TRUE ;
            IF NOT PCASTOK THEN
            BEGIN WRITE(PRINTOUT,PCSTFMT,PCASTNO[P],
                        FOR J ← 74 STEP 1 UNTIL 79 DO CARD[0,J] ) ;
                  LINECOUNT ← LINECOUNT + 1
            END;
            PCASTOK ← FALSE ;
      END;
      FOR D ← 1 STEP 1 UNTIL DCST  DO
      BEGIN FOR P ← 1 STEP 1 UNTIL PCST DO
            IF DCASTNO[D] = PCASTNO[P] THEN  DCASTOK ← TRUE ;
            IF NOT DCASTOK THEN
            BEGIN WRITE(PRINTOUT,DCSTFMT,DCASTNO[D],
                        FOR J ← 74 STEP 1 UNTIL 79 DO CARD[0,J] ) ;
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                    LINECOUNT ← LINECOUNT + 1
                END;
                DCASTOK ← FALSE ;
            END ;
        END  CAST LIST EDIT ;


                COMMENT   THIS PROCEDURE HANDLES ALL CARDS FOR ONE STATION  ;

        PROCEDURE PROCESSLASTSTATION ;
        BEGIN
            PCST ← DCST ← 0 ;
            FOR I ← 0 STEP 1 UNTIL CARDCNT DO
            BEGIN FOR J ← 1 STEP 1 UNTIL 80  DO ERRCOL[J] ← " " ;
                FOR J ← 74 STEP 1 UNTIL 79 DO
                    IF CARD[I,J] = " " THEN
                    BEGIN ERRSW ← TRUE ;
                        ERRCOL[J] ← "*"
                    END;
                IF CARD[I,80] = "J" THEN PROCESSMASTERCARD ELSE
                IF CARD[I,80] = "K" THEN PROCESSPARAMCARD  ELSE
                IF CARD[I,80] = "L" THEN PROCESSDETAILCARD ELSE
                IF CARD[I,80] = "N" THEN PROCESSCOMMENTCARD ELSE
                BEGIN ERRSW ← TRUE ;
                    ERRCOL[80] ← "*"
                END ;
                IF ERRSW THEN BEGIN PROCESSBADCARD ; ERRSW ← FALSE END;
            END;
            EDITCASTLIST ;
        END PROCESSING THIS STATION ;


                COMMENT   THIS PROCEDURE LIST OUT ALL THERMOMETER NUMBERS
                          USED, HOW OFTEN, AND ON WHAT STATION FIRST USED ;

        PROCEDURE NUWWRAPITUP ;
        BEGIN
        BOOLEAN FOUND ;
        LABEL THLST ;
            WRITE (PRINTOUT[PAGE]) ;  WRITE(PRINTOUT,OKTITLE) ;
            WRITE (PRINTOUT,THTITLE) ;
            FOR THCOUNT ← 1 STEP 1 WHILE TRUE  DO
            BEGIN READ (THERMOTAPE, THERMOFMT, THCARD ) [THLST] ;
                FOUND ← FALSE ;
                IF   THFLAG[THCOUNT] ≠ 0
                THEN BEGIN FOR J ← 1 STEP 1 WHILE NOT FOUND  DO
                          IF   THLIST[THCOUNT] = GDLIST[J]
                          THEN BEGIN WRITE(PRINTOUT,THLISTFMT,THLISTOUT) ;
                                     WRITE(THERMOPUNCH,THERMOFMT,THCARD) ;
                                     FOUND ← TRUE ;
                               END ;
                     END
                ELSE IF   TH[2] = "999" AND THFLAG[THCOUNT -1] ≠ 0
                     THEN WRITE (THERMOPUNCH,THERMOFMT,THCARD ) ;
            END ;
```

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THLST:WRITE (PRINTOUT[PAGE]) ;  WRITE(PRINTOUT,NGTITLE) ;
      WRITE (PRINTOUT,THTITLE) ;
      FOR J ← 1 STEP 1 UNTIL NGCOUNT  DO
      WRITE (PRINTOUT, THLISTFMT, NGLISTOUT ) ;
END WRAPPING IT UP  ;


           COMMENT   THIS PROCEDURE HANDLES ALL DATA CARDS ;

PROCEDURE PROCESSDATA ;
BEGIN BOOLEAN FIRSTCARD,LASTCARD ;
      LABEL ENDOFDATA ;
      FIRSTCARD ← TRUE ;  LASTCARD ← FALSE ;
      CARDCNT ← PCST ← DCST ← 0 ;  LINECOUNT ← 17 ;
      NGCOUNT ← GDCOUNT ← 0 ;
      WHILE TRUE DO
      BEGIN READ (CRUISEDATA,DATAFMT,DATACD) [ENDOFDATA] ;
            STATION←0&COL[74][12:42:6] & COL[75][18:42:6] &
                      COL[76][24:42:6] & COL[77][30:42:6] &
                      COL[78][36:42:6] & COL[79][42:42:6] ;
            ERRSW ← FALSE ;
            IF NOT FIRSTCARD AND STATION ≠ LASTSTATION THEN
            BEGIN CARDCNT ←  CARDCNT-1 ;
                  PROCESSLASTSTATION ;
                  CARDCNT ← 0
            END ;
            FOR J ← 1 STEP 1 UNTIL 80 DO  CARD[CARDCNT,J] ← COL[J] ;
            CARDCNT ← CARDCNT +1 ;
            LASTSTATION ← STATION ;
            FIRSTCARD ← FALSE ;
      END PROCESSING ONE DATA CARD;
   ENDOFDATA: CARDCNT ← CARDCNT-1 ;
              PROCESSLASTSTATION ;
              NOWWRAPITUP ;
END PROCESSING ALL DATA CARDS ;


COMMENT    THIS IS THE PROGRAM IN ITS PURE DISTILLED FORM ;

PTA ← TIME(2) ;  ITA ← TIME(3) ;
WRITE (PRINTOUT, EXPLAIN ) ;
PROCESSTHERMOMASTERS ;
PROCESSDATA ;
WRITE (PRINTOUT,TIMEFMT,PTA,TIME(2),ITA,TIME(3) ) ;
END.
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APPENDIX 3 The main program SYNØP

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CSYNOP                          SYNOPTIC PROGRAM                                SYNO000U
C        UWMS-0980-C                                                            SYNO005C
C                                                                               SYNO010U
C        UNIVERSITY OF WASHINGTON                                               SYNO015
C        DEPARTMENT OF OCEANOGRAPHY                                             SYNO020
C        SEATTLE, WASHINGTON  98105                                             SYNO025
C                                                                               SYNO030
C        ORIGINATED BY..  EUGENE E. COLLIAS, MONIQUE R. RONA,                   SYNO035
C                         AND CUTHBERT M. LOVE                                  SYNO040
C                                                                               SYNO045
C        PROGRAMMED BY..  MARSHA M. WALLIN              JUNE 1964               SYNO050
C        REVISION A BY..  LINDA S. GREEN                NOVEMBER 1964           SYNO055A
C        REVISION B BY..  LINDA S. GREEN                JULY 1965               SYNO060B
C        REVISION C BY..  LINDA S. GREEN                OCTOBER 1966            SYNO065C
C                                                                               SYNO070A
C        WRITTEN IN FORTRAN II, VERSION 2, FOR IBM 709/7090/7094                SYNO071C
C                                                                               SYNO072C
C                                                                               SYNO075A
C        SUBROUTINES USED BY THIS PROGRAM ARE THERMO (REV.B AND REV.C),         SYNO080C
C        BIDE (UWMS-0950), DEBI (0948), RDBUF (0933), BLANK (0941), AND         SYNO085C
C        XRND (0944).                                                           SYNO086C
C                                                                               SYNO090A
C        THE FIRST CARD OF THE DATA DECK IS A TITLE FOR THE THERMOMETER         SYNO095A
C        TABLE.  THIS IS FOLLOWED BY THE THERMOMETER DECK.  A BLANK CARD        SYNO100A
C        MUST BE BETWEEN THE THERMOMETER TABLE AND THE OBSERVED DATA.           SYNO105A
C        THE FORMAT FOR THE CRUISE PARAMETER CARD IS AS FOLLOWS..               SYNO110A
C            COL. 3-4       SHIP CODE                                           SYNO115A
C            COL. 13-14     DISTANCE FROM METER WHEEL TO WATER (METERS)         SYNO120A
C            COL. 15        METER WHEEL TYPE CODE                               SYNO125A
C            COL. 16-18     YES      IF PUNCHING IS DESIRED, OTHERWISE BLANK    SYNO130A
C                                    (PUNCHES AUXILIARY AND DETAIL CARDS)       SYNO135B
C            COL. 19-21     YES      IF TAPE IT3 (8) IS TO BE WRITTEN,          SYNO140C
C                                    OTHERWISE BLANK                            SYNO145C
C            COL. 22-24     YES      IF SPECIAL CHEMISTRY BOTTLE NUMBERS ARE    SYNO146C
C                                    TO BE PUNCHED IN COL. 70-73 OF DETAIL      SYNO147C
C                                    CARDS, OTHEWSISE BLANK                     SYNO148C
C            COL. 80        M                                                   SYNO150A
C                                                                               SYNO155
C        THE LAST CARD OF THE DECK MUST BE BLANK WITH A -J- IN COLUMN 80.       SYNO160A
C                                                                               SYNO165
      DIMENSION DELR(8,2),A(2),B(2),C(2),MEST(9),ZLAST(9),AN(9),LSTE(40)SYNO170
     1,WHEEL(9),LSAL(9),TITER(9),FACTOR(9),SPCH(9),ZONE(9),ZTRUP(40),    SYNO175
     2 NO1(9),NO2(9),CRU(9),STAP(9),JCA(9),JRES(9),WSIGN(9),PAGE(9),     SYNO180C
     3 LGMT(9),OFAC(9),FLAG(9),ICAST(40),WHL(40),EST(40),SLIP(40),       SYNO185
     4 REV(40),BOTNO(3,40),CAPT(3,40),TT(3,40),OHM(40),OXY(40),CHEM(40),SYNO190
     5 CRUD(40),STAD(40),ANN(9),FLG(40),ZTRUE(40),ZANG(40),ZAVE(40),     SYNO195C
     6 SALW(40),SALP(40),SALL(40),OX1(40),OX2(40),OX1W(40)               SYNO200C
      DIMENSION OX2W(40),OX1P(40),OX2P(40),NSIGT(40),TAV(6,40),          SYNO205
     1 SIGT(6,40),SIGTW(6,40),SIGTP(6,40),AOU(6,40),AOUP(6,40),          SYNO210
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 2 AOUW(6,40),SATN(6,40),SATNW(6,40),SATNP(6,40),ZMAX(9),MAXZ(9),
 3 TF(4,40),ZANGP(40),TAVP(6,40),TFLAG(3,40),ELM(3,40),P3T024(13),
 4 TZ(3,40),APF(6,40),AUF(3,40),BNOT(30),DZD(30),NSO(40),KCA(9) ,
 5 TAVW(6,40),VV(3,40),PP(3,40),QQ(3,40),ZANGT(40),ZTRUT(40),FGMT(9)
 6,TCOR(3,40),RHOM(40),ELP(3,40),TTF(60),THZT(60),BBT(60),TFT(60),
 7 ELZO(60),ZZO(60),REVV(60),SIGW(60),APO(60),SATT(60),AMEST(9)
  DIMENSION SALO(60),OX10(60),OX20(60),XX(9),GMTL(9),PSPC(40),
 1 COMENT(20,11),KSTCOM(20)
C
  COMMON BOTNO,CAPT,TT,ZAVE,TZ,TAV,N,NSIGT,KPP,NSO,ZTRUE,ELM,
 1 TF,KOL,DZD,BNOT,APF,AUF,VV,PP,QQ,TCOR,RHOM,NOML,NOTMP,
 2 BL,IT1,IT2
C
  EQUIVALENCE  (MSD,XMSD), (WEA1,PWEA1),  (LGMT,GMTL),
 1 (P3T024(1),SHIP),    (P3T024(2),ALA1),     (P3T024(3),ALA2),
 2 (P3T024(4),PALA3),   (P3T024(5),ALA4),     (P3T024(6),ALO1),
 3 (P3T024(7),ALO2),    (P3T024(8),PALO3),    (P3T024(9),ALO4),
 4 (P3T024(10),SQUAR),  (P3T024(11),YR),      (P3T024(12),AMO),
 5 (P3T024(13),DAY)
C
C      OCTAL EQUIVALENTS OF BCD CHARACTERS
B      BL = 606060606060
B      ONE = 016060606060
B      AJ = 416060606060
B      AK = 426060606060
B      AL = 436060606060
B      AM = 446060606060
B      AMINUS = 406060606060
B      ANORTH = 456060606060
B      SOUTH = 626060606060
B      EAST = 256060606060
B      WEST = 666060606060
B      TTHOMP = 636360606060
B      STAR = 546060606060
B      UNPRO = 646060606060
B      W1 = 676060606060
B      YES = 702562606060
C
       IT1 = 5
       IT2 = 6
       IT3 = 8
C
C      INITIALIZE ALL COUNTING
C
       NOSALA = 0
       NOSIG = 0
       NOTMP = 0
       NOXY = 0
       NAOU = 0
       NOTHZ = 0
       NOMAST = 0
       NOPC = 0
       NODC = 0
```

```
      NOMC = 0
      NOST = 0
      NOBP = 0
      NOBO = 0
      NOML = 0
      NDN = 0
      NOCC = 0
      NOCMSK = 0
      NODTSK = 0
      NOPCSK = 0
      NOTAPE = 0
C
C     CONSTANTS FOR SALINITY BRIDGE 11 AS OF 5/24/63
C
      DELR(1,1) = 0.39
      DELR(2,1) = 0.35
      DELR(3,1) = 0.31
      DELR(4,1) = 0.27
      DELR(5,1) = 0.21
      DELR(6,1) = 0.17
      DELR(7,1) = 0.08
      DELR(8,1) = 0.00
      A(1) = -0.6098
      B(1) = 45.8079E-03
      C(1) = 72.332E-07
C
C     CONSTANTS FOR SALINITY BRIDGE 2 AS OF 5/24/63
C
      DELR(1,2) = 0.77
      DELR(2,2) = 0.66
      DELR(3,2) = 0.55
      DELR(4,2) = 0.44
      DELR(5,2) = 0.33
      DELR(6,2) = 0.22
      DELR(7,2) = 0.10
      DELR(8,2) = 0.00
      A(2) = 4.6375
      B(2) = 3.97605E-02
      C(2) = 0.51637E-05
C
C     FIRST STATEMENT IN PROGRAM MUST BE CALL THERMO TO CONSTRUCT
C     THE TABLE OF THERMOMETERS.
C
      SENSE LIGHT 0
      KPP = 0
      CALL THERMO
      KPP = 1
      READ INPUT TAPE IT1,9000,TEST
 9000 FORMAT(79X,A1)
B     IF(EXORF(TEST,AM)) 100,500,100
C     NO CRUISE PARAMETER CARD
  100 READ 9010,SHIP
 9010 FORMAT(2X,A2)
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```
B        IF(EXORF(SHIP,TTHOMP)) 110,120,110                                    SYN0745C
   110   WRITE OUTPUT TAPE IT2, 9020, SHIP                                     SYN0750A
  9020   FORMAT(35H1CRUISE PARAMETER CARD MISSING FOR A2/6X55HASSUME THAT DSYN0755C
       1ISTANCE IS 4 AND METER WHEEL IS OF TYPE 1./6X25HNO CARDS WILL BE PSYN0760C
       2UNCHED. )                                                             SYN0765A
   120   DIST = 4.0                                                            SYN0770C
         NTYPE = 1                                                             SYN0775
         TAPE = BL                                                             SYN0780C
         KSAL = 0                                                              SYN0785C
         BACKSPACE IT1                                                         SYN0790C
         GO TO 520                                                             SYN0795A
C        READ CRUISE PARAMETER CARD                                            SYN0800C
   500   READ 9030,SHIP,DIST,NTYPE, PUNCH, TAPE, PSPCH                         SYN0805C
  9030   FORMAT(2X,A2,8X,F2.0,I1,3A3)                                          SYN0810C
         KSAL = 0                                                              SYN0815C
C        TEST TO SEE IF PUNCHING IS DESIRED                                    SYN0820A
B        IF(EXORF(PUNCH,YES)) 520,510,520                                      SYN0825B
C        PUNCHING DESIRED                                                      SYN0830A
   510   ASSIGN 5630 TO NPNCH2                                                 SYN0835C
         ASSIGN 5680 TO NPNCH3                                                 SYN0840A
         ASSIGN 5750 TO NPNCH6                                                 SYN0845A
         ASSIGN 5820 TO NPNCH7                                                 SYN0850A
         ASSIGN 5890 TO NPNCH8                                                 SYN0855A
         ASSIGN 4640 TO NPNCH9                                                 SYN0860B
         ASSIGN 5400 TO NPN10                                                  SYN0865B
         GO TO 530                                                             SYN0870C
C        PUNCHING NOT DESIRED                                                  SYN0875A
   520   ASSIGN 5640 TO NPNCH2                                                 SYN0880C
         ASSIGN 5690 TO NPNCH3                                                 SYN0885C
         ASSIGN 5760 TO NPNCH6                                                 SYN0890A
         ASSIGN 5830 TO NPNCH7                                                 SYN0895A
         ASSIGN 5900 TO NPNCH8                                                 SYN0900C
         ASSIGN 4650 TO NPNCH9                                                 SYN0905C
         ASSIGN 5410 TO NPN10                                                  SYN0910C
B  530   IF (EXORF(TAPE,YES)) 540,550,540                                      SYN0915C
C        NO AUXILIARY TAPE DESIRED                                             SYN0920C
   540   NTAPE = 1                                                             SYN0925C
         GO TO 560                                                             SYN0930C
C        WRITE AUXILIARY TAPE                                                  SYN0935C
   550   NTAPE = 2                                                             SYN0940C
         NOTAPE =  1                                                           SYN0945C
C                                                                              SYN0950
   560   READ INPUT TAPE IT1,9000,TEST                                         SYN0955
B  800   IF(EXORF(TEST,AJ)) 810,1000,810                                       SYN0960
   810   READ 9040,CRUZ,STAT                                                   SYN0965
  9040   FORMAT(73X,2A3)                                                       SYN0970
         IDT = 0                                                               SYN0975
         JOB = 0                                                               SYN0980
         NOCOM = 0                                                             SYN0985C
         NOM = 0                                                               SYN0990
         NOMAST = NOMAST + 1                                                   SYN0995
         NOST = NOST + 1                                                       SYN1000
C                                                                              SYN1005
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C     FILL THESE VARIABLES WITH BLANKS FOR PUNCHING DETAIL CARDS          SYN1010A
C     WHEN THERE IS NO MASTER CARD.                                       SYN1015
C                                                                         SYN1020
      DO 820 L = 1, 13                                                    SYN1025C
  820 P3T024(L) = BL                                                      SYN1030C
      SONICZ = BL                                                         SYN1035A
      WRITE OUTPUT TAPE IT2, 9060                                         SYN1040B
      BACKSPACE IT1                                                       SYN1045B
      GO TO 1320                                                          SYN1055C
C                                                                         SYN1060
C     READ STATION MASTER CARD                                            SYN1065
C     JOB IS THE NUMBER OF CASTS PER STATION                              SYN1070
C     IDT IS THE NUMBER OF DETAIL CARDS PER STATION                       SYN1075
C     NOCOM IS THE NUMBER OF COMMENT CARDS PER STATION                    SYN1080B
C                                                                         SYN1085
 1000 JOB = 0                                                             SYN1090
      IDT = 0                                                             SYN1095
      NOCOM = 0                                                           SYN1100B
C                                                                         SYN1105
C     IF NOM = 0 THERE IS NO MASTER CARD FOR THIS STATION                 SYN1110
C                                                                         SYN1115
      NOM = 1                                                             SYN1120
      READ 9050,CO,SHIP,ALA1,ALA2, ALA3,ALA4,ALO1,ALO2,ALO3,ALO4,SQUAR,   SYN1125
     1   YR,AMO,DAY,HRGMT,TH1,TH2,TSTAGE,ZON,SONICZ,COLOR,TRA,DIR,HA,PW,SYN1130
     2   WIND1,WIND2,BARA,TD,TW,WEA1,WEA2,CLT,CLA,VIS,CRUZ,STAT          SYN1135C
 9050 FORMAT(3A2,3A1,A3,3A1,A3,3A2,F3.1,A2,2A1,A2,A4,4X3A2,2A1,2A2,F3.1,SYN1140C
     12A3,5A1,6X2A3)                                                      SYN1145C
      WRITE OUTPUT TAPE IT2, 9060                                         SYN1150B
 9060 FORMAT(1H1)                                                         SYN1155B
B     IF(EXORF(CRUZ,BL)) 1010,8500,1010                                   SYN1160
 1010 NOMC = NOMC + 1                                                     SYN1165
      NOST = NOST + 1                                                     SYN1170
      IF(BLANKF(HRGMT)) 1030,1020,1020                                    SYN1175
 1020 HRGW = BIDEF(HRGMT,4,1)                                             SYN1180
      GO TO 1040                                                          SYN1185
 1030 HRGW = BL                                                           SYN1190
B1040 IF (EXORF(TH1,BL) + EXORF(TH2,BL) + EXORF(TSTAGE,BL) +              SYN1195C
     1           EXORF(ZON,BL)) 1050,1060,1050                            SYN1200C
C     INSHORE INPUT                                                       SYN1205C
 1050 INSH = 1                                                            SYN1210C
      GO TO 1070                                                          SYN1215C
 1060 INSH = 0                                                            SYN1220C
 1070 IF(BLANKF(BARA)) 1090,1080,1080                                     SYN1225C
 1080 BARA = BIDEF(BARA,4,1)                                              SYN1230C
      GO TO 1100                                                          SYN1235C
 1090 BARA = BL                                                           SYN1240
 1100 PALA3 = ALA3                                                        SYN1245*
B     IF(EXORF(ALA3, 526060606060)) 1120,1110,1120                        SYN1250A
B1110 ALA3 = 0                                                            SYN1255A
      GO TO 1140                                                          SYN1260A
B1120 IF(400000000000 * ALA3) 1130,1150,1130                              SYN1265A
B1130 ALA3 = ALA3 * 377777777777                                          SYN1270
 1140 ALA5 = SOUTH                                                        SYN1275*
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      GO TO 1160                                                        SYN1280
 1150 ALA5 = ANORTH                                                     SYN1285
 1160 PALO3 = ALO3                                                      SYN1290
B     IF(EXORF(ALO3, 52606060606O)) 1180,1170,1180                      SYN1295A
B1170 ALO3 = 0                                                          SYN1300A
      GO TO 1200                                                        SYN1305A
B1180 IF(400000000000 * ALO3) 1190,1210,1190                            SYN1310A
B1190 ALO3 = ALO3 * 377777777777                                        SYN1315
 1200 ALO5 = EAST                                                       SYN1320*
      GO TO 1220                                                        SYN1325
 1210 ALO5 = WEST                                                       SYN1330
B1220 IF(EXORF(TD,BL)) 1230,1240,1230                                   SYN1335
 1230 TD = DEBIF(TD) * 0.1                                              SYN1340
      WTD = BIDEF(TD,4,1)                                               SYN1345
      GO TO 1250                                                        SYN1350
 1240 SENSE LIGHT 2                                                     SYN1355
      WTD = BL                                                          SYN1360
B1250 IF(EXORF(TW,BL)) 1270,1260,1270                                   SYN1365
 1260 WTW = BL                                                          SYN1370
      GO TO 1310                                                        SYN1375
 1270 TW = DEBIF(TW) * 0.1                                              SYN1380
      WTW = BIDEF(TW,4,1)                                               SYN1385
      IF(SENSE LIGHT 2) 1310,1280                                       SYN1390
C                                                                       SYN1395
C     COMPUTE RELATIVE HUMIDITY                                         SYN1400
C                                                                       SYN1405
 1280 TTD = 1.0 + TD / 273.2                                            SYN1410
      TTW = 1.0 + TW / 273.2                                            SYN1415
      T1 = EXPF(25.22 * (1.0 / TTD - 1.0 / TTW))                        SYN1420
      T2 = EXPF(25.22 * (1.0 / TTD - 1.0))                              SYN1425
      RH = (TTD / TTW) ** 5.31 * T1 - 10.16 *( 2.02 + 0.927 * TTD)      SYN1430
     1 * (TTD - TTW) * TTD **5.31 * T2                                  SYN1435
      RH = RH * 100.0                                                   SYN1440
      IF(RH - 100.0) 1300,1290,1290                                     SYN1445
 1290 RH = 99.0                                                         SYN1450
 1300 RH = BIDEF(RH,2,0)                                                SYN1455
      GO TO 1320                                                        SYN1460
 1310 RH = BL                                                           SYN1465
 1320 READ INPUT TAPE IT1,9000,TEST                                     SYN1470
B     IF(EXORF(TEST,AK)) 2220,2000,2220                                 SYN1475C
C                                                                       SYN1480
C     READ PARAMETER CARD                                               SYN1485
C                                                                       SYN1490
 2000 SENSE LIGHT 0                                                     SYN1495
      READ 9070, STATP                                                  SYN1500A
 9070  FORMAT(76XA3)                                                    SYN1505A
B     IF(EXORF(STAT,STATP)) 3000,2010,3000                              SYP1510A
 2010 JOB = JOB + 1                                                     SYN1511*
C     TEST FOR ZERO OR BLANK CAST NUMBER                                SYN1512C
      READ 9074, J                                                      SYN1513C
 9074 FORMAT(4XA1)                                                      SYN1514C
      IF(XDEBIF(J)) 2015,2015,2018                                      SYN1514C
 2015 WRITE OUTPUT TAPE IT2,9076,J,CRUZ,STAT                            SYN1515C
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 9076 FORMAT(21H PARAMETER CARD HAD -A1,25H- FOR THE CAST NUMBER ON A3,  SYN1516C
     1 1H-A3,21H.  SKIP THIS STATION.)                                   SYN1517C
      GO TO 2380                                                         SYN1518C
 2018 READ 9080, J,(MEST(J),ZLAST(J),AN(J),WHEEL(J),LSAL(J),TITER(J) ),JSYN1520*
     12, (FACTOR(J),SPCH(J),ZONE(J),NO1(J),NO2(J),CRU(J),STAP(J))        SYN1525
 9080 FORMAT(4XI1,I4,F4.0,A2,A4,I2,F4.2,I1,38XF4.3,A1,A2,2I1,2A3)        SYN1530
      NOPC = NOPC + 1                                                    SYN1535
 2020 JCA(JOB) = J                                                       SYN1540
      JRES(JOB) = J                                                      SYN1545
      WHEEL(J) = DEBIF(WHEEL(J))                                         SYN1550A
      IF(WHEEL(J)) 2030,2040,2040                                        SYN1555A
 2030 WSIGN(J) = AMINUS                                                  SYN1560A
      GO TO 2050                                                         SYN1565A
 2040 WSIGN(J) = BL                                                      SYN1570A
 2050 OFAC(J) = (0.5040 / TITER(J)) * 11.1965                            SYX1575*
      XX(J) = (+1H+)                                                     SYN1580C
      LGMT(J) = MEST(J) + (XDEBIF(ZONE(J)) * 100)                        SYN1585C
      AMEST(J) = BIDEF(MEST(J),-4,-1)                                    SYN1590*
B     IF(EXORF(007700000000 * ZONE(J),005200000000)) 2070,2060,2070      SYN1595
B2060 ZONE(J) = 770077777777 * ZONE(J)                                   SYN1600
      GO TO 2090                                                         SYN1605
B2070 IF(ZONE(J) * 004000000000) 2080,2100,2080                          SYN1610*
B2080 ZONE(J) = ZONE(J) * 773777777777                                   SYN1615
 2090 XX(J) = AMINUS                                                     SYN1620A
 2100 IF(LGMT(J)) 2110,2120,2120                                         SYN1625C
 2110 LGMT(J) = LGMT(J) + 2400                                           SYP1630
      FLAG(J) = (+1H$)                                                   SYN1635
      GO TO 2130                                                         SYN1640
 2120 FLAG(J) = BL                                                       SYN1645
      IF (LGMT(J) - 2400) 2130,2125,2125                                 SYN1647C
 2125 FLAG(J) = STAR                                                     SYN1648A
      LGMT(J) = LGMT(J) - 2400                                           SYN1650
C     LGMT(J) IS THE GMT-TIME OF THIS CAST.                              SYN1655C
 2130 T1 = LGMT(J) / 100                                                 SYN1660C
C     T1 IS THE HOURS-PART OF LGMT(J).                                   SYN1665C
      T2 = LGMT(J) - (LGMT(J) / 100) * 100                               SYN1670C
C     T2 IS THE MINUTES-PART OF LGMT(J).                                 SYN1675C
      FGMT(J) = T1 + T2 / 60.                                            SYN1680C
C     FGMT(J) IS NOW THE GMT TIME IN HOURS.                              SYN1685C
      IF(SENSE LIGHT 1) 2210,2140                                        SYN1695*
 2140 IF(J2) 2150,2210,2150                                              SYN1700
 2150 READ 9090,J,(MEST(J) ,ZLAST(J),AN(J),WHEEL(J),LSAL(J),TITER(J),    SYN1705
     1   FACTOR(J),SPCH(J),ZONE(J),NO1(J),NO2(J),CRU(J),STAP(J) )        SYN1710
 9090 FORMAT(25XI1,I4,F4.0,A2,A4,I2,F4.2,18XF4.3,A1,A2,2I1,2A3)          SYN1715
      SENSE LIGHT 1                                                      SYN1720
      JOB = JOB + 1                                                      SY*1725
      IF(JOB - 9) 2020,2020,2160                                         SYN1730
 2160 WRITE OUTPUT TAPE IT2,9100,STAT                                    SYX1735
 9100 FORMAT(39H0OVERFLOW OF CAST DIMENSION ON STATION A3)               SYN1740A
 2170 READ INPUT TAPE IT1, 9000, TEST                                    SYN1745A
B     IF(EXORF(TEST,AK)) 2190, 2180, 2190                                SYN1750A
 2180 NOPCSK = NOPCSK + 1                                                SYN1755A
      GO TO 2170                                                         SYN1760A
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B2190 IF(EXORF(TEST,AM))2200, 500, 2200                                 SYV1765A
B2200 IF(EXORF(TEST,AJ)) 2170, 1000, 2170                               SYN1770A
 2210 READ INPUT TAPE IT1,9000,TEST                                     SYN1775
B2220 IF(EXORF(TEST,ANORTH)) 2280,2230,2280                             SYN1780B
C                                                                       SYN1785B
C     READ COMMENT CARD                                                 SYN1790B
C                                                                       SYN1795B
 2230 NOCOM = NOCOM + 1                                                 SYN1800B
      IF (NOCOM - 20) 2240,2240,2250                                    SYN1805C
 2240 READ 9110, KSTCOM(NOCOM),(COMENT(NOCOM,LL),LL=1,11)               SYN1810B
 9110 FORMAT(4X,I1,11A6)                                                SYN1815B
      NOCC = NOCC + 1                                                   SYN1820B
      GO TO 2210                                                        SYN1825B
 2250 IF (NOCMSK) 2260,2260,2270                                        SYN1830C
 2260 WRITE OUTPUT TAPE IT2,9120,STAT                                   SYN1835B
 9120 FORMAT(35H0TOO MANY COMMENT CARDS ON STATION A3)                  SYN1840B
C     SKIP REST OF COMMENT CARDS                                        SYN1845B
 2270 READ INPUT TAPE IT1,9000,TEST                                     SYN1850B
      NOCMSK = NOCMSK + 1                                               SYN1855B
B     IF(EXORF(TEST,ANORTH)) 2280,2270,2280                             SYN1860B
C                                                                       SYN1865B
B2280 IF(EXORF(TEST,AK)) 2290,2000,2290                                 SYN1870*
B2290 IF(EXORF(TEST,AL)) 2350,2300,2350                                 SYN1875
C                                                                       SYN1880
C     READ DETAIL CARDS                                                 SYN1885
C                                                                       SYN1890
 2300 IDT = IDT + 1                                                     SY*1895
      IF(IDT - 40) 2340, 2340, 2310                                     SY(1900
 2310 WRITE OUTPUT TAPE IT2,9130, STAT                                  SY*1905
 9130 FORMAT(46H0OVERFLOW OF DETAIL CARD DIMENSION ON STATION A3)       SYN1910A
 2320 READ INPUT TAPE IT1, 9000, TEST                                   SYN1915A
      NODTSK = NODTSK + 1                                               SYN1920A
B     IF(EXORF(TEST,AM)) 2330, 500, 2330                                SYN1925A
B2330 IF(EXORF(TEST,AJ)) 2320, 1000, 2320                               SYN1930A
 2340 READ 9140,ICAST(IDT),WHL(IDT),EST(IDT),SLIP(IDT),REV(IDT),(BOTNO(LSYN1935A
     1,IDT),CAPT(L,IDT),TT(L,IDT),L=1,3),OHM(IDT),OXY(IDT), CHEM(IDT),  SYN1940A
     2  CRUD(IDT),STAD(IDT)                                             SYN1945A
 9140 FORMAT(4X,I1,2F4.0,F2.0,A2,3(A6,A4,A3),F5.2,F4.2,A4,4X,2A3)       SYN1950
      NODC = NODC + 1                                                   SYN1955
B     IF(EXORF(STAT,STAD(IDT))) 2370,2210,2370                          SYN1960A
B2350 IF(EXORF(TEST,AJ)) 2360, 3000, 2360                               SYN1965A
B2360 IF(EXORF(TEST,AM)) 2370,3000,2370                                 SYN1970
C                                                                       SYN1975
C     THE FOLLOWING BLOCK READS UNTIL A MASTER CARD OR CRUISE PARAMETER SYN1980
C     CARD IS REACHED.  THIS IS DONE WHEN A CARD IS OUT OF ORDER OR WHENSYN1985
C     A BAD CONTROL PUNCH IS READ.                                      SYN1990
C                                                                       SYN1995
 2370 WRITE OUTPUT TAPE IT2,9150,STAT                                   SYN2000
 9150 FORMAT(10X,69HA CARD WAS EITHER OUT OF ORDER OR HAD A BAD CONTROL SYN2005
     1PUNCH IN STATION A3, 31H.  PROCEED TO NEXT MASTER CARD.)          SYN2010
 2380 NOBP = NOBP + 1                                                   SYN2015
      READ INPUT TAPE IT1,9000,TEST                                     SYN2020
B     IF(EXORF(TEST,AM)) 2390, 500, 2390                                SYN2025A
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B2390 IF(EXORF(TEST,AJ)) 2380,1000,2380                                  SYN2030*
C                                                                        SYN2035
C     BEGIN PROCESSING ENTIRE STATION                                    SYN2040C
C                                                                        SYN2045C
C     THE FOLLOWING BLOCK IS TO SORT PARAMETER CARD INFORMATION BY ORDER SYN2050
C     OF INCREASING CAST NUMBER WHERE KCA IS THE NEW ARRAY OF CAST NOS.  SYN2055
C                                                                        SYN2060
 3000 BACKSPACE IT1                                                      SYN2065A
      N = IDT                                                            SYN2070*
      DO 3030 LL = 1,JOB                                                 SYN2075*
      MIN = 10                                                           SYN2080
      DO 3020 LM = 1, JOB                                                SYN2085
      IF (JCA(LM) - MIN) 3010,3020,3020                                  SYN2090
 3010 MIN = JCA(LM)                                                      SYN2095
      KK = LM                                                            SYN2100
 3020 CONTINUE                                                           SYN2105
      KCA(LL) = MIN                                                      SYN2110
 3030 JCA(KK) = 10                                                       SYN2115
C                                                                        SYN2120C
C     COMPARE EACH GMT CAST TIME WITH THAT ON -FIRST- CAST AND ADJUST    SYN2125C
C     BY ADDING 24.0 FOR NEXT DAY IF NECCESSARY.  CONVERT TO BCD.        SYN2130C
C                                                                        SYN2135C
      LL = KCA(1)                                                        SYN2140C
      IF (JOB - 1) 3070,3070,3040                                        SYN2145C
 3040 DO 3065 J = 2, JOB                                                 SYN2150C
      LM = KCA(J)                                                        SYx2155C
      IF (FGMT(LM) - FGMT(LL)) 3050,3060,3060                            SYN2160C
 3050 FGMT(LM) = FGMT(LM) + 24.0                                         SYN2165C
      LGMT(LM) = LGMT(LM) + 2400                                         SYN2167C
      FLAG(LM) = STAR                                                    SYN2168C
 3060 FGMT(LM) = BIDEF(FGMT(LM)*10.,-3,0)                                SYN2170C
      GMTL(LM) = BIDEF(LGMT(LM),-4,-1)                                   SYN2172C
 3065 CONTINUE                                                           SYN2173C
 3070 FGMT(LL) = BIDEF(FGMT(LL)*10.,-3,0)                                SYN2175C
      GMTL(LL) = BIDEF(LGMT(LL),-4,-1)                                   SYN2177C
C                                                                        SYN2180
C     GENERATE A NNW ARRAY OF WIRE ANGLES BY ORDER OF INCREASING CAST NOSYN2185
C                                                                        SYN2190
      DO 3100 J = 1, JOB                                                 SYN2195
      LL = KCA(J)                                                        SYN2200
B     IF (EXORF(AN(LL),BL)) 3090,3080,3090                               SYN2205C
 3080 ANN(J) = (+2H--)                                                   SYN2210C
      GO TO 3100                                                         SYN2215C
 3090 ANN(J) = AN(LL)                                                    SYN2220*
 3100 CONTINUE                                                           SYN2225C
      IF (JOB - 1) 3130,3130,3110                                        SYN2230C
 3110 LL = JOB - 1                                                       SYN2235C
      DO 3120 J = 1, LL                                                  SYN2240C
C     -OR- IN A COMMA (73)                                               SYN2245C
B3120 ANN(J) = ANN(J) + 000073000000                                     SYN2250C
      IF (JOB - 9) 3130,3150,3150                                        SYN2255C
 3130 LL = JOB + 1                                                       SYN2260C
      DO 3140 J = LL, 9                                                  SYN2265C
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```
 3140 ANN(J) = BL
 3150 WRITE OUTPUT TAPE IT2,9160
 9160 FORMAT(6H0- - -,21(6H - - -))
C
C     WRITE MASTER CARD IN OFFSHORE OR INSHORE FORMAT
C
      IF (NOM) 3190,3190,3160
 3160 IF (INSH) 3170,3170,3180
 3170 WRITE OUTPUT TAPE IT2, 9170,SHIP,CRUZ,STAT,YR,AMO,DAY,HRGW,ALA1,
     1   ALA2,ALA3,ALA4,ALA5,ALO1,ALO2,ALO3,ALO4,ALO5,SONICZ,WEA1,WEA2,
     2   WIND2,WIND1,VIS,BARA,CLT,CLA,WTD,WTW,RH,DIR,HA,PW,COLOR,TRA,
     3   (ANN(L),L=1,7)
 9170 FORMAT(1H049X17HOBSERVED VALUES  A2,1XA3,1H-A3//14X10HDATE(GMT) A2
     1,1H/A2,1H/A2,10H  HR(GMT) A4,6H  LAT A2,1H-2A1,1H.2A1,7H  LONG A3,
     21H-2A1,1H.2A1,6H  SDG A4,6H  WEA 2A1,7H  WVEL A2,5H DIR A2,6H  VIS
     3 A1/14X3HBA A4,5H  CL A1,5H AMT A1,6H  DRY A4,6H  WET A4,8H  RELHU
     4 A2,10H  WAV DIR A2,4H HT A1,4H PD A1,8H  COLOR A2,8H  SECDI A2,4H
     5 WA 7A3/1H0)
      LCT = 10
      GO TO 3190
C     INSHORE FORMAT
 3180 WRITE OUTPUT TAPE IT2,9180,SHIP,CRUZ,STAT,SQUAR,ZON,YR,AMO,DAY,ZON
     1, HRGW,ALA1,ALA2,ALA3,ALA4,ALA5,ALO1,ALO2,ALO3,ALO4,ALO5,SONICZ,
     2  WEA1,WEA2,WIND2,WIND1,VIS,BARA,CLT,CLA,WTD,WTW,RH,DIR,HA,PD,COLO
     3R ,TRA,(ANN(L),L=1,7),TH1,TH2,TSTAGE
 9180 FORMAT(1H037X17HOBSERVED VALUES  2A3,1H-A3,25X10HAREA CODE A3//14X
     1 6HDATE(+A2,2H) A2,1H/A2,1H/A2,6H  HR(+A2,2H) A4,6H  LAT A2,1H-2A1
     2,1H.2A1,7H  LONG A3,1H-2A1,1H.2A1,6H  SDG A4,6H  WEA 2A1,7H  WVEL
     3 A2,5H DIR A2,6H  VIS A1/14X3HBA A4,5H  CL A1,5H AMT A1,6H  DRY A4
     4,6H  WET A4,8H  RELHU A2,10H  WAV DIR A2,4H HT A1,4H PD A1,8H COLO
     5R A2,8H  SECDI A2,4H WA 7A3/57X8HTIDE HT A2,1H.A1,6H  STG A1/1H0)
      LCT = 11
C
C     START COMPUTING
C
 3190 SENSE LIGHT 0
      NZTST = 0
      IF(NTYPE - 1) 3200,3200,3240
C
C     CHECK DEPTHS
C
C
C     NTYPE = 1  METER WHEEL + ESTIMATED DEPTH + DIST = FINAL DOWN READ
C
 3200 DO 3230 I = 1,N
      J = ICAST(I)
      IF(WHL(I) + EST(I) + DIST - WHEEL(J)) 3220,3210,3220
 3210 FLG(I) = BL
      GO TO 3230
 3220 NZTST = 1
      FLG(I) = STAR
      NDN = NDN + 1
 3230 CONTINUE
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      GO TO 3280                                                        SYN2535
C                                                                       SYN2540
C     NTYPE = 2  METER WHEEL - ESTIMATED DEPTH - DIST = FINAL DOWN READ SYN2545
C                                                                       SYN2550
 3240 DO 3270 I = 1,N                                                   SYN2555
      J = ICAST(I)                                                      SYN2560
      IF(WHL(I) - EST(I) - DIST - WHEEL(J)) 3260,3250,3260              SYN2565
 3250 FLG(I) = BL                                                       SYN2570
      GO TO 3270                                                        SYN2575
 3260 NZTST = 1                                                         SYN2580
      FLG(I) = STAR                                                     SYN2585
      NDN = NDN + 1                                                     SYN2590
 3270 CONTINUE                                                          SYN2595
C                                                                       SYN2600
C                                                                       SYN2605
 3280 DO 3290 I = 1,N                                                   SYN2610
      J = ICAST(I)                                                      SYN2615
C     COMPUTE TRUE WIRE LENGTH                                          SYN2620
      ZTRUE(I) = XRNDF((EST(I) + SLIP(I)) * FACTOR(J))                  SYN2625A
C     COMPUTE WIRE ANGLE DEPTH                                          SYN2630
      ZANG(I) = ZTRUE(I) * COSF(DEBIF(AN(J)) * 0.01745329)              SYN2635C
C     AVERAGE THE TWO FOR THERMOMETRIC DEPTH CALCULATIONS               SYN2640
 3290 ZAVE(I) = (ZTRUE(I) + ZANG(I)) / 2.0                              SYN2645
C                                                                       SYN2650
C     CALL THERMO ONCE FOR EVERY STATION                                SYN2655
C                                                                       SYN2660
 4000 KOL = 0                                                           SYN2665*
      CALL THERMO                                                       SYN2670
C                                                                       SYN2675
C     COMPUTE SALINITY AND OXYGEN                                       SYN2680
C                                                                       SYN2685
      NOTEST = 0                                                        SY*2690
      ILLSAL = 0                                                        SY(2695C
      ILLTTR = 0                                                        SYV2700C
      DO 4390 I = 1, N                                                  SYP2705A
C                                                                       SYV2710
C     BRIDGE NUMBER 88 - SALINITY ON CARDS IN XX.XXX FORMAT             SY(2715
C     BRIDGE NUMBER 99 - SALINITY DONE BY TITRATION.  NO EQUATIONS YET  SYx2720
C     VALID SALINITY BRIDGE NUMBERS ARE 2, 4, 11, AND 22.               SYN2725C
C                                                                       SYN2730
      JJ = ICAST(I)                                                     SYV2735C
      IF(BLANKF(OHM(I)))4010,4020,4020                                  SYV2740
 4010 SALW(I) = BL                                                      SYV2745
      SALP(I) = BL                                                      SYN2750
      LSTE(I) = 0                                                       SYN2755
      GO TO 4210                                                        SYN2760
 4020 L = -1                                                            SYN2765C
      IF (BLANKF(LSAL(JJ))) 4030,4040,4040                              SYV2770C
 4030 ILLSAL = 1                                                        SYN2775C
      LSAL(JJ) = KSAL                                                   SY(2780C
      L = L + 1                                                         SYN2785C
 4040 IF (L) 4050,4050,4010                                             SYN2790C
 4050 IF (LSAL(JJ) - 22) 4070,4060,4130                                 SYN2795C
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C                                                                         SYN2800C
C     CONSTANTS FOR SALINITY BRIDGE 22 AS OF SEPTEMBER 1965               SYN2805C
C                                                                         SYN2810C
 4060 SALL(I) = -0.86900 + 0.046528 * OHM(I) + (6.73 * OHM(I)*OHM(I))    SYN2815C
     1            * 1.E-6                                                 SYN2820C
      GO TO 4200                                                          SYN2825C
 4070 IF(LSAL(JJ) - 11) 4090,4080,4030                                    SYN2830C
 4080 JBD = 1                                                             SYx2835
      GO TO 4170                                                          SYN2840
 4090 IF (LSAL(JJ) - 4) 4100,4120,4030                                    SYN2845C
 4100 IF (LSAL(JJ) - 2) 4030,4110,4030                                    SYN2850C
 4110 JBD = 2                                                             SYN2855
      GO TO 4170                                                          SYN2860
 4120 SALL(I) = 3.32435 + 0.0414724 * OHM(I) + (5.398 * OHM(I) * OHM(I)  SYN2865
     1 ) * 1.E-6                                                          SYN2870
      GO TO 4200                                                          SYN2875A
 4130 IF (LSAL(JJ) - 88) 4030,4150,4140                                   SYN2880C
 4140 IF (LSAL(JJ) - 99) 4030,4160,4030                                   SYN2885C
 4150 SALL(I) = OHM(I) * 1.E-1                                            SYN2890
      GO TO 4200                                                          SYN2895A
 4160 SALW(I) = (+6H TITR.)                                               SYN2900
      SALP(I) = BL                                                        SYN2905
      LSTE(I) = 0                                                         SYN2910
      GO TO 4210                                                          SYN2915
 4170 IF(OHM(I) - 800.0) 4190,4180,4180                                   SYN2920
 4180 SALW(I) = (+6HTOO HI)                                               SYN2925
      SALP(I) = BL                                                        SYN2930
      LSTE(I) = 0                                                         SYN2935
      GO TO 4210                                                          SY*2940
 4190 J = OHM(I) / 100.0                                                  SYN2945
      J = J + 1                                                           SYN2950
      RR = OHM(I) + DELR(J,JBD)                                           SYN2955
      SALL(I) = A(JBD) + (B(JBD) * RR) + (C(JBD) * RR * RR)               SYN2960
 4200 SALW(I) = BIDEF(SALL(I),6,3)                                        SYN2965*
      SALP(I) = BIDEF(SALL(I)*1000.,5,0)                                  SYN2970
      LSTE(I) = 2                                                         SYN2975C
      NOSALA = NOSALA + 1                                                 SY(2980
 4210 KSAL = LSAL(JJ)                                                     SYN2985C
      IF(BLANKF(OXY(I))) 4220,4230,4230                                   SYN2990*
 4220 OX1W(I) = BL                                                        SYx2995
      OX1P(I) = BL                                                        SYN3000
      OX2W(I) = BL                                                        SYN3005
      OX2P(I) = BL                                                        SYN3010
      GO TO 4320                                                          SYN3015
 4230 IF (BLANKF(TITER(JJ))) 4240,4250,4250                               SY*3020C
 4240 ILLTTR = 1                                                          SYN3025C
      GO TO 4220                                                          SYN3030C
 4250 IF (TITER(JJ) - 0.01) 4260,4270,4280                                SYN3035C
C     OXY(I) IS IN MG-A/L                                                 SYN3040C
 4260 OX1(I) = OXY(I) * 0.1                                               SYN3045C
      GO TO 4290                                                          SYV3050C
C     OXY(I) IS IN ML/L                                                   SY(3055C
 4270 OX1(I) = OXY(I) / 11.1965                                           SYN3060C
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      GO TO 4290                                                        SYN3065C
C     OXY(I) IS IN ML                                                   SYN3070C
 4280 OX1(I) = OXY(I) * 0.5040 / TITER(JJ)                              SYN3075C
 4290 OX1W(I) = BIDEF(OX1(I),5,3)                                       SYN3080*
      OX1P(I) = BIDEF(OX1(I)*1000.,-3,0)                                SYN3085C
C     CONVERT FROM MG-A/L TO ML/L                                       SYN3090C
      OX2(I) = OX1(I) * 11.1965                                         SYx3095
      IF(OX2(I) - 10.0) 4310,4300,4300                                  SYN3100C
 4300 NOTEST = 1                                                        SYN3105
 4310 OX2W(I) = BIDEF(OX2(I),5,2)                                       SYP3110
      OX2P(I) = BIDEF(OX2(I)*100.,-3,0)                                 SYN3115C
      NOXY = NOXY + 1                                                   SYN3120
      LSTE(I) = LSTE(I) + 1                                             SYN3125C
C                                                                       SYN3130
C     END SALINITY AND OXYGEN COMPUTATIONS                              SYN3135
C                                                                       SYN3140
C                                                                       SYN3145
C     COMPUTE SIGMA-T, A.O.U. AND PERCENT SATURATION                    SYN3150C
C                                                                       SYN3155
 4320 IF(NSIGT(I)) 4390,4390,4330                                       SYN3160*
 4330 L = NSIGT(I)                                                      SYN3165
      DO 4380 K = 1, L                                                  SYN3170
      J = LSTE(I) - 2                                                   SYN3175C
      IF (J) 4360,4340,4340                                             SYN3180C
 4340 SUMT = -((TAV(K,I) * (TAV(K,I) *(TAV(K,I) + 275.04) - 2236.8396)) SYN3185
     1 + 4482.8332) / (503.57 * (TAV(K,I) + 67.26))                     SYN3190
      AT = 1.0 - 0.001 * TAV(K,I) * (TAV(K,I) * (TAV(K,I) * 1.0843E-03  SYN3195
     1 - 9.8185E-02) + 4.7867)                                          SYN3200
      BT = TAV(K,I) * (TAV(K,I) * (TAV(K,I) * 0.01667 - 0.8164) + 18.03)SYN3205
     1 * 1.E-06                                                         SY(3210
      SG = SALL(I) *(SALL(I) * (SALL(I) * 0.6768E-05 - 48.2496E-05)     SY*3215
     1 +8148.7658E-04) - 934.4586E-04                                   SYN3220
      SIGT(K,I) = SUMT + (AT + BT * SG) * SG + (AT - BT * 0.1324)*0.1324SYN3225
      SIGTW(K,I) = BIDEF(SIGT(K,I),5,2)                                 SYN3230
      SIGTP(K,I) = BIDEF(SIGT(K,I)*100.0,-4,0)                          SYN3235C
      NOSIG = NOSIG + 1                                                 SYN3240
      IF (J) 4370,4370,4350                                             SYN3245C
 4350 OST = 1.E-5 * (TAV(K,I) *(TAV(K,I)*(48.21 - 0.4038*TAV(K,I))-     SY*3250
     1 2464.)+88506.-SALL(I)*(TAV(K,I)*(TAV(K,I)*0.2338-16.)+525.6))    SYV3255
C     APPARENT OXYGEN UTILIZATION IN MG-A/L                             SYN3260
      AOU(K,I) = OST - OX1(I)                                           SYP3265
      AOUP(K,I) = BIDEF(AOU(K,I)*1000.0,-3,0)                           SYN3270
      AOUW(K,I) = BIDEF(AOU(K,I),6,3)                                   SYN3275
C     PERCENT SATURATION                                                SYN3280
      SATN(K,I) = 100.0 * OX1(I) / OST                                  SY*3285
      SATNW(K,I) = BIDEF(SATN(K,I) , 3,0)                               SY*3290
      SATNP(K,I) = BIDEF(SATN(K,I),-3,0)                                SYP3295
      NAOU = NAOU + 1                                                   SYN3300
      GO TO 4380                                                        SYN3305
 4360 SIGTP(K,I) = BL                                                   SYN3310
      SIGTW(K,I) = BL                                                   SYN3315
 4370 AOUW(K,I) = BL                                                    SYN3320
      AOUP(K,I) = BL                                                    SYN3325
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      SATNP(K,I) = BL
      SATNW(K,I) = BL
 4380 CONTINUE
 4390 CONTINUE
C
C     END SIGMA-T AND OXYGEN COMPUTATIONS
C
C     THE FOLLOWING BLOCK SORTS PARAMETER AND DETAIL CARDS BY ORDER OF
C     INCREASING DEPTH.  THAT IS, WITHIN EACH CAST THE DEPTHS WILL BE
C     PRINTED AS THEY WERE SUBMITTED BUT THE SHALLOWEST CAST WILL BE
C     PRINTED FIRST.
C
       MSD = 0.
      DO 4420  JJ = 1, JOB
      JB = JRES(JJ)
      ZMAX(JB) = -10.0
      DO 4410  I = 1,N
      IF(ICAST(I) - JB) 4410,4400,4410
 4400 ZMAX(JB) = MAX1F(ZMAX(JB),EST(I))
C     FIND MAXIMUM SAMPLING DEPTH
      XMSD = MAX1F(XMSD,TZ(I),ZANG(I))
 4410 CONTINUE
 4420 CONTINUE
      ZMXX = 0.0
      DO 4430 JJ = 1, JOB
 4430 ZMXX = MAX1F(ZMXX,ZMAX(JJ))
      DO 4460  LL = 1,JOB
      ZMX = 300000.0
      DO 4450  JJ = 1, JOB
      JB = JRES(JJ)
      IF (ZMAX(JB) - ZMX) 4440,4450,4450
 4440 ZMX = ZMAX(JB)
      MM = JB
 4450 CONTINUE
      MAXZ(LL) = MM
 4460 ZMAX(MM)  = 300000.0
C
C     THE FOLLOWING BLOCK FINDS THE NUMBER OF DEPTHS AND COMMENT
C     CARDS ON EACH CAST AND DETERMINES CARRIAGE CONTROL CHARACTERS.
C
      DO 4470 I = 1, 9
 4470 PAGE(I) = 0
      DO 4530 JJ = 1, JOB
      MM = MAXZ(JJ)
      DO 4490 I = 1, N
      IF (ICAST(I) - MM) 4490,4480,4490
 4480 PAGE(MM) = PAGE(MM) + 1.
 4490 CONTINUE
      IF (NOCOM) 4530,4530,4500
 4500 DO 4520 I = 1, NOCOM
      IF (KSTCOM(I) - MM) 4520,4510,4520
 4510 PAGE(MM) = PAGE(MM) + 0.5
 4520 CONTINUE
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 4530 CONTINUE
      MM = MAXZ(1)
      ZMX = 10. + 11. + 2.2*PAGE(MM)
      PAGE(MM) = BL
      IF (JOB - 1) 4610,4610,4540
 4540 DO 4600 JJ = 2, JOB
      MM = MAXZ(JJ)
      ZMJX = 11. + 2.2*PAGE(MM)
      IF (ZMX - 59.) 4580,4580,4550
 4550 ZMSD = ZMX - 59.
      IF (XMSD + ZMJX - 59.) 4560,4560,4570
 4560 PAGE(MM) = BL
      ZMX = ZMSD + ZMJX - 59.
      GO TO 4600
 4570 PAGE(MM) = ONE
      ZMX = ZMJX
      GO TO 4600
 4580 IF (ZMX + ZMJX - 59.) 4590,4590,4570
 4590 PAGE(MM) = BL
      ZMX = ZMX + ZMJX
 4600 CONTINUE
C
C     PUNCH AUXILIARY CARD
C
C     CODE MAXIMUM SAMPLING DEPTH
 4610 MSD = (XMSD + 49.5) * .01
      IF (MSD - 99) 4630,4630,4620
 4620 MSD = 99
 4630 XMSD = BIDEF(MSD,-2,-1)
      GO TO NPNCH9, (4640,4650)
 4640 PUNCH 9190,RH,(ANN(LL),LL=1,9),XMSD,CRUZ,STAT
 9190 FORMAT(3X,A2,4X,9A2,42X,A2,2X,2A3,1HK)
 4650 GO TO (4665,4660), NTAPE
 4660 WRITE OUTPUT TAPE IT3,9190,RH,(ANN(LL),LL=1,9),XMSD,CRUZ,STAT
C
C     SET SPECIAL CHEMISTRY BOTTLE NUMBERS FOR PUNCHING BY OPTION
C
B4665 IF (EXORF(PSPCH,YES)) 4690,4670,4690
 4670 DO 4680 I = 1, N
 4680 PSPC(I) = CHEM(I)
      GO TO 5000
 4690 DO 4700 I = 1, N
 4700 PSPC(I) = BL
C
C     INITIALIZE
C
 5000 LKLK = 0
      LKLL = 0
      DO 5940 JOD = 1,JOB
      MM = MAXZ(JOD)
C
C     WRITE PARAMETER CARD
C
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      WRITE OUTPUT TAPE IT2,9200,PAGE(MM),SHIP,CRU(MM),STAP(MM),MAXZ(JODSYN3815C
     1),GMTL(MM),XX(MM),ZONE(MM),AMEST(MM),FLAG(MM),AN(MM),ZLAST(MM),WSISYN3820C
     2GN(MM),WHEEL(MM),LSAL(MM),TITER(MM),OFAC(MM),SPCH(MM),FACTOR(MM),  SYN3825C
     3   NO1(MM),NO2(MM)                                                 SYN3830C
 9200 FORMAT(A1,6XA2,A3,10H  STATION A3,7H  CAST I1,16H  MESS.TIME GMT ASYN3835C
     14,7H LOCAL(A1,A2,2H) A4,A1,13H  WIRE ANGLE A2,19H  LAST APPL. DEPTSYN3840C
     2H     -4PF4.4,11H  FINAL MW A1,-4PF4.4/11X15HSALINOMETER NO.I2,    SYN3845C
     3 12H  OXY TITER OPF5.2, 14H OXY CONSTANT  F6.4, 11H  SP.CHEM. A1,  SYN3850
     4 12H  MW FACTOR  F5.3, 10H  CARD NO.I1,4H OF I1 //)                SYN3855
B     IF (EXORF(PAGE(MM),ONE)) 5020,5010,5020                            SYN3860C
 5010 LCT = 0                                                            SYN3865C
 5020 LCT = LCT + 11                                                     SYN3870C
C                                                                        SYN3875B
C     WRITE COMMENTS                                                     SYN3880B
C                                                                        SYN3885B
      IF (NOCOM) 5060,5060,5030                                          SYN3890B
 5030 DO 5050 JJ = 1, NOCOM                                              SYN3895B
      IF (MM - KSTCOM(JJ)) 5050,5040,5050                                SYN3900B
 5040 WRITE OUTPUT TAPE IT2,9210,(COMENT(JJ,LL),LL=1,11)                 SYN3905B
 9210 FORMAT(40X,11A6)                                                   SYN3910B
      LCT = LCT + 1                                                      SYN3915C
 5050 CONTINUE                                                           SYN3920B
      WRITE OUTPUT TAPE IT2,9220                                         SYN3925B
 9220 FORMAT(1H0)                                                        SYN3930*
      LCT = LCT + 2                                                      SYN3935C
C                                                                        SYN3940B
C     WRITE COLUMN HEADINGS                                              SYN3945B
C                                                                        SYN3950B
 5060 WRITE OUTPUT TAPE IT2,9230                                         SYN3955*
 9230 FORMAT(2X,3HREV 23X,10HWIRE THERM 7X,10HWIRE   L-Z 51X,11HSP.CHEM  SYN3960
     1    / 1X,68HBOTTLE LEFT  MIDDLE RIGHT ANGLE DEPTH CALC LENGTH FROMSYN3965
     2 ACCEPTED  AVE  16X,28H---- O X Y G E N ---  BOTTLE / 1X,68H  NO   SYN3970
     3   T      T       T    DEPTH  (Z)   (L-Z) (L)   CURVE  DEPTH    T  SYN3975
     459H   SAL  SIGMA-T ML/L MGA/L   AOU SATN   NO   PO4  NO3  SI03//)  SYN3980A
C                                                                        SYN3985
C     WRITE DETAIL CARDS BELONGING TO THAT CAST                          SYN3990
C                                                                        SYN3995
      DO 5930 I = 1,N                                                    SYN4000
      IF(ICAST(I) - MM) 5930,5070,5930                                   SYN4005
 5070 JJ = NSO(I) + 1                                                    SYN4010
      GO TO(5340,5100,5421,5090,5160,5200,5422,5250,5425,5080,5170,5210,SYN4015C
     1 5180,5560,5300,5220,5310,5510,5423,5240,5426,5230,5320,5500,5427,SYN4020C
     2 5490,5429), JJ                                                    SYN4025C
C                                                                        SYN4030
C     COMBINATION IS NOW P - -                                           SYN4035
C                                                                        SYN4040
 5080 L1 = 1                                                             SYN4045
      L2 = 2                                                             SYN4050
      L3 = 3                                                             SYN4055
      GO TO 5110                                                         SYN4060
C                                                                        SYN4065
C     COMBINATION IS NOW - P -                                           SYN4070
C                                                                        SYN4075
```

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 5090 L2 = 1
      L1 = 2
      L3 = 3
      GO TO 5110
C
C     COMBINATION IS NOW - - P
C
 5100 L3 = 1
      L2 = 2
      L1 = 3
 5110 TF(L1,I) = BIDEF(TF(L1,I),5,2)
 5120 ZANGT(I) = BIDEF(ZANG(I),-4,0)
      IF(ZANG(I) - 200.0) 5130,5130,5140
 5130 ZANGP(I) = ZANGT(I)
      GO TO 5150
 5140 ZANGP(I) = BL
 5150 ZANG(I) = BIDEF(ZANG(I),4,0)
      TAVP(1,I) = BIDEF(TAV(1,I) * 100.,-4,0)
      ZTRUP(I) = BIDEF(ZTRUE(I),4,0)
      ZTRUT(I) = BIDEF(ZTRUE(I),-4,0)
      TAVW(1,I) = BIDEF(TAV(1,I),5,2)
      GO TO 5600
C
C     COMBINATION IS NOW - P P
C
 5160 L1 = 1
      L2 = 2
      L3 = 3
      GO TO 5190
C
C     COMBINATION IS NOW P - P
C
 5170 L2 = 1
      L1 = 2
      L3 = 3
      GO TO 5190
C
C     COMBINATION IS NOW P P -
C
 5180 L1 = 3
      L2 = 2
      L3 = 1
 5190 TF(L2,I) = BIDEF(TF(L2,I),5,2)
      TF(L3,I) = BIDEF(TF(L3,I),5,2)
      GO TO 5120
C
C     COMBINATION IS NOW - P U
C
 5200 L1 = 1
      L2 = 2
      L3 = 3
      GO TO 5260
C
```

```
C     COMBINATION IS NOW P - U                                  SYN4345
C                                                               SYN4350
 5210 L2 = 1                                                    SYN4355
      L1 = 2                                                    SYN4360
      L3 = 3                                                    SYN4365
      GO TO 5260                                                SYN4370
C                                                               SYN4375
C     COMBINATION IS NOW P U -                                  SYN4380
C                                                               SYN4385
 5220 L2 = 1                                                    SYN4390
      L3 = 2                                                    SYN4395
      L1 = 3                                                    SYN4400
      GO TO 5260                                                SYN4405
C                                                               SYN4410
C     COMBINATION IS NOW U P -                                  SYN4415
C                                                               SYN4420
 5230 L3 = 1                                                    SYN4425
      L2 = 2                                                    SYN4430
      L1 = 3                                                    SYN4435
      GO TO 5260                                                SYN4440
C                                                               SYN4445
C     COMBINATION IS NOW U - P                                  SYN4450
C                                                               SYN4455
 5240 L3 = 1                                                    SYN4460
      L1 = 2                                                    SYN4465
      L2 = 3                                                    SYN4470
      GO TO 5260                                                SYN4475
C                                                               SYN4480
C     COMBINATION IS NOW - U P                                  SYN4485
C                                                               SYN4490
 5250 L1 = 1                                                    SYN4495
      L3 = 2                                                    SYN4500
      L2 = 3                                                    SYN4505
 5260 TFLAG(L1,I) = BL                                          SYN4510
      TFLAG(L2,I) = BL                                          SYN4515
      TFLAG(L3,I) = UNPRO                                       SYN4520A
      TF(L2,I) = BIDEF(TF(L2,I),5,2)                            SYN4525
      TF(L3,I) = BIDEF(TF(L3,I),5,2)                            SYN4530
      TAVP(1,I) = BIDEF(TAV(1,I) * 100.,-4,0)                   SYN4535
      ZANGT(I) = BIDEF(ZANG(I),-4,0)                            SYN4540C
      IF(ZANG(I) - 200.0) 5270,5270,5280                        SYN4545
 5270 ZANGP(I) = ZANGT(I)                                       SYN4550C
      GO TO 5290                                                SYN4555
 5280 ZANGP(I) = BL                                             SYN4560
 5290 ZANG(I) = BIDEF(ZANG(I),4,0)                              SYN4565
      TZ(1,I) = BIDEF(TZ(1,I),4,0)                              SYN4570
      ZTRUP(I) = BIDEF(ZTRUE(I),4,0)                            SYN4575
      ZTRUT(I) = BIDEF(ZTRUE(I),-4,0)                           SYN4580C
      TAVW(1,I) = BIDEF(TAV(1,I),5,2)                           SYN4585
      ELP(1,I) = BIDEF(ELM(1,I),4,0)                            SYN4590C
      ELM(1,I) = BIDEF(ELM(1,I),-4,0)                           SYN4595C
      GO TO 5790                                                SYN4600
C                                                               SYN4605
```

```
C     COMBINATION IS NOW P P U
C
 5300 L1 = 1
      L2 = 2
      L3 = 3
      GO TO 5330
C
C     COMBINATION IS NOW P U P
C
 5310 L1 = 1
      L3 = 2
      L2 = 3
      GO TO 5330
C
C     COMBINATION IS NOW U P P
C
 5320 L3 = 1
      L2 = 2
      L1 = 3
 5330 TF(L1,I) = BIDEF(TF(L1,I),5,2)
      GO TO 5260
C
C     COMBINATION IS NOW - - -
C
 5340 IF(ZANG(I) - 200.0) 5350,5350,5360
 5350 ZANGP(I) = BIDEF(ZANG(I),-4,0)
      GO TO 5370
 5360 ZANGP(I) = BL
 5370 ZANG(I) = BIDEF(ZANG(I),4,0)
      ZTRUP(I) = BIDEF(ZTRUE(I),4,0)
      WRITE OUTPUT TAPE IT2,9240,REV(I),(TF(JJ,I),JJ=1,3),ZANG(I),
    1 ZTRUP(I),FLG(I),SALW(I),OX2W(I),OX1W(I),CHEM(I)
 9240 FORMAT(1H0,2XA2,2X,3(A5,2X),A4,13X,A4,A1,14X,4H$$$$,3XA6,7X,A5,1X,
    1 A5,13X,A4)
      LCT = LCT + 2
      IF(LCT - 59) 5390,5390,5380
 5380 WRITE OUTPUT TAPE IT2,9250
 9250 FORMAT(1H1)
      LCT = 0
 5390 LKLK = 1
      GO TO NPN10, (5410,5400)
 5400 PUNCH 9280,ICAST(I),P3TO24,FGMT(MM),ZANGP(I),BL,SALP(I),BL,BL,
    1   OX2P(I),OX1P(I),BL,PSPC(I),CRUD(I),STAD(I)
 5410 GO TO (5930,5420), NTAPE
 5420 WRITE OUTPUT TAPE IT3,9280,ICAST(I),P3TO24,FGMT(MM),ZANGT(I),BL,
    1   SALP(I),BL,BL,OX2P(I),OX1P(I),BL,ZTRUT(I),ELM(I),CRUD(I),STAD(I)
      GO TO 5930
C
C     COMBINATION IS NOW ONE OF [illegible] UNPROTECTED THERMOMETERS
C
C     COMBINATION IS NOW - - U
 5421 L1 = 1
      L2 = 2
```

```
      L3 = 3                                                            SYN4859C
      GO TO 5424                                                        SYN4860C
C                                                                       SYN4861C
C     COMBINATION IS NOW - U -                                          SYN4862C
 5422 L1 = 1                                                            SYN4863C
      L3 = 2                                                            SYN4864C
      L2 = 3                                                            SYN4865C
      GO TO 5424                                                        SYN4866C
C                                                                       SYN4867C
C     COMBINATION IS NOW U - -                                          SYN4868C
 5423 L3 = 1                                                            SYN4870C
      L1 = 2                                                            SYN4871C
      L2 = 3                                                            SYN4872C
 5424 TF(L3,I) = BL                                                     SYN4873C
      TFLAG(L1,I) = BL                                                  SYN4874C
      TFLAG(L2,I) = BL                                                  SYN4875C
      TFLAG(L3,I) = UNPRO                                               SYN4876C
      GO TO 5430                                                        SYN4878C
C                                                                       SYN4880C
C     COMBINATION IS NOW - U U                                          SYN4881C
 5425 L1 = 1                                                            SYN4882C
      L2 = 2                                                            SYN4883C
      L3 = 3                                                            SYN4884C
      GO TO 5428                                                        SYN4885C
C                                                                       SYN4886C
C     COMBINAIOTN IF NOW U - U                                          SYN4887C
 5426 L2 = 1                                                            SYN4888C
      L1 = 2                                                            SYN4890C
      L3 = 3                                                            SYN4891C
      GO TO 5428                                                        SYN4892C
C                                                                       SYN4893C
C     COMBINATION IS NOW U U -                                          SYN4894C
 5427 L2 = 1                                                            SYN4895C
      L3 = 2                                                            SYN4896C
      L1 = 3                                                            SYN4897C
 5428 TF(L2,I) = BL                                                     SYN4898C
      TF(L3,I) = BL                                                     SYN4900C
      TFLAG(L1,I) = BL                                                  SYN4901C
      TFLAG(L2,I) = UNPRO                                               SYN4902C
      TFLAG(L3,I) = UNPRO                                               SYN4903C
      GO TO 5430                                                        SYN4904C
C                                                                       SYN4905C
C     COMBINATION IS NOW U U U                                          SYN4906C
 5429 TF(1,I) = BL                                                      SYN4907C
      TF(2,I) = BL                                                      SYN4908C
      TF(3,I) = BL                                                      SYN4910C
      TFLAG(1,I) = UNPRO                                                SYN4911C
      TFLAG(2,I) = UNPRO                                                SYN4912C
      TFLAG(3,I) = UNPRO                                                SYN4913C
 5430 IF(ZANG(I) - 200.0) 5440,5440,5450                                SYN4914B
 5440 ZANGP(I) = BIDEF(ZANG(I),-4,0)                                    SYN4915B
      GO TO 5460                                                        SYN4916B
 5450 ZANGP(I) = BL                                                     SYN4917B
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 5460 ZANG(I) = BIDEF(ZANG(I),4,0)                                         SYN4918B
      ZTRUP(I) = BIDEF(ZTRUE(I),4,0)                                       SYN4920
      WRITE OUTPUT TAPE IT2,9260,REV(I),(TF(JJ,I),TFLAG(JJ,I),JJ=1,3),     SYN4921C
     1 ZANG(I),ZTRUP(I),SALW(I),OX2W(I),OX1W(I),CHEM(I)                    SYN4922C
 9260 FORMAT(1H0,2X,A2,2X,3(A5,A1,1X),A4,13H $**$*  $**$*  A4,22XA6,7XA5,  SYN4923C
     1 1XA5,13XA4)                                                         SYN4924C
      LCT = LCT + 2                                                        SYN4925C
      IF (LCT - 59) 5480,5480,5470                                         SYN4926C
 5470 WRITE OUTPUT TAPE IT2,9250                                           SYN4927C
      LCT = 0                                                              SYN4928C
 5480 LKLL = 1                                                             SYV4930*
      GO TO NPN10, (5410,5400)                                             SYN4935C
C                                                                          SYN4940
C     COMBINATION IS NOW U U P                                             SYN4945
C                                                                          SYN4950
 5490 L1 = 1                                                               SYP4955
      L2 = 2                                                               SYN4960
      L3 = 3                                                               SYN4965
      GO TO 5520                                                           SYN4970
C                                                                          SYN4975
C     COMBINATION IS NOW U P U                                             SYN4980
 5500 L1 = 1                                                               SYN4985
      L3 = 2                                                               SYN4990
      L2 = 3                                                               SYN4995
      GO TO 5520                                                           SYN5000
C                                                                          SYN5005
C     COMBINATION IS NOW P U U                                             SYN5010
C                                                                          SYN5015
 5510 L3 = 1                                                               SYN5020
      L2 = 2                                                               SY(5025
      L1 = 3                                                               SY*5030
 5520 TFLAG(L3,I) = BL                                                     SYN5035
      TFLAG(L2,I) = UNPRO                                                  SYN5040A
      TFLAG(L1,I) = UNPRO                                                  SYN5045A
      TF(L1,I) = BIDEF(TF(L1,I),5,2)                                       SYN5050
      TF(L2,I) = BIDEF(TF(L2,I),5,2)                                       SYN5055
      TF(L3,I) = BIDEF(TF(L3,I),5,2)                                       SYN5060
      ZANGT(I) = BIDEF(ZANG(I),-4,0)                                       SY*5065C
      IF(ZANG(I) - 200.0) 5530,5530,5540                                   SYN5070
 5530 ZANGP(I) = ZANGT(I)                                                  SYN5075C
      GO TO 5550                                                           SYN5080
 5540 ZANGP(I) = BL                                                        SYN5085
 5550 ZANG(I) = BIDEF(ZANG(I),4,0)                                         SYN5090
      TZ(1,I) = BIDEF(TZ(1,I),4,0)                                         SYN5095
      ZTRUP(I) = BIDEF(ZTRUE(I),4,0)                                       SYN5100
      ZTRUT(I) = BIDEF(ZTRUE(I),-4,0)                                      SYN5105C
      TAVP(1,I) = BIDEF(TAV(1,I) * 100.,-4,0)                              SYN5110
      TAVW(1,I) = BIDEF(TAV(1,I),5,2)                                      SYN5115
      ELP(1,I) = BIDEF(ELM(1,I),4,0)                                       SYN5120C
      ELM(1,I) = BIDEF(ELM(1,I),-4,0)                                      SYN5125C
      GO TO 5720                                                           SYN5130
C                                                                          SYN5135
C     COMBINATION IS NOW P P P                                             SYN5140
```

```
C
 5560 TF(1,I) = BIDEF(TF(1,I),5,2)
      TF(2,I) = BIDEF(TF(2,I),5,2)
      TF(3,I) = BIDEF(TF(3,I),5,2)
      IF(ZANG(I) - 200.0)  5570,5570,5580
 5570 ZANGP(I) = BIDEF(ZANG(I),-4,0)
      GO TO 5590
 5580 ZANGP(I) = BL
 5590 ZANG(I) = BIDEF(ZANG(I),4,0)
      TAVP(1,I) = BIDEF(TAV(1,I) * 100.,-4,0)
      ZTRUP(I) = BIDEF(ZTRUE(I),4,0)
      TAVW(1,I) = BIDEF(TAV(1,I),5,2)
C
C     WRITING FOR A COMBINATION OF  P P P,  P P -  AND  P - -.
C
 5600 WRITE OUTPUT TAPE IT2,9270,REV(I),(TF(J,I),J=1,3),
     1   ZANG(I),ZTRUP(I),FLG(I),TAVW(1,I),APF(1,I),SALW(I),SIGTW(1,I),
     2  OX2W(I),OX1W(I),AOUW(1,I),SATNW(1,I),CHEM(I)
 9270 FORMAT(1H0,2X,A2,2X,3(A5,2X),A4,13X,A4,A1,13X,A5,A2,1X,A6,1X,A5,
     1 1X,A5,1X,A5,1X,A6,1X,A3,2X,A4)
      LCT = LCT + 2
      IF(LCT - 59) 5620,5620,5610
 5610 WRITE OUTPUT TAPE IT2,9250
      LCT = 0
 5620 GO TO NPNCH2, (5630,5640)
 5630 PUNCH 9280,ICAST(I),P3T024,FGMT(MM),ZANGP(I),TAVP(1,I),SALP(I),
     1   SIGTP(1,I),SATNP(1,I),OX2P(I),OX1P(I),AOUP(1,I),PSPC(I),CRUD(I),
     2   STAD(I)
 9280 FORMAT(1H0,I1,2A2,3A1,A3,3A1,A3,3A2,A3,A4,1XA4,1XA5,A4,A3,1XA3,3X
     1 2A3,7XA4,2A3)
 5640 GO TO (5660,5650), NTAPE
 5650 WRITE OUTPUT TAPE IT3,9290,ICAST(I),P3T024,FGMT(MM),ZANGT(I),TAVP(
     11,I),SALP(I),SIGTP(1,I),SATNP(1,I),OX2P(I),OX1P(I),AOUP(1,I),ZTRUT
     2(I),ELM(1,I),CRUD(I),STAD(I)
 9290 FORMAT(1H0I1,2A2,3A1,A3,3A1,A3,3A2,A3,A4,1XA4,1XA5,A4,A3,A4,3X2A3,
     13X2A4,2A3)
 5660 IF(NSIGT(I) - 1) 5930,5930,5670
 5670 L = NSIGT(I)
      DO 5710 M = 2,L
      TAVW(M,I) = BIDEF(TAV(M,I),5,2)
      TAVP(M,I) = BIDEF(TAV(M,I) * 100.,-4,0)
      WRITE OUTPUT TAPE IT2,9300,TAVW(M,I),APF(M,I),SIGTW(M,I),AOUW(M,I)
     1, SATNW(M,I)
 9300 FORMAT(1H0,62X,A5,A2,8X,A5,13X,A6,1X,A3)
      GO TO NPNCH3, (5680,5690)
 5680 PUNCH 9280,ICAST(I),P3T024,FGMT(MM),ZANGP(I),TAVP(M,I),SALP(I),
     1   SIGTP(M,I),SATNP(M,I),OX2P(I),OX1P(I),AOUP(M,I),PSPC(I),CRUD(I),
     2   STAD(I)
 5690 GO TO (5710,5700), NTAPE
 5700 WRITE OUTPUT TAPE IT3,9290,ICAST(I),P3T024,FGMT(MM),ZANGT(I),TAVP(
     1M,I),SALP(I),SIGTP(M,I),SATNP(M,I),OX2P(I),OX1P(I),AOUP(M,I),ZTRUT
     2(I),BL,CRUD(I),STAD(I)
 5710 CONTINUE
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      GO TO 5930                                                        SYN5410
C                                                                       SYN5415
C     WRITING WITH A COMBINATION SUCH AS U U P                          SYN5420
C                                                                       SYN5425
 5720 WRITE OUTPUT TAPE IT2,9310, REV(I),(TF(J,I),TFLAG(J,I),J=1,3),    SYN5430
     1  ZANG(I),TZ(1,I),AUF(1,I),ELP(1,I),ZTRUP(I),FLG(I),TAVW(1,I),    SYN5435
     2 APF(1,I), SALW(I),SIGTW(1,I),OX2W(I),OX1W(I),AOUW(1,I),SATNW(1,I)SYN5440
     3, CHEM(I)                                                         SYN5445
 9310 FORMAT(1H0,2X,A2,2X,3(A5,A1,1X),A4,1X,A4,A1,1X,A4,2X,A4,A1,13X,   SYN5450C
     1 A5,A1,2X,A6,1X,A5,1X,A5,1X,A5,1X,A6,1X,A3,2X,A4)                 SYN5455C
      LCT = LCT + 2                                                     SYN5460C
      IF(LCT - 59) 5740,5740,5730                                       SYN5465C
 5730 WRITE OUTPUT TAPE IT2,9250                                        SYN5470C
      LCT = 0                                                           SYN5475C
 5740 GO TO NPNCH6, (5750,5760)                                         SYN5480C
 5750 PUNCH 9280,ICAST(I),P3TO24,FGMT(MM),ZANGP(I),TAVP(1,I),SALP(I),   SYN5485C
     1  SIGTP(1,I),SATNP(1,I),OX2P(I),OX1P(I),AOUP(1,I),PSPC(I),CRUD(I),SYN5490C
     1  STAD(I)                                                         SYN5495C
 5760 TZ(2,I) = BIDEF(TZ(2,I),4,0)                                      SYN5500*
      ELP(2,I) = BIDEF(ELM(2,I),4,0)                                    SYN5505C
      ELM(2,I) = BIDEF(ELM(2,I),-4,0)                                   SYN5510C
      WRITE OUTPUT TAPE IT2,9320,TZ(2,I),AUF(2,I),ELP(2,I)              SYN5515
 9320 FORMAT(33X,A4,A1,1X,A4)                                           SYN5520
      GO TO (5930,5770), NTAPE                                          SYN5525C
 5770 DO 5780 L = 1,2                                                   SYN5530C
 5780 WRITE OUTPUT TAPE IT3,9290,ICAST(I),P3TO24,FGMT(MM),ZANGT(I),     SYN5535C
     1  TAVP(1,I),SALP(I),SIGTP(1,I),SATNP(1,I),OX2P(I),OX1P(I),AOUP(1,ISYN5540C
     2),ZTRUT(I),ELM(L,I),CRUD(I),STAD(I)                               SYN5545C
      GO TO 5930                                                        SYN5550
C                                                                       SYN5555
C     WRITING BLOCK FOR COMBINATIONS OF EITHER P P U OR P - U           SYN5560
C                                                                       SYN5565
 5790 WRITE OUTPUT TAPE IT2,9330,REV(I),(TF(J,I),TFLAG(J,I),J=1,3),     SYN5570
     1  ZANG(I),TZ(1,I),ELP(1,I),ZTRUP(I),FLG(I),TAVW(1,I),APF(1,I),    SYN5575
     2  SALW(I),SIGTW(1,I),OX2W(I),OX1W(I),AOUW(1,I),SATNW(1,I),CHEM(I) SYN5580
 9330 FORMAT(1H0,2X,A2,2X,3(A5,A1,1X),A4,1X,A4,2X,A4,2X,A4,A1,13X,A5,A2,SYN5585C
     1 1X,A6,1X,A5,1X,A5,1X,A5,1X,A6,1X,A3,2X,A4)                       SYN5590
      LCT = LCT + 2                                                     SYN5595C
      IF(LCT - 59) 5810,5810,5800                                       SYN5600C
 5800 WRITE OUTPUT TAPE IT2,9250                                        SYN5605C
      LCT = 0                                                           SYN5610C
 5810 GO TO NPNCH7, (5820,5830)                                         SYN5615C
 5820 PUNCH 9280,ICAST(I),P3TO24,FGMT(MM),ZANGP(I),TAVP(1,I),SALP(I),   SYN5620C
     1  SIGTP(1,I),SATNP(1,I),OX2P(I),OX1P(I),AOUP(1,I),PSPC(I),CRUD(I),SYN5625C
     2  STAD(I)                                                         SYN5630C
 5830 GO TO (5850,5840), NTAPE                                          SYN5635C
 5840 WRITE OUTPUT TAPE IT3,9290,ICAST(I),P3TO24,FGMT(MM),ZANGT(I),     SYN5640C
     1  TAVP(1,I),SALP(I),SIGTP(1,I),SATNP(1,I),OX2P(I),OX1P(I),AOUP(1,ISYN5645C
     2),ZTRUT(I),ELM(1,I),CRUD(I),STAD(I)                               SYN5650C
 5850 IF(NSIGT(I) - 1) 5930,5930,5860                                   SYN5655C
 5860 L = NSIGT(I)                                                      SYN5660
      DO 5920 M = 2,L                                                   SYN5665*
      TAVP(M,I) = BIDEF(TAV(M,I)*10. , , )                              SYN5670
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      TAVW(M,I) = BIDEF(TAV(M,I),5,2)                                   SYN5675
      TF(L1,I) = BL                                                     SYN5680
      TF(L2,I) = BL                                                     SYN5685
      TF(L3,I) = BIDEF( TF(4,I),5,2)                                    SYN5690C
      TZ(M,I) = BIDEF(TZ(M,I),4,0)                                      SYN5695
      ELP(M,I) = BIDEF(ELM(M,I),4,0)                                    SYN5700C
      ELM(M,I) = BIDEF(ELM(M,I),-4,0)                                   SYN5705C
      WRITE OUTPUT TAPE IT2,9340,(TF(J,I),TFLAG(J,I),J=1,3),TZ(M,I),    SYN5710
     1  ELP(M,I),TAVW(M,I),APF(M,I),SIGTW(M,I),AOUW(M,I),SATNW(M,I)     SYN5715
 9340 FORMAT(1H06X3(A5,A1,1X),5XA4,2XA4,20XA5,A2,8XA5,13XA6,1XA3)       SYN5720C
      LCT = LCT + 2                                                     SYN5725C
      IF(LCT - 59) 5880,5880,5870                                       SYN5730C
 5870 WRITE OUTPUT TAPE IT2,9250                                        SYN5735C
      LCT = 0                                                           SYN5740C
 5880 GO TO NPNCH8, (5890,5900)                                         SYN5745C
 5890 PUNCH 9280,ICAST(I),P3T024,FGMT(MM),ZANGP(I),TAVP(M,I),SALP(I),   SYN5750C
     1  SIGTP(M,I),SATNP(M,I),OX2P(I),OX1P(I),AOUP(M,I),PSPC(I),CRUD(I),SYN5755C
     2  STAD(I)                                                         SYN5760C
 5900 GO TO (5920,5910), NTAPE                                          SYN5765C
 5910 WRITE OUTPUT TAPE IT3,9290,ICAST(I),P3T024,FGMT(MM),ZANGT(I),     SYN5770C
     1  TAVP(M,I),SALP(I),SIGTP(M,I),SATNP(M,I),OX2P(I),OX1P(I),AOUP(M,ISYN5775C
     2),ZTRUT(I),ELM(M,I),CRUD(I),STAD(I)                               SYN5780C
 5920 CONTINUE                                                          SYN5785*
 5930 CONTINUE                                                          SYN5790
      WRITE OUTPUT TAPE IT2,9350                                        SYN5795
 9350 FORMAT(///)                                                       SYN5800
 5940 CONTINUE                                                          SYN5805
      WRITE OUTPUT TAPE IT2,9160                                        SYN5810
C                                                                       SYN5815
C     KOL IS THE NUMBER OF THERMOMETERS THAT COULDN-T BE FOUND FOR      SYN5820
C     THIS STATION                                                      SYN5825
C                                                                       SYN5830
      IF(LKLK) 7010,7010,7000                                           SYN5835
 7000 WRITE OUTPUT TAPE IT2,9360                                        SYN5840
 9360 FORMAT(10X81H$$$$ - NO TEMPERATURES COULD BE COMPUTED AT THESE DEPSYN5845
     1THS.  ALL THREE THERMOMETERS/10X66HWERE EITHER MALFUNCTIONS, BLANKSYN5850
     2S, OR NOT IN THE THERMOMETER TABLE.//)                            SYN5855A
 7010 IF(LKLL) 7030,7030,7020                                           SYN5860
 7020 WRITE OUTPUT TAPE IT2,9370                                        SYN5865
 9370 FORMAT(10X63H$*$* - AT THESE DEPTHS, ONLY UNPROTECTED THERMOMETERSSYN5870
     1 OCCURRED./10X42HSEE BELOW FOR POSSIBLE THERMOMETRIC DEPHTS.//)   SYN5875A
 7030 SONICZ = DEBIF(SONICZ)                                            SYN5880*
      IF(SONICZ) 7080,7080,7040                                         SYN5885A
 7040 IF(SONICZ - ZMXX) 7050,7060,7060                                  SYN5890C
 7050 WRITE OUTPUT TAPE IT2,9380                                        SYN5895
 9380 FORMAT(10X56HMAXIMUM SAMPLING DEPTH WAS GREATER THAN THE SONIC DEPSYN5900
     1TH.//)                                                            SYN5905A
 7060 IF(ILLSAL) 7080,7080,7070                                         SYN5910C
 7070 WRITE OUTPUT TAPE IT2,9390,KSAL                                   SYN5915C
 9390 FORMAT(10X39HILLEGAL SALINOMETER NO.--ASSUMED TO BE I2)           SYN5920C
 7080 IF(ILLTTR) 7100,7100,7090                                         SYN5925C
 7090 WRITE OUTPUT TAPE IT2,9400                                        SYN5930C
 9400 FORMAT(10X46HOXYGEN TITER IS MISSING--OXYGENS NOT COMPUTED.)      SYN5935C
```

```
7100 IF(NOTEST) 7120,7120,7110                                              SYN5940*
7110 WRITE OUTPUT TAPE IT2,9410                                             SYN5945
9410 FORMAT(10X86HSOME OXYGENS IN ABOVE STATION ARE ABOVE  10.00 ML/L--SYN5950C
    1ADJUST OBSERVED CARDS ACCORDINGLY.)                                    SYN5955C
7120 IF(KOL - 1)  7180,7130,7130                                            SYN5960
7130  WRITE OUTPUT TAPE IT2,9420  ,STAT                                     SYN5965
9420 FORMAT(53HUN I T - THERMOMETERS NOT FOUND IN TABLE FOR STATION A3)SYN5970B
     IF (KOL - 30) 7150,7150,7140                                           SYN5975B
7140 WRITE OUTPUT TAPE IT2,9430                                             SYN5980B
9430 FORMAT(1H09X53HMORE THAN 30 FOR THIS STATION--REFER TO DETAIL CARDSYN5985B
    1S. )                                                                   SYN5990B
     GO TO 7170                                                             SYN5995B
7150 DO 7160  J = 1, KOL                                                    SYN6000*
     WRITE OUTPUT TAPE IT2,9440  ,BNOT(J),DZD(J)                            SYN6005
9440  FORMAT(20X,A6,10H AT DEPTH -4PF4.4)                                   SYN6010
7160 CONTINUE                                                               SYN6015
7170 NOBO = NOBO + KOL                                                      SYN6020*
7180 IF(NZTST) 7500,7500,7190                                               SYN6025
7190 WRITE OUTPUT TAPE IT2,9450                                             SYN6030
9450 FORMAT(10X101HSOME DEPTHS IN THE ABOVE STATION DO NOT CHECK.  NOTESYN6035
    1 THE ASTERISKS (*) NEXT TO THE WIRE LENGTH FIELD.   )                  SYN6040
C                                                                           SYN6045
C     THIS BLOCK IS TO COMPUTE AND WRITE ANY ADDITIONAL THERMOMETRIC        SYN6050
C     DEPTHS  WHICH OCCURED IN ARRANGEMENTS SUCH AS - - U, - U U, OR        SYN6055
C     U U U.  THIS CAN BE DONE ONLY IF THERE IS A PROTECTED THERMOMETER SYN6060
C     WITHIN 10 METERS ON THE SAME CAST                                     SYN6065
C                                                                           SYN6070
7500 NUT = 0                                                                SYN6075
     DO 7920 I = 1,N                                                        SYN6080
     IF(NSIGT(I)) 7920,7510,7920                                            SYN6085
7510 IF(I-1) 7610,7610,7520                                                 SYN6090
7520 IF(ABSF(ZTRUE(I) - ZTRUE(I-1)) -10.0) 7530,7530,7610                   SYN6095
7530 IF(ICAST(I) - ICAST(I-1)) 7610,7540,7610                               SYN6100
7540 IF(NSIGT(I-1)) 7560,7560,7550                                          SYN6105
7550 NPP = I - 1                                                            SYN6110
     GO TO 7710                                                             SYN6115
7560 IF(I-2) 7610,7610,7570                                                 SYN6120
7570 IF(ABSF(ZTRUE(I) - ZTRUE(I-2)) -10.0) 7580,7580,7610                   SYN6125
7580 IF(ICAST(I) - ICAST(I-2)) 7610,7590,7610                               SYN6130
7590 IF(NSIGT(I-2)) 7610,7610,7600                                          SYN6135
7600 NPP = I - 2                                                            SYN6140
     GO TO 7710                                                             SYN6145
7610 IF(I + 1 - N) 7620,7620,7920                                           SYN6150
7620 IF(ABSF(ZTRUE(I) - ZTRUE(I+1)) -10.0) 7630,7630,7920                   SYN6155
7630 IF(ICAST(I) - ICAST(I+1)) 7920,7640,7920                               SY*6160
7640 IF(NSIGT(I+1)) 7660,7660,7650                                          SYN6165
7650 NPP = I + 1                                                            SYN6170
     GO TO 7710                                                             SYN6175
7660 IF( I + 2 - N) 7670,7670,7920                                          SYN6180
7670 IF(ABSF(ZTRUE(I) - ZTRUE(I+2)) -10.0) 7680,7680,7920                   SYN6185
7680 IF(ICAST(I) - ICAST(I+2)) 7920,7690,7920                               SYN6190
7690 IF(NSIGT(I+2)) 7920,7920,7700                                          SYN6195
7700 NPP = I + 2                                                            SYN6200
```

```
 7710 M = NSO(I) + 1
      GO TO (7920,7920,7720,7920,7920,7920,7730,7920,7760,7920,7920,
     1 7920,7920,7920,7920,7920,7920,7920,7740,7920,7770,7920,7920,
     2 7920,7780,7920,7820), M
C     COMBINATION IS NOW - - U
 7720 LM = 3
      GO TO 7750
C     COMBINATION IS NOW - U -
 7730 LM = 2
      GO TO 7750
C     COMBINATION IS NOW U - -
 7740 LM = 1
 7750 ASSIGN  7920 TO JJ
      GO TO 7830
C     COMBINATION IS NOW - U U
 7760 LM = 2
      LL = 3
      GO TO 7790
C     COMBINATION IS NOW U - U
 7770 LM = 1
      LL = 3
      GO TO 7790
C     COMBINATION IS NOW U U -
 7780 LM = 1
      LL = 2
 7790 SENSE LIGHT 1
      ASSIGN 7800 TO JJ
      GO TO 7830
 7800 IF(SENSE LIGHT 1) 7810,7920
 7810 LM = LL
      GO TO 7830
C     COMBINATION IS NOW U U U
 7820 LM = 1
      ASSIGN 7900 TO JJ
 7830 M = NSIGT(NPP)
 7840 DO 7890 KKK = 1,M
      NUT = NUT + 1
C
C     CORRECT UNPROTECTED
C
      TTF(NUT) = (((CAPT(LM,I) + VV(LM,I)) *(TAV(KKK,NPP) - TT(LM,I)))
     1 / (PP(LM,I) - (TAV(KKK,NPP) - TT(LM,I)))) + TCOR(LM,I)
     2 + CAPT(LM,I)
      NOTMP = NOTMP + 1
C     COMPUTE THERMOMETRIC DEPTH
      THZT(NUT) = XRNDF((TTF(NUT) - TAV(KKK,NPP)) /(RHOM(I) * QQ(LM,I)))
C     COMPUTE L - Z
      ELZO(NUT) = ZTRUE(I) - THZT(NUT)
      BBT(NUT) = BOTNO(LM,I)
      TFT(NUT) = TAV(KKK,NPP)
      ZZO(NUT) = ZTRUE(I)
      REVV(NUT) = REV(I)
      SALO(NUT) = SALW(I)
```

```
      J = LSTE(I) - 2                                                   SYN6470C
      IF (J) 7870,7850,7850                                             SYN6475C
 7850 SUMT = -((TAV(KKK,NPP) * (TAV(KKK,NPP) * (TAV(KKK,NPP) + 275.04)  SYN6480
     1-2236.8396))+4482.8332)/(503.57*(TAV(KKK,NPP)+67.26))             SYN6485
      AT = 1.0 - 0.001 * TAV(KKK,NPP) *(TAV(KKK,NPP) * (TAV(KKK,NPP)    SYN6490
     1 * 1.0843E-03 - 9.8185E-02) + 4.7867)                             SYN6495
      BT = TAV(KKK,NPP) * (TAV(KKK,NPP) * (TAV(KKK,NPP) * 0.01667 -     SYN6500
     2 0.8164) + 18.03) * 1.E-06                                        SYN6505
      SG = SALL(I) * (SALL(I) * (SALL(I) * 0.6768E-05 - 48.2496E-05)    SYN6510
     1 + 8148.7658E-04) - 934.4586E-04                                  SYN6515
      SIGG = SUMT + (AT + BT * SG) * SG + (AT - BT * 0.1324) * 0.1324   SYN6520
      SIGW(NUT) = BIDEF(SIGG,5,2)                                       SYN6525
      NOSIG = NOSIG + 1                                                 SYN6530
      IF (J) 7880,7880,7860                                             SYN6535C
 7860 OX1O(NUT) = OX1(I)                                                SYN6540C
      OX2O(NUT) = OX1O(NUT) * 11.1965                                   SYN6545
      OST = 1.E-5*(TAV(KKK,NPP)*(TAV(KKK,NPP)*(48.21-0.4038*TAV(KKK,NPP)SYN6550
     1)-2464.)+88506.-SALL(I)*(TAV(KKK,NPP)*(TAV(KKK,NPP)*0.2338-16.)   SYN6555
     2+525.6))                                                          SYN6560
C                                                                       SYN6565
C     COMPUTE AOU                                                       SYN6570
C                                                                       SYN6575
      APO(NUT) = BIDEF(OST - OX1O(NUT),6,3)                             SYN6580*
C                                                                       SYN6585
C     COMPUTE PERCENT SATURATION                                        SYN6590
C                                                                       SYN6595
      SATT(NUT) = BIDEF(100.0 * OX1O(NUT) / OST,3,0)                    SYN6600*
      NAOU = NAOU + 1                                                   SYN6605
      OX1O(NUT) = BIDEF(OX1O(NUT) ,5,3)                                 SYN6610
      OX2O(NUT) = BIDEF(OX2O(NUT),5,2)                                  SYN6615
      GO TO 7890                                                        SYN6620C
 7870 SIGW(NUT) = BL                                                    SYN6625
 7880 APO(NUT) = BL                                                     SYN6630
      SATT(NUT) = BL                                                    SYN6635
      OX1O(NUT) = BL                                                    SYN6640
      OX2O(NUT) = BL                                                    SYN6645
 7890 CONTINUE                                                          SYN6650
      GO TO JJ, (7900,7800,7920)                                        SYN6655C
 7900 IF(LM - 3) 7910,7920,7920                                         SYN6660*
 7910 LM = LM + 1                                                       SYN6665
      GO TO 7840                                                        SYN6670
 7920 CONTINUE                                                          SYN6675
C     NUT IS THE NUMBER OF THERMOMETRIC DEPTHS COMPUTED FROM COMBINATIONSYN6680
C     SUCH AS - - U, - U U, AND U U U                                   SYN6685
      IF(NUT) 7950,7950,7930                                            SYN6690
 7930 WRITE OUTPUT TAPE IT2,9460,STAT                                   SYN6695
 9460 FORMAT(1H0,39X,43HADDITIONAL THERMOMETRIC DEPTHS FOR STATION A3 //SYN6700
     1 4X,21HREV       UNPROTECTED 17X,6HTHERMO5X,4HWIRE 13X,3HL-Z /    SYN6705
     13X,72HBOTTLE     THERMO   TEMP    PROTECTED    DEPTH    LENGTH   CSYN6710
     2ALC    FROM     19X,25H   - - O X Y G E N - - -  / 5X,2HNO 8X,    SYN6715
     3 2HNO 13X,90HTEMP USED      (Z)       (L)      (L-Z)    CURVE    SALSYN6720
     4   SIGMA-T    ML/L  MGA/L   AOU   SATN    )                       SYN6725
      DO 7940  J = 1, NUT                                               SYN6730
```

```
      THZT(J) = BIDEF(THZT(J),4,0)                                      SYN6735
      ZZO(J) = BIDEF(ZZO(J),4,0)                                        SYN6740
      ELZO(J) = BIDEF(ELZO(J),4,0)                                      SYN6745
 7940 WRITE OUTPUT TAPE IT2,9470,REVV(J),BBT(J),TTF(J),TFT(J),THZT(J),  SYN6750
     1  ZZO(J),ELZO(J),SALO(J),SIGW(J),OX20(J),OX10(J),APO(J),SATT(J)   SYN6755
 9470 FORMAT(5XA2,6XA6,2XF5.2,6XF5.2,6XA4,6XA4,6XA4,13XA6,2XA5,5XA4,2XA5SYN6760
     1,1XA6,1XA3)                                                       SYN6765
 7950 GO TO (7970,7960), NTAPE                                          SYN6770C
 7960 WRITE OUTPUT TAPE IT3,9480                                        SYN6775C
 9480 FORMAT(79X,1HX)                                                   SYN6780C
 7970 READ INPUT TAPE IT1, 9000, TEST                                   SYN6785*
B     IF(EXORF(TEST,AM)) 800,500,800                                    SYN6790
C                                                                       SYN6795
C                                                                       SYN6800
 8500 WRITE OUTPUT TAPE IT2,9060                                        SYN6805
      IF(NOBP) 8510,8510,8520                                           SYN6810C
 8510 WRITE OUTPUT TAPE IT2,9490                                        SYN6815
 9490 FORMAT(10X56HTHERE WERE NO BAD CONTROL PUNCHES OR CARDS OUT OF ORDSYN6820A
     1ER.)                                                              SYN6825A
      GO TO 8530                                                        SYN6830
 8520 WRITE OUTPUT TAPE IT2,9500,NOBP                                   SYN6835
 9500 FORMAT(50HONO. OF BAD CONTROL PUNCHES OR CARDS OUT OF ORDER I5)   SYN6840
 8530 WRITE OUTPUT TAPE IT2,9510,NOST                                   SYN6845
 9510 FORMAT(16HONO. OF STATIONS34XI5)                                  SYN6850A
      WRITE OUTPUT TAPE IT2,9520,NOMC                                   SYN6855
 9520 FORMAT(20HONO. OF MASTER CARDS30XI5)                              SYN6860A
      WRITE OUTPUT TAPE IT2,9530,NOMAST                                 SYN6865
 9530 FORMAT(37HONO. OF STATIONS WITHOUT MASTER CARDS13XI5)             SYN6870A
      WRITE OUTPUT TAPE IT2,9540,NOPC                                   SYN6875
 9540 FORMAT(23HONO. OF PARAMETER CARDS27XI5)                           SYN6880A
      WRITE OUTPUT TAPE IT2, 9550, NOPCSK                               SYN6885A
 9550 FORMAT(31HONO. OF PARAMETER CARDS SKIPPED19XI5)                   SYN6890A
      WRITE OUTPUT TAPE IT2,9560,NODC                                   SYN6895
 9560 FORMAT(20HONO. OF DETAIL CARDS30XI5)                              SYN6900A
      WRITE OUTPUT TAPE IT2, 9570, NODTSK                               SYN6905A
 9570 FORMAT(1H0,49HNO. OF DETAIL CARDS SKIPPED AFTER MAX. OF 40    I5)SYN6910A
      WRITE OUTPUT TAPE IT2,9580,NOCC                                   SYN6915B
 9580 FORMAT(21HONO. OF COMMENT CARDS29XI5)                             SYN6920B
      WRITE OUTPUT TAPE IT2,9590,NOCMSK                                 SYN6925B
 9590 FORMAT(29HONO. OF COMMENT CARDS SKIPPED21XI5)                     SYN6930B
      WRITE OUTPUT TAPE IT2,9600,NOML                                   SYN6935B
 9600 FORMAT(35HONO. OF MALFUNCTIONING THERMOMETERS15XI5)               SYN6940B
      WRITE OUTPUT TAPE IT2,9610,NOBO                                   SYN6945
 9610 FORMAT(40HONO. OF THERMOMETERS NOT FOUND IN TABLES10XI5)          SYN6950A
      WRITE OUTPUT TAPE IT2,9620,NOSALA                                 SYN6955
 9620 FORMAT(27HONO. OF SALINITIES COMPUTED23XI5)                       SYN6960A
      WRITE OUTPUT TAPE IT2,9630,NOSIG                                  SYN6965
 9630 FORMAT(26HONO. OF SIGMA-T-S COMPUTED24XI5)                        SYN6970A
      WRITE OUTPUT TAPE IT2,9640,NOTMP                                  SYN6975
 9640 FORMAT(29HONO. OF TEMPERATURES COMPUTED21XI5)                     SYN6980A
      WRITE OUTPUT TAPE IT2,9650,NOXY                                   SYN6985
 9650 FORMAT(24HONO. OF OXYGENS COMPUTED26XI5)                          SYN6990A
      WRITE OUTPUT TAPE IT2,9660,NAOU                                   SYN6995
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9660 FORMAT(1H0,49HNO. OF AOU-S AND PERCENT SATURATIONS COMPUTED     I5)SYN7000
     WRITE OUTPUT TAPE IT2,9670,NDN                                     SYN7005
9670 FORMAT(34H0NO. OF DEPTHS WHICH DID NOT CHECK16XI5)                 SYN7010A
     IF (NOTAPE) 8550,8550,8540                                         SYN7015C
8540 WRITE OUTPUT TAPE IT3,9680                                         SYN7020C
9680 FORMAT(79X,1HZ)                                                    SYN7025C
     END FILE IT3                                                       SYN7030C
     REWIND IT3                                                         SYN7035C
8550 CALL EXIT                                                          SYN7040*
     END                                                                SYN7045
```

APPENDIX 4 Subroutine THERMØ

Subroutine to correct reversing thermometers and calculate thermometric depths

```
CTHERM                     SUBROUTINE THERMO-REVISION C
C     DEPARTMENT OF OCEANOGRAPHY
C     UNIVERSITY OF WASHINGTON
C     SEATTLE, WASHINGTON  98105
C
C     PROGRAMMED BY..  MARSHA M. WALLIN           JUNE 1964
C     REVISION A BY..  LINDA S. GREEN             NOVEMBER 1965
C     REVISION C BY..  LINDA S. GREEN             APRIL 1966
C
C     SUBROUTINE TO COMPUTE TEMPERATURE AND THERMOMETRIC DEPTHS
C     FOR SYNOPTIC PROGRAM (UWMS-0980).
C
C
      SUBROUTINE THERMO
      DIMENSION RHO(14),Z(14),THM(300),VO(300),P(300),Q(300),T(300,15),
     1 D(300,15),BT(3,40),NBASE(3),
     2 TFIN(4,40),CT(3,40),VV(3,40),PP(3,40),QQ(3,40),ST(3,40),
     3 TCOR(3,40),DZZ(30),   DDEPTH(40),BTON(30),NSOL(40),NSIG(40),
     4 TAVE(6,40),AFP(6,40),AFU(3,40),RHOM(40),THERZ(3,40),ALMZ(3,40),
     5 ALZ(40),IDELT(3)
      DIMENSION TITLE(12)
C
      COMMON BT,CT,ST,DDEPTH,THERZ,TAVE,II,NSIG,KP,NSOL,ALZ,ALMZ,TFIN,
     1 KR,DZZ,BTON,AFP,AFU,VV,PP,QQ,TCOR,RHOM,NOML,NOTMP,BL,IT1,IT2
C
      IF(KP) 300,100,300
C
B 100 CODE = 101010106060
B     AMALF = 604421432660
B     ALEFT = 436060606060
B     AMID = 446060606060
B     RIGHT = 516060606060
B     ALFMD = 434460606060
B     AMDRT = 445160606060
B     ALFRT = 435160606060
C     IDOT = 0.06 * 100.
      IDOT = 6
C
C     LIST OF MEAN DENSITIES
C
      RHO(1) = 1.0242
      RHO(2) = 1.0253
      RHO(3) = 1.0261
      RHO(4) = 1.0267
      RHO(5) = 1.0275
      RHO(6) = 1.0282
      RHO(7) = 1.0291
      RHO(8) = 1.0305
      RHO(9) = 1.0318
      RHO(10) = 1.0330
      RHO(11) = 1.0344
      RHO(12) = 1.0355
      RHO(13) = 1.0366
```

```
      RHO(14) = 1.0510                                                   THM0530C
C                                                                        THM0540
C     LIST OF CORRESPONDING DEPTHS                                       THM0550
C                                                                        THM0560
      Z(1) = 0.0                                                         THM0570
      Z(2) = 100.0                                                       THM0580
      Z(3) = 200.0                                                       THM0590
      Z(4) = 300.0                                                       THM0600
      Z(5) = 500.0                                                       THM0610
      Z(6) = 700.0                                                       THM0620
      Z(7) = 1000.0                                                      THM0630
      Z(8) = 1500.0                                                      THM0640
      Z(9) = 2000.0                                                      THM0650
      Z(10) = 2500.0                                                     THM0660
      Z(11) = 3000.0                                                     THM0670
      Z(12) = 3500.0                                                     THM0680
      Z(13) = 4000.0                                                     THM0690
      Z(14) = 10000.0                                                    THM0700C
C                                                                        THM0710
C                                                                        THM0720
      READ INPUT TAPE IT1,900,TITLE                                      THM0730A
  900 FORMAT(12A6)                                                       THM0740A
      LCNT = 60                                                          THM0750A
      I = 0                                                              THM0760*
  105 I = I + 1                                                          THM0770
      IF (I - 1) 110,110,115                                             THM0780A
  110 READ INPUT TAPE IT1,920,THM(I),UP,VO(I),P(I),Q(I),(T(I,J),D(I,J),JTHM0790A
     1=1,10),AMON,YER                                                    THM0800A
      ASSIGN 180 TO NNN                                                  THM0810A
      GO TO 150                                                          THM0820C
  115 IF(I-300) 125,125,120                                              THM0830A
  120 WRITE OUTPUT TAPE IT2,910                                          THM0840
  910 FORMAT(10X39HOVERFLOW OF THERMOMETER TABLE DIMENSION)              THM0850
      CALL EXIT                                                          THM0860
  125 READ INPUT TAPE IT1,920,THM(I), UP,  VO(I),P(I),Q(I),(T(I,J),      THM0870
     1    D(I,J),J=1,10),AMON,YER                                        THM0880
  920 FORMAT(1X,A6,A1,F3.0,F4.0,F5.5,10(F2.0,F3.2),4X,2A2)               THM0890
C     IF THERE ARE MORE THAN 10 CORRECTION FACTORS FOR ONE THERMOMETER,  THM0900A
C     ADDITIONAL ONES MAY BE ENTERED ON CONTINUATION CARDS WITH 999 IN   THM0910A
C     THE VO FIELD.  THERE MAY BE UP TO FIVE CORRECTION FACTORS ON       THM0920A
C     THIS CARD.                                                         THM0930A
      IF (VO(I) - 999.) 150,130,130                                      THM0940A
C     CONTINUATION CARD FOUND                                            THM0950A
  130 IF (THM(I) - THM(I-1)) 135,140,135                                 THM0960A
  135 WRITE OUTPUT TAPE IT2,930                                          THM0970A
  930 FORMAT(/30H THERMOMETER DATA OUT OF ORDER)                         THM0980A
      CALL EXIT                                                          THM0990A
  140 DO 145 J = 11, 15                                                  THM1000A
      T(I-1,J) = T(I,J-10)                                               THM1010A
  145 D(I-1,J) = D(I,J-10)                                               THM1020A
      ASSIGN 185 TO NNN                                                  THM1030A
      I = I - 1                                                          THM1040A
      GO TO 160                                                          THM1050A
```

```
      150 DO 155 J = 11, 15                                                  THM1060A
B         T(I,J) = 400000000000                                              THM1070C
B     155 D(I,J) = 400000000000                                              THM1080C
          ASSIGN 180 TO NNN                                                  THM1090A
B     160 IF(EXORF(THM(I),BL)) 165,190,165                                   THM1100*
      165 IF(LCNT - 58) 175,170,170                                          THM1110A
      170 WRITE OUTPUT TAPE IT2,940,TITLE                                    THM1120A
      940 FORMAT(1H19X12A6/)                                                 THM1130A
          LCNT = 0                                                           THM1140A
      175 LCNT = LCNT + 1                                                    THM1150A
          GO TO NNN, (180,185)                                               THM1160A
      180 WRITE OUTPUT TAPE IT2,950,THM(I), UP,  VO(I),P(I),Q(I),(T(I,J),    THM1170*
         1  D(I,J),J=1,10),AMON,YER,I                                        THM1180
      950 FORMAT(1X,A6,A1,F5.0,F6.0,F8.5,10(F4.0,F5.2),1X,A2,1X,A2,1X,I3)    THM1190
          GO TO 105                                                          THM1200
      185 WRITE OUTPUT TAPE IT2,960,THM(I),(T(I,J),D(I,J),J=11,15)           THM1210A
      960 FORMAT(1XA6,20X5(F4.0,F5.2))                                       THM1220A
          GO TO 105                                                          THM1230A
      190 LLB = I - 1                                                        THM1240
          DO 200 L = 1,LLB                                                   THM1250
          DO 200 J = 2,15                                                    THM1260A
          IF(BLANKF(D(L,J))) 195,200,200                                     THM1270
      195 LO = J - 1                                                         THM1280
          D(L,J) = D(L,LO)                                                   THM1290
          T(L,J) = T(L,LO)                                                   THM1300
      200 CONTINUE                                                           THM1310
          RETURN                                                             THM1320
C                                                                            THM1330
C         FIND THERMOMETERS                                                  THM1340
C                                                                            THM1350
      300 DO 888 NO =1,II                                                    THM1360
          DO 380 I = 1,3                                                     THM1370
          ALMZ(I,NO) = BL                                                    THM1380C
B         IF(EXORF(BT(I,NO),BL)) 310,305,310                                 THM1390
C         THERMOMETER IS BLANK OR MALFUNCTION                                THM1400
      305 NBASE(I) = 0                                                       THM1410
B         TFIN(I,NO) = BL                                                    THM1420
          GO TO 380                                                          THM1430
B     310 IF(EXORF(CT(I,NO),CODE)) 320,315,320                               THM1440
      315 NBASE(I) = 0                                                       THM1450
B         TFIN(I,NO) = AMALF                                                 THM1460A
          NOML = NOML + 1                                                    THM1470
          GO TO 380                                                          THM1480
B     320 IF(EXORF(CT(I,NO),BL)) 325,305,325                                 THM1490
C         THERMOMETER WAS NEITHER A BLANK NOR A MALFUNCTION                  THM1500
      325 DO 375 J = 1,LLB                                                   THM1510
B         IF(EXORF(BT(I,NO),THM(J))) 375,330,375                             THM1520
C                                                                            THM1530
C         FOUND THERMOMETER.  NOW IS IT PROTECTED OR UNPROTECTED--           THM1540
C                                                                            THM1550
      330 IF(BLANKF(Q(J))) 335,340,340                                       THM1560
C         IT IS PROTECTED                                                    THM1570
      335 NBASE(I) = 1                                                       THM1580
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      GO TO 345
C     IT IS UNPROTECTED
  340 NBASE(I) = 2
      QQ(I,NO) = Q(J)
  345 VV(I,NO) = VO(J)
      PP(I,NO) = P(J)
      CT(I,NO) = DEBIF(CT(I,NO))* 0.01
      ST(I,NO) = DEBIF(ST(I,NO)) * 0.10
      DO 370 K = 1,15
      IF(CT(I,NO) - T(J,K)) 350,365,370
  350 IF(K - 1) 355,355,360
  355 TCOR(I,NO) = D(J,1)
      GO TO 380
  360 TCOR(I,NO) = (CT(I,NO) - T(J,K-1)) * (D(J,K) - D(J,K-1)) / (T(J,K)
     1 - T(J,K-1)) + D(J,K-1)
      GO TO 380
  365 TCOR(I,NO) = D(J,K)
      GO TO 380
  370 CONTINUE
      TCOR(I,NO) = D(J,15)
      GO TO 380
  375 CONTINUE
C
C     KEEP TRACK OF MISSING THERMOMETERS
C
      NBASE(I) = 0
      KR = KR + 1
      DZZ(KR) = ALZ(NO)
      BTON(KR) = BT(I,NO)
C     NOT IN TABLE
B     TFIN(I,NO) = 456031606360
  380 CONTINUE
C
C     THE FOLLOWING EQUATION GIVES A VALUE WHICH DETERMINES THE
C     EXACT POSITIONS AND ARRANGEMENTS OF THE THERMOMETERS
C
      NSOL(NO) = 9 * NBASE(1) + 3 * NBASE(2) + NBASE(3)
      NSS = NSOL(NO) + 1
      GO TO ( 750, 755, 730, 760, 555, 615, 730, 605, 730, 765, 560,
     1 620, 565, 400, 500, 630, 495, 660, 730, 610, 730, 625, 490, 665,
     2 730, 670, 730), NSS
C
C     COMBINATION IS NOW P P P
C
C     CORRECT PROTECTED
C
  400 DO 405 L = 1,3
      TFIN(L,NO) = CT(L,NO) + (((CT(L,NO) + VV(L,NO)) * (CT(L,NO) - ST(
     1 L,NO))) / (PP(L,NO) - (CT(L,NO) + VV(L,NO)) - (CT(L,NO) -
     1 ST(L,NO)))) + TCOR(L,NO)
  405 CONTINUE
      NOTMP = NOTMP + 3
      TMAX = MAX1F(TFIN(1,NO),TFIN(2,NO),TFIN(3,NO))
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      TMIN = MIN1F(TFIN(1,NO),TFIN(2,NO),TFIN(3,NO))                    THM2120
C                                                                       THM2130
C     ARE ALL THREE WITHIN 0.06 OF EACH OTHER.  IF SO, EXIT WITH THE    THM2140
C     AVERAGE.                                                          THM2150
C                                                                       THM2160
      MMMM = XRNDF(TMAX*100.) - XRNDF(TMIN*100.)                        THM2170A
      IF(MMMM - IDOT) 410,410,415                                       THM2180A
C     THE THREE TEMPERATURES ARE WITHIN 0.06 OF EACH OTHER SO RETURN    THM2190
C     WITH THE MEAN                                                     THM2200
  410 NSIG(NO) = 1                                                      THM2210
      TAVE(1,NO) = (TFIN(1,NO) + TFIN(2,NO) + TFIN(3,NO)) / 3.0         THM2220
B     AFP(1,NO) = BL                                                    THM2230
      GO TO 888                                                         THM2240
  415 IDELT(1) = XABSF(XRNDF(TFIN(1,NO)*100.) - XRNDF(TFIN(2,NO)*100.)) THM2250C
      IDELT(2) = XABSF(XRNDF(TFIN(1,NO)*100.) - XRNDF(TFIN(3,NO)*100.)) THM2260C
      IDELT(3) = XABSF(XRNDF(TFIN(2,NO)*100.) - XRNDF(TFIN(3,NO)*100.)) THM2270C
      NOBJ = 0                                                          THM2280
      DO 425 KJR = 1,3                                                  THM2290
      IF (IDELT(KJR) - IDOT) 425,425,420                                THM2300C
  420 NOBJ = NOBJ + 1                                                   THM2310
  425 CONTINUE                                                          THM2320
      IF(NOBJ - 2) 465,435,430                                          THM2330
C                                                                       THM2340
C     NONE OF THE DIFFERENCES WAS LESS THAN 0.06 SO EXIT WITH EACH ONE. THM2350
C                                                                       THM2360
  430 TAVE(1,NO) = TFIN(1,NO)                                           THM2370
      TAVE(2,NO) = TFIN(2,NO)                                           THM2380
      TAVE(3,NO) = TFIN(3,NO)                                           THM2390
B     AFP(1,NO) = ALEFT                                                 THM2400A
B     AFP(2,NO) = AMID                                                  THM2410A
B     AFP(3,NO) = RIGHT                                                 THM2420A
      NSIG(NO) = 3                                                      THM2430
      GO TO 888                                                         THM2440
C                                                                       THM2450
C     TWO DIFFERENCES WERE GREATER THAN 0.06 SO EXIT WITH THE AVERAGE   THM2460
C     OF THE TWO THAT WERE WITHIN 0.06 AND ALSO THE THIRD.              THM2470
C                                                                       THM2480
  435 NSIG(NO) = 2                                                      THM2490C
      IF(IDELT(1) - IDELT(2)) 440,440,445                               THM2500C
  440 IF(IDELT(1) - IDELT(3)) 450,450,460                               THM2510C
  445 IF(IDELT(2) - IDELT(3)) 455,455,460                               THM2520C
C                                                                       THM2530
C     DELT(1) IS LESS THAN 0.06                                         THM2540
C                                                                       THM2550
  450 TAVE(1,NO) = (TFIN(1,NO) + TFIN(2,NO)) / 2.0                      THM2560
      TAVE(2,NO) = TFIN(3,NO)                                           THM2570
B     AFP(1,NO) = ALFMD                                                 THM2580A
B     AFP(2,NO) = RIGHT                                                 THM2590A
      GO TO 888                                                         THM2600
C                                                                       THM2610
C     DELT(2) IS LESS THAN 0.06                                         THM2620
C                                                                       THM2630
  455 TAVE(1,NO) = (TFIN(1,NO) + TFIN(3,NO)) / 2.0                      THM2640
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      TAVE(2,NO) = TFIN(2,NO)                                           THM2650
B     AFP(1,NO) = ALFRT                                                 THM2660A
B     AFP(2,NO) = AMID                                                  THM2670A
      GO TO 888                                                         THM2680
C                                                                       THM2690
C     DELT(3) IS LESS THAN 0.06                                         THM2700
C                                                                       THM2710
  460 TAVE(1,NO) =(TFIN(2,NO) + TFIN(3,NO)) / 2.0                       THM2720
      TAVE(2,NO) = TFIN(1,NO)                                           THM2730
B     AFP(1,NO) = AMDRT                                                 THM2740A
B     AFP(2,NO) = ALEFT                                                 THM2750A
      GO TO 888                                                         THM2760
C                                                                       THM2770
C     ONLY ONE DIFFERENCE WAS GREATER THAN 0.06 SO EXIT WITH ALL THREE  THM2780
C     SEPARATELY, THE AVERAGE OF ALL THREE TOGETHER, AND ALSO THE TWO   THM2790
C     AVERAGES OF THOSE WITHIN 0.06 OF EACH OTHER.                      THM2800
C                                                                       THM2810
  465 SENSE LIGHT 0                                                     THM2820
      NSIG(NO) = 6                                                      THM2830
      TAVE(1,NO) = TFIN(1,NO)                                           THM2840
      TAVE(2,NO) = TFIN(2,NO)                                           THM2850
      TAVE(3,NO) = TFIN(3,NO)                                           THM2860
      TAVE(4,NO) = (TFIN(1,NO) + TFIN(2,NO) + TFIN(3,NO)) / 3.0         THM2870
B     AFP(1,NO) = ALEFT                                                 THM2880A
B     AFP(2,NO) = AMID                                                  THM2890A
B     AFP(3,NO) = RIGHT                                                 THM2900A
B     AFP(4,NO) = BL                                                    THM2910
      NJO = 4                                                           THM2920
      IF(IDELT(1) - IDOT) 470,470,475                                   THM2930C
  470 NJO = NJO + 1                                                     THM2940
      TAVE(NJO,NO) = (TFIN(1,NO) + TFIN(2,NO)) / 2.0                    THM2950
B     AFP(NJO,NO) = ALFMD                                               THM2960A
      IF(IDELT(2) - IDOT) 480,480,485                                   THM2970C
  475 SENSE LIGHT 1                                                     THM2980
  480 NJO = NJO + 1                                                     THM2990
      TAVE(NJO,NO) = (TFIN(1,NO) + TFIN(3,NO)) / 2.0                    THM3000
B     AFP(NJO,NO) = ALFRT                                               THM3010A
      IF(SENSE LIGHT 1) 485,888                                         THM3020
  485 NJO = NJO + 1                                                     THM3030
      TAVE(NJO,NO) = (TFIN(2,NO) + TFIN(3,NO)) / 2.0                    THM3040
B     AFP(NJO,NO) = AMDRT                                               THM3050A
      GO TO 888                                                         THM3060
C                                                                       THM3070
C     COMBINATION IS NOW U P P OR SOME ARRANGEMENT THEREOF              THM3080
C                                                                       THM3090
C     IT IS U P P                                                       THM3100
  490 L1 = 1                                                            THM3110
      L2 = 2                                                            THM3120
      L3 = 3                                                            THM3130
B     AFP(L2,NO) = AMID                                                 THM3140A
B     AFP(L3,NO) = RIGHT                                                THM3150A
      GO TO 505                                                         THM3160
C                                                                       THM3170
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C       IT IS P U P                                                     THM3180
  495 L2 = 1                                                            THM3190
      L1 = 2                                                            THM3200
      L3 = 3                                                            THM3210
B     AFP(L3,NO) = RIGHT                                                THM3220A
B     AFP(L2,NO) = ALEFT                                                THM3230A
      GO TO 505                                                         THM3240
C                                                                       THM3250
C       IT IS P P U                                                     THM3260
  500 L2 = 1                                                            THM3270
      L3 = 2                                                            THM3280
      L1 = 3                                                            THM3290
B     AFP(L2,NO) = ALEFT                                                THM3300A
B     AFP(L3,NO) = AMID                                                 THM3310A
  505 ASSIGN 510 TO ITRA                                                THM3320C
      GO TO 575                                                         THM3330C
  510 DO 525 KJ = 2, 14                                                 THM3340C
      IF(DDEPTH(NO) - Z(KJ)) 515,520,525                                THM3350
  515 RHOM(NO) = ((DDEPTH(NO) - Z(KJ-1)) / (Z(KJ) - Z(KJ - 1))) *      THM3360
     1(RHO(KJ) - RHO(KJ-1)) + RHO(KJ - 1)                               THM3370
      GO TO 530                                                         THM3380
  520 RHOM(NO) = RHO(KJ)                                                THM3390
      GO TO 530                                                         THM3400
  525 CONTINUE                                                          THM3410
      RHOM(NO) = RHO(14)                                                THM3420C
  530 LK = 1                                                            THM3430
      LM = L1                                                           THM3440C
C                                                                       THM3450
C     CORRECT UNPROTECTED                                               THM3460
C                                                                       THM3470
  535 TFIN(LM,NO) = (((CT(L1,NO) + VV(L1,NO)) * (TAVE(LK,NO)            THM3480C
     1 - ST(L1,NO))) / (PP(L1,NO) -(TAVE(LK,NO) - ST(L1,NO)))) +        THM3490
     2 TCOR(L1,NO) + CT(L1,NO)                                          THM3500
C                                                                       THM3510
C     COMPUTE THERMOMETRIC DEPTH                                        THM3520
  540 THERZ(LK,NO) = (TFIN(LM,NO) - TAVE(LK,NO))/(RHOM(NO) * QQ(L1,NO)) THM3530C
      THERZ(LK,NO) = XRNDF(THERZ(LK,NO))                                THM3540A
C                                                                       THM3550
C     COMPUTE L - Z                                                     THM3560
C                                                                       THM3570
      ALMZ(LK,NO) = ALZ(NO) - THERZ(LK,NO)                              THM3580
      IF(SENSE LIGHT 1) 545,550                                         THM3590
  545 LK = 2                                                            THM3600
      LM = 4                                                            THM3610C
      GO TO 535                                                         THM3620
  550 NOTMP = NOTMP + 1                                                 THM3630C
      GO TO 888                                                         THM3640
C                                                                       THM3650
C     COMBINATION IS NOW - P P OR SOME ARRANGEMENT THEROF               THM3660
C                                                                       THM3670
C     IT IS NOW - P P                                                   THM3680
  555 L1 = 1                                                            THM3690
      L2 = 2                                                            THM3700
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      L3 = 3                                                            THM3710
B     AFP(L2,NO) = AMID                                                 THM3720A
B     AFP(L3,NO) = RIGHT                                                THM3730A
      GO TO 570                                                         THM3740
C     IT IS NOW P - P                                                   THM3750
  560 L2 = 1                                                            THM3760
      L1 = 2                                                            THM3770
      L3 = 3                                                            THM3780
B     AFP(L2,NO) = ALEFT                                                THM3790A
B     AFP(L3,NO) = RIGHT                                                THM3800A
      GO TO 570                                                         THM3810
C     IT IS NOW P P -                                                   THM3820
  565 L2 = 1                                                            THM3830
      L3 = 2                                                            THM3840
      L1 = 3                                                            THM3850
B     AFP(L2,NO) = ALEFT                                                THM3860A
B     AFP(L3,NO) = AMID                                                 THM3870A
  570 ASSIGN 888 TO ITRA                                                THM3880C
  575 SENSE LIGHT 1                                                     THM3890*
C     CORRECT PROTECTED                                                 THM3900
      LO = L2                                                           THM3910
  580 TFIN(LO,NO) = CT(LO,NO) + (((CT(LO,NO) + VV(LO,NO)) * (CT(LO,NO)  THM3920
     1 - ST(LO,NO))) / (PP(LO,NO) - (CT(LO,NO) + VV(LO,NO)) -           THM3930
     2 (CT(LO,NO) - ST(LO,NO)))) + TCOR(LO,NO)                          THM3940
      IF(SENSE LIGHT 1) 585,590                                         THM3950
  585 LO = L3                                                           THM3960
      GO TO 580                                                         THM3970
  590 NNN = XABSF(XRNDF(TFIN(L2,NO)*100.) - XRNDF(TFIN(L3,NO)*100.))    THM3980C
      NOTMP = NOTMP + 2                                                 THM3990C
C     ARE THE TEMPERATURES WITHIN 0.06 OF EACH OTHER                    THM4000
      IF(NNN - IDOT) 595,595,600                                        THM4010C
C     YES, THEY ARE SO AVERAGE THEM                                     THM4020
  595 NSIG(NO) = 1                                                      THM4030
      TAVE(1,NO) = (TFIN(L2,NO) + TFIN(L3,NO)) / 2.0                    THM4040
      AFP(1,NO) = BL                                                    THM4050
      GO TO ITRA, (510,888)                                             THM4060C
C     THEY ARE NOT WITHIN 0.06 OF EACH OTHER SO RETURN WITH BOTH        THM4070
  600 NSIG(NO) = 2                                                      THM4080
      TAVE(1,NO) = TFIN(L2,NO)                                          THM4090
      TAVE(2,NO) = TFIN(L3,NO)                                          THM4100
      AFP(1,NO) = AFP(L2,NO)                                            THM4110
      AFP(2,NO) = AFP(L3,NO)                                            THM4120
      SENSE LIGHT 1                                                     THM4125C
      GO TO ITRA, (510,888)                                             THM4130C
C                                                                       THM4140
C     COMBINATION IS NOW P - U OR SOME ARRANGEMENT THEREOF              THM4150
C                                                                       THM4160
C     IT IS NOW - U P                                                   THM4170
  605 L1 = 1                                                            THM4180
      L2 = 2                                                            THM4190
      L3 = 3                                                            THM4200
      GO TO 635                                                         THM4210
C     IT IS NOW U - P                                                   THM4220
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  610 L2 = 1                                                             THM4230
      L1 = 2                                                             THM4240
      L3 = 3                                                             THM4250
      GO TO 635                                                          THM4260
C     IT IS NOW - P U                                                    THM4270
  615 L1 = 1                                                             THM4280
      L3 = 2                                                             THM4290
      L2 = 3                                                             THM4300
      GO TO 635                                                          THM4310
C     IT IS NOW P - U                                                    THM4320
  620 L3 = 1                                                             THM4330
      L1 = 2                                                             THM4340
      L2 = 3                                                             THM4350
      GO TO 635                                                          THM4360
C     IT IS NOW U P -                                                    THM4370
  625 L2 = 1                                                             THM4380
      L3 = 2                                                             THM4390
      L1 = 3                                                             THM4400
      GO TO 635                                                          THM4410
C     IT IS NOW P U -                                                    THM4420
  630 L3 = 1                                                             THM4430
      L2 = 2                                                             THM4440
      L1 = 3                                                             THM4450
  635 NSIG(NO) = 1                                                       THM4460
B     AFP(1,NO) = BL                                                     THM4470
      TFIN(L3,NO) = CT(L3,NO) + (((CT(L3,NO) + VV(L3,NO)) * (CT(L3,NO)   THM4480
     1 - ST(L3,NO))) / (PP(L3,NO) -(CT(L3,NO) + VV(L3,NO)) - (CT(L3,NO)  THM4490
     1  - ST(L3,NO)))) + TCOR(L3,NO)                                     THM4500
      TAVE(1,NO) = TFIN(L3,NO)                                           THM4510
C                                                                        THM4520
C     CORRECT UNPROTECTED                                                THM4530
C                                                                        THM4540
      TFIN(L2,NO) = (((CT(L2,NO) + VV(L2,NO)) * (TAVE(1,NO) -            THM4550
     1 ST(L2,NO))) /(PP(L2,NO) - (TAVE(1,NO) - ST(L2,NO)))) +            THM4560
     2  TCOR(L2,NO) + CT(L2,NO)                                          THM4570
C                                                                        THM4580
C     COMPUTE THERMOMETRIC DEPTH                                         THM4590
C                                                                        THM4600
      DO 650 KL = 2, 14                                                  THM4610C
      IF(DDEPTH(NO) - Z(KL)) 640,645,650                                 THM4620
  640 RHOM(NO) = ((DDEPTH(NO) - Z(KL - 1)) / (Z(KL) - Z(KL -1)))*        THM4630
     1 (RHO(KL)- RHO(KL-1)) + RHO(KL - 1)                                THM4640
      GO TO 655                                                          THM4650
  645 RHOM(NO) = RHO(KL)                                                 THM4660
      GO TO 655                                                          THM4670
  650 CONTINUE                                                           THM4680
      RHOM(NO) = RHO(14)                                                 THM4690C
  655 THERZ(1,NO) = XRNDF((TFIN(L2,NO)-TAVE(1,NO))/(RHOM(NO)*QQ(L2,NO)))THM4700A
C                                                                        THM4710
C     COMPUTE L - Z                                                      THM4720
C                                                                        THM4730
      ALMZ(1,NO) = ALZ(NO) - THERZ(1,NO)                                 THM4740
      NOTMP = NOTMP + 2                                                  THM4750
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      GO TO 888                                                         THM4760
C                                                                       THM4770
C     COMBINATION IS NOW P U U OR SOME ARRANGEMENT THEREOF              THM4780
C                                                                       THM4790
C     IT IS NOW P U U                                                   THM4800
  660 L1 = 1                                                            THM4810
      L2 = 2                                                            THM4820
      L3 = 3                                                            THM4830
B     AFU(L2,NO) = AMID                                                 THM4840A
B     AFU(L3,NO) = RIGHT                                                THM4850A
      GO TO 675                                                         THM4860
C     COMBINATION IS NOW U P U                                          THM4870
  665 L2 = 1                                                            THM4880
      L1 = 2                                                            THM4890
      L3 = 3                                                            THM4900
B     AFU(L2,NO) = ALEFT                                                THM4910A
B     AFU(L3,NO) = RIGHT                                                THM4920A
      GO TO 675                                                         THM4930
C     IT IS NOW U U P                                                   THM4940
  670 L2 = 1                                                            THM4950
      L3 = 2                                                            THM4960
      L1 = 3                                                            THM4970
B     AFU(L2,NO) = ALEFT                                                THM4980A
B     AFU(L3,NO) = AMID                                                 THM4990A
  675 TFIN(L1,NO) = CT(L1,NO) + (((CT(L1,NO) + VV(L1,NO)) * (CT(L1,NO)  THM5000
     1 - ST(L1,NO))) / (PP(L1,NO) -(CT(L1,NO) + VV(L1,NO)) -(CT(L1,NO)  THM5010
     2 - ST(L1,NO)))) + TCOR(L1,NO)                                     THM5020
      SENSE LIGHT 1                                                     THM5030
      TAVE(1,NO) = TFIN(L1,NO)                                          THM5040
      LU = L2                                                           THM5050
  680 TFIN(LU,NO) = (((CT(LU,NO) + VV(LU,NO)) * (TAVE(1,NO)-ST(LU,NO))) THM5060
     1 / (PP(LU,NO) - (TAVE(1,NO) - ST(LU,NO)))) + TCOR(LU,NO)+CT(LU,NO)THM5070
      IF(SENSE LIGHT 1) 685,690                                         THM5080
  685 LU = L3                                                           THM5090
      GO TO 680                                                         THM5100
  690 DO 705 KK = 2, 14                                                 THM5110C
      IF(DDEPTH(NO) - Z(KK)) 695,700,705                                THM5120
  695 RHOM(NO) = (( DDEPTH(NO) - Z(KK-1)) / (Z(KK)-Z(KK-1)))*(RHO(KK) - THM5130
     1 RHO(KK-1)) + RHO(KK-1)                                           THM5140
      GO TO 710                                                         THM5150
  700 RHOM(NO) = RHO(KK)                                                THM5160
      GO TO 710                                                         THM5170
  705 CONTINUE                                                          THM5180
      RHOM(NO) = RHO(14)                                                THM5190C
  710 SENSE LIGHT 1                                                     THM5200
      JJ = 1                                                            THM5210
      LP = L2                                                           THM5220
  715 THERZ(JJ,NO) = XRNDF((TFIN(LP,NO) - TAVE(1,NO)) / (RHOM(NO)*QQ(LP,THM5230A
     1 NO)))                                                            THM5240A
C                                                                       THM5250
C     COMPUTE L - Z                                                     THM5260
C                                                                       THM5270
      ALMZ(JJ,NO) = ALZ(NO) - THERZ(JJ,NO)                              THM5280
```

```
      IF(SENSE LIGHT 1) 720,725                                         THM5290
  720 JJ = 2                                                            THM5300
      LP = L3                                                           THM5310
      GO TO 715                                                         THM5320
  725 NSIG(NO) = 1                                                      THM5330
      AFU(1,NO) = AFU(L2,NO)                                            THM5340
      AFU(2,NO) = AFU(L3,NO)                                            THM5350
B     AFP(1,NO) = BL                                                    THM5360
      NOTMP = NOTMP + 3                                                 THM5370
      GO TO 888                                                         THM5380
C                                                                       THM5390
C     COMBINATION IS NOW U U U, U U -, OR U - - OR SOME ARRANGEMENT     THM5400
C     THEROF.  THERMOMETRIC DEPTHS WILL BE COMPUTED IN THE MAIN         THM5410
C     PROGRAM IF THERE IS A PROTECTED THERMOMETER WITHIN 10 METERS      THM5420
C     ON THE SAME CAST.                                                 THM5430
C                                                                       THM5440
  730 NSIG(NO) = 0                                                      THM5450
      DO 745 JOK = 2, 14                                                THM5460C
      IF(DDEPTH(NO) - Z(JOK)) 735,740,745                               THM5470
  735 RHOM(NO) = ((DDEPTH(NO) - Z(JOK-1))/(Z(JOK)-Z(JOK-1)))*(RHO(JOK)  THM5480
     1 -RHO(JOK-1))+RHO(JOK-1)                                          THM5490
      GO TO 888                                                         THM5500
  740 RHOM(NO) = RHO(JOK)                                               THM5510
      GO TO 888                                                         THM5520
  745 CONTINUE                                                          THM5530
      RHOM(NO) = RHO(14)                                                THM5540C
      GO TO 888                                                         THM5550
C                                                                       THM5560
C     COMBINATION IS NOW - - -                                          THM5570
C                                                                       THM5580
  750 NSIG(NO) = -1                                                     THM5590
      GO TO 888                                                         THM5600
C                                                                       THM5610
C     COMBINATION IS NOW - - P OR SOME ARRANGEMENT THEREOF              THM5620
C     IT IS NOW - - P                                                   THM5630
  755 L1 = 3                                                            THM5640
      GO TO 770                                                         THM5650
C     IT IS NOW - P -                                                   THM5660
  760 L1 = 2                                                            THM5670
      GO TO 770                                                         THM5680
C     IT IS NOW P - -                                                   THM5690
  765 L1 = 1                                                            THM5700
  770 TFIN(L1,NO) = CT(L1,NO) + (((CT(L1,NO) + VV(L1,NO)) * (CT(L1,NO) -THM5710
     1 ST(L1,NO))) / (PP(L1,NO) -(CT(L1,NO) + VV(L1,NO)) - ( CT(L1,NO)  THM5720
     2 - ST(L1,NO)))) + TCOR(L1,NO)                                     THM5730
      TAVE(1,NO) = TFIN(L1,NO)                                          THM5740
      NSIG(NO) = 1                                                      THM5750
      NOTMP = NOTMP + 1                                                 THM5760
B     AFP(1,NO) = BL                                                    THM5770
  888 CONTINUE                                                          THM5780
      RETURN                                                            THM5790
       END                                                              THM5800
```

APPENDIX 5 Subroutine BIDE

```
*       FAP                                                                BIDE000
         COUNT    100                                                      BIDE001
*BIDE    FAP PROGRAM FOR CONVERTING FLOATING OR (FORTRAN) FIXED POINT      BIDE002
*        BINARY NUMBERS IN BCD FORM.                                       BIDE003
*        UWMS-0950                                                         BIDE004
*                                                                          BIDE005
*        UNIVERSITY OF WASHINGTON                                          BIDE006
*        DEPARTMENT OF OCEANOGRAPHY                                        BIDE007
*        SEATTLE, WASHINGTON  98105                                        BIDE008
*                                                                          BIDE009
*        PROGRAMMED BY..  PAAVO KOVALA                                     BIDE00A
*                                                                          BIDE00B
*        Q = BIDEF (P, M, N)                                               BIDE00C
*        Q = BCD NUMBER                                                    BIDE00D
*        P = BINARY NUMBER                                                 BIDE00E
*        M = TOTAL NUMBER OF CHARACTERS IN Q, MAXIMUM 6                    BIDE00F
*        N = NUMBER OF DECIMALS, MAXIMUM 6                                 BIDE00G
*        IF  M = 0,  Q = BLANK.                                            BIDE010
*        IF M IS NEGATIVE, LEADING ZEROES ARE RETAINED AND MINUS SIGN,     BIDE011
*        IF NEEDED, IS COMBINED WITH THE RIGHTMOST CHARACTER OF Q.         BIDE012
*        IF  N = 0,  THERE IS NO DECIMAL POINT.                            BIDE013
*        IF N IS NEGATIVE, P IS A FORTRAN II INTEGER.                      BIDE014
         ENTRY    BIDE                                                     BIDE015
         ENTRY    XBIDE                                                    BIDE015
         LBL      BIDE,X                                                   BIDE015
XBIDE    BES      0                                                        BIDE015
 BIDE    SXA      XR,1                 SAVE XR1                            BIDE016
         SXA      XR+1,2               SAVE XR2                            BIDE017
         SXA      XR+2,4               SAVE XR4                            BIDE018
         AXT      0,7                  0 INTO XR1, XR2, XR4                BIDE019
         TZE      PLA-1                                                    BIDE020
         TPL      PLA                                                      BIDE021
         AXT      1,1                  1 INTO XR1 IF P IS NEGATIVE         BIDE022
         SSP                           SET SIGN OF P PLUS                  BIDE023
 PLA     STO      A                    P INTO A                            BIDE024
         MPY      =03000000            6*M INTO AC                         BIDE025
         TNZ      MNZ                                                      BIDE026
         CLA      B+2                                                      BIDE027
         TRA      XR                   M=0, Q=BLANK                        BIDE028
 MNZ     TPL      NST-1                                                    BIDE029
         TXI      *+1,1,2              M IS NEGATIVE, ADD 2 TO C(XR1)      BIDE030
         SSP                                                               BIDE031
         STA      FIN+1                ABS. VALUE OF M INTO ADDRESS OF FIN-1  BIDE032
 NST     LDQ      -3                   N INTO MQ                           BIDE033
         TQP      PLN                                                      BIDE034
         CLA      A                    N IS NEGATIVE, P IS FIXED PT. NUMBER   BIDE035
         TNZ      NZA                                                      BIDE036
 NUL     TXH      NZA-1,1,1            IF NEGATIVE M, LEADING ZEROES RETAINED  BIDE037
         CLA      B                    M IS POSITIVE, BLANKS ADDED         BIDE038
         TRA      FIN                                                      BIDE039
 NZA     LGR      54                   NONZERO P INTO MQ,                  BIDE040
         TRA      CVT                  READY FOR CONVERTING INTO BCD       BIDE041
 PLN     MPY      =03000000            N IS POSITIVE, 6*N INTO AC          BIDE042
```

```
         TZE       IND                                                               BIDE043
         PAC       0,2                 N IS POSITIVE, -6*N INTO XR2                  BIDE044
IND      CLA       A                                                                 BIDE045
         TZE       ADJ                 P=0, BYPASS CONVERSION                        BIDE046
         TXL       FIX,2,0                                                           BIDE047
         XCA                                                                         BIDE048
         LDC       -3,4                N IS POSITIVE. PUT N INTO XR4                 BIDE049
         FMP       A,4                 MULTIPLY P BY 10**N                           BIDE050
FIX      UFA       =0233000000000      CONVERT FL. PT. P INTO FIXED PT. NUMBER       BIDE051
         FRN                           ROUND P                                       BIDE052
         ANA       =01777777           REMOVE CHARACTERISTIC                         BIDE053
         TNZ       CVT-1                                                             BIDE054
         STZ       A                   P=0 AFTER ROUNDING, 0 INTO A                  BIDE055
         TRA       ADJ                 BYPASS CONVERSION                             BIDE056
         LGR       36                  SHIFT P INTO MQ                               BIDE057
CVT      DVP       =012                LAST CHARACTER OF Q IN AC                     BIDE058
         TXL       LOOP-2,1,2                                                        BIDE059
         TNZ       LOOP-3              P AND M ARE NEGATIVE.                         BIDE060
         ORA       =012                LAST CHAR. OF Q IS 0, MAKE IT MINUS ZEROBIDE061
         ORA       =040                COMBINE MINUS SIGN WITH LAST CHAR. OF Q BIDE062
         STO       A                   LAST CHARACTER OF Q INTO A                    BIDE063
         AXT       24,4                                                              BIDE064
LOOP     CLM                           CLEAR AC                                      BIDE065
         DVP       =012                                                              BIDE066
         ALS       30,4                SHIFT NEXT CHAR. OF Q IN FRONT OF OTHERSBIDE067
         ADD       A                   AND COMBINE IT WITH THEM                      BIDE068
         STO       A                                                                 BIDE069
         TIX       LOOP,4,6                                                          BIDE070
         LGL       66                                                                BIDE071
         ADD       A                   CONVERTED NUMBER NOW IN AC                    BIDE072
ADJ      TXL       NDP,2,0             IF N IS NONPOSITIVE, NO DECIMAL POINT         BIDE073
         LGR       0,2                 SHIFT DECIMALS INTO MQ                        BIDE074
         ALS       6                   SHIFT INTEGER, MAKE ROOM FOR DECIMAL PT.BIDE075
         ORA       =033                INSERT DECIMAL POINT                          BIDE076
         LGL       0,2                 SHIFT Q INTO AC                               BIDE077
NDP      TZE       NUL                 IF Q CONSISTS OF ZEROES,BYPASS FOLLOWINGBIDE078
         TXH       FIN,1,1             IF M IS NEGATIVE, RETAIN LEADING ZEROES       BIDE079
         TXL       BLA-2,2,0           IF N IS NONPOSITIVE, TRANSFER                 BIDE080
         TXL       FIN,2,-24           IF N IS GREATER THAN 3, SKIP FOLLOWING        BIDE081
         TXI       *+1,2,-12           N IS POSITIVE, LESS THAN 4                    BIDE082
         LGR       0,2                 SHIFT N+2 CHARACTERS INTO MQ                  BIDE083
REP      TZE       BLA                 IF 0 IN AC, PUT BLANKS IN AC                  BIDE084
         TXL       BLA+1,2,-36         IF 6 CHARACTERS IN MQ, SHIFT INTO AC          BIDE085
         LGR       6                   SHIFT ONE MORE CHARACTER INTO MQ              BIDE086
         TXI       REP,2,-6                                                          BIDE087
BLA      CAL       B+2,1               BLANKS AND POSSIBLE MINUS SIGN INTO AC        BIDE088
         LGL       0,2                 SHIFT Q INTO AC, RIGHT ADJUSTED               BIDE089
FIN      LDQ       B+2                 FILL MQ WITH BLANKS                           BIDE090
         LGR       **                  SHIFT Q INTO MQ, LEFT ADJUSTED                BIDE091
         XCA                           Q INTO AC                                     BIDE092
XR       AXT       **,1                RESTORE XR1                                   BIDE093
         AXT       **,2                RESTORE XR2                                   BIDE094
         AXT       **,4                RESTORE XR4                                   BIDE095
```

```
        TRA     1,4                                                    BIDE096
A       DEC     0,10.,100.,1000.,10000.,100000.,1000000.               BIDE097
B       OCT     606060606000,606060606040,606060606060                 BIDE098
        END                                                            BIDE099
```

APPENDIX 6 Subroutine DEBI

```
*      FAP
        COUNT    100
* DEBI  AND XDEBI, FAP PROGRAMS FOR CONVERTING BCD NUMBERS,
*       WITH POSSIBLE MINUS SIGN COMBINED WITH UNIT CHARACTER,
*       INTO FLOATING OR (FORTRAN II) FIXED POINT BINARY NUMBERS.
*       UWMS-0948
*
*       UNIVERSITY OF WASHINGTON
*       DEPARTMENT OF OCEANOGRAPHY
*       SEATTLE, WASHINGTON  98105
*
*       PROGRAMMED BY..  PAAVO KOVALA
*
*       BCD INPUT DATA WORD MUST HAVE 6 NUMERICAL CHARACTERS.
*       IN CASE OF ILLEGAL CHARACTER OR TOO LARGE NUMBER, COMMENT IS
*       WRITTEN ON TAPE NO. 6 (A3) AND RESULT IS MADE ZERO.
*       BLANKS ARE READ AS ZEROES.
        ENTRY    XDEBI
        ENTRY    DEBI
 XDEBI  STZ      A-7                ZERO FOR FIXED POINT
        TRA      *+2
 DEBI   STL      A-7                NONZERO FOR FLOATING POINT
        SXA      IR,1               SAVE INDEX REGISTERS 1
        SXA      IR+1,2             AND 2
        AXT      6,1
        AXT      0,2
        STO      MES2+6             SAVE ORIGINAL WORD
        STO      MES1+2
        STO      D
 LOOP   ANA      =077               LAST CHARACTER IN AC
        SUB      =060               CHECK WHETHER IT IS BLANK
        TNZ      FOUND              NOT BLANK, TRANSFER
        CAL      D                  IT WAS BLANK
        ARS      6                  TAKE NEXT CHARACTER
        SLW      D
        TIX      LOOP,1,1
        TRA      IR
 FOUND  CAL      D
        TZE      IR                 NUMBER IS 0, SKIP THE REST
        AXT      0,1
        LDQ      =011               9 INTO MQ
        ANA      =040               CHECK FOR MINUS SIGN
        TZE      POS                NO MINUS SIGN IF 0 IN AC
        CAL      D
        ANA      =0777777777737     REMOVE MINUS SIGN
        SLW      D
        ANA      =077               CHECK LAST CHARACTER
        TZE      NON+2              IT WAS MINUS SIGN ALONE. ILLEGAL.
        STL      A-6                THERE IS MINUS SIGN
        SUB      D+5                CHECK WHETHER IT WAS MINUS ZERO (52)
        TNZ      POS+1
        STZ      A                  IT WAS MINUS ZERO, 0 INTO A
        TRA      POS+5
```

```
POS      STZ     A-6                                                               DEBI053
         CAL     D                                                                 DEBI054
         ANA     =077                                                              DEBI055
         TLQ     NON                  CHECK FOR NON-NUMERIC CHARACTERS             DEBI056
         SLW     A,1                  STORE NUMERIC CHARACTER                      DEBI057
         CAL     D                                                                 DEBI058
         ARS     6                                                                 DEBI059
         SLW     D                                                                 DEVI060
         TZE     *+2                  FINISH CHECKING IF 0 IN AC                   DEGI061
         TXI     POS+2,3,1            NUMBER OF CHARACTERS INTO XR1, XR2           DEBI062
         TXL     SIGN,1,0                                                          DEBI063
MULT     LDQ     D+6,1                                                             DEBI064
         MPY     A,1                  MULTIPLY CHARACTERS BY APPROPRIATE           DEBI065
         STQ     A,1                  POWER OF 10                                  DEBI066
         TIX     MULT,1,1                                                          DEBI067
         CLA     A                                                                 DEBI068
         ADD     A,2                  SUM THE PRODUCTS                             DE)I069
         TIX     *-1,2,1                                                           DEBI070
         STO     A                    RESULTING BINARY NUMBER INTO A               DEBI071
SIGN     CLA     A                                                                 DEBI072
         ZET     A-6                                                               DEBI073
         SSM                          SET SIGN MINUS FOR NEGATIVE NUMBER           DEBI074
         ZET     A-7                                                               DEBI075
         TRA     IR-2                                                              DEBI076
         TOV     *+1                  OVERFLOW INDICATOR OFF                       DEII077
         ALS     18                   SHIFT FIXED PT. INTEGER INTO DECREMENT       DEBI078
         TNO     IR                   CHECK WHETHER NUMBER WAS TOO LARGE           DEBI079
         WTDA    3                    NUMBER WAS TOO LARGE FOR FORTRAN II,         DEBI080
         RCHA    COM1                 WRITE A COMMENT                              DEBI081
         TRA     ZERO-1                                                            DEBI082
         ORA     =0233000000000       MAKE FLOATING POINT NUMBER                   DEBI083
         FAD     =0233000000000                                                    DEBI084
IR       AXT     **,1                 RESTORE INDEX REGISTERS 1                    DEBI085
         AXT     **,2                 AND 2                                        DEBI086
         TRA     1,4                                                               DEBI087
NON      SUB     =060                 CHECK WHETHER IT WAS BLANK                   DEBI088
         TZE     POS+4                CONSIDER BLANK AS ZERO                       DEBI089
         WTDA    3                    NON-NUMERIC CHARACTER IN DATA WORD           DEBI090
         RCHA    COM2                                                              DEBI091
         TCOA    *                    WAIT UNTIL WRITING IS COMPLETED              DEBI092
ZERO     PXD     0,0                  RESULT MADE ZERO                             DEBI093
         TRA     IR                                                                DEBI094
COM1     IOCD    MES1,,9                                                           DEBI095
COM2     IOCD    MES2,,7                                                           DEBI096
MES1     BCI     9, THE NUMBER      IS TOO LARGE FOR FORTRAN II I FORMAT           DEBI097
MES2     BCI     7, DEBI OR XDEBI WAS FED BAD BCD WORD                             DEBI098
D        DEC     0,100000,10000,1000,100,10                                        DEBI099
A        BES     7                                                                 DEBI100
         PZE                                                                       DEBI101
         END                                                                       DEBI102
```

APPENDIX 7 Subroutine RDBUF

```
*      FAP
       COUNT   18
* BUFFER-TO-STORAGE HOLLERITH    . . . . . . . . . . . . .
*       UWMS-0933
*
*       UNIVERSITY OF WASHINGTON
*       DEPARTMENT OF OCEANOGRAPHY
*       SEATTLE, WASHINGTON  98105
*
*       PROGRAMMED BY..  CHARLES KIRKLEY
*
* A FORTRAN READ STATEMENT WILL CAUSE IOH TO TREAT THE CONTENTS
* OF ITS BUFFER AS NEW INPUT.
*
       LBL     RDBUF,KIRK
       ENTRY   (BSH)
       ENTRY   (CSH)
(BSH)  BSS     0                 ENTRY FOR MACHINE-LANGUAGE PROGRAMS
(CSH)  CAL     NTIN              FEED A LIKELY UNIT TO PLACATE IOS
       LDQ     *+2               GET SWITCH SETTING
       TRA*    $(IOH)            GO TO IOH
       NOP     *+1               SWITCH SETTING - INPUT
       TRA     1,4               RETURN TO IOH TO USE PRESENT
*                                  CONTENTS OF BUFFER
 NTIN  PZE     ,,5
       END
```

APPENDIX 8 Subroutine EXØR

```
*      FAP
       COUNT   8
*EXOR          LOGICAL FORTRAN FUNCTION         EXORF(A,B)
*       UWMS-0945
*
*       UNIVERSITY OF WASHINGTON
*       DEPARTMENT OF OCEANOGRAPHY
*       SEATTLE, WASHIGNTON  98105
*
       ENTRY   EXOR
 EXOR  STQ     A
       ERA     A
       TRA     1,4
     A BSS     1
       END
```

Naval Oceanographic Office
Anti-Submarine Warfare Force, Pacific
Fleet Post Office
San Francisco, California 96610
1 Attn: Commander
1 Attn: Liaison Officer

1 Chief
Naval Air Systems Command
Department of the Navy
Washington, D.C. 20360
1 Attn: AIR 370E

1 Office of the U.S. Naval Weather Service
Washington Navy Yard
Washington, D.C. 20390

1 Chief
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Department of the Navy
Washington, D.C. 20390
1 Attn: Code 70

U.S. Navy Electronics Laboratory
San Diego, California 92152
1 Attn: Code 3102
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Pt. Mugu, Hueneme, California 93041

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1 Chief, Naval Ship Systems Command
Department of the Navy
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1 Attn: Code 1622B

1 Officer-in-Charge
Navy Weather Research Facility
Naval Air Station, Bldg. R-48
Norfolk, Virginia 23511

1 Naval Air Development Center (ADL)
Johnsville, Warminster, Pa. 18974

1 Fleet Weather Central
Joint Typhoon Warning Center
COMNAVMARIANAS Box 12
San Francisco, California 94101

1 Superintendent, Naval Academy
Annapolis, Maryland 21402

2 Department of Meteorology and Oceanography
Naval Postgraduate School
Monterey, California 93940

1 Commanding Officer
U.S. Navy Mine Defense Laboratory
Panama City, Florida 32402

1 Commanding Officer
Naval Underwater Sound Laboratory
New London, Connecticut 06321

1 Officer-in-Charge
Fleet Numerical Weather Facility
Naval Postgraduate School
Monterey, California 93940

Air Force

1 Headquarters, Air Weather Service
(AWSS/TIPD), Air Force
Scott AFB, Illinois 62225

1 AFCRL (CRZF)
L. G. Hanscom Field
Bedford, Massachusetts 01730

Army

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Corps of Engineers
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Washington, D.C. 20310

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Washington Science Center
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Coast & Geodetic Survey, ESSA
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Norfolk, Virginia 23510

1 Director, Institute for Oceanography
ESSA, Gramax Bldg.
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1 ESSA, Geophysical Sciences Library (AD 712)
Washington Science Center
Rockville, Maryland 20852

1 Commanding Officer
Coast Guard Oceanographic Unit
Bldg. 159, Navy Yard Annex
Washington, D.C. 20390

1 Chief, Office of Marine Geology & Hydrology
Geological Survey
Menlo Park, California 94025

1 Director
Pacific Marine Center
Coast and Geodetic Survey, ESSA
Seattle, Washington 98102

1 Geological Division
Marine Geology Unit
Geological Survey
Washington, D.C. 20240

1 National Science Foundation
Office of Sea Grant Programs
1800 G Street, N.W.
Washington, D.C. 20550

1 Laboratory Director
Bureau of Commercial Fisheries
Ocean Research Laboratory
South Rotunda, Museum Bldg.
Stanford, California 94035

1 Bureau of Commercial Fisheries
Fish & Wildlife Service
P. O. Box 3830
Honolulu, Hawaii 96812

1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 3098, Fort Crockett
Galveston, Texas 77552

1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 1155
Juneau, Alaska 99801

1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 6
Woods Hole, Massachusetts 02543

1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
P. O. Box 280
Brunswick, Georgia 31521

1 Laboratory Director
Tuna Resources Laboratory
Bureau of Commercial Fisheries
P. O. Box 271
La Jolla, California 92038

1 Bureau of Commercial Fisheries & Wildlife
Fish and Wildlife Service
Librarian, Sandy Hook Marine Laboratory
P. O. Box 428
Highlands, New Jersey 07732

1 Director
National Oceanographic Data Center
Washington, D.C. 20390

1 Laboratory Director
Biological Laboratory
Bureau of Commercial Fisheries
#75 Virginia Beach Drive
Miami, Florida 33149

1 Director, Bureau of Commercial Fisheries
Fish and Wildlife Service
Department of the Interior
Washington, D.C. 20240

1 Bureau of Commercial Fisheries
Biological Laboratory, Oceanography
2725 Montlake Boulevard, East
Seattle, Washington 98102

1 Dr. Gene A. Rusnak
U.S. Geological Survey
Marine Geology & Hydrology
345 Middlefield Road
Menlo Park, California 94025

1 Head, Office of Oceanography & Limnology
Smithsonian Institution
Washington, D.C. 20560

Advanced Research Projects Agency
The Pentagon, Washington, D.C. 20310
1 Attn: Nuclear Test Detection Office

RESEARCH LABORATORIES

2 Director, Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

1 Director, Narragansett Marine Laboratory
University of Rhode Island
Kingston, Rhode Island 02881

1 Chairman, Department of Meteorology and Oceanography
New York University
New York, New York 10453

1 Director, Lamont Geological Observatory
Columbia University
Palisades, New York 10964

1 Director, Hudson Laboratories
145 Palisade Street
Dobbs Ferry, New York 10522

1 Great Lakes Research Division
Institute of Science & Technology
University of Michigan
Ann Arbor, Michigan 48105

1 Department of Physics
Northern Michigan University
Marquette, Michigan 49855

1 Director, Chesapeake Bay Institute
Johns Hopkins University
Baltimore, Maryland 21218

1 Director, Marine Laboratory
University of Miami
#1 Rickenbacker Causeway
Miami, Florida 33149

2 Head, Department of Oceanography & Meteorology
Texas A&M University
College Station, Texas 77843

1 Director
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, California 92038

1 Allan Hancock Foundation
University Park
Los Angeles, California 90007

1 Head, Department of Oceanography
Oregon State University
Corvallis, Oregon 97331

1 Director, Arctic Research Laboratory
Pt. Barrow, Alaska 99723

1 Head, Department of Oceanography
University of Washington
Seattle, Washington 98105

1 Director, Institute of Marine Science
University of Alaska
College, Alaska 99735

1 Director, Bermuda Biological Station for Research
St. Georges, Bermuda

1 Director, Hawaiian Marine Laboratory
University of Hawaii
Honolulu, Hawaii 96825

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Trieste, Italy

1 Department of Engineering
University of California
Berkeley, California

1 Applied Physics Laboratory
University of Washington
1013 N.E. Fortieth Street
Seattle, Washington 98105

1 Physical Oceanographic Laboratory
Nova University
1786 S.E. Fifteenth Avenue
Fort Lauderdale, Florida 33316

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University of Tokyo
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Department of Scientific and Industrial Research
P. O. Box 8009
Wellington, New Zealand
Attn: Librarian

1 Director, Instituto Nacional de Oceanographia
Rivadavia 1917-R25
Buenos Aires, Argentina

1 Lieutenant Nestor C. L. Granelli
Head, Geophysics Branch
Montevideo 459, 4° "A"
Buenos Aires, Argentina

1 Oceanographische Forschungsantalt der Bundeswehr
Lornsenstrasse 7
Kiel, Federal Republic of Germany

1 Underwater Warfare Division of the Norwegian Defense Research Establishment
Karljohansvern, Horten, Norway

1 Department of Geodesy & Geophysics
Columbia University
Cambridge, England

1 Institute of Oceanography
University of British Columbia
Vancouver, B.C., Canada

1 Department of the Geophysical Sciences
University of Chicago
Chicago, Illinois 60637

1 Coastal Engineering Laboratory
University of Florida
Gainesville, Florida 32601

1 Institute of Geophysics
University of Hawaii
Honolulu, Hawaii 96825

1 Dr. J. A. Gast
Wildlife Building
Humboldt State College
Arcata, California 95521

1 Department of Geology & Geophysics
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

1 Division of Engineering and Applied Physics
Harvard University
Cambridge, Massachusetts 02138

1 Department of Geology
Yale University
New Haven, Connecticut 06520

1 Westinghouse Electric Corporation
1625 K Street, N.W.
Washington, D.C. 20006

1 Great Lakes Studies
University of Wisconsin, Milwaukee
Milwaukee, Wisconsin 53201
Attn: Dr. C. H. Mortimer

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13. ABSTRACT

A coordinated computer-compatible system has been developed to eliminate most of the hand calculations involved in processing oceanographic data taken at a hydrographic (water-sampling) station. A special field-log form is used at the time the oceanographic station is occupied so that machine processing of the data is expedited. These data are first punched either on paper tape using a Friden Flexowriter or on Hollerith (IBM) cards and then submitted to a computer to make selected computations.

The computer program uses only uncorrected readings from the meter wheel, estimated wire length, reversing thermometers, salinity, oxygen, and other chemical determinations. The final results are printed, and other output options may be selected such as punched cards, magnetic tape, or both. Output formats for punched cards are essentially those used by the National Oceanographic Data Center. Many error checks and quality control evaluations are incorporated into the program.

The program is written in FORTRAN-II and FAP especially for the IBM-7094-7040 Direct Couple System. An average of 2.5 sec of computer time is required for a station of 12 sampling depths.

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