PRNC – 190

PUERTO RICO NUCLEAR CENTER

A MANUAL FOR HYDROGRAPHIC CRUISES

Prepared for the Puerto Rico Water Resources Authority
By the Staff of Puerto Rico Nuclear Center of the
University of Puerto Rico

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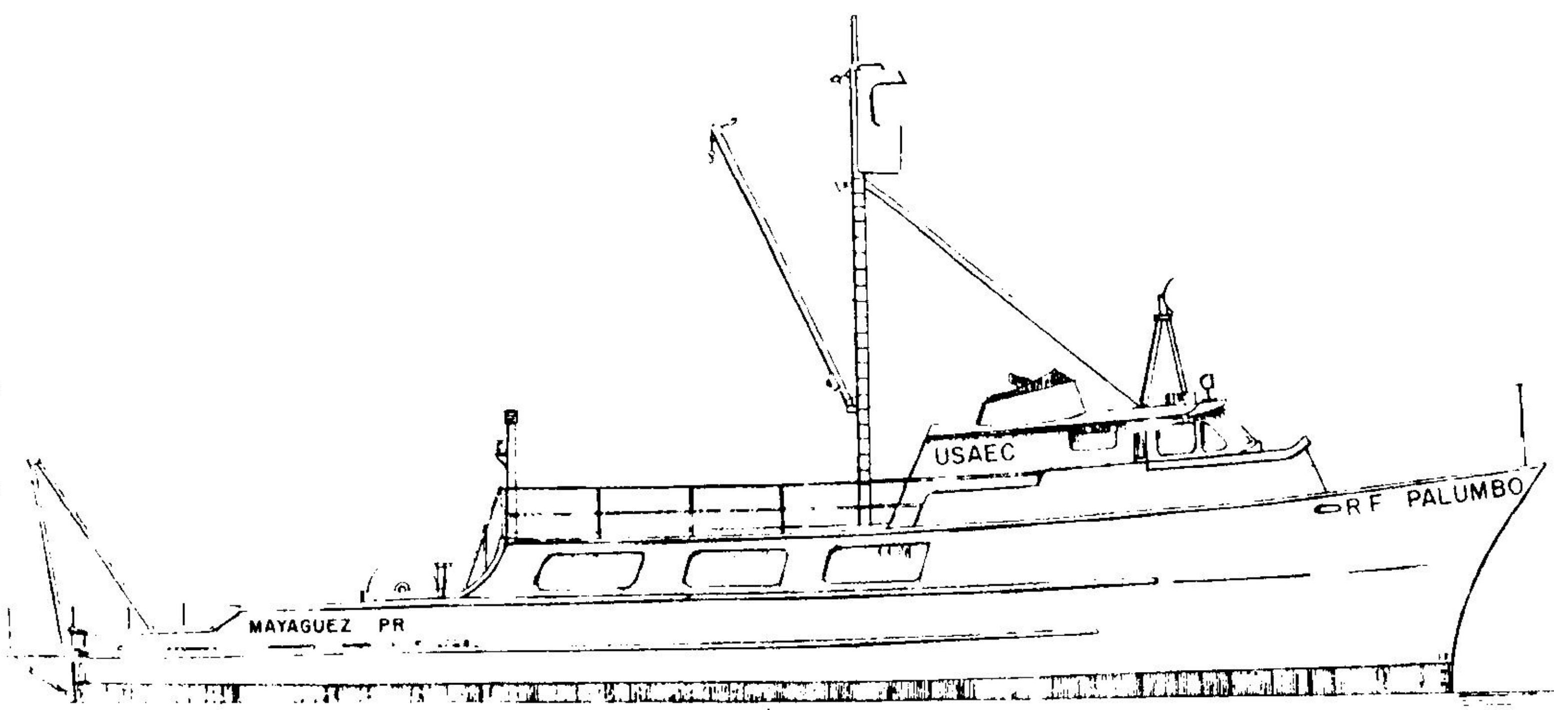
A MANUAL FOR HYDROGRAPHIC CRUISES

By

E. D. WOOD
Oceanographer

May, 1975



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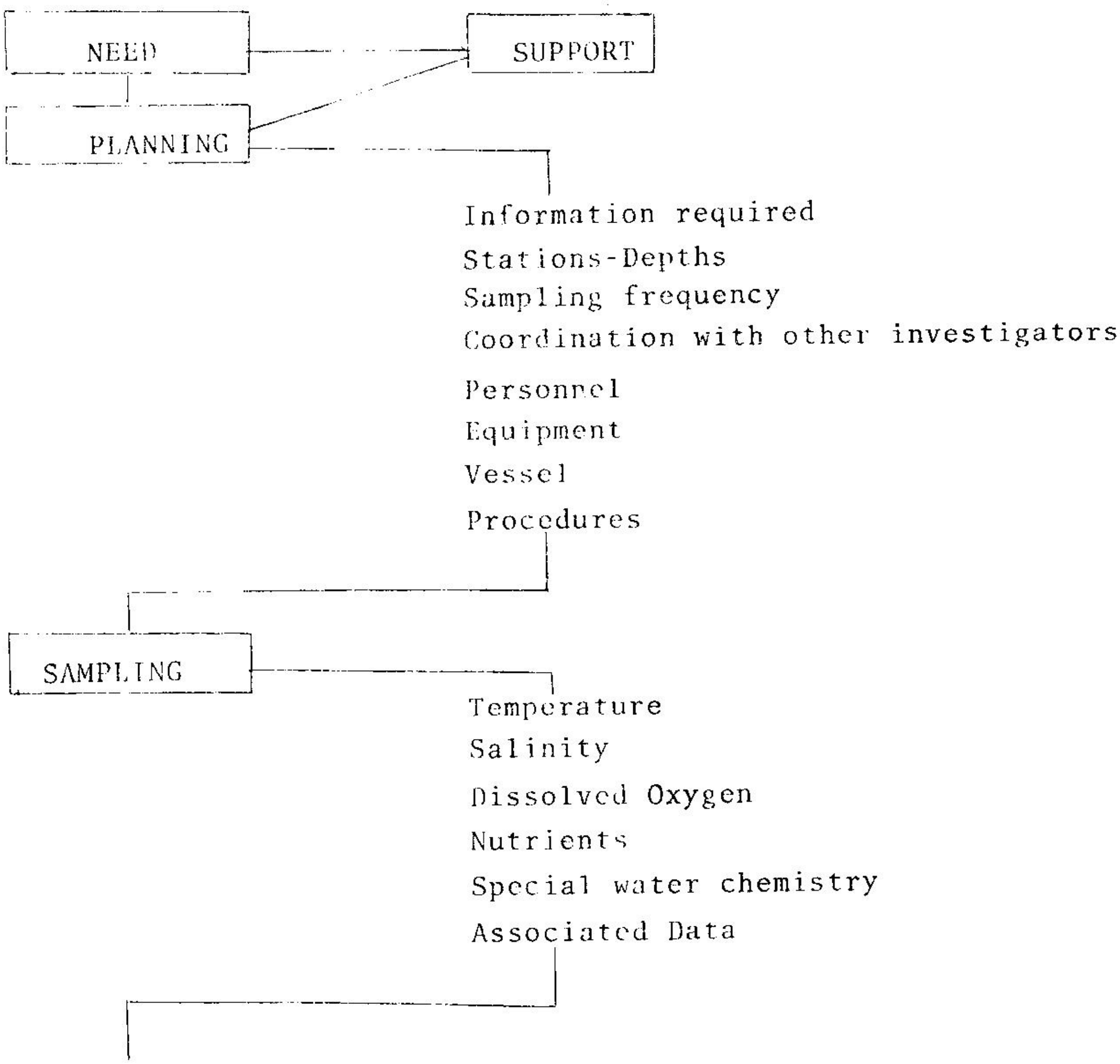
INTRODUCTION

This handbook is intended to serve as a guide to persons planning and executing hydrographic cruises and those who interpret and evaluate the resulting data. It is expected that persons reading this manual will have some basic knowledge of the subject and will use the references cited when necessary.

The general process is outlined in Table 1 and explained in the text. The Appendix contains examples of data sheets, detailed explanations for the station log sheet and computer programs used in data processing.

Table 1.

HYDROGRAPHIC RESEARCH



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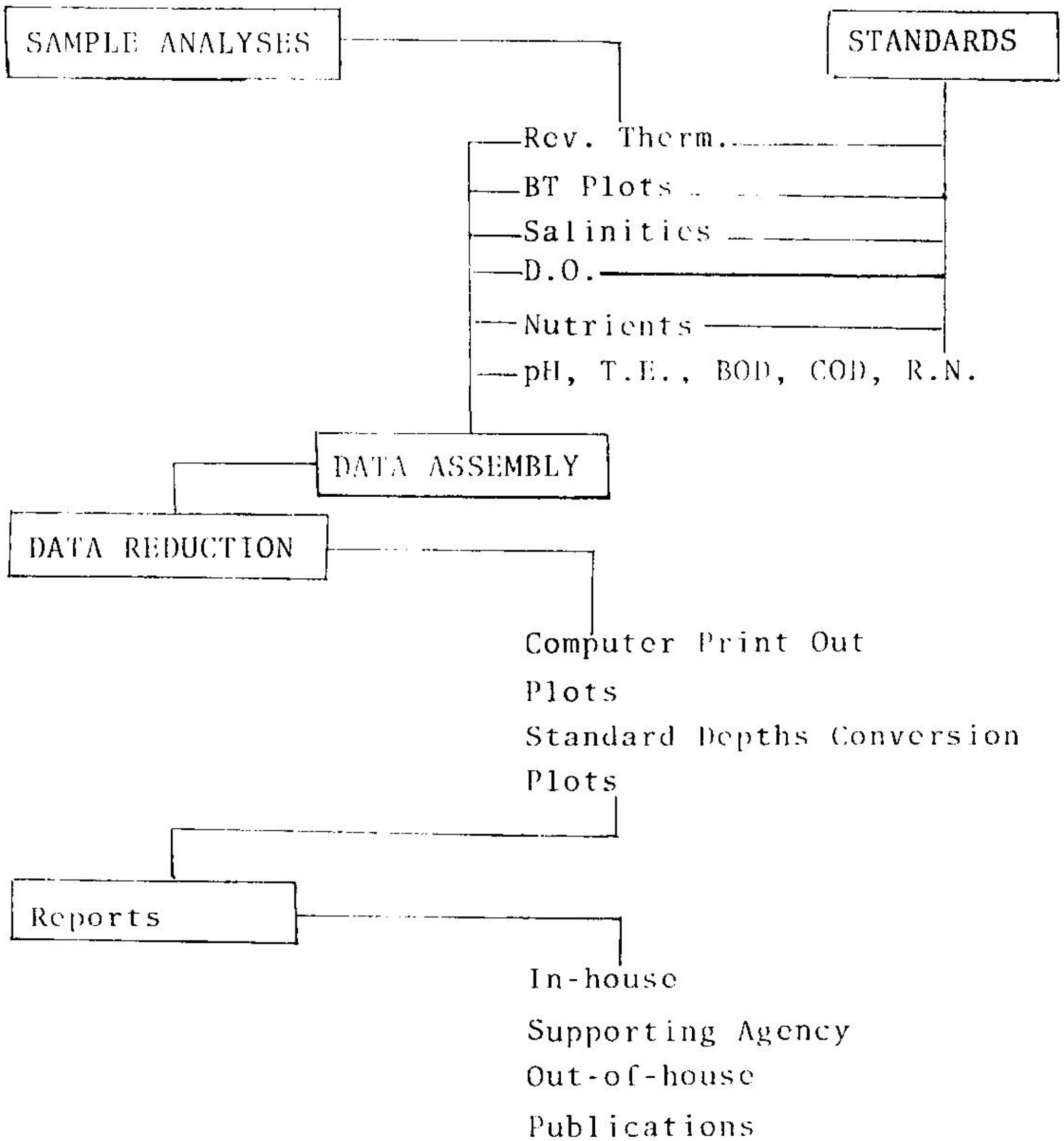


HYDROGRAPHIC PROCEDURES

Hydrographic Cruise Numbers

Cruise Number

Each cruise of a boat or ship receives a unique serial number containing two letters of the ship's name, a dash, and a three-digit arabic number. For example, for the RMV R.F. Palumbo, "PA", then dash "-", then the 3-digit number, "123." The final serial number reads PA-123. Usually the number is used for all ship sampling from the time the vessel leaves port until it returns. The same cruise number may be used even though the vessel has put into port if the work is at one site or region. Multiple cruise numbers may be assigned if the chief scientist and/or the mission change before the vessel returns to its home port.

Station Number

Each station occupied by the ship receives a unique station number. Station numbers run consecutively continuing from one cruise to the next. The combination of the three digits of the cruise number and the last three digits of the station number make up the reference number for each station.

Bridge Log

At the time of sampling the bridge officer is responsible for filling out a bridge log in duplicate. This log contains the following information: cruise and station numbers, dates and times, weather conditions, position, and type of sampling. The original copy goes to the chief scientist and the carbon copy is placed in the ship's file. (Example in Appendix.)

Scientific Crew

The ship's captain has the overall responsibility for the ship's operation, the safety of the ship, and all persons on board.

A scientist, usually the ranking staff member on the cruise, is designated as "Chief Scientist" and is responsible for the successful completion of the scientific effort. He is assisted by a "Cruise Leader." One or more "Group Leaders" may also be designated on a multiple discipline or round-the-clock sampling type of cruise.

Chief Scientist

The chief scientist is responsible for the scientific effort and coordinates with the ship's captain to carry out the scientific effort. A cruise plan is made out under the direction of the chief scientist and furnished to the ship's captain and members of the scientific crew. The basic welfare of the scientific crew regarding job assignments, proper rest and nourishment, cleanliness of staterooms, etc. are the responsibilities of the chief scientist, as well as supervising the proper procedures and techniques for obtaining the desired scientific goal.

Crew

The scientific crew is obliged to refrain from ship's crew activities except when requested to act by a responsible member of the ship's crew, or if action is needed to prevent damage or harm to the ship, personnel or equipment. Any unsolicited actions are reported to the watch officer as soon as practical. Upon request from the captain, the chief scientist should furnish a list of scientific personnel who can participate in the ship's watch.

The chief scientist may delegate any or all of the above mentioned activities, but he is not relieved of responsibilities for them.

Cruise Plan

A cruise plan is a flexible schedule of work to be done and a brief description of how the work is to be accomplished. How well it is followed depends upon the forethought of the originator, the preparedness of the entire crew, and the occurrence of non-controllable interferences. The cruise plan includes the following headings:

I. Research Vessel
II. Supporting Agency
III. Cruise Name and Number
IV. Dates
V. Total Days & Miles
VI. Objectives
VII. Personnel
VIII. Discussion
IX. Stations
X. Equipment
XI. Type of Samples
XII. Travel

and maps showing the cruise track and/or station locations.

A copy of the cruise plan is distributed to the scientific crew, the ship (several copies), project leader, division head, office in charge of the ship, and other interested parties. The cruise plan should be followed closely to accomplish the objectives, but changes can be at the discretion of the chief scientist and/or the ship's captain.

Hydrographic Station Log

The data for each hydrographic station are recorded in duplicate on a station log sheet by the persons working on deck. This sheet is composed of three sections. It is designed to have the data key punched for computer analysis. The first section is called the "Master Card" and contains the following: name of ship, cruise and station identification, position, date, time, depth, weather, and sea conditions. The second section is the "Parameter Card" which provides information on the casts: number, time, depths, oxygen calculation factor, and meter wheel correction factor. The third section is the "Data Card" and has the actual data for each depth. The cast number, depth of the sample, water sampling bottle number, thermometer numbers and readings, and individual sample bottle numbers are recorded in this section. (U.S. Navy Hydrographic Off. Pub. 607 & 614). (A step-by-step explanation for filling out the station log is given in the Appendix.)

Hydro-wire

Most oceanographic ships are equipped with a mechanical winch with a stainless steel wire rope of about 5mm (3/16") diameter of varying lengths with a lead weight on the end. This wire is fed through a metering block about 3 m (10 ft.) off the deck and down over the side of the ship. Sampling equipment is then clamped to the wire and lowered to the desired depth. The sampling equipment is usually handled by the scientific crew, while the operation of the hydro-winch falls to members of the ship's crew. The meter wheel is calibrated periodically by measuring a segment of wire passing through the meter wheel. The depth of the sample is determined mathematically using the wire angle and the meter wheel correction factor. The sample depth is also calculated from reversing thermometer data.

Sampling Bottles

Water samples are collected by lowering a "bottle," open at the end, to the desired depth, then closing the end plugs or valves with a "messenger" and returning the bottle to the deck of the ship.

Several types of sampling bottles have been devised. A well known oceanographic sampler is the Nansen bottle. It is clamped on the hydro-wire by one end, then the entire bottle is inverted and clipped into place. This bottle has connected, rotating valves, one at each end, and a rack which holds two to four thermometers. A number of other types of water samplers have been developed and some are available commercially. One such bottle, the Niskin bottle, is made of PVC which minimizes metal contamination. The model commonly used at the Puerto Rico Nuclear Center (PRNC) holds five liters and is sufficient for most sampling (twelve and thirty liter bottles are used also). The five liter bottles are equipped with thermometer racks holding three thermometers each. These bottles differ from the Nansen bottles in that they are clamped to the hydro-wire with two bolts, the ends are closed at depth by tripping two end plugs which are pulled together by a spring or elastic passing through the middle of the bottle, and the thermometers are reversed by a rotating rack on the side of the bottle.

When sampling in series on a cast, each bottle above the bottom one has a messenger attached to it. The messenger is a brass weight which clamps freely around the wire and is attached to the bottle by a short lanyard. The bottles are placed on the hydro-wire at predetermined intervals, recorded on the station sheet, and on a card used by the winch operator as shown below:

Table 2. Example of information recorded on the Station Log and Winch Card.

Cast	Estimated Depth	Meter Wheel	Slippage	Bottle Number
		103		
1	0	100		1
1	25	75		2
1	50	50		3
1	100	0		4

Since all bottles are on the same cast (column 1), all are numbered the same under "Cast." If a second or third cast is necessary, either for samples at different depths, a malfunction in the cast, or additional samples at the same depth, the casts are so numbered, e.g., Cast 2,3.

The desired depth of the sample is entered (column 2) in descending order with depth being measured in meters positively down from the surface. The bottles are hung on the hydro-wire in reverse order with the meter wheel reading, shown in column 3, corresponding to the bottle numbers shown in column 5. The meter wheel reading is determined by subtracting the estimated depth of each bottle from the deepest depth sampled on the cast. The additional three meters, (column 3, supra) on the ship, are needed to get the last bottle to the water from the level of the "Hero's Platform."

The "Hero's Platform" is a cage which extends from the side or stern of the ship in which a person stands while attaching the sampling equipment to the hydro-wire. The platform is usually equipped with a snap on a short rope, which secures the hydro-wire while attaching the equipment, and a tray to hold messengers and tools.

Times are recorded on the station log sheet for the start of the cast, the time the bottles are down, and when the messenger is dropped. A minimum of three minutes is allowed for the bottles to equilibrate before being tripped. This allows time for the thermometers to come to equilibrium and for the bottles to be flushed. The times for the start of the haul, completion of the cast and the initials of all scientific personnel active in the work at the station are also recorded. When the bottles are removed from the hydro-wire the winch operator notes the meter wheel reading and notifies the scientific crew of any difference between the "down" and "up" readings. He also writes the difference down on the winch card as "slippage" (column 4).

Set-up for Cast

The scientific crew sets out bottles for the individual samples in the bottle rack before or during the lowering of the cast. Samples usually include salinity, dissolved oxygen, phosphate and nitrate. The bottle numbers and the thermometer numbers corresponding to the sampling bottle number are recorded on the station log sheet. Great care is used to ensure that no mix-up occurs with respect to bottle and thermometer numbers.

The person setting out the bottles checks to see that the cases are arranged with the smallest numbers in the upper left-hand corner and bottle numbers increasing from left to right and top to bottom (top=away from; bottom= toward the reader). The order of the bottle numbers is checked, 1) as the bottles are placed in the rack, 2) as the numbers are recorded on the station log sheet when the bottles are filled, and 3) again when they are returned to their respective cases. Thermometer numbers are recorded directly from the bottle (<u>not</u> from another sheet!) and checked with each reading.

The initial set-up includes the strategic location of oxygen reagents, tools, messengers, magnifiers for reading thermometers, flashlight and wire angle gauge.

HYDRO TEAM

Hydro Area

The hydro area is a working area. No horseplay, unnecessary shouting, nor radios should be permitted. The winch man is not to be distracted nor his line of sight to the "A" frame blocked. Persons not active in the sampling should be encouraged to avoid interfering with the hydrowork.

The hydro team on deck at any one time usually consists of two to five persons. The person in charge may be the chief scientist, cruise leader, or a team (watch) leader. A number of duties may be assigned to specific members of the team, and shared or rotated:

1. hanging bottles*
2. filling out station log sheets
3. setting up for sample bottles
4. drawing and treating oxygen samples
5. drawing other samples
6. reading thermometers
7. carrying bottles

*NOTE: One person is responsible for hanging and retrieving sample bottles. The care of the bottles, thermometers, messengers, and directions to the bridge are his responsibility only!

Bottle Hanger

The "bottle hanger" has the winch man lower the lead weight over the side, attaches the wire to the ship with the snap, and "zeros" the meter wheel. The "bottle carrier" carries the sample bottle, hands the "bottle hanger" one bottle for the deepest measurement first, and then watches to see that no details are overlooked. Especially, the condition of the reversing thermometers prior to descent is checked. He then fetches the next bottle and the procedure is repeated. The "bottle hanger" attaches the bottles to the wire and tightens the clamps securely. The following items are then prepared and checked.

1. end plugs cocked
2. air vent closed
3. discharge cock closed
4. thermometers reversed
5. mercury bulb checked to see that all mercury has dropped
6. messenger attached

Next, the wire is released from the snap hook. The winch man is signalled to lower the bottles to the next desired depth. The "bottle hanger" may at any time request the bridge officer to maneuver the ship during the lowering or raising of the cast to reduce the wire angle, reduce roll, protect the equipment from hitting on the ship, or to prevent damage to the ship by having the wire drawn against it. It is his responsibility to watch the wire and sampling equipment at all times the wire is in the water, including the three minute "soak" period, and to be especially vigilant while the ship's propeller is turning. The bridge should be reminded to keep an eye on the depth indicator when sampling gear is down and kept advised of the various stages in sampling.

Drawing Samples

If three or more people are on the hydro team, sample drawing should commence as soon as the "bottle carrier" has placed the first bottle in the rack. All bottles are rinsed at least three times. Special care should be given to rinsing dry bottles especially if they contain salt crystals. These bottles should be soaked or washed with acid prior to use. The dissolved oxygen samples are drawn first followed by salinity and nutrients. (The order may be changed, but dissolved oxygen is usually first.)

Dissolved Oxygen

Dissolved oxygen samples are drawn through a tube which extends to the bottom of the bottle. Two regular rinses of about 50 ml each are made. The stopper is rinsed each time. The third rinse is made by inverting the bottle with the tube running to the bottom, rinsing the walls and allowing any bubbles in the tube to escape. The stopper is held in the rinse water during this operation. After about 100 ml have been used, the bottle is righted and allowed to fill to overflowing. The tube is withdrawn from the water only at the end of the filling and while still flowing. Immediately, 1 ml of $MnSO_4$ solution is added while placing the tip of the dispenser a few millimeters below the surface. One milliliter of NaI-NaOH solution is added in the same fashion. The stopper is then dropped into place and the bottle inverted several times to thoroughly mix the sample. If a bubble is present at this point, the sample should be dumped and re-drawn.

After 15 to 30 minutes the oxygen bottles are reversed slowly several times to re-suspend the precipitate, then treated with 1 ml of H_2SO_4 approximately 45 minutes after being drawn. The samples should be titrated within 24 hours.

The method is similar to that found in Strickland and Parsons, 1968. The oxygen titer is calculated from the standardization process and entered on the station log sheet. The results are reported as milliliters per liter (ml/l), milligrams per liter (mg/l) and percent saturation (% sat.).

Salinity

Salinity samples are collected in 250 ml polycarbonate bottles with good-fitting screw caps. Care is taken not to use dry bottles unless they have been rinsed previously with fresh water. The bottles are triple rinsed and filled to the round. A check is made, when putting the cases away, to see that all caps are secure. Salinity samples can be analyzed on shipboard or returned to the laboratory. Salinity is determined by an induction salinometer using standard (Copenhagen) water and a substandard collected from the open sea. The techniques used in the analyses are those recommended by the salinometer manufacturer. Results are reported as parts per thousand (°/oo). (Beckman, 1965 and Plessey, 1962).

Nutrients

Nutrients commonly measured in sea water are phosphate ($PO_4^{\equiv}$), nitrate (NO_3^-) and silicate (SiO_2) because they are usually the limiting factors for phytoplankton in the surface waters. The analysis of silicate is sometimes deleted because SiO_2 is only limiting to those plankton, such as radiolarians, which use it in their skeletons. High concentrations of these complexes in surface waters are of interest because of their effect on biological communities. A moderate supply of nutrients is usually beneficial whereas an overabundance degrades the system. High nutrient concentration can be caused by upwelling of deep water from agricultural, industrial and municipal run-off. The latter is more likely around Puerto Rico. Nutrient concentrations generally increase with depth. The nutrients measured are qualified with the word "reactive" because it is recognized that there is more of a particular nutrient present in the water than measured. However, it is assumed that the nutrient concentration measured represents the amount available to the plants at that particular time. Appreciable productivity is possible with low nutrients if the turnover rate of "bound" to "free" nutrient is rapid.

Samples for the various nutrient analyses can be stored in a common bottle or in separate bottles. These bottles are usually plastic and not fully filled as they are generally frozen until the samples can be analyzed. Samples left exposed to light or heat will be altered by plankton growth and/or degradation of organic matter. Ammonia and nitrite (degradation products of nitrate) are usually not detected in open ocean samples. Therefore, their presence would indicate improper sample handling. The samples are analyzed by standard colorimetric methods as described in Strickland and Parsons, 1968. The data are reported as microgram atoms per liter (µg-at./l).

Temperature

Reversing Thermometers

Oceanographic temperatures are measured in a number of ways. The most common and most accurate is with the use of the reversing thermometer. These thermometers are constructed in such a fashion that after equilibration at a desired depth, the mercury column is interrupted when the thermometer is turned end-for-end, thereby "fixing" the temperature so that it can be read on deck. These thermometers can be read to 0.01°C. Ideally, at least three reversing thermometers are used on each sampling bottle. Two have their mercury reservoir bulbs protected against pressure by an outer jacket of mercury. The third is unprotected. The pressure, and therefore the depth, can be determined by the difference in readings from the protected and unprotected thermometers. In addition to the main thermometer of each reversing thermometer, there is a small, or auxiliary, thermometer used to measure the temperature of the thermometer on deck so that the glass expansion effect can be determined.

These thermometers must be handled with great care! They are never allowed to lie horizontal. When preparing a bottle for sampling, the "bottle hanger" and the "bottle carrier" both check to see that the mercury has dropped cleanly. If the thermometer gives problems it may have to be tapped or removed from the rack and reversed several times with gentle tapping.

The thermometers are usually allowed to equilibrate with the deck temperature (out of direct sunlight) for 5 to 30 minutes before being read. A magnifying lens is used to read the thermometer to make sure they are lined up on the horizontal. One person reads the thermometers and a second person records the data on the station log sheet. The practice is for the reader to call out the sampling bottle number, followed by the left thermometer number, then the readings. For example, "Main (or Big T), twenty-one point four-six, Auxiliary (or little t), twenty-eight point seven." The person recording data reads back the data as he records them. The process is then repeated for the middle and right thermometers, and on to the remaining bottles. The persons then change roles and go through the whole procedure again. This provides two complete and independent readings for each thermometer. The initials of those reading thermometers and the times that the readings were taken is also recorded on the station log sheet.

The temperature data are computer processed upon return to the laboratory. They are inspected for errors and combined with other hydrographic parameters for the standard calculations and initial data print-out and plotting. Temperature is expressed in degrees Celsius (°C). (Equations are in the Appendix.)

Bathythermograph

The bathythermograph (BT) is also commonly used to record temperature. The BT is a torpedo-shaped mechanical device, sensitive to both temperature and depth. A pen scribes an X-Y plot of the two parameters on a gold-coated slide. The slide has the following information scratched on the upper left corner:

1. cruise and station numbers
2. station name
3. date
4. time
5. depth
6. BT number

The BT can be lowered with a hydrocast or by itself. It was actually designed to be used while the ship is underway. BT slides are commonly read by placing them into a calibrated viewer and recording depth and temperature where breaks in the profile occur. The points are then connected. The method we use at PRNC is to project the slide onto a two-sided screen with a 35 mm slide projector. The temperature profile is then traced on a lined sheet of paper. The slide image is adjusted to fit the scale on the paper using reversing thermometer data for the surface and deep temperature corresponding to the BT. The paper scale has been checked previously by lowering the BT to known depths with reversing thermometers.

Other Sampling

Many other types of sampling may occur in conjunction with a hydrographic cruise. The basic data may be determined using other methods. Also STD records, salinity, temperature and depth in profile, and oxygens can be determined using a polarographic probe either *in situ* or on samples brought to the deck. Special chemistry may include: pH, alkalinity, sulfide, trace metals, radionuclides, etc. In addition, sediment samples may be taken by core, grab or dredge. Plankton or fish nets may be towed, or the vessel may support small craft or be engaged in current measurements while hydrographic work is being carried on.

Data Processing

The chief scientist is responsible for assembling all data sheets and samples at the end of a cruise and for having them delivered to the proper people for the analyses. The thermometer readings are handled by a computer program which corrects for calibration errors and deck temperature. The program "REVTHR" (Appendix) also computes averaged protected thermometer values and the sampling depth where protected and unprotected readings are available.

When all of the values are available, the data are put on punch cards, following the form of the oceanographic station log, and processed by a program called "OCNSTN" (Appendix). This program provides punch cards to be run by another program "OCNST2", to plot the depth profiles of the parameters: temperature, salinity, sigma-t, oxygen and phosphate. The data from one station can be compared with the data from another station better if they are converted to standard depths. This is accomplished by a program, "AVOCN", (Appendix) which also averages the data.

The data are continually scanned for errors and inconsistencies. The print-outs are then ready for distribution to participating scientists and reports to funding agencies as shown in Table 1.

A_P_P_E_N_D_I_X

STEPS FOR USE OF STATION LOG SHEET

i. Make carbon copy - Sample sheet, Table 15

ii. Use pencil

iii. Write neatly - numbers like examples: Ø123456789

iv. Cruise and Station No. - From Bridge Log, e.g., "PA-ØØ1-Ø1Ø - Table 16

v. Station - Name or Number designated by Chief Scientist, e.g., "JB-14"

vi. Vessel Name, e.g., RV R.F. Palumbo

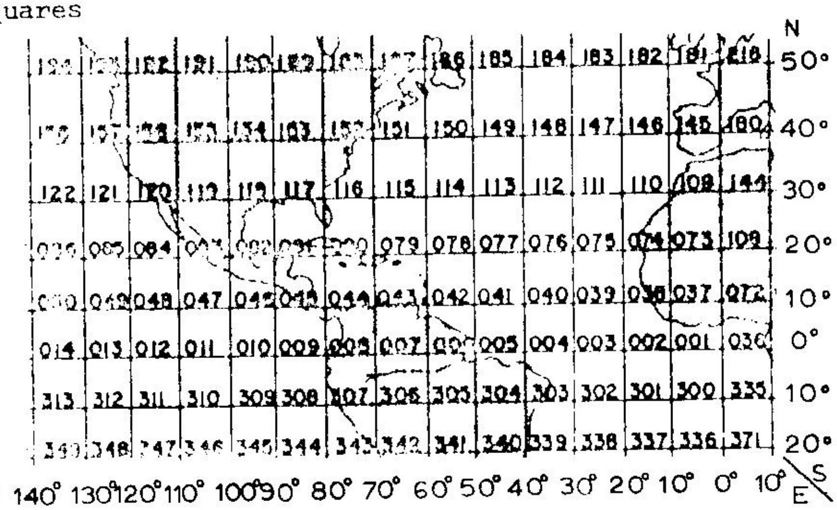
vii. Local Date - Use Roman numeral month, e.g., 5-V-71

Master Card

Space	Item	Instructions
1-2	Country	USA is Number "31"
3-4	Ship	Palumbo not yet listed
5-9	Latitude	From Bridge Log Sheet "18° 31.9' " (Lat. N)
10-15	Longitude	From Bridge Log Sheet "79° 4Ø.2' " (Long. W)
16-18	Marsden Squares	

Table 3

MARSDEN SQUARES



Space	Item	Instructions
19-24	Date	GMT "71 1Ø Ø5"
25-27	Time	GMT in hours and tenths of hr. e.g., "14.6" For Puerto Rico, add 4 hours to the messenger time of the first cast and round off to nearest tenth of an hour.

Space	Item	Instructions
28-33	Station Name	6 spaces available for Chief Scientists Station designation. "JB-Ø14"
34-37	Depth in meters	Sonic (or chart) Depth "Ø161" Fathoms to meters, Table 12 Meters to fathoms, Table 13
38-39	Max. Sample Depth	Drop last two digits on deepest sampling depth. For 1550 m write "15"
40-41	Blank	
42-43	Water color	

Table 4
FOREL WATER COLOR SCALE

Code	Description
00	Deep blue.
10	Blue.
20	Greenish-blue (or green blue).
30	Bluish-green (or blue green).
40	Green
50	Light green
60	Yellowish-green
70	Yellow green.
80	Green yellow.
90	Greenish-yellow.
99	Yellow.

Space	Item	Instructions
44-45	Transparency	Secchi disc depth (meters) "22"
46-47	Waves. Dir.	Direction waves coming <u>from</u>.

Table 5

-COMPASS DIRECTION CODE
True Direction From Which Surface Wind is Blowing or From Which Wave System is Approaching, in 10° intervals. (WMO-Code 23)

Code	
00	Calm.
01	5° to 14°.
02	15° to 24° NNE.
03	25° to 34°.
04	35° to 44°.
05	45° to 54° NE.
06	55° to 64°.
07	65° to 74° ENE.
08	75° to 84°.
09	85° to 94° E.
10	95° to 104°.
11	105° to 114° ESE.
12	115° to 124°.
13	125° to 134°.
14	135° to 144° SE.
15	145° to 154°.
16	155° to 164° SSE.
17	165° to 174°.
18	175° to 184° S.
19	185° to 194°.
20	195° to 204° SSW.
21	205° to 214°.
22	215° to 224°.
23	225° to 234° SW.
24	235° to 244°.
25	245° to 254° WSW.
26	255° to 264°.
27	265° to 274° W.
28	275° to 284°.
29	285° to 294° WNW.
30	295° to 304°.
31	305° to 314°.
32	315° to 324° NW.
33	325° to 334°.
34	335° to 344° NNW.
35	345° to 354°.
36	355° to 4° N.
99	Direction variable or unknown.

Space	Item	Instructions

48 Wave height

Table 6

-STATE OF SEA-

WIND WAVES

Code	Description	Height Meters
0	Calm-glassy-----	0
1	Calm-ripples----	0-1/10
2	Smooth-wavelets-	1/10-1/2
3	Slight----------	1/2-1 1/4
4	Moderate--------	1 1/4-2 1/2
5	Rough-----------	2 1/2-4
6	Very rough------	4-6
7	High------------	6-9
8	Very high-------	9-14
9	Phenomenal------	over 14

Space	Item	Instructions
49	Wave period	Number of seconds crest to crest.
50-51	Wind Dir.	Same as for waves - use Table 5.
52-53	Wind Speed	In meters per second

Table 7 VELOCITY CONVERSION-KNOTS TO METERS PER SECOND

Knots	0	1	2	3	4	5	6	7	8	9
00	00.0	00.5	01.0	01.5	02.1	02.6	03.1	03.6	04.1	04.6
10	05.2	05.7	06.2	06.7	07.2	07.7	08.2	08.8	09.3	09.8
20	10.3	10.8	11.3	11.8	12.4	12.9	13.4	13.9	14.4	14.9
30	15.4	16.0	16.5	17.0	17.5	18.0	18.5	19.1	19.6	20.1
40	20.6	21.1	21.6	22.1	22.7	23.2	23.7	24.2	24.7	25.2
50	25.7	26.3	26.8	27.3	27.8	28.3	28.8	29.3	29.9	30.4
60	30.9	31.4	31.9	32.4	33.0	33.5	34.0	34.5	35.0	35.5
70	36.0	36.6	37.1	37.6	38.1	38.6	39.1	39.6	40.2	40.7
80	41.2	41.7	42.2	42.7	43.2	43.8	41.3	44.8	45.3	45.9
90	46.3	46.9	47.4	47.9	48.4	48.9	40.4	49.9	50.5	51.0

Space	Item	Instructions
54-56	Barometer	Barometric Pressure in millibars using only two digits to the left of the decimal and one to the right. 1021.6 becomes "21.6" 997.4 becomes "97.4", Table 14
57-62	Air temperature	Wet and dry bulb in °C to one decimal place (Relative humidity and temperature conversion tables are in H.O. 607).
63-64	Weather	By code, Table 8
65	Cloud type	By code, Table 9
66	Cloud cover	By code, Table 10
67	Visibility	By code, Table 11

Space	Item	Instructions
68-70	Relative humidity in %	(Rain = 100%) From Bridge Log Sheet or calculated from wet/dry temperatures.
74-76	Cruise Number	From Bridge Log Sheet - Table 16
77-79	Station Number	From Bridge Log Sheet - Table 16
80		Blank

Chronological Record of Events

In the upper right corner of the Oceanographic Station Log (Table 15) is space to record the number of pages required for the particular station and time zone.

Each cast is numbered sequentially with the times for each part of a cast and the wire angle at the time the messenger was dropped. The time the cast was down and the messenger times are critical. All spaces should be filled in here including the initials of the scientific crew (observers).

Parameter Card

Space	Item	Instructions
1	Cast Number	Taken from the timed events recorded in the upper right
2-5	Local Messenger Time	Taken from the timed events recorded in the upper right
6-9	Last Applicable Depth	Deepest depth sampled on this cast
10-11	Wire Angle	In degrees
12-15	Final Down Reading	Deepest depth plus the distance from the Hero's platform to the water surface.
16-19	Oxygen titer	Concentration factor to determine oxygen values.(From titration standardization - Table 17.)
20-38		Repeat of 1-19 for Cast 2
39-57		Repeat of 20-38 for Cast 3 (The ocean station program is limited to 3 casts per station.)

Space	Item	Instructions
58-65		Blank
66-69	Meter Wheel Factor	Calibration of Meter Wheel
70-71	Time Zone	Zones from the Greenwich Meridian.
72-73	Card No. of	Page No. of total pages for the station.
74-79	Reference Number	Cruise and station numbers
80		Blank

Data Card

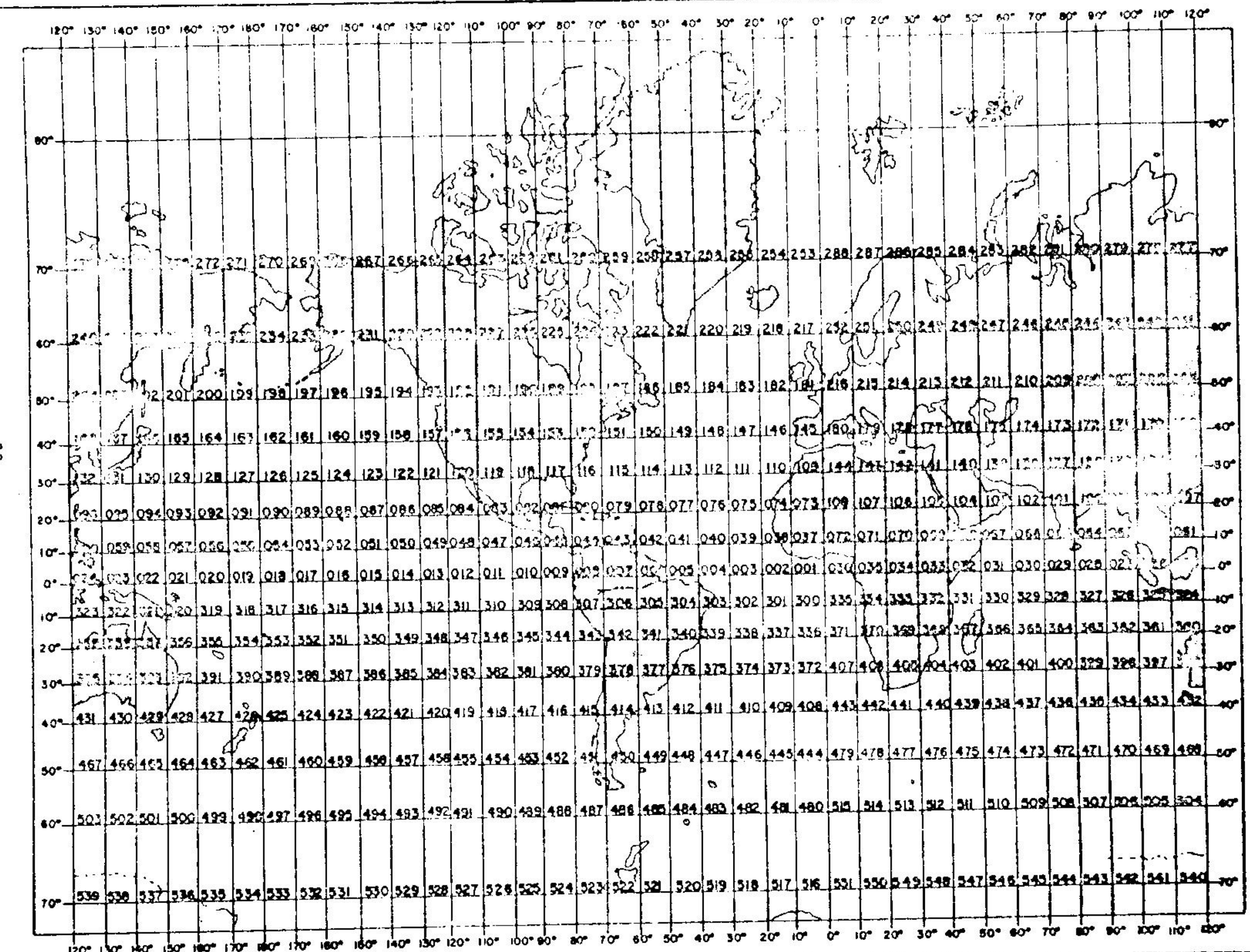
One card is punched for each sample depth, however, two lines are used for each depth to allow space for two readings on each thermometer and extra samples.

Space	Item	Instructions
1	Cast	Cast Number
2-5	Estimated Depth	Arrange numbers in their respective columns to avoid confusion.
6-9	Meter Wheel	Meter wheel reading is the deepest sampling depth minus the estimated depth.
10-11	Slip No.	Amount a bottle slips on the wire during the cast, i.e., the down reading minus the up reading of the meter wheel.
12-13	Reversing Bottle No.	The number of the particular sample bottle.
14-18	Thermometer No.	Serial number of the left deep sea reversing thermometer.
19-22	Big "T"	The reading of the main thermometer to one hundredth of a degree C.
23-25	Little "t"	The reading of the auxiliary thermometer to one tenth of a degree C.
26-37		Repeat of 14-25 for the middle thermometer.

Space	Item	Instructions
38-49		Repeat of 26-37 for the right thermometer (usually an unprotected thermometer).
50-52	Bot.	Salinity bottle number.
53-57	Bridge	Salinity as determined by the induction salinometer to a thousandth of a part per thousand.
58-60	Bot.	Oxygen bottle number. (After the oxygen values have been recorded, the spaces 58-60 can be used to enter the thermometric depths).
61-64	Titra	The amount of titer required to titrate the oxygen samples to a hundredth of a milliliter.
65-67	Phos.	(Nutrient bottle numbers are recorded (on the right side on shipboard, later (covered with the nutrient concentration (values for key punching.
68-71	Nitra	
72-73		
74-79	Reference No.	Cruise and station numbers
80	Control No.	3 for continued data, 5 for end of station and Ø for end of data.

MARSDEN SQUARES

Table 3 complete



PART II

OCEANOGRAPHIC CODES AND TABLES

Table 8—WEATHER STATE CODE

00–49. No precipitation at the ship at the time of observation.

00–19. No precipitation, fog, duststorm, sandstorm, or drifting snow at the ship at the time of observation or during the preceding hour, except for 09.

00	Cloud development not observed or not observable.	*No hydrometeors except clouds.*
01	Clouds generally dissolving or becoming less developed.	
02	State of sky on the whole unchanged.	*Characteristic change of the state of sky during past hour.*
03	Clouds generally forming or developing.	
04	Visibility reduced by smoke, e. g., veldt or forest fires, industrial smoke, or volcanic ashes.	*Haze, dust, sand, or smoke.*
05	Dry haze.	
06	Widespread dust in suspension in the air, not raised by wind at or near the ship at the time of observation.	
07	Dust or sand raised by wind at or near the ship at the time of observation, but no well developed dust devil(s), and no duststorm or sandstorm seen.	
08	Well-developed dust devil(s) seen at or near the ship within last hour, but no duststorm or sandstorm.	
09	Duststorm or sandstorm within sight of the ship or at the ship during the last hour.	
10	Light fog (visibility 1,100 yards or more).	
11	Patches of.	*Shallow fog at the ship not deeper than about 33 feet.*
12	More or less continuous.	
13	Lightning visible, no thunder heard.	
14	Precipitation within sight, but not reaching surface at the ship.	
15	Precipitation within sight, reaching surface, but distant (i. e., estimated to be more than 3 miles from the ship).	
16	Precipitation within sight, reaching surface, near to but not at the ship.	
17	Thunder heard, but no precipitation at the ship	
18	Squall(s).	*Within sight during the last hour.*
19	Funnel cloud(s) (tornado or water-spout).	

20–29. Precipitation, fog or thunderstorm at the ship during the preceding hour but NOT at the time of observation.

20	Drizzle (not freezing)	*Not falling as showers.*
21	Rain (not freezing).	
22	Snow.	
23	Rain and snow.	
24	Freezing drizzle or freezing rain.	
25	Shower(s) of rain.	
26	Shower(s) of snow, or of rain and snow.	
27	Shower(s) of hail or of hail and rain.	
28	Fog.	
29	Thunderstorm (with or without precipitation).	

30–39. Duststorm, sandstorm, or drifting snow.

30	Slight or moderate duststorm or sandstorm.	*Has decreased during preceding hour.*
31	Slight or moderate duststorm or sandstorm.	*No appreciable change during preceding hour.*
32	Slight or moderate duststorm or sandstorm.	*Has increased during preceding hour.*
33	Severe duststorm or sandstorm.	*Has decreased during preceding hour.*

Table 8 (continued)

34	Severe duststorm or sandstorm.	*No appreciable change during preceding hour.*
35	Severe duststorm or sandstorm.	*Has increased during preceding hour.*
36	Slight or moderate drifting snow.	*Generally low.*
37	Heavy drifting snow.	
38	Slight or moderate drifting snow.	*Generally high.*
39	Heavy drifting snow.	

40–49. Fog at the time of observation.

40	Fog at a distance at the time of observation, but not at the ship during the last hour, the fog extending to a level above that of the observer.	
41	Fog in patches.	
42	Fog, sky discernible.	*Has become thinner during preceding hour.*
43	Fog, sky not discernible.	
44	Fog, sky discernible.	*No appreciable change during preceding hour.*
45	Fog, sky not discernible.	
46	Fog, sky discernible.	*Has begun or has become thicker during preceding hour.*
47	Fog, sky not discernible.	
48	Fog, depositing rime, sky discernible.	
49	Fog, depositing rime, sky not discernible.	

50–99. Precipitation at the ship at the time of observation.

50–59. Drizzle at time of observation.

50	Drizzle, not freezing, intermittent.	*Slight at time of observation.*
51	Drizzle, not freezing, continuous.	
52	Drizzle, not freezing, intermittent.	*Moderate at time of observation.*
53	Drizzle, not freezing, continuous.	
54	Drizzle, not freezing, intermittent.	*Thick at time of observation.*
55	Drizzle, not freezing, continuous.	
56	Drizzle, freezing, slight.	
57	Drizzle, freezing, moderate or thick.	
58	Drizzle and rain, slight.	
59	Drizzle and rain, moderate or heavy.	

60–69. Rain at time of observation.

60	Rain, not freezing, intermittent.	*Slight at time of observation.*
61	Rain, not freezing, continuous.	
62	Rain, not freezing, intermittent.	*Moderate at time of observation.*
63	Rain, not freezing, continuous.	
64	Rain, not freezing, intermittent.	*Heavy at time of observation.*
65	Rain, not freezing, continuous.	
66	Rain, freezing, slight.	
67	Rain, freezing, moderate or heavy.	
68	Rain or drizzle and snow, slight.	
69	Rain or drizzle and snow, moderate or heavy.	

70–79. Solid precipitation not in showers at time of observation.

70	Intermittent fall of snow flakes.	*Slight at time of observation.*
71	Continuous fall of snow flakes.	
72	Intermittent fall of snow flakes.	*Moderate at time of observation.*
73	Continuous fall of snow flakes.	
74	Intermittent fall of snow flakes.	*Heavy at time of observation.*
75	Continuous fall of snow flakes.	
76	Ice needles (with or without fog).	
77	Granular snow (with or without fog).	
78	Isolated starlike snow crystals (with or without fog).	
79	Ice pellets.	

80–99. Showery precipitation, or precipitation with current or recent thunderstorm.

80	Rain shower(s), slight.	
81	Rain shower(s), moderate or heavy.	
82	Rain shower(s), violent.	
83	Shower(s) of rain and snow mixed, slight.	
84	Shower(s) of rain and snow mixed, moderate or heavy.	
85	Snow shower(s), slight.	
86	Snow shower(s), moderate or heavy.	
87	Shower(s) of soft or small hail with or without rain, or rain and snow, slight.	
88	Shower(s) of soft or small hail with or without rain, or rain and snow mixed, moderate or heavy.	
89	Shower(s) of hail with or without rain, or rain and snow mixed, not associated with thunder, slight.	
90	Shower(s) of hail, with or without rain, or rain and snow mixed, not associated with thunder, moderate or heavy.	
91	Slight rain at time of observation.	*Thunderstorm during preceding hour but not at time of observation.*
92	Moderate or heavy rain at time of observation.	
93	Slight snow, or rain and snow mixed, or hail* at time of observation.	
94	Moderate or heavy snow, or rain and snow mixed, or hail* at time of observation.	

* Hail, small hail, soft hail.

95 **Thunderstorm,** slight or moderate, without hail* but with rain and/or snow at time of observation.

96 **Thunderstorm,** slight or moderate, with hail* at time of observation.

Thunderstorm at time of observation.

97 **Thunderstorm,** heavy, without hail* but with rain and/or snow at time of observation.

98 Thunderstorm combined with duststorm or sandstorm at time of observation

99 Thunderstorm, heavy, with hail* at time of observation.

*Hail, small hail, soft hail.

Table 9.—CLOUD TYPE CODE

Code	*Cloud type*
0	Stratus or Fractostratus (St or Fs).
1	Cirrus (Ci).
2	Cirrostratus (Cs).
3	Cirrocumulus (Cc).
4	Altocumulus (Ac).
5	Altostratus (As).
6	Stratocumulus (Sc).
7	Nimbostratus (Ns).
8	Cumulus or Fractocumulus (Cu or Fc).
9	Cumulonimbus (Cb).

Use code for SIGNIFICANT cloud layer.

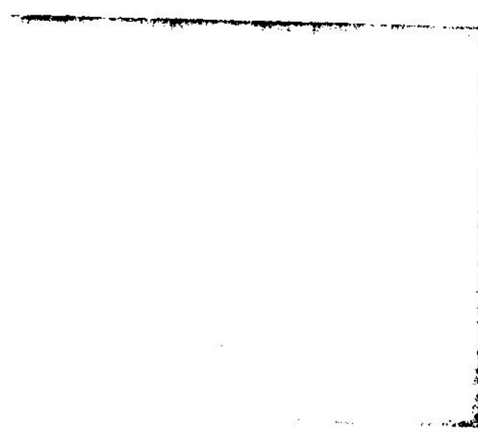
CLOUD TYPES

Compiled by the U. S. Weather Bureau to aid in the interpretation and coding of cloud observations.

Family "A" High Clouds: Cirrus (Ci), Cirrocumulus (Cc). Mean lower level, 6,000 meters, 20,000 feet.

CODE 1

CIRRUS →

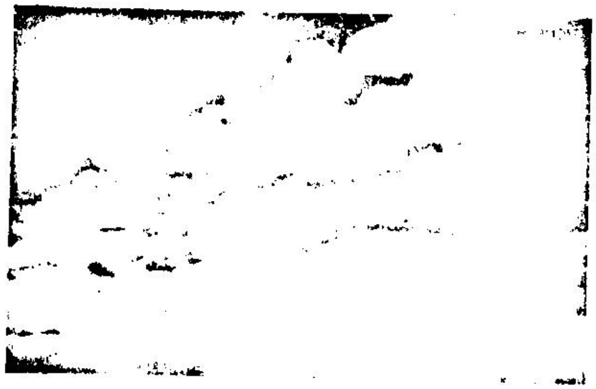


(NOTE.—*Further illustrations and descriptions of clouds are contained in U. S. Weather Bureau Circular S, Second Edition, "Manual of Cloud Forms and Codes for States of the Sky." This publication may be obtained by cooperating marine observers at U. S. Weather Bureau Port Offices and Marine Centers.)*

CODE 1

CIRRUS →

H1: Filaments or strands of cirrus scattered and not increasing (often "Mares' Tails").

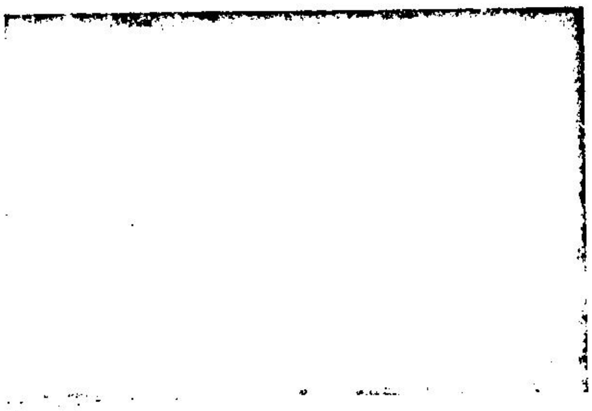


← CIRRUS

CODE 1

H2: **Dense cirrus** in patches or twisted sheaves **usually** not increasing; possibly but not certainly the remains of the upper part of cumulonimbus.

Table 9 (continued)



← CIRRUS **CODE 1**

H3: Cirrus, often anvil-shaped; either the remains of the upper portions of cumulonimbus or part of a distant cumulonimbus, the rest of which is not visible.

(See notes on L9 for coding requirements when cumulonimbus is present.)

← CIRRUS **CODE 1**

H4: Cirrus (often hook-shaped) gradually spreading over the sky and usually thickening as a whole.

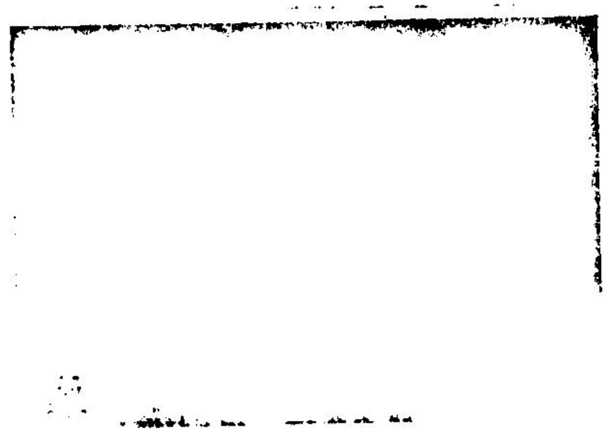
The essential characteristic is the gradual spreading over the sky.

Note that these clouds must extend to the horizon from which they are advancing, where owing to the effect of perspective they may assume the appearance of cirrostratus.

CODES 1 & 2 CIRRUS & CIRROSTRATUS →

H5: Cirrus and cirrostratus, often in bands converging toward the horizon; or cirrostratus alone; in either case gradually spreading over the sky and usually thickening as a whole, but the continuous layer not reaching 45° altitude.

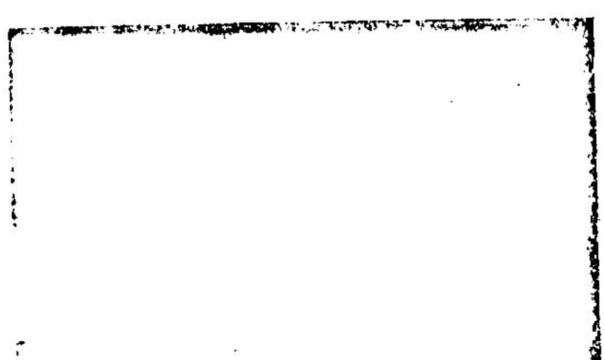
When cirrus is present, the angular altitude refers to the leading edge of the cirrostratus layer.



CODES 1 & 2 CIRRUS & CIRROSTRATUS →

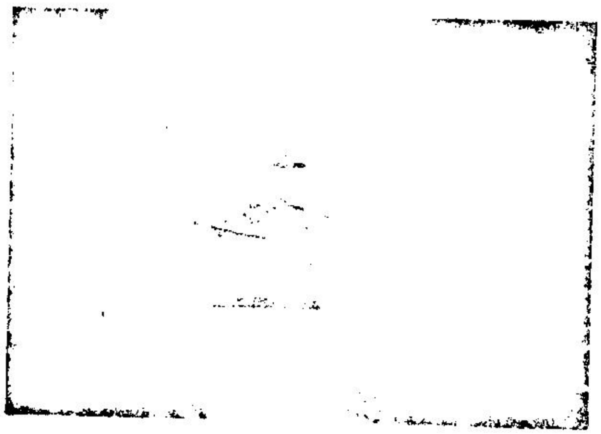
H6: Cirrus and cirrostratus often in bands converging toward the horizon; or cirrostratus alone; in either case gradually spreading over the sky and usually thickening as a whole, and the continuous layer exceeding 45° altitude.

When cirrus is present, the angular altitude refers to the leading edge of the cirrostratus layer.



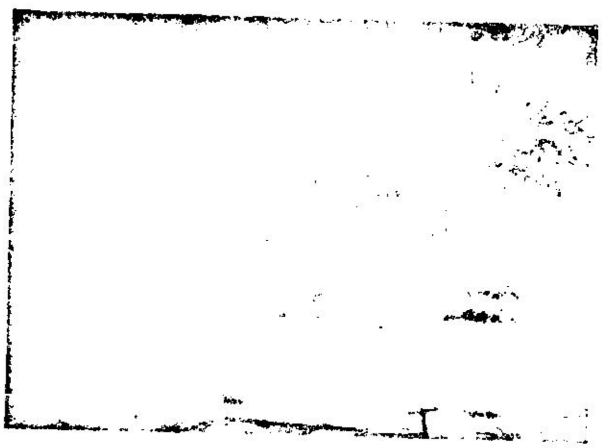
CODE 2 CIRROSTRATUS →

H7: Cirrostratus covering the entire sky.
During the day, when the sun is sufficiently high above the horizon, the sheet is never thick enough to prevent shadows of objects on the ground.



← CIRROSTRATUS CODE 2

H8: Cirrostratus not increasing and not covering the whole sky; cirrus and cirrocumulus may be present.
If cirrocumulus is present, the cirrostratus must predominate to satisfy the requirements of Code 2. If the cirrocumulus predominates, the sky would be coded as Code 3.



← CIRROCUMULUS CODE 3

H9: Cirrocumulus alone or cirrocumulus with some cirrus or cirrostratus, but the cirrocumulus being the main cirriform cloud present. (Cirrocumulus may be present in Code 1 to Code 2.

Family "B" Middle Clouds: Altocumulus (Ac), Altostratus (As). Mean upper level, 6,000 meters, 20,000 feet; mean lower level, 2,000 meters, 6,500 feet.

← ALTOSTRATUS CODE 5

M1: Thin altostratus (semitransparent everywhere) through which the sun or moon can be dimly seen. A sheet of this cloud resembles thick cirrostratus from which it is often derived without any break; but halo phenomena, sun pillar, etc., are not seen in cirrostratus, and the sun or moon appears as though shining through ground glass and does not cast shadows.

Table 9 (continued)

ALTOSTRATUS OR NIMBOSTRATUS →

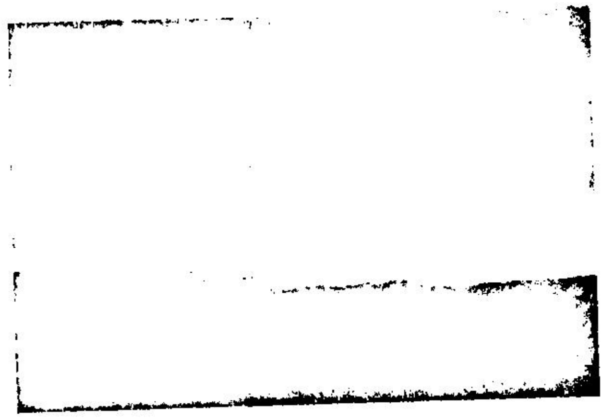
CODES 5 & 7

M2: Thick altostratus or nimbostratus (through portions of the sheet the position of the sun or moon may be indicated by a light patch).

The sun and moon are completely hidden by at least some parts of the cloud sheet, which may be fibrous in appearance. Thick altostratus can be formed either by thickening of thin altostratus or by the fusing together of cloudlets in a sheet of altocumulus.

Nimbostratus is derived either by a change from thick altostratus or by the fusing together of the cloud elements in a sheet of dense altocumulus, stratocumulus, or stratus.

When nimbostratus gives precipitation it is in the form of continuous rain or snow. Nimbostratus usually has a dark gray color and its lower surface always has a wet appearance, widespread trailing precipitation, "virga," which may or may not reach the ground; it is quite uniform and it is not possible to make out definite detail.



ALTOCUMULUS →

CODE 4

M3: Thin (semitransparent) altocumulus; cloud elements not changing much; at a single level.

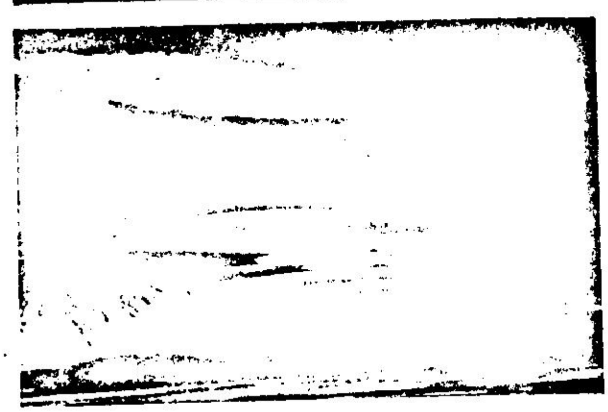
This cloud is fairly regular and of uniform thickness. The cloudlets or waves are always separated by clear spaces or lighter patches and are neither very large nor very dark.

ALTOCUMULUS →

CODE 4

M4: Thin (semitransparent) altocumulus in patches (often almond- or fish-shaped); cloud elements continually changing and/or occurring at more than one level.

Lenticular patches often pile up in layers, at times with clear spaces between. They also merge horizontally in the form of rafts or somewhat discontinuous sheets.



← ALTOCUMULUS

CODE 4

M5: Thin (semitransparent) altocumulus in bands or in a layer gradually spreading over the sky and usually thickening as a whole; it may become partly opaque or double-layered.

M5 designates one or perhaps two advancing layers of altocumulus, usually of irregular thickness, the amount and thickness of which are definitely increasing. The altocumulus stretches to the horizon, at least in the direction from which it is advancing.

Table 9 (continued)

← ALTOCUMULUS Code 4

M6: Altocumulus formed by the spreading out of cumulus.

Cumulus clouds of sufficiently great vertical development may undergo an extension of their summits while their bases may gradually melt away. Sheets of altocumulus, which are generally fairly thick and opaque at first, are formed in this manner. They have rather large elements, dark and soft; later they may thin out and finally have rifts in them or, at any rate, semitransparent intervening spaces.

When there is doubt as to whether a spreading sheet should be termed altocumulus or stratocumulus, it is best to code 4, since the cumulus clouds may then also be coded 8.

← ALTOSTRATUS & ALTOCUMULUS Codes 4 & 5

M7: Any of the following cases:

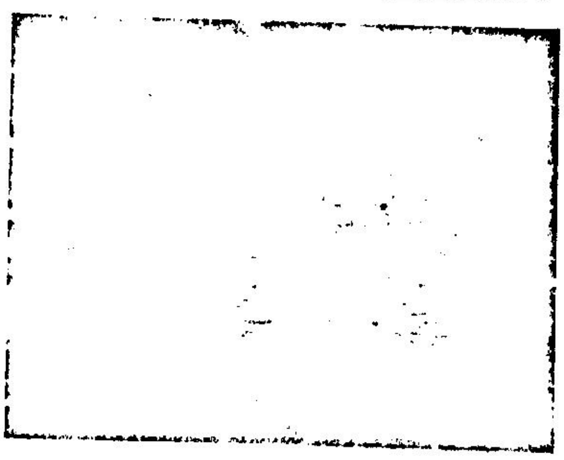
(*a*) Double-layered altocumulus, usually opaque in parts, not increasing.

(*b*) A thick (opaque) layer of altocumulus, not increasing.

(*c*) Altostratus and altocumulus both present at the same or different levels.

Type (*a*): Two layers of altocumulus, the lower of which resembles a gray veil, often hardly visible, lying at a level very little lower in places and for a short time hiding the cloudlets of the altocumulus sheet sufficiently to give it the appearance of altostratus. This double-layered altocumulus is coded M7 only if the altocumulus is not systematically increasing; otherwise it is coded M5.

Type (*b*): The under surface of opaque altocumulus is marked by a more or less corrugated or wave-like structure, sometimes called wrinkled.



← ALTOCUMULUS Code 4

M8: Altocumulus in the form of cumulus-shaped tufts or altocumulus with turrets.

Tufted altocumulus are white or gray cloudlets that have no definite shadows and that have very slightly domed tops. The tufts resemble very small broken cumulus clouds whose bases are not flat. Turreted altocumulus shows somewhat greater vertical development than the tufted form. The turrets rise from a common flat base.

Table 9 (continued)

← ALTOCUMULUS Code 4

M9: Altocumulus of a chaotic sky; generally at more than two different levels; dense cirrus in patches is usually also present.

These clouds are characterized by a lack of regularity with respect to form and distribution in space, both horizontally and vertically.

Family "C" Low Clouds: Stratocumulus (Sc), Stratus (St), Nimbostratus (Ns). Mean upper level, 2,000 meters, 6,500 feet; mean lower level, close to surface.

Family "D" Clouds With Vertical Development: Cumulus (Cu), Cumulonimbus (Cb).

Code 8 CUMULUS →

L1: Cumulus with little vertical development and seemingly flattened.

These clouds occur in three forms:

A. In a state of formation.
B. Completely formed.
C. Completely formed but broken up by the wind (fractocumulus).

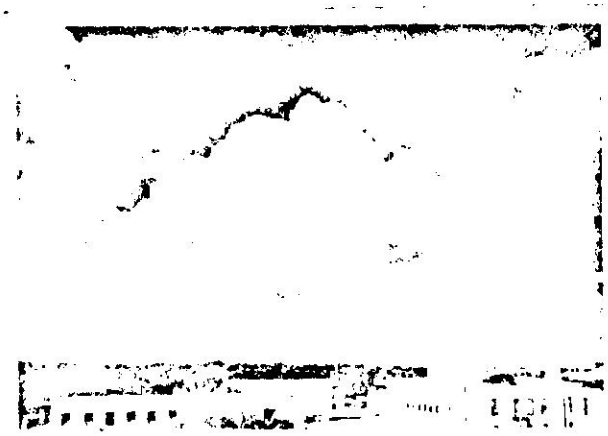
They usually have a marked diurnal growth over land, developing until the middle of the afternoon and decreasing later, both as to amount and vertical extent. At sea and on coasts, cumulus clouds often occur at night.

The presence of even a single cumulonimbus with any amount of stratocumulus, stratus, or cumulus clouds will require coding.

When the cumulus clouds begin to spread out in any part of the sky, the clouds will be coded 6 rather than 8, unless the spreading portions form altocumulus, in which case they will be coded 4 and 8.

Fractocumulus of fine weather are detached white clouds usually in an otherwise clear sky. (See L7 for description of fracto cumulus of bad weather.)

Code 8 CUMULUS →

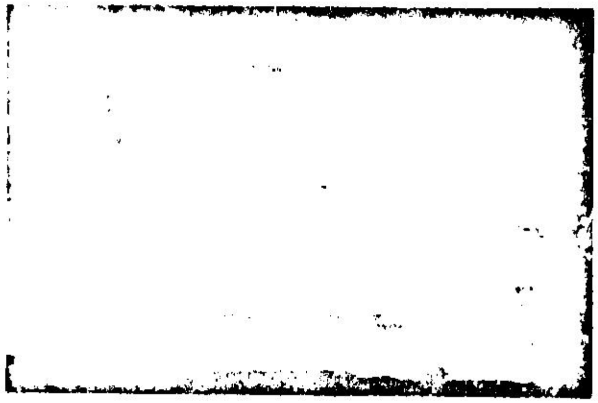


L2: Cumulus of considerable development, generally towering, with or without other cumulus or stratocumulus; bases all at the same level.

These clouds are massive in appearance, occasionally wind-tossed and broken, with horizontal bases and very great vertical development. They are sometimes in the form of towers or of complex heaps with "cauliflower" formation. They often have caps or hoods (pileus), which are distinguished from the spreading tops of cumulonimbus by their smoothness, sharpness, and short duration (a few minutes).

(See L8 for the coding of cumulus of considerable development and stratocumulus with bases at different levels.)

Table 9 (continued)



← CUMULONIMBUS **Code 9**

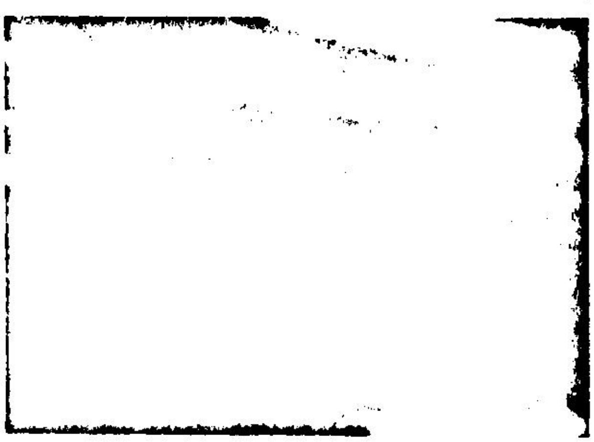
L3: Cumulonimbus with tops lacking clear-cut outlines but distinctly not cirriform or anvil-shaped; with or without cumulus, stratocumulus, or stratus.

These are cumuliform clouds of great vertical development with tops composed in part at least of ice crystals, the presence of which is revealed by a partial or general indefiniteness of previously well-defined "cauliflower" tops.

(See L9 for the coding of cumulonimbus having clearly fibrous tops.)

← STRATOCUMULUS **Code 6**

L4: Stratocumulus formed by the spreading out of cumulus; cumulus also often present.



← STRATOCUMULUS **Code 6**

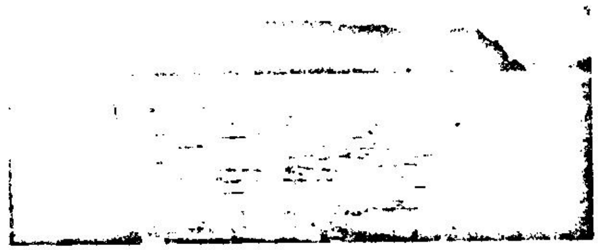
L5: Stratocumulus not formed by the spreading out of cumulus.

This includes a wide variety of aspects of stratocumulus, ranging from thin clouds at a single level with semitransparent parts or even clear spaces, to the dark and menacing clouds, often at two or more levels, immediately before or after precipitation. Code 6 applies only in the absence of fractocumulus of bad weather, cumulus, or cumulonimbus. If stratus and stratocumulus are both present, code 6 applies while stratocumulus is dominant.

Table 9 (continued)

STRATUS OR FRACTOSTRATUS →

Code 0



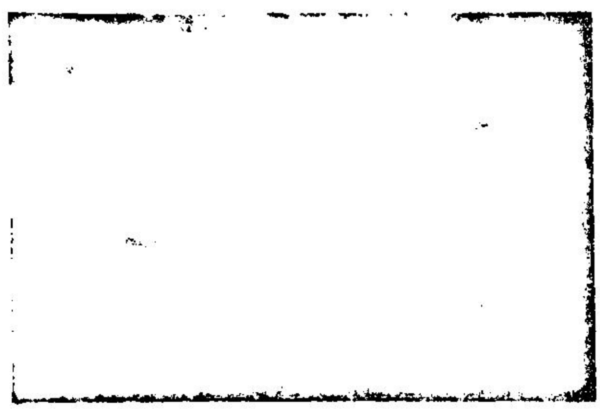
L6: Stratus or Fractostratus, or both, but not fractostratus of bad weather.

These clouds are usually in a low single layer and may be localized in extent. Clouds properly coded 0, unlike those coded 0 and 8, are not very dark or menacing.

The designation "fractostratus" is used when a layer of stratus is broken up into irregular shreds.

FRACTOSTRATUS OR FRACTOCUMULUS

Codes 0 & 8 →



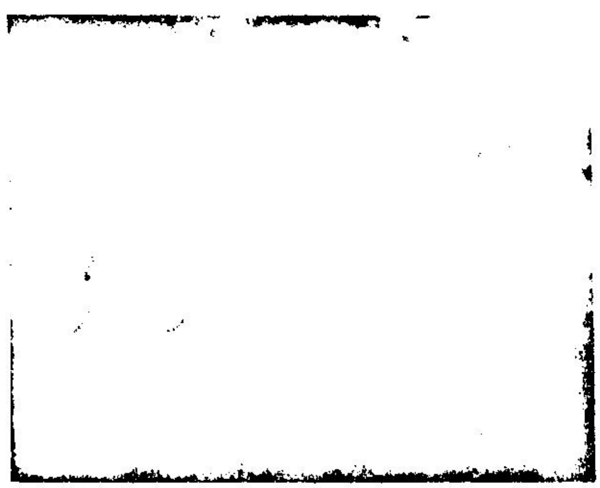
L7: Fractostratus and/or fractocumulus of bad weather ("scud") usually under altostratus and nimbostratus. (By "bad weather" is meant the conditions usually prevailing immediately before, during, or immediately after precipitation.)

Fractocumulus clouds of bad weather are usually dark, receive little light; these clouds generally become very numerous and may merge into a sheet covering the entire sky.

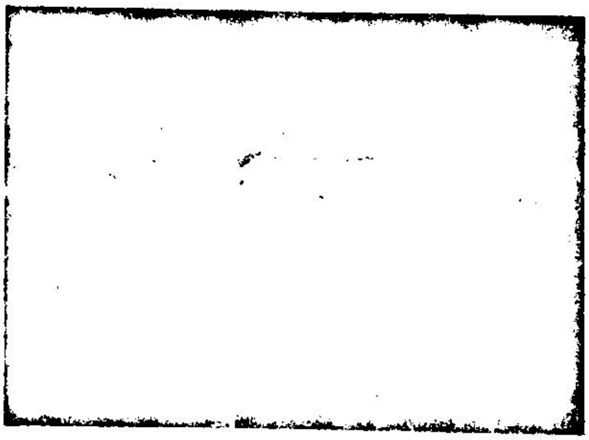
(See L1 for description of fractocumulus of good weather.)

CUMULUS & STRATOCUMULUS →

Codes 6 & 8



L8: Cumulus and stratocumulus other than those formed by the spreading out of cumulus with bases at different levels. The lower cumulus clouds may or may not extend up through the upper stratocumulus layer.



← CUMULONIMBUS **Code 9**

L9: Cumulonimbus having a clearly fibrous (cirriform) top, often anvil-shaped, with or without cumulus, stratocumulus, or stratus, or "scud."

By extension at various levels, cumulonimbus often produces cirrus, altocumulus, or stratocumulus clouds. Therefore, cumulonimbus may coexist with clouds that should be coded, when detached from the parent cloud, Code 1 or 2 If these clouds are not detached, they should not be coded separately.

Cumulonimbus clouds generally produce showers of rain or snow and sometimes of hail, and often thunderstorms as well.

If the whole of the cloud cannot be seen the fall of a real heavy shower is enough to characterize the cloud as a cumulonimbus.

Table 10-CLOUD COVER CODE

Code	*Amount of sky covered in tenths*
0	No clouds.
1	Less than 1 and 1.
2	2 and 3.
3	4.
4	5.
5	6.
6	7 and 8.
7	9 and 9 plus.
8	10.
9	Sky obscured.

Table 11-VISIBILITY CODE

[Use range-finder readings of known landmarks if possible.]

Code	Objects not visible at—	Description
0	50 yards	Dense fog.
1	200 yards	Thick fog.
2	400 yards	Fog.
3	1,000 yards	Moderate fog.
4	1 nautical mile	Thin fog or mist.
5	2 nautical miles	Visibility poor.
6	5 nautical miles	Visibility moderate.
7	10 nautical miles	Visibility good.
8	30 nautical miles	Visibility very good.
9	Over 30	Visibility excellent.

Table 12.—DEPTH CONVERSION—FATHOMS TO METERS

[1 fathom=1.8285 meters]

Fathoms	0	1	2	3	4	5	6	7	8	9
0	0.0	1.8	3.7	5.5	7.3	9.1	11.0	12.8	14.6	16.5
10	18.3	20.1	21.9	23.8	25.6	27.4	29.3	31.1	32.9	34.7
20	36.6	38.4	40.2	42.1	43.9	45.7	47.5	49.4	51.2	53.0
30	54.9	56.7	58.5	60.3	62.2	64.0	65.8	67.7	69.5	71.3
40	73.2	75.0	76.8	78.6	80.5	82.3	84.1	86.0	87.8	89.6
50	91.4	93.3	95.1	96.9	98.8	100.6	102.4	104.2	106.1	107.9
60	109.7	111.6	113.4	115.2	117.0	118.9	120.7	122.5	124.4	126.2
70	128.0	129.8	131.7	133.5	135.3	137.2	139.0	140.8	142.6	144.5
80	146.3	148.1	150.0	151.8	153.6	155.4	157.3	159.1	160.9	162.8
90	164.6	166.4	168.2	170.1	171.9	173.7	175.6	177.4	179.2	181.0
100	182.9	184.7	186.5	188.4	190.2	192.0	193.8	195.7	197.5	199.3
110	201.2	203.0	204.8	206.7	208.5	210.3	212.1	214.0	215.8	217.6
120	219.5	221.3	223.1	224.9	226.8	228.6	230.4	232.3	234.1	235.9
130	237.7	239.6	241.4	243.2	245.1	246.9	248.7	250.5	252.4	254.2
140	256.0	257.9	259.7	261.5	263.3	265.2	267.0	268.8	270.7	272.5
150	274.3	276.1	278.0	279.8	281.6	283.5	285.3	287.1	288.9	290.8
160	292.6	294.4	296.3	298.1	299.9	301.7	303.6	305.4	307.2	309.1
170	310.9	312.7	314.5	316.4	318.2	320.0	321.9	323.7	325.5	327.3
180	329.2	331.0	332.8	334.7	336.5	338.3	340.2	342.0	343.8	345.6
190	347.5	349.3	351.1	353.0	354.8	356.6	358.4	360.3	362.1	363.9
200	365.8	367.6	369.4	371.2	373.1	374.9	376.7	378.6	380.4	382.2
210	384.0	385.9	387.7	389.5	391.4	393.2	395.0	396.8	398.7	400.5
220	402.3	404.2	406.0	407.8	409.6	411.5	413.3	415.1	417.0	418.8
230	420.6	422.4	424.3	426.1	427.9	429.8	431.6	433.4	435.2	437.1
240	438.9	440.7	442.6	444.4	446.2	448.0	449.9	451.7	453.5	455.4
250	457.2	459.0	460.1	462.7	464.5	466.3	468.2	470.0	471.8	473.7
260	475.5	477.3	479.1	481.0	482.7	484.6	486.5	488.3	490.1	491.9
270	493.8	495.6	497.4	499.3	501.1	502.9	504.7	506.6	508.4	510.2
280	512.1	513.9	515.7	517.5	519.4	521.2	523.0	524.9	526.7	528.5
290	530.3	532.2	534.0	535.8	537.7	539.5	541.3	543.1	545.0	546.8

Fathoms	0	10	20	30	40	50	60	70	80	90
300	549	567	585	603	622	640	658	677	695	713
400	732	750	768	786	805	823	841	860	878	896
500	914	933	951	969	988	1,006	1,024	1,042	1,061	1,079
600	1,097	1,116	1,134	1,152	1,170	1,189	1,207	1,225	1,244	1,262
700	1,280	1,298	1,317	1,335	1,353	1,372	1,390	1,408	1,426	1,445
800	1,463	1,481	1,500	1,518	1,536	1,554	1,573	1,591	1,609	1,628
900	1,646	1,664	1,682	1,701	1,719	1,737	1,756	1,774	1,792	1,810

Fathoms	0	100	200	300	400	500	600	700	800	900
1,000	1,829	2,012	2,195	2,377	2,560	2,743	2,926	3,109	3,292	3,475
2,000	3,658	3,840	4,023	4,206	4,389	4,572	4,755	4,938	5,121	5,303
3,000	5,486	5,669	5,852	6,035	6,218	6,401	6,584	6,766	6,949	7,132
4,000	7,315	7,498	7,681	7,864	8,047	8,229	8,412	8,595	8,778	8,961
5,000	9,144	9,327	9,510	9,692	9,875	10,058	10,241	10,424	10,607	10,790
6,000	10,973	11,155	11,338	11,521	11,704	11,887	12,070	12,253	12,436	12,618
7,000	12,801	12,984	13,167	13,350	13,533	13,716	13,899	14,082	14,264	14,447
8,000	14,630	14,813	14,996	15,179	15,362	15,545	15,727	15,910	16,093	16,276
9,000	16,459	16,642	16,825	17,008	17,190	17,373	17,556	17,739	17,922	18,105

Table 13.—DEPTH CONVERSION—METERS TO FATHOMS

Meters	0	1	2	3	4	5	6	7	8	9
0	0. 0	0. 5	1. 1	1. 6	2. 2	2. 7	3. 3	3. 8	4. 4	4. 9
10	5. 5	6. 0	6. 6	7. 1	7. 7	8. 2	8. 7	9. 3	9. 8	10. 4
20	10. 9	11. 5	12. 0	12. 6	13. 1	13. 7	14. 2	14. 8	15. 3	15. 9
30	16. 4	17. 0	17. 5	18. 0	18. 6	19. 1	19. 7	20. 2	20. 8	21. 3
40	21. 9	22. 4	23. 0	23. 5	24. 1	24. 6	25. 2	25. 7	26. 2	26. 8
50	27. 3	27. 9	28. 4	29. 0	29. 5	30. 1	30. 6	31. 2	31. 7	32. 3
60	32. 8	33. 4	33. 9	34. 4	35. 0	35. 5	36. 1	36. 6	37. 2	37. 7
70	38. 3	38. 8	39. 4	39. 9	40. 5	41. 0	41. 6	42. 1	42. 7	43. 2
80	43. 7	44. 3	44. 8	45. 4	45. 9	46. 5	47. 0	47. 6	48. 1	48. 7
90	49. 2	49. 8	50. 3	50. 9	51. 4	51. 9	52. 5	53. 0	53. 6	54. 1
100	54. 7	55. 2	55. 8	56. 3	56. 9	57. 4	58. 0	58. 5	59. 1	59. 6
110	60. 1	60. 7	61. 2	61. 8	62. 3	62. 9	63. 4	64. 0	64. 5	65. 1
120	65. 6	66. 2	66. 7	67. 3	67. 8	68. 4	68. 9	69. 4	70. 0	70. 5
130	71. 1	71. 6	72. 2	72. 7	73. 3	73. 8	74. 4	74. 9	75. 5	76. 0
140	76. 6	77. 1	77. 6	78. 2	78. 7	79. 3	79. 8	80. 4	80. 9	81. 5
150	82. 0	82. 6	83. 1	83. 7	84. 2	84. 8	85. 3	85. 9	86. 4	86. 9
160	87. 5	88. 0	88. 6	89. 1	89. 7	90. 2	90. 8	91. 3	91. 9	92. 4
170	93. 0	93. 5	94. 1	94. 6	95. 1	95. 7	96. 2	96. 8	97. 3	97. 9
180	98. 4	99. 0	99. 5	100. 1	100. 6	101. 2	101. 7	102. 3	102. 8	103. 3
190	103. 9	104. 4	105. 0	105. 5	106. 1	106. 6	107. 2	107. 7	108. 3	108. 8
200	109. 4	109. 9	110. 5	111. 0	111. 6	112. 1	112. 6	113. 2	113. 7	114. 3
210	114. 8	115. 4	115. 9	116. 5	117. 0	117. 6	118. 1	118. 7	119. 2	119. 8
220	120. 3	120. 8	121. 4	121. 9	122. 5	123. 0	123. 6	124. 1	124. 7	125. 2
230	125. 8	126. 3	126. 9	127. 4	128. 0	128. 5	129. 0	129. 6	130. 1	130. 7
240	131. 2	131. 8	132. 3	132. 9	133. 4	134. 0	134. 5	135. 1	135. 6	136. 2
250	136. 7	137. 3	137. 8	138. 3	138. 9	139. 4	140. 0	140. 5	141. 1	141. 6
260	142. 2	142. 7	143. 3	143. 8	144. 4	144. 9	145. 5	146. 0	146. 5	147. 1
270	147. 6	148. 2	148. 7	149. 3	149. 8	150. 4	150. 9	151. 5	152. 0	152. 6
280	153. 1	153. 7	154. 2	154. 7	155. 3	155. 8	156. 4	156. 9	157. 5	158. 0
290	158. 6	159. 1	159. 7	160. 2	160. 8	161. 3	161. 9	162. 4	163. 0	163. 5

Meters	0	10	20	30	40	50	60	70	80	90
300	164	170	175	180	186	191	197	202	208	213
400	219	224	230	235	241	246	252	257	262	268
500	273	279	284	290	295	301	306	312	317	323
600	328	334	339	344	350	355	361	366	372	377
700	383	388	394	399	405	410	416	421	427	432
800	437	443	448	454	459	465	470	476	481	487
900	492	498	503	509	514	519	525	530	536	541

Meters	0	100	200	300	400	500	600	700	800	900
1,000	547	601	656	711	766	820	875	930	984	1, 039
2,000	1, 094	1, 148	1, 203	1, 258	1, 312	1, 367	1, 422	1, 476	1, 531	1, 586
3,000	1, 640	1, 695	1, 750	1, 804	1, 859	1, 914	1, 969	2, 023	2, 078	2, 133
4,000	2, 187	2, 242	2, 297	2, 351	2, 406	2, 461	2, 515	2, 570	2. 625	2, 679
5,000	2, 734	2, 789	2, 843	2, 898	2, 953	3, 007	3, 062	3, 117	3, 172	3, 226
6,000	3, 281	3, 336	3, 390	3, 445	3, 500	3, 554	3, 609	3, 664	3, 718	3, 773
7,000	3, 828	3, 882	3, 937	3, 992	4, 046	4, 101	4, 156	4, 210	4, 265	4, 320
8,000	4, 375	4, 429	4, 484	4, 539	4, 593	4, 648	4, 703	4, 757	4, 812	4, 867
9,000	4, 921	4, 976	5, 031	5, 085	5, 140	5, 195	5, 249	5, 304	5, 359	5, 413

Table 14A -BAROMETRIC PRESSURE CONVERSION—INCHES TO MILLIBARS

[Neglecting 900 and 1,000 millibars. For example: 45=945, and 03=1003.]

Inches	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
27.9	45	45	46	46	46	46	47	47	48	48
28.0	48	48	49	49	50	50	50	51	51	51
28.1	52	52	52	53	53	53	54	54	54	55
28.2	55	55	56	56	56	57	57	57	58	58
28.3	58	59	59	59	60	60	60	61	61	61
28.4	62	62	62	63	63	63	64	64	64	65
28.5	65	66	66	66	66	67	67	68	68	68
28.6	68	68	69	70	70	70	70	71	72	72
28.7	72	72	73	73	73	74	74	74	75	75
28.8	75	76	76	76	77	77	77	78	78	78
28.9	79	79	79	80	80	80	81	81	81	82
29.0	82	82	83	83	83	84	84	84	85	85
29.1	85	86	86	86	87	87	88	88	88	88
29.2	89	89	90	90	90	90	91	91	92	92
29.3	92	93	93	93	94	94	94	95	95	95
29.4	96	96	96	97	97	97	98	98	98	99
29.5	99	99	00	00	00	01	01	01	02	02
29.6	02	03	03	03	04	04	04	05	05	05
29.7	06	06	06	07	07	08	08	08	08	09
29.8	09	10	10	10	10	11	11	12	12	12
29.9	12	13	13	14	14	14	15	15	15	16
30.0	16	16	17	17	17	18	18	18	19	19
30.1	19	20	20	20	21	21	21	22	22	22
30.2	23	23	23	24	24	24	25	25	25	26
30.3	26	26	27	27	27	28	28	28	29	29
30.4	30	30	30	30	31	31	32	32	32	32
30.5	33	33	34	34	34	34	35	35	36	36
30.6	36	37	37	37	38	38	38	39	39	39
30.7	40	40	40	41	41	41	42	42	42	43
30.8	43	43	44	44	44	----	----	----	----	----

Table 14B -BAROMETRIC PRESSURE CONVERSION—MILLIMETERS TO MILLIBARS

[Neglecting 900 and 1,000 millibars. For example: 45=945, and 03=1003.]

Millimeters	0	1	2	3	4	5	6	7	8	9
720	60	61	63	64	65	67	68	69	71	72
730	73	75	76	77	79	80	81	83	84	85
740	87	88	89	91	92	93	95	96	97	99
750	00	01	03	04	05	07	08	09	11	12
760	13	15	16	17	19	20	21	23	24	25
770	27	28	29	31	32	33	35	36	37	39
780	40	41	43	44	45	47	48	49	51	52
790	53	55	56	57	59	60	61	63	64	65

Table 17. Oceanographic Station Log

OCEANOGRAPHIC STATION LOG — PUERTO RICO NUCLEAR CENTER

CRUISE & STATION NO PA-021 - 491

STATION NAME QTO-4C

VESSEL RV R.F. PALUMBO

LOCAL DATE 11-X-74

MASTER CARD

COUNTRY	SHIP	LATITUDE N	LONGITUDE W	MARSDEN SQUARE	YEAR	MO	DAY	HOUR GMT	STATION NAME	SONIC DEPT (232 FM.)	MAX. SAMP. DEPT.
31	--	18°32.5	Ø67°57.2	Ø43	74	1Ø	12	Ø2.4	QTO-4C	Ø424	Ø3

WATER COLOR	WATER TRANS	WAVES DIR	WAVES H	WAVES P	WIND DIR.	WIND SPEED	BAROM.	AIR TEMP. DRY °C	AIR TEMP. WET °C	WEATHER	CLOUD TY	CLOUD AM	VIS	REL. HUM.	CRUISE NO	STATION NO.
2Ø	2Ø	Ø8	2	5	Ø7	Ø4	15:4	28.2		Ø2	8	7	6	Ø8.2	Ø21	491

CAST	WIRE ANGLE	START TIME
1	8	22Ø2
2	12	2248

WINCH CARD ✓

BT. SLIDE NO. Ø5Ø88

PARAMETER CARD

CAST	MESS TIME OF CAST LOCAL TIME	LAST APPLICABLE DEPTH	WIRE ANGLE	FINAL DOWN READING ON METERWHEEL	OXYGEN TITER	CAST	MESS TIME OF CAST LOCAL TIME	LAST APPLICABLE DEPTH	WIRE ANGLE	FINAL DOWN READING ON METERWHEEL	OXYGEN TITER	CAST	MESS TIME OF CAST LOCAL TIME	LAST APPLICABLE DEPTH	WIRE ANGLE	FINAL DOWN READING ON METERWHEEL	OXYGEN TITER	METER WHEEL FACTOR	TIME ZONE	CA NO
1	2223	Ø1ØØ	Ø8	Ø1Ø3	1.Ø18	2	23Ø3	Ø3ØØ	12	Ø3Ø3	1.Ø18							Ø.997	Ø4	1

DETAIL & PARAMETER CARDS DUPLICATE COL: 74-79 FROM MASTER — DETAIL CARD A

CAST	ESTIMATED DEPTH (WIRE L.)	METER WHEEL	SLIP NO.	REV BOTT. NO.	LEFT THERMOMETER NO	LEFT T	LEFT t	MIDDLE THERMOMETER NO	MIDDLE T	MIDDLE t	RIGHT THERMOMETER NO.	RIGHT T	RIGHT t	SALINITY BOT	SALINITY BRIDGE	OXYGEN BOT	OXYGEN TITRA
1	ØØØØ	Ø1ØØ		Ø1	Y4829	26.47	27.9	Y4921	26.45	27.5	K1947	26.49	26.7	Ø46		126	
						26.49	28.4		26.43	27.9		26.54	26.8				
1	ØØ25	ØØ75		Ø2	Y4116	26.63	27.6	Y4832	26.6Ø	27.4	K1946	26.82	27.2	Ø47		127	
						26.61	27.9		26.62	27.8		26.81	27.5				
1	ØØ5Ø	ØØ5Ø		Ø3	K2612	26.82	28.3	Y4833	26.79	27.7	Y4729	26.2Ø	27.4	Ø48		128	
						26.81	28.Ø		26.77	27.8		27.22	27.8				
1	Ø1ØØ	ØØØØ		Ø4	K2613	24.79	27.7	26734	24.84	27.5	25632	25.23	26.8	Ø49		129	
						24.83	27.9		24.82	27.3		25.24	26.9				
2	Ø15Ø	Ø15Ø		Ø1	Y4829	23.Ø9	27.7	Y4921	23.11	27.Ø	K1947	24.18	27.Ø	Ø5Ø		13Ø	
						23.11	27.6		23.17	27.4		24.19	27.2				
2	Ø2ØØ	Ø1ØØ		Ø2	Y4116	21.62	27.6	Y4832	21.59	27.3	25632	22.17	27.Ø	Ø51		131	
						21.65	27.8		21.63	27.9		22.17	27.1				
2	Ø25Ø	ØØ5Ø		Ø3	K2612	19.43	27.7	Y4833	19.44	27.6	Y4729	2Ø.41	26.9	Ø52		132	
						19.39	27.8		19.41	27.3		2Ø.38	26.8				
2	Ø3ØØ	ØØØØ		Ø4	K2613	17.29	27.4	26734	17.3Ø	27.Ø	K1946	19.48	26.8	Ø53		133	
						17.33	27.8		17.31	27.3		19.46	26.9				

COMPUTER PROGRAMS

"REVTHR"

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C     THERMOMETER CORRECTION PROGRAM (04/04/73 - JK)                    AB
C     SPECIFICATION INFORMATION                                         AB
      LOGICAL LCRUZ,LSTA,LZ,LSTOR                                       AB
      DIMENSION     NTHRMA(50),ITYPEA(50),V0A(50),FKA(50),QA(50)        AB
      DIMENSION     AIMAIN(7,50),AIAUX(7,50)                            AB
      DIMENSION     RHOMA(31)                                           AB
      DIMENSION     TM1(2),TA1(2),DATE(4)                               AB
      DIMENSION     ITHRM(2),INDEX(3,2),TM(2,3,2),TA(2,3,2)
C                                                                       AB
C     THERMOMETER TABLE SET-UP AND OUTPUT                               AB
      WRITE(6,9000)                                                     AB
      WRITE(6,9001)                                                     AB
      NTABLE= 0                                                         AB
      N= 0                                                              AB
    1 N= N+1                                                            AB
    2 IF(N.GT.50)  GO TO 6                                              AB
      GO TO 4                                                           AB
    3 WRITE(6,9002)  N                                                  AB
    4 READ(5,8000,ERR=41)  NTHRMA(N),ITYPEA(N),V0A(N),FKA(N),QA(N)      AB
      GO TO  42                                                         AB
   41 READ(5,8010,ERR=3)                                                AB
      GO TO  3                                                          AB
   42 READ(5,8010,ERR=3)  NDUMMY,(AIMAIN(I,N),I=1,7),(AIAUX(I,N),I=1,7) AB
      IF(NTHRMA(N).LT.0)  GO TO 7                                       AB
      IF(ITYPEA(N).EQ.1.OR.ITYPEA(N).EQ.2)  GO TO 5                     AB
      WRITE(6,9003)  NTHRMA(N),ITYPEA(N)                                AB
      GO TO 4                                                           AB
    5 IF(NTHRMA(N).EQ.NDUMMY)  GO TO 1                                  AB
      WRITE(6,9004)  NTHRMA(N),NDUMMY                                   AB
      GO TO 4                                                           AB
    6 WRITE(6,9005)                                                     AB
    7 NTABLE= N-1                                                       AB
      WRITE(6,9006)  NTABLE                                             AB
      IF(NTABLE.LE.0)  CALL EXIT                                        AB
      WRITE(6,9007)                                                     AB
      WRITE(6,9008)  (NTHRMA(N),ITYPEA(N),V0A(N),FKA(N),QA(N),          AB
     1               (AIMAIN(I,N),I=1,7),(AIAUX(I,N),I=1,7),N=1,NTABLE) AB
      READ (5,8001)  (RHOMA(I),I=1,31)                                  AB
      WRITE(6,9009)                                                     AB
      WRITE(6,9010)  (RHOMA(I),I=1,31)                                  AB
      WRITE(6,9000)                                                     AB
C                                                                       AB
C     DATA READ SECTION AND BRANCH                                      AB
C     INITIALIZE COUNTERS ETC.                                          AB
      IEND= 0                                                           AB
      NCARD= 0                                                          AB
      ITHRM(1)= 0                                                       AB
      ITHRM(2)= 0                                                       AB
C     READ THERMOMETER DATA                                             AB
  500 NCARD= NCARD+1                                                    AB
      GO TO  501                                                        AB
 3000 WRITE(6,9300)      NCARD                                          AB
  501 READ(5,8002,END=1000,ERR=3000)  NBOT1,ZCABL1,NTHRM1,ITYPE1,(TM1(I)AB
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```
     1                   ,TA1(I),I=1,2),(DATE(I),I=1,4),ACRUZ1,NCRUZ1,NSTA1   AB
C       COMPUTE LOGICAL VARIABLES FOR BRANCHING                              AB
        LCRUZ= (ACRUZ1.EQ.ACRUZ).AND.(NCRUZ1.EQ.NCRUZ)                       AB
        LSTA =  NSTA1.EQ.NSTA                                                AB
        LZ    = (NBOT1.EQ.NBOT).AND.(ZCABL1.EQ.ZCABL)                        AB
        LSTOR= .NOT.((ITHRM(1).EQ.3).AND.(ITHRM(2).EQ.1))
C       BRANCH ON INTERSECTION OF LOGICAL VARIABLES                          AB
        IF(LCRUZ.AND.LSTA.AND.LZ.AND.LSTOR)  GO TO 2001                      AB
        GO TO 1001                                                           AB
C                                                                            AB
C       COMPUTATION SECTION                                                  AB
 1000   IEND= 1                                                              AB
 1001   CONTINUE                                                             AB
C       BYPASS COMPUTATION ON FIRST ENTRY                                    AB
        IF((ITHRM(1).EQ.0).AND.(ITHRM(2).EQ.0))  GO TO 1100                  AB
C       CHECK EXISTENCE OF PROTECTED READINGS                                AB
        IF(ITHRM(1).EQ.0)  GO TO 1030                                        AB
C       CORRECT PROTECTED READINGS AND OUTPUT                                AB
        I2= ITHRM(1)                                                         AB
        DO 1020 I=1,I2                                                       AB
        J=INDEX(I,1)                                                         AB
        WRITE(6,9101)   NTHRMA(J),ITYPEA(J)                                  AB
        DO 1010 K=1,2                                                        AB
        TMAIN= TM(K,I,1)                                                     AB
        TAUX = TA(K,I,1)                                                     AB
C       CHECK FOR SPURIOUS DATA (TM=TA=0.0)                                  AB
        IF((TMAIN.EQ.0.).AND.(TAUX.EQ.0.))  GO TO 1010                       AB
C       INTERPOLATE FOR INDEX CORRECTIONS AND WRITE                          AB
        CALL INTRPL(AIMAIN(1,J),5.,5.,7,TMAIN,EYEM,IERM)                     AB
        CALL INTRPL(AIAUX (1,J),5.,5.,7,TAUX ,EYEA,IERA)                     AB
        WRITE(6,9102)   TMAIN,EYEM,TAUX,EYEA                                 AB
        IF(IERM.NE.0)  WRITE(6,9103)                                         AB
        IF(IERA.NE.0)  WRITE(6,9104)                                         AB
        C=(TMAIN+V0A(J))*(TMAIN-TAUX-EYEA)/(FKA(J)-100.)                     AB
        TW=TMAIN+C+EYEM                                                      AB
        WRITE(6,9105)   TW                                                   AB
C       AVERAGE PROTECTED READINGS FOR COMPUTATION                           AB
        IF(K.EQ.1)   TWA=TW                                                  AB
        IF(K.EQ.2)   TWA=(TWA+TW)/2.                                         AB
 1010   CONTINUE                                                             AB
        IF(I.EQ.1)   TWAVG=TWA                                               AB
        IF(I.EQ.2)   TWAVG=(TWAVG+TWA)/2.                                    AB
        IF(I.EQ.3)   TWAVG=(2.*TWAVG+TWA)/3.
 1020   CONTINUE                                                             AB
        GO TO 1040                                                           AB
 1030   WRITE(6,9106)                                                        AB
C       CHECK EXISTENCE OF UNPROTECTED READINGS                              AB
 1040   IF(ITHRM(2).EQ.0)  GO TO 1060                                        AB   1
C       CORRECT UNPROTECTED READINGS AND OUTPUT                              AB   1
        J=INDEX(1,2)                                                         AB   1
        WRITE(6,9101)   NTHRMA(J),ITYPEA(J)                                  AB   1
        DO 1050 K=1,2                                                        AB   1
        TMAIN= TM(K,1,2)                                                     AB   1
```

```
      TAUX = TA(K,1,2)
C     CHECK FOR SPURIOUS DATA (TM=TA=0,0)
      IF((TMAIN.EQ.0.).AND.(TAUX.EQ.0.)) GO TO 1050
C     INTERPOLATE FOR INDEX CORRECTIONS AND WRITE
      CALL INTRPL(AIMAIN(1,J),5.,5.,7,TMAIN,EYEM,IERM)
      CALL INTRPL(AIAUX (1,J),5.,5.,7,TAUX ,EYEA,IERA)
      WRITE(6,9102)  TMAIN,EYEM,TAUX,EYEA
      IF(IERM.NE.0)  WRITE(6,9103)
      IF(IERA.NE.0)  WRITE(6,9104)
C     CHECK FOR EXISTENCE OF PROTECTED READING
      IF(ITHRM(1).EQ.0)  GO TO 1050
      C= (TMAIN+V0A(J))*(TWAVG-TAUX-EYEA)/FKA(J)
      TU= TMAIN+C*EYEM
      WRITE(6,9107)  TU
      IF(K.EQ.1)  TUA=TU
      IF(K.EQ.2)  TUA=(TUA+TU)/2.
 1050 CONTINUE
C     DEPTH COMPUTATION
C     CHECK FOR EXISTENCE OF PROTECTED READING
      IF(ITHRM(1).EQ.0)  GO TO 1100
C     INTERPOLATE FOR MEAN DENSITY, CYCLE ON THERMOMETRIC DEPTH
      ZTHERM=ZCABL
      DO 1055 I=1,2
      CALL INTRPL(RHOMA,0.,100.,31,ZTHERM,RHOM,IER)
      IF(IER.NE.0)  WRITE(6,9108)  ZTHERM
 1055 ZTHERM= (TUA-TWAVG)/RHOM/QA(J)
      WRITE(6,9009)
      WRITE(6,9109)  TWAVG,TUA,ZTHERM
      GO TO 1100
 1060 WRITE(6,9110)      TWAVG
 1100 CONTINUE
      IF(IEND.NE.0)  CALL EXIT
C
C     WRITE CHANGE OF STATUS HEADINGS
      IF(.NOT.LCRUZ)  WRITE(6,9111)  ACRUZ1,NCRUZ1
      IF(.NOT.LSTA)   WRITE(6,9112)  NSTA1,(DATE(I),I=1,4)
      IF(.NOT.LZ)     WRITE(6,9113)  ZCABL1,NBOT1
C
C     INITIALIZE STORAGE COUNTERS
      ITHRM(1)= 0
      ITHRM(2)= 0
C
C     STORAGE SECTION
 2001 CONTINUE
C     INVERT THERMOMETER MAP FOR INDEX
      CALL MAPINV(NTHRMA,NTABLE,NTHRM1,INDEX1,IER)
C     CHECK FOR INVALID THERMOMETER NUMBER
      IF(IER.EQ.0)  GO TO 2010
      WRITE(6,9201) NTHRM,NCARD
      GO TO 500
 2010 ITYPE=ITYPEA(INDEX1)
      IF(ITYPE1.NE.ITYPE)  WRITE(6,9202)  ITYPE,ITYPE1,NCARD,NTHRM1
C     CHECK FOR FILLED STORAGE (2PROTECTED OR 1UNPROTECTED)
```

"REVTHR"

```
      IF(ITHRM(ITYPE).LT.(3/ITYPE))  GO TO 2020
      WRITE(6,9203)  ITYPE
      GO TO 1001
C     UPDATE INDICES AND STORE LAST DATA READ
 2020 ITHRM(ITYPE)= ITHRM(ITYPE)+1
      ISTOR= ITHRM(ITYPE)
      INDEX(ISTOR,ITYPE)= INDEX1
      DO 2030 I=1,2
      TM(I,ISTOR,ITYPE)= TM1(I)
 2030 TA(I,ISTOR,ITYPE)= TA1(I)
      ACRUZ=ACRUZ1
      NCRUZ=NCRUZ1
      NSTA= NSTA1
      NBOT= NBOT1
      ZCABL= ZCABL1
C     RETURN TO DATA READ
      GO TO 500
C
C
C     FORMATS
C     READING FORMATS
 8000 FORMAT(I6,1X,I1,1X,F3.0,1X,F4.0,1X,F5.5)
 8010 FORMAT(I6,4X,14F5.2)
 8001 FORMAT(10F8.4)
 8002 FORMAT(I3,F4.0,I6,I1,2(F4.2,F5.1),24X,3A5,2A5,2I3)
C
C     WRITING FORMATS
 9000 FORMAT('1PUERTO RICO NUCLEAR CENTER - TEMPERATURE AND DEPTH ',
     1       'CALCULATIONS' / 1X,63('*') // )
 9001 FORMAT(' BEGIN TABLE SET-UP')
 9002 FORMAT('0++++++++++ERROR.....INPUT ERROR (COUNTER STATUS N=',
     1       I3,')' )
 9003 FORMAT('0++++++++++ERROR.....INPUT TYPE(',I1,')_FOR THERMOMETER ',
     1       I6,' OUT OF BOUNDS' )
 9004 FORMAT('0++++++++++ERROR.....THERMOMETER NUMBERS ON FIRST(',I6,
     1       ') AND SECOND(',I6,') CARDS DIFFER' )
 9005 FORMAT('0?????????WARNING...THERMOMETER TABLES ARE FILLED'_1
 9006 FORMAT(' END OF TABLE SET-UP    NTABLE=',I3 )
 9007 FORMAT('-DATA ECHO' /,'  TH NR TP VO   1/A      Q',T31,'T    5    10
     1    15    20    25    30    35',T83,'5    10    15    20    25
     230    35' /)
 9008 FORMAT(1X,I6,1X,I1,1X,F4.0,1X,F5,0,1X,F6,5,3X,7F6.2,6X,7F6.2 )
 9009 FORMAT( )
 9010 FORMAT(10(1X,F8.4))
C
 9101 FORMAT('0THERMOMETER=',I6,'  (TYPE=',I1,')' )
 9102 FORMAT(T45,'MAINT=',F5.2,' (1=',F5.2,')     AUXT=',F5.2,' (1=',
     1       F5.2,')' )
 9103 FORMAT(' *********NOTE......MAIN TEMPERATURE OUT OF BOUNDS' )
 9104 FORMAT(' *********NOTE......AUX. TEMPERATURE OUT OF BOUNDS' )
 9105 FORMAT(1H+,T101,'TW=',F5.2)
 9106 FORMAT('0*********NOTE......NO PROTECTED THERMOMETER READING')
 9107 FORMAT(1H+,T111,'TU=',F5.2)
```

"REVTHR"

```
9108 FORMAT(' **********NOTE......DEPTH OUT OF BOUNDS (Z=',F6.1,')' )      AB  2
9109 FORMAT(T41,'AVERAGE CORRECTED TEMPERATURES AND THERMOMETRIC DEPTH'AB  2
    1         T101,'TW=',F5.2,T111,'TU=',F5.2,T121,'Z=',F6.1)             AB  2
9110 FORMAT('0**********NOTE......NO UNPROTECTED THERMOMETER READING'    JK2
    1      '            (TWAVG='   F5.2, ')'   )                          JK3
9111 FORMAT(1H0,9(1HC),10X,'CRUISE=',1X,A3,I3,10X,87(1HC))               AB  2
9112 FORMAT(1H0,9(1HS),10X,'STATION=',1X,I3,1X,'(DATE=',3A5,A3,')',10X,AB  2
    1         63(1HS))                                                    AB  2
9113 FORMAT(1H0,9(1H#),10X,'DEPTH=',1X,F6.1,1X,'(BOTTLE=',1X,I3,')',    AB  2
    1         10X,74(1H#))                                                AB  2
9114  FORMAT(100X,'TW=',F5.2)
C                                                                         AB  2
9201 FORMAT(' **********ERROR.....THERMOMETER NUMBER ',I6,'(CARD',I4,    AB  2
    1         ') IS NOT VALID' )                                          AB
9202 FORMAT(' ?????????WARNING...TABLE TYPE(',I1,') AND INPUT TYPE(',    AB  2
    1         I1,',ON CARD',I4,') FOR THERMOMETER ',I6,' DIFFER' )        AB  2
9203 FORMAT(' ?????????WARNING...STORAGE FOR DATA WITH PROTECTION CODE'AB  2
    1         ,I1,' FILLED - BRANCH TO COMPUTATION' )                    AB  2
9300 FORMAT('0**********ERROR.....INPUT ERROR ON CARD ',I6 )             AB  2
      END                                                                 AB  2

C       SUBROUTINE TO INVERT THERMOMETER NUMBER MAP                       AB  2
C                                                                         AB
      SUBROUTINE MAPINV(IARRAY,N,IELMNT,INDEX,IERR)                       AB
      DIMENSION IARRAY(1)                                                 AB
      INDEX=0                                                             AB
      IERR=0                                                              AB
    1 INDEX=INDEX+1                                                       AB  2
      IF(INDEX.GT.N)   GO TO 2                                            AB  2
      IF(IELMNT.EQ.IARRAY(INDEX))   GO TO 3                               AB  2
      GO TO 1                                                             AB  2
    2 INDEX=N                                                             AB  2
      IERR=1                                                              AB  2
    3 RETURN                                                              AB  2
      END                                                                 AB  2

C       LINEAR INTERPOLATION SUBROUTINE                                   AB  2
C                                                                         AB  2
      SUBROUTINE INTRPL(YARRAY,X1,DX,N,X,Y,IERR)                          AB  2
      DIMENSION YARRAY(1)                                                 AB
      XMAX= X1+DX*FLOAT(N-1)                                              AB  2
      IF(X.LT.X1) GO TO 2                                                 AB
      IF(X.GT.XMAX) GO TO 3                                               AB
      IM1=(X-X1)/DX                                                       AB
       Y=(YARRAY(IM1+2)-YARRAY(IM1+1))*(X-(X1+DX*FLOAT(IM1)))/DX          AB
    1    +YARRAY(IM1+1)                                                   AB
      IERR= 0                                                             AB
    1 RETURN                                                              AB
    2 Y= YARRAY(1)                                                        AB
      IERR= -1                                                            AB
      GO TO 1                                                             AB
    3 Y= YARRAY(N)                                                        AB
      IERR= 1                                                             AB
      GO TO 1                                                             AB
      END
```

PUERTO RICO NUCLEAR CENTER - TEMPERATURE AND DEPTH CALCULATIONS
****

BEGIN TABLE SET-UP
END OF TABLE SET-UP   NTABLE= 34

DATA ECHO

TH NR	TP	VO	1/K	Q	MAIN THERMOMETER T 5	10	15	20	25	30	35
4842	1	132.	6100.	.00000	-0.06	-0.09	-0.06	-0.07	-0.08	-0.11	0.02
4844	1	110.	6100.	.00000	-0.04	-0.06	-0.04	-0.03	-0.08	-0.05	0.00
4846	1	117.	6100.	.00000	-0.09	-0.09	-0.08	-0.08	-0.09	-0.11	[illegible]
4847	1	127.	6100.	.00000	-0.09	-0.10	-0.09	-0.11	-0.08	-0.08	0.00
4848	1	113.	6100.	.00000	-0.10	-0.10	-0.12	-0.11	-0.13	-0.11	0.00
4796	2	106.	6100.	.00743	-0.11	-0.11	-0.12	-0.09	-0.10	-0.12	0.00
4803	2	110.	6100.	.00735	-0.10	-0.11	-0.11	-0.10	-0.12	-0.10	0.00
4806	2	114.	6100.	.00753	-0.10	-0.08	-0.09	-0.10	-0.11	[illegible]	0.00
6776	1	106.	6100.	.00000	0.00	0.00	0.00	0.01	0.02	0.01	0.01
6777	1	106.	6100.	.00000	0.02	0.00	0.03	0.00	0.00	0.02	0.00
6776	1	112.	6100.	.00000	0.03	0.05	0.01	0.02	0.03	0.02	0.02
6779	1	105.	6100.	.00000	0.05	0.06	0.05	0.01	0.04	0.05	0.06
6282	2	139.	6100.	.00776	0.00	-0.01	0.01	0.01	0.00	0.00	0.02
6283	2	135.	6100.	.00770	-0.01	0.01	0.00	0.01	0.01	-0.02	0.00
6284	2	136.	6100.	.00826	-0.02	-0.01	-0.01	-0.01	-0.01	-0.03	0.00
6285	2	133.	6100.	.00752	-0.03	-0.04	-0.03	-0.04	-0.04	-0.06	-0.06
7018	1	101.	6100.	.00000	-0.03	-0.02	0.00	0.00	0.00	0.00	0.00
7019	1	117.	6100.	.00000	0.03	0.03	0.03	0.02	0.03	0.02	0.03
7024	1	100.	6100.	.00000	0.03	0.01	0.02	0.00	0.02	0.03	0.05
7123	1	102.	6100.	.00000	0.00	0.00	0.00	0.00	0.00	[illegible]	0.02
7124	1	104.	6100.	.00000	-0.01	-0.01	-0.01	0.01	0.00	0.00	0.01
7125	1	99.	6100.	.00000	0.03	0.03	0.03	0.02	0.01	0.02	0.03
7126	1	105.	6100.	.00000	0.02	0.03	0.04	0.01	0.02	0.02	0.03
7127	1	104.	6100.	.00000	0.00	0.02	0.00	0.02	0.04	0.03	0.02
25824	1	117.	6300.	.00000	-0.01	-0.02	0.00	0.00	-0.01	-0.01	0.01
25825	1	124.	6300.	.00000	0.00	-0.02	0.00	0.00	0.00	0.00	0.02
25828	1	108.	6300.	.00000	0.00	0.00	0.00	0.00	0.00	0.01	0.00
25832	1	110.	6300.	.00000	0.00	0.00	-0.02	0.00	0.00	[illegible]	0.00
25841	1	106.	6300.	.00000	0.00	-0.02	0.00	0.00	0.01	0.00	0.00
26566	1	112.	6300.	.00000	0.00	-0.03	0.00	0.00	0.00	[illegible]	0.01
26569	1	89.	6300.	.00000	0.03	0.00	0.01	0.02	0.03	0.04	0.02
26570	1	101.	6300.	.00000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26589	2	129.	6300.	.01079	-0.02	-0.04	-0.03	-0.03	-0.03	-0.03	-0.05
26600	2	127.	6300.	.01072	-0.01	-0.05	-0.03	-0.03	-0.03	-0.02	-0.04

1.0264   1.0266   1.0268   1.0271   1.0275   1.0277   1.0281   1.0285
1.0294   1.0297   1.0299   1.0302   1.0305   1.0308   1.0311   1.0313
1.0321   1.0323   1.0326   1.0328   1.0331   1.0333   1.0335   1.0338
1.0345

AUXILIARY

5	10	15	20	25	30	35
-0.30	-0.30	-0.30	-0.20	-0.30	-0.30	-0.20
-0.30	-0.30	-0.30	-0.20	-0.30	-0.30	-0.20
-0.20	-0.20	-0.20	-0.20	-0.20	-0.27	-0.10
-0.30	-0.41	-0.30	-0.20	-0.30	-0.30	-0.30
0.00	0.00	0.00	0.10	0.20	0.00	0.00
-0.30	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40
-0.30	-0.30	-0.30	-0.20	-0.20	-0.20	-0.30
-0.20	-0.20	-0.40	-0.50	-0.30	-0.30	-0.30
0.00	0.00	0.00	0.10	0.00	0.20	0.20
0.00	0.00	0.00	0.00	0.00	0.00	-0.10
-0.10	0.10	0.00	-0.10	0.10	0.00	0.00
-0.10	0.00	0.00	0.00	0.00	0.00	0.00
-0.10	-0.10	0.00	0.00	-0.10	-0.10	0.00
0.00	0.00	0.00	-0.10	0.00	0.00	-0.10
0.00	0.00	-0.10	-0.10	0.00	0.00	-0.10
0.00	0.00	-0.10	-0.10	0.00	-0.10	-0.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00
-0.20	-0.10	0.00	0.10	0.00	0.00	0.10
0.20	-0.20	-0.10	-0.10	-0.10	-0.10	-0.10
0.10	-0.20	-0.10	-0.10	-0.20	-0.20	-0.20
-0.20	-0.10	-0.20	-0.20	-0.10	-0.10	-0.20
-0.10	-0.10	-0.10	-0.10	-0.20	-0.27	-0.10
-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	0.20
-0.20	-0.20	-0.20	-0.10	-0.10	-0.10	0.20
0.10	0.20	0.10	0.10	0.10	0.00	0.40
0.20	0.10	0.20	0.00	0.20	0.10	0.00
0.20	0.10	0.20	0.10	0.10	0.00	0.20
0.10	0.10	0.20	0.10	0.20	0.10	0.10
0.10	0.00	0.10	0.00	0.10	0.10	0.10
0.20	0.10	0.20	0.60	0.30	0.50	0.00
0.00	0.10	0.20	0.20	0.10	0.00	0.00
0.00	0.10	0.20	0.00	0.20	0.10	0.00
0.10	0.10	0.00	0.00	0.10	0.00	0.10
0.00	-0.10	-0.10	-0.10	0.00	0.00	0.00

1,0288	1,0292
1,0316	1,0319
1,0340	1,0343

```
C   OCEANOGRAPHIC STATION LOG DATA, SIGMA T AND WIRE ANGLE DEPTHS CALC.  A   00005
C   ALL DATA CARDS REQUIRE PRNC REFERENCE NUMBER PUNCHED IN SPACES 74-79. A   00010
C   ALL DATA CARDS REQUIRE '0' IN SPAC 80 EXCEPT '0' FOR LAST DATA CARD   A   00015
C   IN THE SUM OR 'E' IF ANOTHER STATION IS TO FOLLOW.
C   STATION NAME GOES IN SPACES 28-33.                                    A   00020
C   RELATIVE HUMIDITY GOES IN SPACES 68-70.                               A   00025
CXXXXXTHERMOMETRIC DEPTH FROM OXYGEN BOTTLE NR COLUMN (58-60)            A   00030
C   ONLY THREE CASTS ALLOWED PER STATION.
      DIMENSION M(33),IP(3,7),IQ(27),TAB(5,4)                             A   00035
      EQUIVALENCE (I,TAVE)
      INTEGER TZ                                                          A   00045
      REAL MO
      DATA TAB/6.52,5.93,5.44,5,,4.58,6,44,5.86,5.38,4,95,4,52,
     1 6,35,5,79,5.31,4,39,4,46,6,27,5,72,5,25,4,83,4,4/
  501 FORMAT(3I2,4I3,3I2,I3,2A3,A4,4X,3A2,2A1,2A2,3I3,A2,3A1,2A3,2I3,A1) A
  502 FORMAT(3(I1,2I2,I4,I2,2I4),8X,I4,I2,2I1,6X,I1)                      A   00050
  503 FORMAT(I1,2I4,2I2,7(I5,I4,I3),I3,I5,I3,I4,A1,1X,2A2,1X,A2,2I3,I1)  A   00055
  601 FORMAT('1NAV BALBOA CRUISE 'A3,9X,'STATION ',2A3,9X,'PRNC REFEREA   00060
     1NCE ',2I3)                                                          A   00065
  602 FORMAT('0DATE  'I3,'/'I2,'/'I2,3X,'BARO'4X,F6.1,3X,'WEATHER',4X,A2A  00070
     1,3X,'WIND VELOC  ',A2,3X,'WAVE PERIOD  ',A1)                        A   00075
  603 FORMAT(' HOUR',/X,F4.1,3X,'TEMP DRY  ',F4.1,3X,'VISIBILITY  ',A1,3A  00080
     1X,'WIND DIREC  ',A2,3X,'TRANSPAR   ',A2)                            A   00085
  604 FORMAT(' LAT',4X,I2,'-',F4.1,' N',3X,'TEMP WET  ',F4.1,3X,'CLOUD TA  00090
     1YP  ',A1,3X,' WAVE DIREC  ',A2,3X,'SONIC DEP ',A4)                  A   00095
  605 FORMAT(' LONG ',I3,'-',F4.1,' W',3X,'REL HUMID  ',A3,3X,'CLOUD AMTA  00100
     1',7X,A1,3X,'WAVE HEIGHT  ',A1,3X,'COLOR',/X,A2)                     A   00105
  606 FORMAT('0CAST ',I1,2X,'MESS TIME ',F4.1,' GMT, '2I2,' LOCAL  MAX DA  00110
     1EPTH ',I4,'  WIRE ANGLE ',I2/ 9X,'OXYGEN TITER ',F5.3,'  METER WHEA  00115
     2EL FACTOR ',F5.3 //)                                                A   00120
  607 FORMAT('     DEPTH (M)',T26,'TEMP',T54,'OXYGEN',/' WIRE   CZ    TZ  A   00130
     1Z   TL    TM   TAVE   SALIN  SIG T ML/L MG/L %SAT   PHOS NITRA')    A   00135
  608 FORMAT(' ERROR, CAST NUMBER WRONG OR DETAIL CARD OUT OF ORDER')     A   00140
  609 FORMAT(' DELTA 1 GREATER THAN 2%')                                  A   00145
  610 FORMAT(' DELTA 3 GREATER THAN 2%')                                  A   [illegible]
  611 FORMAT(1X,3(I4,3X),I3,1X,3(F5.2,1X),F6.3,F7.2,2(F5.2),F7.2,        A   [illegible]
     1 2 ,A1,'.',A2,2X,'.',A2)
  612 FORMAT(' ERROR, DATA CARD FROM DIFFERENT CRUISE OR STATION '2I3)    A   [illegible]
  613 FORMAT('0SURFACE SAMPLE, BOTTOM SAMPLE, PLANKTON OR NEKTON,')       A   [illegible]
  614 FORMAT('1ALL DEPTHS ARE IN METERS.  NUTRIENTS IN UG-AT/L,'/         A   [illegible]
     1' MAX-SAMP. DEPTH = MAXIMUM SAMPLING DEPTH + E-2,'/                 A   [illegible]
     2' WATER COLOR - FOREL WATER COLOR SCALE, H.O. 215,'/                A   [illegible]
     3' TRANSPARENCY = SECCHI DISC DEPTH,'/                               A   [illegible]
     4' WIND AND WAVE DIRECTION COMING FROM + E-1 ROUNDED, TABLE IN H.O.A  [illegible]
     5215,'/                                                              A   [illegible]
     6' WAVE HEIGHT - H.O.215 WIND WAVE CODE,'/                           A   [illegible]
     7' WAVE PERIOD - IN SECONDS,'/                                       A   [illegible]
     8' WIND SPEED - IN METERS PER SECOND,'/                              A   [illegible]
     9' WEATHER,VISIBILITY,CLOUD TYPE AND AMOUNT - H.O. 215 CODE,')       A   [illegible]
      PRINT 614                                                           A   [illegible]
    5 READ 501,M                                                          A   [illegible]
      IF(M(1)) 91,91,20                                                   A   [illegible]
   20 PRINT 601,M(31),M(12),M(13),M(31),M(32)                             A   [illegible]
                                                                          A   [illegible]
```

"OCNSTN"

```
      E    =M(4)/1 .
      EM   =M(6)/1 .
      EM 1=M(11)/1 .
      EM 2=M(22)/1 . +1 .
      IF EM22.GT.1  .) EM22=EM22-100.
      E  3=M(23)/1 .
      E  4=M(24)/1 .
   21 PRINT 6 2, (5),M(1 ),M(8),EM22 ,M(25),M(21),M(19)
   22 PRINT 603,EM11,EM2 , (28),M(2 ),M(16)
   23 PRINT  4, (3),E  ,E 24,M(26),M(17),M(14)
   24 PRINT 605, (5),EM6, (29),M(27),M(18), (15)
   11 READ 5 2, ((IP(I,J),J=1,7),I=1,3),IP53,IP54,IP55,IP56,IP57
      L=
   27 IF(IP(1,1).EQ.0) GO TO 32
      GO TO 95
   32 PRINT 613
      GO TO
   95 IF(L-3) 105,105,91
  105 C   = ( (IP(L,2)+IP(4,24)+IP(L,3)/60 .
      P  =IP 3/1 .
      P  =IP(L,7)/1  .
   25 PRINT 626,IP(L,1),C T,IP(L,2),IP(L,3),IP(L,4),IP(L,5),P 7,P53
   26 PRINT 607
      IF (L.GT.1) GO TO 13
   12 READ 5 3,(ID(I),I=1,16),D1 ,D20,D21,D22,    ID(25),ID(26),ID(27)
      I=
   13 D7=ID(7)/1 .
      D =ID( )/1 .
      D1 =ID(10)/1 .
      D  =I (11)/1 .
      D1 =I (13)/1 .
      D  =I (14)/1 .
      D1 =I (16)/1  .
      D1 =(((ID(1 )/1  .)*P(7)=.  9
      SA    .
      T    .
      SIGMAT= .
   85 IF ID(22).NE.M(31).OR.ID(23).NE.M(32)) GO TO 92
   71 IF(ID( )-IP(L,1)) 9 ,91,104
   92 PRINT 628
  104 L=L+1
      GO TO
   92 PRINT 612,ID(2 ),ID(25)
      IF(ID(27)- ) 91,12,2
   91 I =((I (2)+ID( ))*C (IP(L,5)*1.745329E-2)*P5 ))+1.
      IF(ID(2).  . )I=
CXXXXXTHERMOMETRIC DEPTH FROM OXYGEN BOTTLE    COLUMN (5P=60)
      I =ID(17)
   72 IF(ID(7)) 73,72,74
   73 IF(ID( )) 79,79,54
   74 IF(ID(10)) 53,53,55
   23 T   =7
      GO TO 79
```

"OCNSTN"

```
 55 TA[illegible]E=(D7+D17)/2.
    IF[illegible]ABS(D7-D17)-.02*[illegible]AVE) 79,79,27
 27 PR[illegible]NT 609
 58 T[illegible]L[illegible]=D17
 79 IF  ID(9)) 7[illegible],7[illegible],9[illegible]
 7[illegible] IF  ID(1[illegible])) 29,[illegible]
 [illegible] IF ID(11)) 59,[illegible],6[illegible]
 29 S[illegible] [illegible]=[illegible]9
    G[illegible] TO 64
 61 S[illegible]E=( D9 + [illegible]11 )/2.
    IF  A[illegible]S( D9 - D11 )-.02*SAVE) 64,64,28
 2[illegible] P[illegible]NT [illegible]1[illegible]
 [illegible]  S[illegible] E=[illegible]16
 64 IF T.[illegible].2. [illegible]) GO TO 29
 5[illegible] C[illegible]A[illegible]7[illegible], [illegible]65
 57 A[illegible] T*(8.2367-.[illegible]1.29T+.[illegible]210[illegible].7[illegible]T)+1.E-3
 6[illegible] [illegible]T*([illegible]7-.[illegible]04*T+.[illegible]T[illegible]+1.E-6
 [illegible] [illegible]=(T-3.9[illegible])**2/[illegible] .[illegible]7 *(T+2[illegible]./(T+67.2[illegible])
 1[illegible] [illegible]=.[illegible]+1.47[illegible]-[illegible]107*[illegible]
 131 [illegible]AT=AT+(5.[illegible]+.[illegible]22[illegible])*(1.-.T+2[illegible]*(S[illegible]-.132[illegible]))
 29 [illegible]=D[illegible]*1.*2[illegible]
    I[illegible]L=I[illegible].
    I[illegible]=TA[illegible]E/[illegible].+1.
    I[illegible] (I[illegible].LT.1.OR.I[illegible].[illegible].5.OR.IT.LT.1.OR.IT.GT.4) GO TO 3[illegible]
    P=[illegible]([illegible]AVE,[illegible].)/[illegible].
    Q=[illegible]D(CL,1.)
    [illegible] =1.-P
    [illegible] =1.-[illegible]
    [illegible] [illegible]=[illegible]./([illegible]*([illegible]*TA[illegible](IT,IC+1)+[illegible]*TA[illegible](IT+1,IC+1))+[illegible]
   1 [illegible]*TA[illegible](IT,I[illegible])+[illegible]*TA[illegible](IT,IC+1)))
    [illegible]  TO 32
 31 [illegible]=[illegible].
 3[illegible] PR[illegible] T 611,I[illegible](2),I[illegible],T[illegible],I[illegible](5),D7,D1[illegible],T,SAVE,SIGMAT,D1[illegible],[illegible]L,PSAT,
   1 [illegible],D2[illegible],D21,D22
    CALL [illegible]T([illegible]),[illegible](3),I[illegible],T,SAVE,SIGMAT,D1[illegible],D19,[illegible])
 [illegible]4 IF(ID(27)-[illegible]) 91,[illegible]2,5
 91 C[illegible]L EXIT
    E[illegible]
```

[illegible] IS

2.45[illegible]	1	21[illegible]64.[illegible]	2	2.75[illegible]	3	[illegible]67[illegible]
21[illegible]4[illegible]	[illegible]	17[illegible]457[illegible]74[illegible]	7	17[illegible]3575 [illegible]	10	17[illegible]
17[illegible]9[illegible]412.674	13	2[illegible]62455	14	1674341742[illegible]	15	1[illegible]7[illegible]
[illegible]44[illegible]	2[illegible]	17[illegible]1[illegible]7[illegible]	21	155[illegible]	22	[illegible]74[illegible]
2117[illegible]7[illegible]	25	22157141[illegible]5[illegible]	26	175432[illegible]7[illegible]	27	1[illegible]7[illegible]
17[illegible]41[illegible]	32	221[illegible]561363	33	205[illegible]	34	[illegible]
22[illegible]6[illegible]						

[illegible]ALENCE

1[illegible] I 1657

"OCNSTN"

```
      SUBROUTINE OUTPLT(ISTATN,JDAT,IZ,TEMP,SALT,SIGT,OXGN,PHOS1,PHOS2 )
      DIMENSION ISTATN(2),IDAT(3),JDAT(3)
      DIMENSION IPHOS(4)
      DATA  I,J,K  / [illegible] /
      INTGR(N)= N/([illegible])-"57
      INTGR1(N)= (N+[illegible])/([illegible]/2)
C     DECODE PHOSPHATE ASCII INTO REAL
      DECODE(2,7802,PHOS1)  IPHOS(1),IPHOS(2)
      DECODE(2,7802,PHOS2)  IPHOS(3),IPHOS(4)
C     DECODE STATION NAME INTO TRANSECT INDICES
      DECODE(3,7801,ISTATN(2) ) I,JA
D     PRINT [illegible]   I,JA,J,J1
      J= INTGR1(JA)
C     SHUFFLE DATE ARRAY TO GET:  MO./DAY/YR.
      IDAT(1)= JDAT(2)
      IDAT(2)= JDAT(3)
      IDAT(3)= JDAT(1)
C     INCREMENT DEPTH COUNTER
      IF((I.NE.IOLD).OR.(J.NE.JOLD))  K= 0
      K= K+1
      IOLD= I
      JOLD= J
D     PRINT 9102,  IPHOS
      DO  50  L=1,4
   50 IPHOS(L)= INTGR(IPHOS(L))
D     PRINT 9102,  IPHOS
      DUMMY= 0.
      DO  100  L=1,4
      IF((IPHOS(L).LT.0).OR.(IPHOS(L).GT.9))  GO TO  1[illegible]
      DUMMY= DUMMY+FLOAT(IPHOS(L))*(10.**(2-L))
  100 CONTINUE
      PHOS= DUMMY
C     PUNCH DATA CARD FOR PLOT PROGRAM
      WRITE(7,9001)  ISTATN,I,J,K,IDAT,IZ,TEMP,SALT,SIGT,OXGN,PHOS
D     PRINT 9101,  ISTATN,I,J,K,IDAT,IZ,TEMP,SALT,SIGT,OXGN,PHOS
      RETURN
C     FORMATS
 7801 FORMAT(1X,I1,A1)
 7802 FORMAT(2A1)
 9001 FORMAT(2A3,1X,3I1,[illegible],I2,2(1H/,I2),[illegible]X,I3,5(2X,F6.2) )
 9101 FORMAT(1X,2A3,3[illegible],2X,I11,2(1H/,I11),I12 / 1X,5E15.5 )
 9102 FORMAT(10(1X,[illegible]))
      END
```

TAGS

003777777777

AL DUMMIES

T[illegible]	344	JDAT	345	IZ	346	TEMP	347
[illegible]	351	OXG	[illegible]52	PHOS1	353	PHOS2	354

```
      "OCNST2"
      DIMENSION  USER(2),JOB(2)
      DIMENSION  ADAT(2,3,6),DUMMY(8)
      DIMENSION  SALT(8,3,6),TEMP(8,3,6),SIGT(8,3,6),OXGN(8,3,6)
      DIMENSION  PHOS(8,3,6),Z(8,3,6)
      DATA  JOB / 10HOCNSTN2    /
      DATA  USER / 10HWOOD,E.D.    /
      DATA  NPRNC,NJK / 250351,250313  /
      DATA  ECH / 5H     /
C     INITIALIZE ARRAYS & PARAMETERS
    1 SITE= ECH
      I1= 1
      I2= 1
      DO  100  I=1,6
      DO  100  J=1,3
      ADAT(1,J,I)= ECH
      ADAT(2,J,I)= ECH
      DO  100  K=1,8
      SALT(K,J,I)= 34.60
      TEMP(K,J,I)= 15.00
      SIGT(K,J,I)= 15.00
      OXGN(K,J,I)= 0.
      PHOS(K,J,I)= 0.
  100    Z(K,J,I)= 0.
C     READ AND STORE ARRAYS
      READ(5,8001,END=1000)  SITE,I1,I2
      IF(I1.LT.1)  I1= 1
      IF(I2.GT.6)  I2= 6
      IF(I1.GT.I2)  I1= I2
    2 READ(5,8002)  I,J,K,DUMMY
      IF((100*I+10*J+K).EQ.999)   GO TO  3
      IF((I.GT.6).OR.(I.LT.1))   GO TO  2
      IF((J.GT.3).OR.(J.LT.1))   GO TO  2
      IF((K.GT.8).OR.(K.LT.1))   GO TO  2
      ADAT(1,J,I)= DUMMY(1)
      ADAT(2,J,I)= DUMMY(2)
         Z(K,J,I)= DUMMY(3)
      TEMP(K,J,I)= DUMMY(4)
      SALT(K,J,I)= DUMMY(5)
      SIGT(K,J,I)= DUMMY(6)
      OXGN(K,J,I)= DUMMY(7)
      PHOS(K,J,I)= DUMMY(8)
      GO TO  2
    3 CONTINUE
      WRITE(6,9001)  SITE,I1,I2
      DO  200  I=I1,I2
      DO  200  J=1,3
      DO  200  K=1,8
  200 WRITE(6,9002)   I,J,K,ADAT(1,J,I),ADAT(2,J,I),Z(K,J,I),TEMP(K,J,I),
     1                SALT(K,J,I),SIGT(K,J,I),OXGN(K,J,I),PHOS(K,J,I)
 9001 FORMAT('1',A3,2X,2I5 )
 9002 FORMAT(1X,3I1,2X,2A5,6F10.2)
      IER= 0
      CALL OPART(USER,NPRNC,NJK,JOB,0,2,IER)
```

```
      "OCNST2"
      IF(IER.LT.0)  GO TO  1000
      CALL OCNPLT(SITE,ADAT,SALT,TEMP,SIGT,OXGN,PHOS,Z,I1,I2)
      IER= 9
      CALL OPART(USER,NPRNC,NJK,JOB,0,2,IER)
      IF(IER.LT.0)  GO TO  1000
      GO TO  1
 1000 CALL EXIT
C     FORMATS
 8001 FORMAT(A3,2X,2I5)
 8002 FORMAT(7X,3I1,2X,2A5,F3.0,5F7.2 )
      END

      SUBROUTINE OCNPLT(SITE,ADAT,SALT,TEMP,SIGT,OXGN,PHOS,Z,I1,I2)
      DIMENSION  Z0(3),Z2(3)
      DIMENSION  ADAT(2,3,6)
      DIMENSION  SALT(8,3,6),TEMP(8,3,6),SIGT(8,3,6),OXGN(8,3,6)
      DIMENSION  PHOS(8,3,6),Z(8,3,6)
      DATA  UNIT,SIZ / 0.75,0.1 /
      DATA  SALT0,SCSALT,SALT1,SALT2 / -168.75,5.0,34.6,37.4 /
      DATA  TEMP0,SCTEMP,TEMP1,TEMP2 / -10.75,1.0,19.0,29.0 /
      DATA  SIGT0,SCSIGT,SIGT1,SIGT2 / -10.75,1.0,19.0,29.0 /
      DATA  OXGN0,SCOXGN,OXGN1,OXGN2 / 4.25,2.0,0.0,7.0 /
      DATA  PHOS0,SCPHOS,PHOS1,PHOS2 / 4,25,10.0,0.0,1.4 /
      DATA  Z0,SCZ,Z1,Z2 / 21.5,20.0,15.0,-0.04,0.0,25.0,112.5,312.5 /
      WRITE(6,9000) SITE,ADAT(1,1,1),SALT(1,1,1),TEMP(1,1,1),SIGT(1,1,1)
     1             ,OXGN(1,1,1),PHOS(1,1,1),Z(1,1,1),I1,I2
 9000 FORMAT(' OCNPLT(',A5,5X,A5,6F10.2,2I5,')' )
      SIZE= UNIT*SIZ
C     CYCLE OVER TRANSECTS
      DO  500  I=I1,I2
C     DRAW FIRST PAGE (SALINITY,TEMPERATURE,SIGMA-T)
      IPAGE= 1
      DO  100  J=1,3
      NK= 2**J
      CALL GRAAF(SALT(1,J,I),Z(1,J,I),SALT0,Z0(J),SCSALT,SCZ,SALT1,Z1,
     1           SALT2,Z2(J),UNIT,NK,1,SIZE,0.0 )
      CALL GRAAF(TEMP(1,J,I),Z(1,J,I),TEMP0,Z0(J),SCTEMP,SCZ,TEMP1,Z1,
     1           TEMP2,Z2(J),UNIT,NK,4,SIZE,60.0 )
      CALL GRAAF(SIGT(1,J,I),Z(1,J,I),SIGT0,Z0(J),SCSIGT,SCZ,SIGT1,Z1,
     1           SIGT2,Z2(J),UNIT,NK,2,SIZE,45.0 )
  100 CONTINUE
      CALL BOXES(UNIT,IPAGE,I,SITE,ADAT(1,1,I) )
C     DRAW SECOND PAGE (OXYGEN,PHOSPHATE)
      IPAGE= 2
      DO  200  J=1,3
      NK= 2**J
      CALL GRAAF(OXGN(1,J,I),Z(1,J,I),OXGN0,Z0(J),SCOXGN,SCZ,OXGN1,Z1,
     1           OXGN2,Z2(J),UNIT,NK,3,SIZE,45.0 )
      CALL GRAAF(PHOS(1,J,I),Z(1,J,I),PHOS0,Z0(J),SCPHOS,SCZ,PHOS1,Z1,
     1           PHOS2,Z2(J),UNIT,NK,2,SIZE,0.0 )
  200 CONTINUE
      CALL BOXES(UNIT,IPAGE,I,SITE,ADAT(1,1,I) )
  500 CONTINUE
      RETURN
      END
```

"OCNST2"

```
      SUBROUTINE GRAAF(X,Y,X0,Y0,XSCAL,YSCAL,X1,Y1,X2,Y2,UNIT,NPTS,
     1                ICYMB,SIZE,THETA )
      DIMENSION  X(1),Y(1)
      XBOUND(I)= (X0+XSCAL*AMINJK(AMAXJK(X(I),X1),X2))*UNIT
      YBOUND(I)= (Y0+YSCAL*AMINJK(AMAXJK(Y(I),Y1),Y2))*UNIT
      WRITE(6,9000)  X(1),Y(1),X0,Y0,XSCAL,YSCAL,UNIT,NPTS,ICYMB,SIZE,
     1               THETA
 9000 FORMAT(' GRAAF(',7F10.2,2I5,2F10.2,')' )
      CALL CYMBAL(ICYMB,XBOUND(1),YBOUND(1),SIZE,THETA )
      DO  100  I=2,NPTS
      WRITE(6,9001)  I
 9001 FORMAT(' I=',I5 )
      XX= XBOUND(I)
      YY= YBOUND(I)
      CALL PLOT(XX,YY,2)
  100 CALL CYMBAL(ICYMB,XX,YY,SIZE,THETA)
      RETURN
      END


      FUNCTION AMAXJK(X,Y)
      AMAXJK= Y
      IF(X.GT.Y)  AMAXJK= X
      RETURN
      END


      FUNCTION AMINJK(X,Y)
      AMINJK= Y
      IF(X.LT.Y)  AMINJK= X
      RETURN
      END
```

"OCNST2"

```
      SUBROUTINE BOXES(UNIT,IPAGE,IGRID,SITE,DAT)
      REAL LEFT
      DIMENSION  DAT(2)
      DIMENSION  X(2),Y(9),D(4),AN(7)
      DIMENSION  TEXT(10,2,2),TEXT3(7)
      DATA X / 4.25,10.25 /
      DATA Y / 2.5,15.0,15.5,20.0,20.5,21.5,22.5,23.5,26.0 /
      DATA D / 14.0,12.5,4.5,1.0 /
      DATA AN / '   0',' 10',' 25',' 50','100','200','300' /
      DATA UP,DOWN,LEFT,RIGHT / 90.,-90.,180.,0. /
      DATA  TIC,SIZ / 0.16666667,0.25  /
      DATA (TEXT(I,1,1),I=1, 5) / 25HHYDROSTATION VERTICAL PRO /
      DATA (TEXT(I,1,1),I=6,10) / 25HFILES FOR TEMPERATURE,     /
      DATA (TEXT(I,2,1),I=1, 5) / 25HSALINITY AND SIGMA-T,      /
      DATA (TEXT(I,2,1),I=6,10) / 25H                           /
      DATA (TEXT(I,1,2),I=1, 5) / 25HHYDROSTATION VERTICAL PRO /
      DATA (TEXT(I,1,2),I=6,10) / 25HFILES FOR DISSOLVED        /
      DATA (TEXT(I,2,2),I=1, 5) / 25HOXYGEN AND REACTIVE PHOSP /
      DATA (TEXT(I,2,2),I=6,10) / 25HHATE.                      /
      WRITE(6,9000)  UNIT,IPAGE,IGRID,SITE,DAT
 9000 FORMAT(' BOXES(',F10.2,2I5,2X,A3,2X,2A5,')' )
      IF((IPAGE.GT.2).OR.(IPAGE.LT.1))  GO TO  700
      ENCODE(35,7001,TEXT3)  SITE,IGRID,DAT
      SIZE= SIZ*UNIT
C     DRAW BOX OUTLINES
      CALL SEGMNT(X(1),Y(1),D(1),UNIT,RIGHT)
      CALL SEGMNT(X(2),Y(1),D(2),UNIT,UP    )
      CALL SEGMNT(X(2),Y(3),D(3),UNIT,UP    )
      CALL SEGMNT(X(2),Y(5),D(4),UNIT,UP    )
      CALL SEGMNT(X(2),Y(6),D(1),UNIT,LEFT  )
      CALL SEGMNT(X(1),Y(6),D(4),UNIT,DOWN  )
      CALL SEGMNT(X(1),Y(5),D(1),UNIT,RIGHT)
      CALL SEGMNT(X(2),Y(4),D(1),UNIT,LEFT  )
      CALL SEGMNT(X(1),Y(4),D(3),UNIT,DOWN  )
      CALL SEGMNT(X(1),Y(3),D(1),UNIT,RIGHT)
      CALL SEGMNT(X(2),Y(2),D(1),UNIT,LEFT  )
      CALL SEGMNT(X(1),Y(2),D(2),UNIT,DOWN  )
C     DRAW TICS ON VERTICAL LINES
      XX= X(1)
      YY= 2.
      DO  100  I=1,18
      YY= YY+1.
      CALL SEGMNT(XX,YY,TIC,UNIT,LEFT)
  100 CONTINUE
      YY= Y(6)-10./25.
      CALL SEGMNT(XX,YY,TIC,UNIT,LEFT)
      YY= Y(6)
      CALL SEGMNT(XX,YY,TIC,UNIT,LEFT)
C     WRITE HEADING FOR PAGE
      XX= (X(1)+2.)*UNIT
      YY= Y(9)*UNIT
      CALL SYMBOL(XX,YY,SIZE,TEXT(1,1,IPAGE),0.,50 )
      YY= YY-2.*SIZE
```

```
      CALL SYMBOL(XX,YY,SIZE,TEXT(1,2,IPAGE),0.,50 )
      YY= YY-2.*SIZE
      CALL SYMBOL(XX,YY,SIZE,TEXT3,0.,35 )
C     GENERATE HORIZONTAL AXES ( BRANCH ON 'IPAGE' )
C     DRAW AXES
      CALL SEGMNT(X(1),Y(8),D(1),UNIT,RIGHT)
      CALL SEGMNT(X(2),Y(7),D(1),UNIT,LEFT)
C     DRAW TICS ON SCALES
      I2= 15
      XX= X(1)
      DX= 1.0
      DO  1100  I=1,I2
      CALL SEGMNT(XX,Y(7),TIC,UNIT,UP)
 1100 XX= XX+DX
      IF(IPAGE.EQ.2)  GO TO  1101
      I2= 29
      DX= 0.5
 1101 XX= X(2)
      DO  1200  I=1,I2
      CALL SEGMNT(XX,Y(8),TIC,UNIT,UP)
 1200 XX= XX-DX
C     LABEL UPPER AXIS
      XX= (X(1)-0.5)*UNIT
      YY= Y(8)*UNIT
      ICYMB= 1
      ANGLE= 45.
      IF(IPAGE.EQ.2)  ICYMB= 3
      CALL CYMBAL(ICYMB,XX,YY,SIZE/2.,ANGLE)
      GO TO(1201,1202),IPAGE
 1201 XX= (X(1)+1.75)*UNIT
      I2= 3
      DX= 5.*UNIT
      RITE= 35.
      GO TO  1203
 1202 XX= (X(1)-0.125)*UNIT
      I2= 7
      DX= 2.*UNIT
      RITE= 0.
 1203 YY= (Y(8)+0.25)*UNIT
      DRITE= 1.
      DO  1300  I=1,I2
      CALL NUMBER(XX,YY,SIZE,RITE,RIGHT,-1)
      XX= XX+DX
 1300 RITE= RITE+DRITE
      XX= (X(2)+0.25)*UNIT
      YY= (Y(8)-0.125)*UNIT
      GO TO(1301,1302),IPAGE
 1301 CALL SYMBOL(XX,YY,SIZE,'SALINITY',RIGHT,8)
      GO TO  1303
 1302 CALL SYMBOL(XX,YY,SIZE,'OXYGEN',RIGHT,6)
 1303 CONTINUE
C     LABEL LOWER AXIS
      GO TO(1350,1450),IPAGE
```

```
1350 YY= (Y(7)+0,125)*UNIT
     CALL SYMBOL(XX,YY,SIZE,'TEMPERATURE',RIGHT,11)
     YY= YY-0,5*UNIT
     CALL SYMBOL(XX,YY,SIZE,'SIGMA-T',RIGHT,7)
     XX= (X(2)-1,25)*UNIT
     YY= (Y(7)+0,25)*UNIT
     RITE= 28,
     DO  1400  I=1,7
     CALL NUMBER(XX,YY,SIZE,RITE,RIGHT,-1)
     XX= XX-2,*UNIT
1400 RITE= RITE-2,
     XX= (X(1)-0,5)*UNIT
     YY= (Y(7)+0,25)*UNIT
     CALL CYMBAL(4,XX,YY,SIZE/2,,60,)
     YY= YY-0,5*UNIT
     CALL CYMBAL(2,XX,YY,SIZE/2,,45,)
     GO TO  1550
1450 XX= (X(2)+0,25)*UNIT
     YY= (Y(7)-0,125)*UNIT
     CALL SYMBOL(XX,YY,SIZE,'PHOSPHATE',RIGHT,9)
     XX= (X(2)-4,375)*UNIT
     YY= (Y(7)+0,25)*UNIT
     RITE= 1,0
     DO  1500  I=1,6
     CALL NUMBER(XX,YY,SIZE,RITE,RIGHT,1)
     XX= XX-2,*UNIT
1500 RITE= RITE-0,2
     XX= (X(1)-0,5)*UNIT
     YY= Y(7)*UNIT
     CALL CYMBAL(2,XX,YY,SIZE/2,,0,)
1550 CONTINUE
C     DRAW TICS ON HORIZONTAL LINES
     DO  300  I=2,6,2
     XX= X(1)-1,
     YY= Y(I)
     DO  200  J=1,15
     XX= XX+1,
     CALL SEGMNT(XX,YY,TIC,UNIT,UP)
 200 CONTINUE
 300 CONTINUE
C     LABEL VERTICAL AXIS
     XX= 3,25*UNIT
     YY= Y(6)*UNIT-SIZE/2,
     CALL SYMBOL(XX,YY,SIZE,AN(1),0,,3)
     YY= YY-10,*UNIT/25,
     CALL SYMBOL(XX,YY,SIZE,AN(2),0,,3)
     YY= Y(4)*UNIT-SIZE/2,
     IGO= 1
 400 CONTINUE
     CALL SYMBOL(XX,YY,SIZE,AN(1),0,,3)
     YY= YY-1,*UNIT
     CALL SYMBOL(XX,YY,SIZE,AN(3),0,,3)
     YY= YY-1,*UNIT
```

```
      CALL SYMBOL(XX,YY,SIZE,AN(4),0.,3)
      YY= YY-2.*UNIT
      CALL SYMBOL(XX,YY,SIZE,AN(5),0.,3)
      GO TO(500,600),IGO
  500 CONTINUE
C     WRITE SCALE TITLE AFTER LABELIG SECOND BOX
      XX= 2.75*UNIT
      YY= 13.0*UNIT
      CALL SYMBOL(XX,YY,SIZE,'DEPTH (M)',90.,9)
      IGO= 2
      XX= 3.25*UNIT
      YY= Y(2)*UNIT-SIZE/2.
      GO TO 400
  600 CONTINUE
      YY= YY-4.*UNIT
      CALL SYMBOL(XX,YY,SIZE,AN(6),0.,3)
      YY= YY-4.*UNIT
      CALL SYMBOL(XX,YY,SIZE,AN(7),0.,3)
C     DRAW PAGE SEPARATOR AND ESTABLISH NEW ORIGIN
      CALL SEGMNT(0.5,11.,12.,2.,-90.)
      CALL WHERE(XX,YY)
      CALL PLOT(XX,YY,-3)
  700 RETURN
 7001 FORMAT('TRANSECT ',A3,'-',I1,', DATE ',2A5,4X )
      END
```

```
      SUBROUTINE SEGMNT(X,Y,LENTH,UNIT,THETA)
      REAL LENTH
      ANGLE= THETA*3.14159265/180.
      X1= X*UNIT
      X2= X1+LENTH*UNIT*COS(ANGLE)
      Y1= Y*UNIT
      Y2= Y1+LENTH*UNIT*SIN(ANGLE)
      CALL PLOT(X1,Y1,3)
      CALL PLOT(X2,Y2,2)
      RETURN
      END
```

"OCNST2"

```
      SUBROUTINE CYMBAL(ISYMB,X,Y,SIZE,THETA)
C     ISYMB= 1      CIRCLE DEFINED BY 25 POINTS
C     ISYMB= 2      SQUARE DEFINED BY 5 POINTS
C     ISYMB= 3      CROSS DEFINED BY 4 POINTS
C     ISYMB= 4      TRIANGLE DEFINED BY 4 POINTS
C     WHEN ISIZE= 1 ALL FIGURES INSCRIBED IN THE UNIT CIRLE
      DIMENSION  NPTS(4),COORD(3,25,4)
      DATA NPTS / 25,5,4,4 /
      DATA (COORD(I,01,1),I=1,3) / +1.00000,+0.00000,+3. /
      DATA (COORD(I,02,1),I=1,3) / +0.96593,+0.25882,+2. /
      DATA (COORD(I,03,1),I=1,3) / +0.86603,+0.50000,+2. /
      DATA (COORD(I,04,1),I=1,3) / +0.70711,+0.70711,+2. /
      DATA (COORD(I,05,1),I=1,3) / +0.50000,+0.86603,+2. /
      DATA (COORD(I,06,1),I=1,3) / +0.25882,+0.96593,+2. /
      DATA (COORD(I,07,1),I=1,3) / +0.00000,+1.00000,+2. /
      DATA (COORD(I,08,1),I=1,3) / -0.25882,+0.96593,+2. /
      DATA (COORD(I,09,1),I=1,3) / -0.50000,+0.86603,+2. /
      DATA (COORD(I,10,1),I=1,3) / -0.70711,+0.70711,+2. /
      DATA (COORD(I,11,1),I=1,3) / -0.86603,+0.50000,+2. /
      DATA (COORD(I,12,1),I=1,3) / -0.96593,+0.25882,+2. /
      DATA (COORD(I,13,1),I=1,3) / -1.00000,+0.00000,+2. /
      DATA (COORD(I,14,1),I=1,3) / -0.96593,-0.25882,+2. /
      DATA (COORD(I,15,1),I=1,3) / -0.86603,-0.50000,+2. /
      DATA (COORD(I,16,1),I=1,3) / -0.70711,-0.70711,+2. /
      DATA (COORD(I,17,1),I=1,3) / -0.50000,-0.86603,+2. /
      DATA (COORD(I,18,1),I=1,3) / -0.25882,-0.96593,+2. /
      DATA (COORD(I,19,1),I=1,3) / +0.00000,-1.00000,+2. /
      DATA (COORD(I,20,1),I=1,3) / +0.25882,-0.96593,+2. /
      DATA (COORD(I,21,1),I=1,3) / +0.50000,-0.86603,+2. /
      DATA (COORD(I,22,1),I=1,3) / +0.70711,-0.70711,+2. /
      DATA (COORD(I,23,1),I=1,3) / +0.86603,-0.50000,+2. /
      DATA (COORD(I,24,1),I=1,3) / +0.96593,-0.25882,+2. /
      DATA (COORD(I,25,1),I=1,3) / +1.00000,+0.00000,+2. /
      DATA (COORD(I,01,2),I=1,3) / +0.70711,+0.70711,+3. /
      DATA (COORD(I,02,2),I=1,3) / -0.70711,+0.70711,+2. /
      DATA (COORD(I,03,2),I=1,3) / -0.70711,-0.70711,+2. /
      DATA (COORD(I,04,2),I=1,3) / +0.70711,-0.70711,+2. /
      DATA (COORD(I,05,2),I=1,3) / +0.70711,+0.70711,+2. /
      DATA (COORD(I,01,3),I=1,3) / +1.00000,+0.00000,+3. /
      DATA (COORD(I,02,3),I=1,3) / -1.00000,+0.00000,+2. /
      DATA (COORD(I,03,3),I=1,3) / +0.00000,+1.00000,+3. /
      DATA (COORD(I,04,3),I=1,3) / +0.00000,-1.00000,+2. /
      DATA (COORD(I,01,4),I=1,3) / +0.86603,-0.50000,+3. /
      DATA (COORD(I,02,4),I=1,3) / +0.00000,+1.00000,+2. /
      DATA (COORD(I,03,4),I=1,3) / -0.86603,-0.50000,+2. /
      DATA (COORD(I,04,4),I=1,3) / +0.86603,-0.50000,+2. /
      IF((ISYMB.GT.4).OR.(ISYMB.LT.1))  GO TO  300
      ANGLE= THETA*3.14159265/180.
      S= SIN(ANGLE)
      C= COS(ANGLE)
      K= ISYMB
      J2= NPTS(K)
      DO  100  J= 1,J2
```

"OCNST2"

```
      X1= X+SIZE*(COORD(1,J,K)*C-COORD(2,J,K)*S)
      Y1= Y+SIZE*(COORD(1,J,K)*S+COORD(2,J,K)*C)
      IPEN= COORD(3,J,K)
  100 CALL PLOT(X1,Y1,IPEN)
      CALL PLOT(X,Y,3)
  200 RETURN
  300 WRITE(6,9000)  ISYMB
      ISYMB= 0
      GO TO 200
 9000 FORMAT('0CALL TO ''CYMBAL'' WITH ISYMB=',I4,' OUT OF RANGE' / )
      END


      SUBROUTINE OPART(USER,N1,N2,JOB,SIZE,IER)
      DIMENSION TEXT(18),ARGDAT(2),ARGTIM(2),WORD(2),USER(2),JOB(2)
      DATA WORD / 'START',' END ' /
      INDEX= 2
      IF(IER.NE.0)  GO TO  1
      INDEX= 1
      CALL PLOTS(IER)
      IF(IER.LT.0)  GO TO 3
      CALL WHERE(X,Y)
      CALL PLOT(X,-25.,-3)
      CALL SYMBOL(0.,2.,.4,'SCRIBBLE, SCRIBBLE, SCRIBBLE,..',90.,31)
    1 SIZ= SIZE
      IF((90.*SIZ).GT.20.)  SIZ= 2./9.
      CALL WHERE(X,Y)
      CALL PLOT(X+4.,25.,-3)
      CALL PLOT(0.,-25.,-2)
      CALL DATE(ARGDAT)
      CALL TIME(ARGTIM(1),ARGTIM(2))
      ENCODE(90,7001,TEXT)  WORD(INDEX),USER,N1,N2,JOB,ARGDAT,ARGTIM,
     1                      WORD(INDEX)
      WRITE(6,9000) TEXT
      X= 2.*SIZ
      Y= (22.-90.*SIZ)/2.
      THETA= 90.
      NCHAR=  90
      CALL SYMBOL(X,Y,SIZ,TEXT,THETA,NCHAR)
      X= 3.*SIZ
      CALL PLOT(X,25.,-3)
      CALL PLOT(0.,-25.,-2)
    2 RETURN
    3 WRITE(6,9001)
      GO TO  2
 7001 FORMAT(' ',A5,'--- USER ',2A5,' (',I6,',',I6,') JOB ',2A5,' DATE '
     1       ,A5,A4,' ',A5,':',A2,' ---',A5,' ' )
 9000 FORMAT('0CALL TO ''OPART''        ',18A5 / )
 9001 FORMAT('0CALL TO ''OPART''        PLOTTER NOT AVAILABLE' / )
      END
```

"AVOCN"

```
      IT=TT(I)/5.-1.
      ENGL=OO(I)*1.4286
      IF (IC.LT.1.OR.IC.GT.3.OR.IT.LT.1.OR.IT.GT.4) GO TO 122
      P=AMOD(TT(I),5.)/5.
      Q=AMOD(SS(I)/1,  25,1.)
      OMP=1.-P
      OMQ=1.-QP
      PSAT=OO(I)*1 ../(OMP*(OMQ*TAB(IT,IC+1)+QP*TAB(IT+1,IC+1))+OMP*
     1 (OMQ*TAB(IT,IC)+Q*TAB(IT,IC+1)))
      GO TO 123
  122 PSAT=99999.
  123 PRINT 903,ICE (I),TT(I),SS(I),SSTG,OO(I),ENGL,PSAT,PP(I),ENI(I)
  903 FORMAT(11X,22X,F5.  F7.3,F7.2,2F5.2,F7.2,F5.2,F6.2)
      GO TO 5                                                F 02092
  701 PRINT 600
  600 FORMAT(' ERROR A')                                     F 02712
      GO TO 5                                                F 02722
  703 PRINT 601
  601 FORMAT(' ERROR B')                                     F 02742
      GO TO 5                                                F 02752
  705 PRINT 602
  602 FORMAT(' ERROR C')                                     F 02772
      GO TO 5                                                F 02782
  711 PRINT 604
  604 FORMAT(' ERROR E')                                     F 02832
      GO TO 5                                                F 02842
  713 PRINT 605
  605 FORMAT(' ERROR F')                                     F 02862
      GO TO 5                                                F 02872
  715 PRINT 606
  606 FORMAT(' ERROR G')                                     F 02892
      GO TO 5                                                F 02902
  721 PRINT 608
  608 FORMAT(' ERROR I')                                     F 02952
    5 IF(IHCRN.GT.3) RETURN
      PRINT 906, OLDCR,OLDSTA,CR,STA
  906 FORMAT('1AVERAGE DATA FOR ',2A3,' THROUGH ',2A3)
      PRINT 905
  905 FORMAT('0DEPTH TEMPERATURE SALINITY   SIGMA T    OXYGEN   PHOS
     1 NIT  ENI')
      DO 202 J=1,17
      IF(CTR(J).EQ.0.) GO TO 202
      DO 203 I=1,7
      DATST(I)=0.
  203 CONTINUE
      DO 201 K=1,2
      IF (DATSTO(1,J,K).EQ.-1.) GO TO 201
      DO 200 I=1,6
      DATST(I)=DATST(I)+DATSTO(I,J,K)/CTR(J)
  200 CONTINUE
  201 CONTINUE
      PRINT 904,IDEP(J),DATST
  904 FORMAT(I ,2X,I5,5X,F 3.3)
  202 CONTINUE
      CALL EXIT
      END                                                    F 02932
```

"AVOCN"

```
54 SS(ID)=F(I)
   GO TO 34
55 OO(ID)=F(I)
   GO TO 34
56 PP(ID)=F(I)
   GO TO 34
57 E[illegible]I(ID)=F(I)
   GO TO 34
69 ID=ID-1
60 IF(ID-N) 36,36,61
61 N=ID
36 IF(ICNT-5) 71,70,7[illegible]
71 ICNT=ICNT+1
   GO TO 9
35 ID = ID+1
   R=SD(ID)
   IF(ID-R) 3[illegible],81,81
81 IF(ID-15) 82,83,83
82 Q=5.1
   GO TO 33
83 Q=10.1
   GO TO 33
34 IF(ID-25) 35,6[illegible],6[illegible]
70 O[illegible]=0.
   PREV=0.
   PREVD=[illegible].
   DO 123 I=1,N
   Z=SD(I)
   M=SD(I)
   R=TT(I)
   W=SS(I)
   CL=(W-.03)/(1.805)
   SSOO=((.0002398*CL-.00157)*CL + 1.47[illegible])*CL -.069
   ET=1.E-6*R*((.[illegible]1667*R-.-15[illegible])*(+1 . 5)
   AT=.[illegible]1*R*((.[illegible]1[illegible]3[illegible]-.[illegible]9 [illegible])*R+4.7867)
   SUMT=(R-3.98)*(R-[illegible].2[illegible])*(R+2[illegible].)/(5[illegible].57*(R+67.26))
   SSTO=(SSOO+.1324)*(1.-AT+BT*(SSOO-.1324))-SUMT
   ASTU=1./(SSTO*.[illegible]1 +1.)
   V=4886./(1.+ [illegible]3*Z)
   B=((.[illegible] +*R-.5[illegible]1)*R+2[illegible].33)*R+227.
   C=(.15[illegible]*R+9.5)*R + 1[illegible].[illegible]
   XA=(.[illegible]4*R-2.72)*R +1[illegible]7.[illegible]-Z*[illegible].E-4*((.[illegible]2*R-.c7)*R +32.4)
   E=4.5+.1*R-Z*1.E-4*(1.[illegible]-.[illegible]*R)
   Q=(SSOO-28.)*.1
   O=(-1.[illegible]E-8*R*Z+C*1.E-[illegible])*Z+(E*Q-XA)*Q
   ASTP=ASTU*(1.-2*[illegible].[illegible]-[illegible]*(U+[illegible]-[illegible]))
   DELTA=ASTP - AP(I)
   DD=.5*(DELTA+PREVD)*(Z-PREV)
   DH=DH+DD
   PREV=Z
   PREVD=DELTA
   DELTA=DELTA*1.E+5 +.[illegible]5
   I[illegible]EP(I) = SD(I)
    IF(I.GT.17) GO TO 123
   CTR(I)=CTR(I)+1.
   DATSTO(1,I,NC)=TT(I)
   DATSTO(2,I,NC)=SS(I)
   DATSTO(3,I,NC)=[illegible]
   DATSTO(4,I,NC)=[illegible](I)
   DATSTO(5,I,NC)=PP(I)
   DATSTO(6,I,NC)=[illegible](I)
   [illegible]=SS(I)/1.02555-1?.
```

```
      D3=D(KK+1)
      GO TO 40
   39 M=[illegible]
      F1=F(I-2)
      F2=F(I-1)
      F3=F(I)
      F4=F(I+1)
      D1=D(I-2)
      D2=D(I-1)
      D3=D(I)
      D4=D(I+1)
   40 IF((D2-D1)*(D3-D1))[illegible]
  701 IF((D1-D2)*(D3-D2))[illegible]
  702 IF((D1-D2)*(D2-D3))[illegible]
  7[illegible] PTRP=F1*(D2-[illegible])*([illegible])/(([illegible])*(D3-D1))
      PTRP = PTRP + [illegible]*(D3-D)/(((D1-D2)*(D3-D2))
      PTRP=PTRP + F3*([illegible])/((D1-D3)*(D2-D3))
      XMAX=.5*((D2**2)*(F3-F2)+(D3**2)*(F1-F3)+(D1**2)*(F2-F1))
      IF(D1*(F3-F2)+D2*(F1-F3)+D3*(F2-F1))7[illegible],75[illegible],7[illegible]
  7[illegible] XMAX=XMAX/(D1*(F3-F2)+D2*(F1-F3)+D3*(F2-F1))
   75 IF(D2-XMAX)1[illegible]
  1[illegible] IF(D3-XMAX) [illegible]
  1[illegible] JJ=1
  1[illegible] IF([illegible]) 42,41,42
   41 IF((D3-D2)*([illegible])[illegible],71[illegible],71[illegible]
  71[illegible] IF((D2-D3)*([illegible])[illegible],712
  712 IF((D2-D4)*(D3-D4))71[illegible],715,716
  716 PT=F2*(D3-[illegible])*([illegible])*(D4-D2))
      PT=PT + F3*([illegible])/((D2-D3)*(D4-D3))
      PT=PT + F4*([illegible])/((D2-D4)*(D3-D4))
      XMAX=.5*(([illegible])*(F4-F3)+([illegible]**2)*(F2-F4)+( 4**2)*(F3-F2))
      IF(D2*(F4-F3)+D3*([illegible])+D4*(F3-F2))714,751,714
  714 XMAX=XMAX/(D2*(F4-F3)+D3*(F2-F4)+D4*(F3-F2))
  751 IF(D2-XMAX) [illegible]
  1[illegible] IF(D3-XMAX) [illegible]
   9[illegible] PTRP=(PT+PTRP)/2.
  1[illegible] JJ=1
   42 IF(JJ-1) 1[illegible]9,11[illegible],1[illegible]9
  11[illegible] IF(PTRP-F2) [illegible]
  1[illegible] IF(PTRP-F3) 1[illegible]7,1[illegible]
  1[illegible] IF(PTRP-F3) 1[illegible],1[illegible]
  107 IF((D3-D2)+F2)72[illegible]
  72[illegible] PTRP=(F3-F2)*([illegible])/(D3-D2)+F2
  1[illegible]9 GO TO (43,44,45,46,47),ICNT
   43 TT(ID)=PTRP
      GO TO 34
   44 SS(ID)=PTRP
      GO TO 34
   45 OO(ID)=PTRP
      GO TO 34
   46 PP(ID)=PTRP
      GO TO 34
   47 ENI(ID)=PTRP
      GO TO 34
   49 I=1
      GO TO 52
   5[illegible] I=2
      GO TO 52
   51 I=K
   52 GO TO (53,54,55,5[illegible],57),IC[illegible]
   53 TT(ID)=F(I)
      GO TO 34
```

```
    1 300.,500.,700.,800.,1000.,1200.,1500.,2000.,2500.,3000.,4000.,
    2 5000.,6000./
      DATA AP/,97254,,97259,,97255,,972505,,972415,,972382,,97219,
    1 ,971952,,97174,,971515,,97122,,97084,,9702,,96995,,96951,,96907,
    2 ,96819,,96732,,96602,,96558,,96177,,9597,,95566,,95173,,94791/
      DATA II,SS,DD,PP,R,   1/2*0.,/
      IF( C.EQ.0) OLDCRU = CRU
      IF( C.EQ.0) OLDSTA=STA
      NC=MIN0(NC+1,30)
      ICNT=1
      K=1
      C=0.                                                               F 00670
      PRINT 821,CRU,STA                                                  F 00680
  821 FORMAT(1H1A5,1X,A5,2X,'STANDARD DEPTHS')                           F 00690
    9 I =1
      R=0.                                                               F 00790
      GO TO (14,11,12,13,15),ICNT                                        F 00800
   14 DO 24 I=1,NSTOP
   24 X(I)=T(I)                                                          F 00820
      GO TO 10                                                           F 00830
   11 DO 21 I=1,NSTOP                                                    F 00840
   21 X(I)=S(I)                                                          F 00850
      GO TO 10                                                           F 00860
   12 DO 22 I=1,NSTOP                                                    F 00870
   22 X(I)=O(I)                                                          F 00880
      GO TO 10                                                           F 00890
   13 DO 23 I=1,NSTOP                                                    F 00900
      P(I)=AMAX1(P(I),.. 1)                                              F 00910
   23 X(I)=P(I)
      GO TO 10
   15 DO 25 I=1,NSTOP
      END(I)=AMAX1(END(I),.  1)
   25 X(I)=END(I)
   10 K=0
      DO 29 I=1,NSTOP                                                    F 00930
      IF(X(I)) 28,29,28                                                  F 00940
   28 K=K+1                                                              F 00950
      F(K)=X(I)                                                          F 00960
      D(K)=Z(I)                                                          F 00960
   29 CONTINUE                                                           F 00970
      KK=K-1                                                             F 00980
      IF (K-3) 36,30,30                                                  F 00990
   30 IF(D(1)-R)31,49,34                                                 F 01010
   31 IF(D(2)-R)32,50,37                                                 F 01010
   32 DO 33 I=3,KK                                                       F 01020
      IF(D(I)-R) 33,52,35                                                F 01030
   33 CONTINUE                                                           F 01040
      IF(D(K)-R+C) 59,51,38                                              F 01060
   37 M=1                                                                F 01070
      F1=F(1)                                                            F 0108
      F2=F(2)                                                            F 0109
      F3=F(3)                                                            F 0110
      D1=D(1)                                                            F 0111
      D2=D(2)                                                            F 0111
      D3=D(3)                                                            F 0112
      GO TO 40                                                           F 0113
   38 M=1                                                                F 0114
      F1=F(KK-1)                                                         F 0115
      F2=F(KK)                                                           F 0116
      F3=F(KK+1)                                                         F 0117
      D1=D(KK-1)                                                         F 0118
      D2=D(KK)                                                           F 0119
                                                                         F 012
                                                                         F 0121
```

```
      SIGMAT=XT+(SQ+,1324)*(1,-AT+BT*(SQ-,1324))
   29 MG =OTITRA*1.4286
      IC=CL-17,
      II=IAVE/5,-1,
      IF (IC,LT,1,OR,IC,GT,3,OR,IT,LT,1,OR,IT,GT,4) GO TO 31
      PP=AMOD(IAVE,5,)/5,
      Q= MOD(CL,1,)
      OMP=1,-PP
      OQ =1,-Q
      PSAT=OTITRA*100,/(PP*(OMQ*TAB(II,IC+1)+Q*TAB(II+1,IC+1))+OMP*
     1 (OMQ*TAB(II,IC)+ TAB(II,IC+1)))
      GO TO 32
   31 PSAT=5000,
   32 PRINT 611,IESTOP,   ,IB,ING,ELTMPM,EMTMPM,II,SAVE,SIGMAT,OTITRA
     1 , CL,PSAT, PO412,
      IF( STOP,EQ,2)  STOP=4
      OD(NSTOP)=IZ
      (NSTOP)=TI
      (NSTOP)=SAVE
      (NSTOP)=OTITRA
      (NSTOP)=PO412
      NO( STOP)=ENO3
      IF ( STOP,NE,4) GO TO 33
      OD(2)=,2*OD(4)+, *OD(1)
      (2)=,2*T(4)+,  (1)
      (2)=,2*S(4)+,   (1)
      (2)=,2*O(4)+,   (1)
      (2)=,2*P(4)+,   (1)
      ENO(2)=,2*ENO(4)+,    (1)
      D(3)=,5*(OD(4)+  (1))
      (3)=,5*(T(4)+T(1))
      (3)=,5*(S(4)+S(1))
      (3)=,5*(O(4)+ (1))
      (3)=,5*(P(4)+P(1))
      ENO(3)=,5*(ENO( )+E (1))
   33 IF (IDC RL,EQ,3) GO TO 1
      IF (OD(NSTOP),  ,3  ,  ,OR,OD(NSTOP),LE,250,) GO TO 34
      OD( STOP+1)=300,
      GO TO 36
   34 IF(OD(NSTOP),GE,1   ,  ,OR,OD(NSTOP),LE,75,) GO TO 35
      OD( STOP+1)=10 ,
   36 NSTOP= STOP+1
      FACT=(OD( STOP)- OD( STOP-1))/(OD(NSTOP-1)-OD(NSTOP-2))
      T(NSTOP)=T(NSTOP-1)+FACT*(T(NSTOP-1)-T(NSTOP-2))
      S(NSTOP)=S(NSTOP-1)+FACT*(S(NSTOP-1)-S(NSTOP-2))
      O(NSTOP)=O(NSTOP-1)+FACT*(O(NSTOP-1)-O(NSTOP-2))
      P(NSTOP)=P( STOP-1)+FACT*(P(NSTOP-1)-P(NSTOP-2))
      ENO(NSTOP)=ENO( STOP-1)+FACT*(ENO(NSTOP-1)-ENO(NSTOP-2))
   35 CALL STANDP(TAB)
      IF(IDC RL-3 ) 91,1 ,5
   91 CALL EXIT                                                     A
      END                                                           A
      SUBROUTINE STANDP(TAB)
C     PROGRAM STANDEPS, INTERPOLATES BETWEEN POINTS TO GIVE STANDARD    E
C     DEPTH EQUIVALENTS, LISTS WITH DOUBTFUL VALUES AND PUNCHES '4' CARDS,
      COMMON OD,T,S,O,P, STOP,CTRY,LATDEG,ELATMN,LONDEG,ELONMN,MARS,YR,
     1 MO,DAY,CRU,STA,   NRL,E
      DIMENSION SD(25)   (40),T(40),S(40),O(40),P(40),ENO(40),ENI(40)
      DIMENSION F(40),    ),A (25),TT(40),SS(40),OO(40),PP(40),X(40)    F
      DIMENSION ICE     DAT  (  ,17,30),CTR(17),DAIST(9),TAB(5,4)
      DATA DATS  ,DA    ,   ,    *-1  ,  *,  ,  /
      DATA SD/  ,10,,2   ,  ,5  ,75,,100,,15 ,,200,,250,,30 ,,400,,
```

```
      IF (BAROM.GT.1000.) BAROM= BAROM-100.
      PRINT 602,MO,DAY,Y ,BAROM,[illegible],INVEL,WAVPER
      PRINT 603, [illegible]
      PRINT 604,LATDEG,[illegible],CLDTYP,WAVDIR,SONDEP
      PRINT 605,LONDEG,[illegible],CLDAMT,WAVHYT,COLOR
      READ(2,202)((IR(I,J),J=1,7),I=1,3),EMIFAC,TIMZN,CARD1,CARD2,PCNTRL
      L=1
      IF (IR(1,1).EQ.0) GO TO 98
      GO TO 35
 [illegible]
 [illegible]
 [illegible]
 10   [illegible]
 [illegible]
      PRINT [illegible],IR(L,1),[illegible],IR(L,2),[illegible],IR(L,5),L7,EMIFAC
      PRINT [illegible]
      IF (L.GT.1) GO TO [illegible]
   12 READ(2,503)CASTNO,IESTOP,[illegible],SLIP,IBOTMR,ELTHMR,
     1 ELTMPR , ELTMPA, [illegible],EMTOPA,RTTHMR,RTTMPM,RTIMPA,
     2 SLDIAL, SBROG,[illegible],PO412,IC31,IC432,DO-02,DSTN,IDCNRL
      [illegible]=IE.31+IE.32,1.0,
      IESTOP= STOP+1
      T=[illegible]
   13 [illegible]
      S[illegible]E=0.
      T[illegible]E=0.
      SIGMAT=0.
      IF(DO[illegible].[illegible]TA) GO TO 92
      IF CASTNR-IR(L,1)) 90,51,154
   90 PRINT 608
  154 L=L+1
      GO TO 92
   92 PRINT 612, [illegible]
      IF IDCNRL-3 ) 91,[illegible]
   51 IZ=((IESTOP+SLIP)*[illegible](IR(L,5)*1,7453292E-2)*EMIFAC)+1.
      IF (IESTOP.EQ.0) [illegible]
CXXXXXTHERMOMETRIC DEPTH FROM OXYGEN BOTTLE ON COLUMN (58-60)
      IZ=OBOTMR
      IF(ELTMPM) 73,73,7[illegible]
   73 IF(EMTMPM) 79,79,[illegible]
   74 IF(EMTMPM) 53,53,5[illegible]
   53 TAVE=ELTMPM
      GO TO 79
   55 TAVE=(ELTMPM+EMTMPM)/2.
      IF ( ABS(ELTMPM-EMTMPM)-.[illegible]*TAVE) 79,79,27
   27 PRINT 609
   54 TAVE =EMTMPM
      IF(EMTMPR) 79,7[illegible]
   79 IF (SBROG) 28,2[illegible]
   5[illegible] IF(EMTMPA) 59,59,[illegible]
   59 SAVE =EMTMPR
      GO TO 64
   61 SAVE=( EMTMPR + EMTMPA )/2.
      IF( ABS( EMTMPR - EMTMPA )-.02*SAVE) 64,64,28
   28 PRINT 610
   6[illegible] SAVE=SBROG
   64 IF(TT.EQ.[illegible] ) GO TO 29
      CL=SAVE/1.80655
      AT=TT*(4.7867-.098[illegible]*TT+.0010843*TT*TT)*1.E-3
      BT=TT*(18.[illegible]-.[illegible]*TT+.[illegible]*TT*TT)*1.E-6
      XT=-(TT-3.98)**2/[illegible]*(TT+283.)/(TT+67.26)
      S0=-.069+1.47[illegible]*CL-.0[illegible]*CL**2+.0000398*CL**3
```

"AVOCN"

```
C  OCEANOGRAPHIC STATION LOG DATA, SIGMA T AND WIRE ANGLE  DEPTHS CALC,   A
C  ALL DATA CARDS REQUIRE PRNC REFERENCE NUMBER PUNCHED IN SPACES 74-79.  A
C  ALL DATA CARDS REQUIRE '3' IN SPAC 80 EXCEPT '0' FOR LAST DATA CARD   A
C     IN THE RUN OR '5' IF ANOTHER STATION IS TO FOLLOW.                A
C  STATION NAME GOES IN SPACES 28-33,                                    A
C  RELATIVE HUMIDITY GOES IN SPACES 68-70                                A
CXXXXXTHERMO ETRIC DEPTH FROM OXYGEN BOTTLE NR COLUMN (58-60)
C     ONLY THREE CASTS ALLOWED PER STATION.                              A
      COMMON OD,T,S,O,P,ASTOP,CTRY,LATDEG,FLATMN,LONDEG,FLONMN,MARS,YR,
     1 MO,DAY,CRU,STA,IOCNRL,END
      DIMENSION OD(40),T(40),S(40),O(40),P(40),ID(3,7),TAB(5,4),END(40)
      EQUIVALENCE(II,TAVE)
      INTEGER TZ
      REAL  SL
      DATA TAB/6.52,5.93,5.44,5.,4.58,6.44,5.86,5.38,4.95,4.52,
     1 6.35,5.79,5.31,4.89,4.46,6.27,5.72,5.25,4.83,4.4/
  501 FORMAT(F2.0,A2,A2,F3.1,A3,F3.1,I3,3A2,F3.1,2A3,A4,4X,3A2,2A1,
     1 2A2,F3.1,A2,3A1,A3,3X,2A3,A1)
  502 FORMAT(3(I1,2I2,I4,I2,2I4),6X,F4.3,F2.0,2F1.0,6X,F1.0)
  503 FORMAT(F1.2,I3,F3,0,F2.0,I2,3(F2.0,F4.2,F3.1),F3.0,F5.3,F3.0,2F4.2
     1 ,I2,1X,I2,A3,I1)
  601 FORMAT('1R  BALLOTED CRUISE ',A3,9X,'STATION ',2A3,9X,'PRNC REFEREA
     1NCE  '2A3)
  602 FORMAT(' DATE  'A3,'/'A2,'/'A2,3X,'BARO'4X,F6.1,3X,'WEATHER',4X,A2A
     1,2X,'WIND VELOC  ',A2,3X,'WAVE PERIOD  ',A1)                        A
  603 FORMAT(' HOUR',/X,F4.1,3X,'TEMP DRY  ',F4.1,3X,'VISIBILITY  ',A1,3A
     1X,'WI   DIREC  ',A2,3X,'TRANSPAR     ',A2)                          A
  604 FORMAT(' LAT',3X,A2,'-',F4.1,' N',3X,'TEMP WET  ',F4.1,3X,'CLOUD TA
     1YPE  ',A1,3X,'WAVE DIREC  ',A2,3X,'SONIC DEP ',A4)                  A
  605 FORMAT(' LONG ',A3,'-',F4.1,' W',3X,'REL HUMID  ',A3,3X,'CLOUD AMTA
     1',3X,A1,3X,'WAVE HEIGHT  ',A1,3X,'COLOR',7X,A2)                     A
  606 FORMAT('0CAST ',I1,2X,'MESS TIME ',F4.1,' GMT, ',2I2,' LOCAL  MAX DA
     1EPTH ',I4,'  WIRE ANGLE ',I2/ 9X,'OXYGEN TITER ',F5.3,'  METER WHEA
     2EL FACTOR ',F5.3 //)                                                A
  607 FORMAT('     DEPTH (M)',T26,'TEMP',T54,'OXYGEN',/' WIRE  CZ    TZ   A
     1 IL    IL  TAVE   SALIN  SIG T ML/L MG/L %SAT   PHOS NITRA')
  608 FORMAT(' ERROR, CAST NUMBER WRONG OR DETAIL CARD OUT OF ORDER')    A
  609 FORMAT(' DELTA T GREATER THAN 2%')                                 A
  610 FORMAT(' DELTA S GREATER THAN 2%')                                 A
  611 FORMAT(1X,3(I4,1X),I3,1X,3(F5.2,1X),F6.3,F7.2,2(F5.2),F7.2,
     1 1X,F4.2,F6.2)
  612 FORMAT(' ERROR, DATA CARD FROM DIFFERENT CRUISE OR STATION '2A3)   A
  613 FORMAT('0SURFACE SAMPLE, BOTTOM SAMPLE, PLANKTON OR NEKTON,')      A
  614 FORMAT('1ALL DEPTHS ARE IN METERS,  NUTRIENTS IN UG-AT/L,'/        A
     1' MAX-SAMP. DEPTH = MAXIMUM SAMPLING DEPTH * E-2,'/                A
     2' WATER COLOR - FOREL WATER COLOR SCALE, H.O. 215,'/               A
     3' TRANSPARENCY = SECCHI DISC DEPTH,'/                              A
     4' WIND AND WAVE DIRECTION COMING FROM * E-1 ROUNDED, TABLE IN H.O. A
     5215,'/                                                             A
     6' WAVE HEIGHT - H.O.215 WIND WAVE CODE,'/                          A
     7' WAVE PERIOD - IN SECONDS,'/                                      A
     8' WIND SPEED - IN METERS PER SECOND,'/                             A
     9' WEATHER,VISIBILITY,CLOUD TYPE AND AMOUNT - H.O. 215 CODE,')      A
      PRINT 614                                                           A
    5 READ (2,501)CTRY,SHIP,LATDEG,FLATMN,LONDEG,FLONMN,MARS,YR,MO,DAY,
     1 WTHR,STNAM1,STNAM2,SONDEP,COLOR,TRANSP,WAVDIR,WAVHYT,WAVPER,
     2 WINDIR,WINVEL,BAROM,AIRTPD,AIRTPW,WHR,CLDTYP,CLDAMT,VIS,RELNUM,
     3 CRU,STA,ICNTRL
      IF(CTRY) 21,21,22
   22 PRINT 601,CRU,STNAM1,STNAM2,CRU,STA
      ASTOP=0
      BAROM=BAROM*1...
```

CHAPTER 3

TEMPERATURE AND DEPTH CALCULATIONS

3-1 GENERAL REMARKS.—The determination of true sea water temperatures and the depths at which they are obtained by means of Nansen bottles and deep-sea reversing thermometers are relatively complex. This entire chapter explains the methods and calculations involved in computing these values. The formulas given herein have been reduced to their simplest forms to enable rapid processing of data by observers in the field. For the person desiring more detailed information as to the derivation of these formulas, reference is made to H. O. Pub. No. 614, Processing Oceanographic Data.

The calculations involved in determining the temperatures and depths of Nansen bottle samples are recorded on the A-sheet, which is described in chapter 14, and on related graphs. Although these calculations can be made with an ordinary slide rule, the use of a special reversing thermometer slide rule, or a calculator, makes the process easier. The Hydrographic Office uses a small, inexpensive, plastic slide rule made for this purpose.

3-2 Deep-Sea Reversing Thermometer Calibration Corrections.—Before each deep-sea reversing thermometer can be used it must be tested and precisely calibrated to determine small errors in graduations of the scales of the main and auxiliary thermometers; the volume of mercury in the bulb of the main thermometer; the glass constant; and for unprotected thermometers, the pressure coefficients. Each thermometer used by the Hydrographic Office is tested and calibrated by the Bureau of Standards which issues a calibration sheet for it before use at sea.

When the thermometers are used at sea, either a copy of the calibration sheet or a card as shown in figure 3-1, giving the necessary information, is provided for each thermometer. Select the calibration sheet or card with the thermometer manufacturer's serial number corresponding to that of the reversing thermometer being used, and obtain the volume of mercury in the bulb of the main thermometer, called the V_0; the correction for the main thermometer scale, called the index correction; and the index correction for the auxiliary thermometer. These walues are to be recorded in the proper columns of the A-sheet. The glass constant of each main thermometer, called K, and the pressure coefficient of each unprotected thermometer, called Q, are also given on this sheet.

3-3 THERMOMETER CORRECTIONS.—To determine the true temperatures of the water samples, the protected thermometer readings must be corrected to allow for expansion of the glass and mercury after reversal and for the errors in the index scale. To determine the true depths at which the samples were actually taken, similar corrections must be applied to the unprotected thermometers, and also using the corrected temperatures of the protected thermometers. Thus, slightly different formulas are required to correct the protected and unprotected thermometers. As the formula to correct the unprotected thermometers requires the use of the corrected temperatures of the protected thermometers, the calculations for the latter must be completed first. It is mainly for this reason that when protected and unprotected thermometers are paired on a Nansen bottle, the protected thermometer is always placed in the left-hand tube and the unprotected in the right-hand tube of the thermometer frame. The data are then recorded and the calculations carried out on the A-sheet in the order in which they are used.

3-4 Correcting the PROTECTED Thermometer.—The protected thermometer is corrected to give the true temperature of the water by the following formula:

$$T_w = T' + C + I$$

T_w=The corrected value of the protected reversing thermometer. This is the true water temperature.

NUMBER 4720 | MAKE R & W | TYPE ☐ PROTECTED ☑ UN-PROTECTED | RANGE -2° to +30°C | V_0 = 99°C | "K" VALUE = 6100

DEEP SEA REVERSING THERMOMETER CORRECTIONS

MAIN THERMOMETER		AUXILIARY THERMOMETER	
TEMPERATURE	CORRECTION	TEMPERATURE	CORRECTION
0°C	-.01	0°C	-.1
6°C	-.01	10°C	.0
10°C	-.01	20°C	.0
16°C	-.01	30°C	-.1
20°C	-.01	40°C	
25°C	-.01	50°C	
30°C	-.02		
°C			
°C			

T°		T°		T°		T°		T°		T°	
0.0											
	-.01										
27.6											
	-.02										
30.0											

"Q" FACTOR

1000 M =	.01275
2000 M =	.01272
3000 M =	
4000 M =	

CORRECTIONS TAKEN FROM BUSTDS/W.H.O.I. CALIBRATION SHEET

NUMBER

DATED 17 June 1954

COPIED BY BSR

DATE 3 Nov. 1954

1. Apply thermometer corrections algebraically.
2. Keep a complete history of this thermometer on the back of card. Indicate condition and action of thermometer by checks (✓) in applicable columns, where possible. Explain condition accurately where checks are not applicable.
3. Reverse the thermometer at least once every day.
4. Always store thermometer in the carrying case with the large reservoir DOWN, unless the stored thermometer will be subjected to temperatures colder than -10°C.
5. ALWAYS TRANSFER THIS CARD WITH THE THERMOMETER.

DEEP SEA REVERSING THERMOMETER CORRECTIONS AND HISTORY RECORD PRNC-NHO-1483 (New 8-54) NAVY-DPPO PRNC, WASH., D.C.

NUMBER 4720 | MAKE R & W | TYPE ☐ PROTECTED ☑ UN-PROTECTED | RANGE -2° to +30°C

THERMOMETER HISTORY RECORD

CRUISE	DATE	REPRODUCIBILITY				If malfunctional, check action of mercury.					OBSERVER'S NAME
		GOOD ±.02	FAIR ±.05	POOR ±.08	ERRATIC >±.10	SEPARATES	DOESN'T BREAK	BREAKS IMPROPERLY	FLOODS	OTHER (Explain)	
	2 Jan 54									Received at Hydro.	JHB
	17 June 54									Calibrated	C.B.
SP-14	15 Nov. 54	✓									BSR.
RE-15	2 Aug. 55	✓									BSR.

Figure 3-1. Deep-sea reversing thermometer corrections and history card.

T′=The uncorrected temperature reading of the main protected reversing thermometer.

I=The index correction for errors in the main protected thermometer scale. This is given on the calibration sheet or card and must be interpolated for the temperature reading (T') as closely as the calibration sheet will permit.

$C=\frac{(T'+V_0)\ (T'-t)}{K-100}$ This is the correction for the thermal expansion of the thermometer system, where

V_0=The volume of mercury below the 0° C. mark determined at 0° C. in the reversed main thermometer, expressed in degrees Celsius. It is given on the calibration sheet.

t=The temperature reading of the auxiliary thermometer corrected for index errors. The corrections are given on the calibration sheet. It is the temperature at which the protected reversing thermometer is read.

K=The reciprocal thermal coefficient of expansion of the thermometer system. It is a constant dependent upon the type of glass of which the thermometer is made. The K-value is given on the calibration sheet. Since most reversing thermometers are read to hundredths °C., the correction is desired to the same accuracy. This accuracy can be obtained when the denominator of the fraction is taken to be K-100.

An example of correcting a *protected thermometer* is shown as follows:

Given:

9.33° C. (uncorrected main thermometer as shown on the A-sheet).

20.2° C. (uncorrected auxiliary thermometer as shown on the A-sheet).

From the calibration sheet for this thermometer we find:

V_0=96°.

t=20.2° C.± the auxiliary thermometer index correction (in this case +0.7° C.)=20.9° C.

K=6100.

I=−0.01° C. (index correction for the main thermometer at 9.33° C.).

Find:

$C=\frac{(9.33+96)\ (9.33-20.9)}{6100-100}$.

$C=\frac{(105.33)\ (11.57)}{6000}$.

$C=-0.20°$.

Find:

$T_w=T'+C+I$.

$T_w=9.33°+(-0.20°)+(-0.01°)$.

$T_w=9.12°$.

3-5 Correcting the UNPROTECTED Thermometer.—The unprotected thermometer is corrected by the following formula:

$$T_u=T'_u+C+I$$

where the symbols are defined as:

T_u=The corrected reading of the unprotected reversing thermometer, a function of both temperature and pressure.

T'_u=The uncorrected temperature reading of the main unprotected reversing thermometer.

I=The index correction for errors in the main unprotected thermometer scale. This is given on the calibration sheet or card and must be interpolated for the temperature reading (T'_u) as close as the calibration sheet will permit.

$C=\frac{(T'_u+V_0)\ (T_w-t_u)}{K}$ This is the correction for the thermal expansion of the thermometer system, where

V_0=The volume of mercury below the 0° C. mark determined at 0° C. in the reversed main thermometer, expressed in degrees Celsius. It is given on the calibration sheet.

T_w=The corrected value of the *protected* reversing thermometer reading, (the true water temperature at depth of reversal).

t_u=The temperature reading of the unprotected auxiliary thermometer corrected for index errors. The corrections are given on the calibration sheet. It is the temperature at which the unprotected reversing thermometer is read.

K=The reciprocal thermal coefficient of expansion of the thermometer system. It is a constant which is dependent upon the type of glass with which the thermometer is made. The *K*-value is given on the calibration sheet.

An example of correcting an *unprotected thermometer* is shown as follows:

Given:

$T'_u = 16.40°$ C. (Uncorrected main thermometer as shown on the A-sheet.

$t'_u = 20.7°$ C. (Uncorrected auxiliary thermometer as shown on the A-sheet.

From the calibration sheet for this thermometer we find:

$V_0 = 99°$.

$t_u = 20.7°$ C. ± the auxiliary thermometer index correction (in this case 0.0° C.) $= 20.7$ C.

$K = 6100$.

$I = -0.01°$ C. (index correction for the main thermometer at 16.4° C.).

From the paired *protected* thermometer we find:

$T_w = 9.12°$ C.

Find:

$$C = \frac{(16.40+99)\ (9.12-20.7)}{6100}.$$

$$C = \frac{(115.40)\ (11.58)}{6100}.$$

$C = -0.22°$.

Find:

$T_u = T'_u + C + I$.

$T_u = 16.40° + (-0.22°) + (-0.01°)$.

$T_u = 16.17°$.

3-6 REVERSING THERMOMETER CALCULATIONS WITH THE SLIDE RULE.—To simplify the calculations of reversing thermometer corrections, a special oceanographic slide rule was developed. The type used by the Hydrographic Office is shown in figure 3-2. Printed on the face of the slide rule are four scales marked A, B, C, and D. The A-scale gives the values of $V_0 + T'$ or $V_0 + T'_u$. The B-scale denotes the K—value for each thermometer. The C-scale gives the $T'-t$ or $T_w - t_u$. The D-scale gives the value C.

The reverse side of the slide has a three-place table of cosines for wire angles of 1° to 60°. On the back of the slide rule is a depth conversion table for fathoms to meters.

3-7 Correcting the PROTECTED Thermometer with the Slide Rule.—Corrections for the protected thermometer are made with the slide rule as follows:

Step 1: $V_0 + T'$. Determine this value and locate it on the A-scale.

Step 2: K. Determine K and set its value on the B-scale under the value for $V_0 + T'$ on the A-scale.

Step 3: $T'-t$. Determine this value and locate it on the C-scale.

Step 4: C. The answer (C) is read from the D-scale directly below the value $T'-t$ on the C-scale.

The sign of C is *plus* when T' is *greater* than t.

The sign of C is *minus* when T' is *less* than t.

3-8 Correcting the UNPROTECTED Thermometer with the Slide Rule.—Corrections for the unprotected thermometer are made with the slide rule as follows:

Step 1: $V_0 + T'_u$. Determine this value and locate it on the A-scale.

Step 2: K. Determine K and set its value on the B-scale under the value for $V_0 + T'_u$.

Step 3: $T_w - t_u$. Determine this value and locate it on the C-scale.

Step 4: C. The answer (C) is read from the D-scale directly below the value $T_w - t_u$ on the C-scale.

The sign of C is *plus* when T_w is *greater* than t_u.

The sign of C is *minus* when T_w is *less* than t_u.

3-9 THERMOMETRIC DEPTH DETERMINATION.—After the reversing thermometer readings have been corrected, the thermometric depth for each Nansen bottle equipped with an unprotected thermometer, e. g., the depth at which the thermometers reversed, can be calculated. Such calculations are possible only when protected and unprotected reversing thermometers are paired on a Nansen bottle. Usually protected and unprotected thermometers are not paired on every bottle but only at selected depths.

There are two methods in general use for determining thermometric depth. Although similar, one involves direct use of a formula, while the other uses preconstructed graphs based on the formula. Each unprotected reversing thermometer has a unique graph called a depth anomaly (ΔZ) graph from which the depth correction is read directly.

3-10 Determining Thermometric Depth by Formula.—The thermometric depth may be determined directly by the following formula:

$$Z = \frac{T_u - T_w}{\rho_m Q}$$

where:

Z = The thermometric depth in meters.

T_u = The corrected reading of the *unprotected* reversing thermometer.

T_w = The corrected reading of the *protected* reversing thermometer.

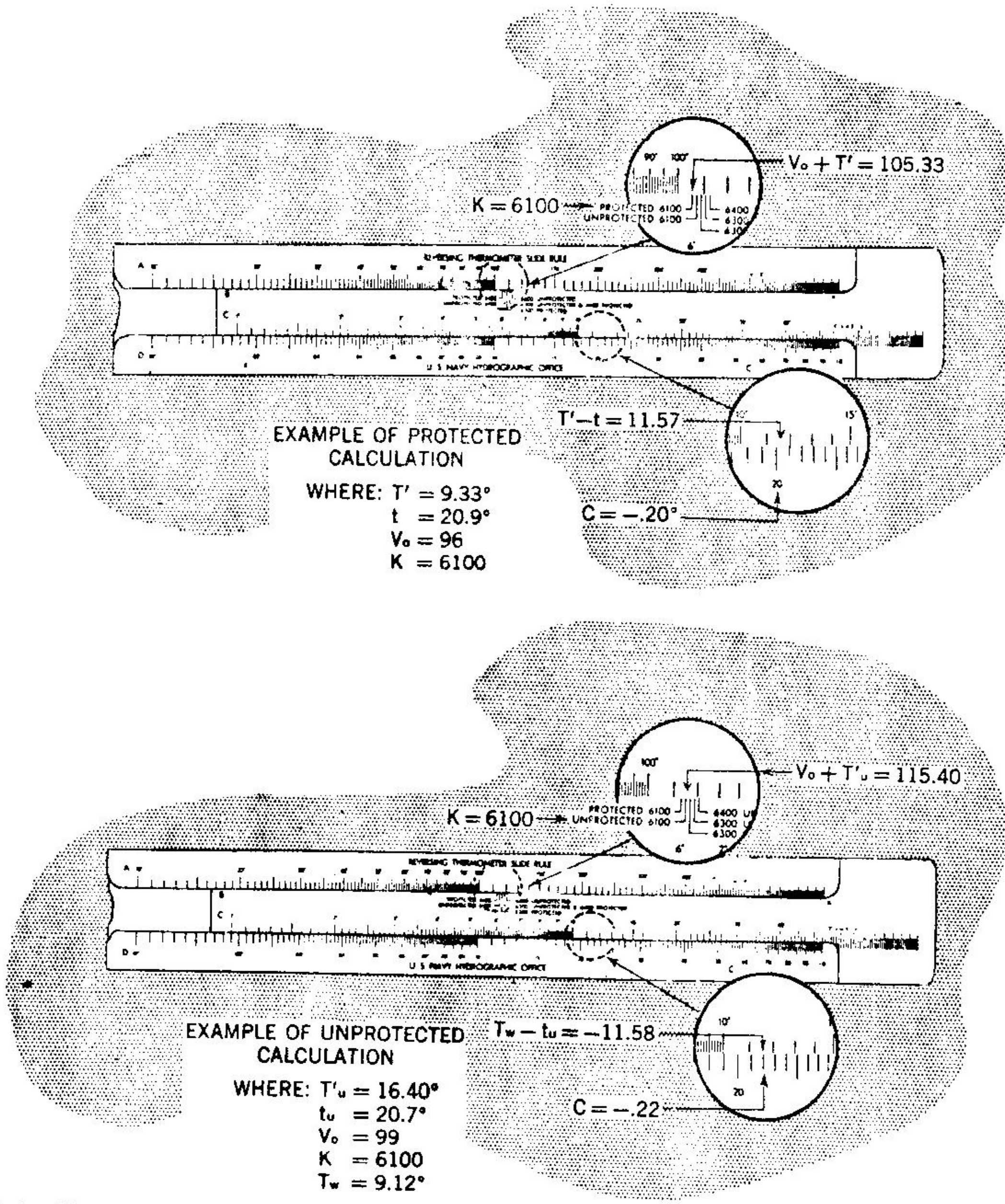

Figure 3–2. **Two drawings of reversing thermometer slide rule with protected and unprotected sample calculations.**

ρ_m = The mean density of the water column above the level of reversal. This may be obtained from graphs, tables, or the computed densities of the station. Graphs of these values for several areas are shown in figure 3–3 and in table 17.

Q = The pressure coefficient of the unprotected thermometer, expressed in degrees Celsius increase in the reading per 0.1 kg/cm² increase in pressure. As so defined, Q has a magnitude of roughly 0.01. Q is given on the thermometer calibration certificate.

An example of the calculation of thermometric depth is shown as follows:

Given:

$T_w = 16.17°$.

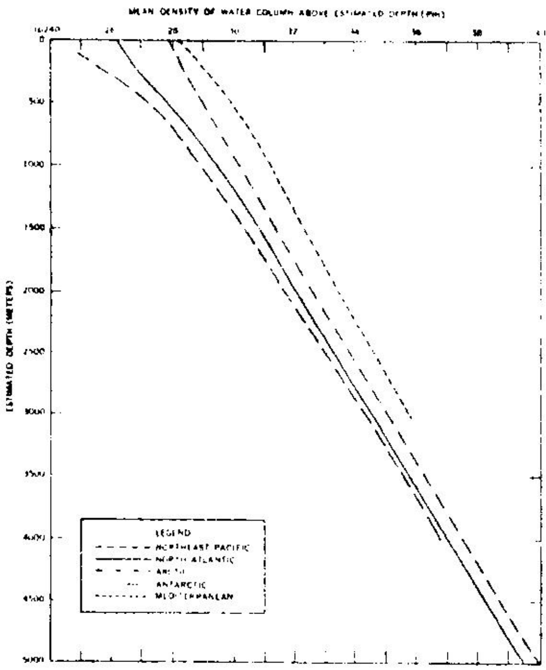

Figure 3-3. Mean density (ρ_m) of sea water.

$T_w = 9.12°$.
$\rho_m = 1.0281$ at 600 m.
$Q = 0.01275$.

Find:

$$Z = \frac{(16.17)-(9.12)}{(1.0281)\ (0.01275)}.$$

$$Z = \frac{7.05}{0.01311}.$$

$Z = 538$ meters.

This figure is entered in the "Thermometric Depth" column of the A-sheet.

3–11 Determining Thermometric Depth by Depth Anomaly (ΔZ) Graphs.—The depth anomaly (ΔZ) graph permits more rapid application of the above formula inasmuch as certain values of the formula may be precalculated and graphed. Thus, to find the thermometric depth of reversal of a given unprotected thermometer, ΔZ is read from its graph and added algebraically to $100(T_u - T_w)$ corresponding to the given $T_u - T_w$. ΔZ is defined as the meters depth by which Z differs from $100(T_u - T_w)$. In other words, since ρ_m is approximately 1.0 and Q is roughly 0.01, $Z = 100(T_u - T_w) + \Delta Z$.

Each unprotected thermometer should have its own depth anomaly (ΔZ) graph. A sample one is shown in figure 3–4. Enter the graph with T_u-T_w from the Difference column of the A-sheet (7.05°) and determine the ΔZ (−167m). Enter this value in the Correction column. Be sure to indicate if the correction is to be added or subtracted. Add this correction algebraically to the difference times 100 and enter this value (538m) in the Thermometric Depth (Z) column of the A Sheet.

3–12 Constructing a Depth Anomaly (ΔZ) Graph.—If it is assumed that an ideal unprotected thermometer will register an increase of 0.01° C. per meter of depth in sea water, then 100 times the difference between the protected and unprotected thermometer readings would equal the depth in meters. Actually, this is not exactly the case due to minute variations in the glass and other slight imperfections that are impossible to avoid in manufacture. Thus, the unprotected thermometer will have Q-factors that are somewhat greater or less than the ideal (0.01). Therefore, correction graphs can be constructed using the values of Q and ρ_m, assuming values of T_u-T_w, and then solving the formula, in section 3–10 above, for depth (Z). The difference between the computed or thermometric depth and the ideal or assumed depth is the depth anomaly (ΔZ). For example, the values used to construct the ΔZ graph shown in figure 3–4 are given below:

Assumed depth in meters	Assumed T_u-T_w	ρ_m	Q	Z	ΔZ
100	1.00°	1.0264	0.01275	76	24
500	5.00°	1.0277	.01275	382	118
1,000	10.00°	1.0294	.01275	762	238
1,500	15.00°	1.0308	.01274	1141	359
2,000	20.00°	1.0321	.01272	1521	479
2,500	25.00°	1.0333	.01272	1902	598

The values of ΔZ are plotted at the values of T_u-T_w and a curve drawn through the points. It should be noted that in the sample these are *negative* errors, that is the thermometric depth is less than the assumed or ideal depth, and that the corrections obtained from this graph must be *subtracted* from $100(T_u$-$T_w)$ to obtain the correct thermometric depth.

3–13 ACCEPTED DEPTH DETERMINATIONS.—There are two methods in general use for determining the accepted depth; e. g., the best possible determination of the true depth of each Nansen bottle at the time of reversal. These are the depth-difference method (wire length, L, minus thermometric depth, Z) and the depth-ratio method (thermometric depth, Z, divided by wire length, L). In the first, a reasonably accurate picture of the true wire shape during cast is reproduced graphically, and in the second the ratio of the thermo-

REFERENCES

Beckman, 1965. Instruction manual for Model RS-7B Portable Induction Salinometer. Beckman Instruments, Inc. Cedar Grove, N.J.

Coohran, J.B., 1955. Instruction Manual for Oceanographic Observations. 2nd Ed., H.O. Pub. No. 607, U.S. Navy Hydrographic Office, Washington, D.C.

Duxbury, A.C. and P.A. Dinkins, 1966. Manual for Oceanographic Field Observations. Dept. of Ocean. U. of Washington, Seattle.

La Fond, F.C., 1951. Processing Oceanographic Data. H.O. Pub. 614. U.S. Navy Hydrographic Office, Washington, D.C.

Plessey, 1962. Operation and Maintenance Instructions Model 6220 Laboratory Salinometer. Plessey Environmental Systems. San Diego, Ca. (Formally Bissett-Berman).

Strickland, J.D.H. and T.R. Parsons, 1968. A practical handbook of sea water analysis. Bull. 167. Fisheries Research Board of Canada, Ottawa.