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OCEANS IV: A PROCESSING, ARCHIVING AND RETRIEVAL SYSTEM FOR OCEANOGRAPHIC STATION DATA

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ABSTRACT

OCEANS IV is a powerful system of programs used by the Canadian Oceanographic Data Centre to manage its oceanographic station data file. This file, at present, contains 30,000 stations consisting of, on the average, 10 observed levels each. The data are stored in geographical order on magnetic tape. The system can accept up to 35 different physical and chemical parameters in a partially open ended format. To date only 16 parameters have been assigned codes.

The four basic functions of the OCEANS IV system are:

(1) Processing of reversing thermometer readings.
(2) Preparing temperature, salinity and chemical data for archival in the oceanographic station data file.
(3) Printing data reports on request.
(4) Providing a flexible retrieval of data from the file.

CONTENTS

APPENDICES

LIST OF FIGURES

Figure

Figure

Figure

1. INTRODUCTION

1.1 PURPOSE

The Canadian Oceanographic Data Centre manages, among other files, a rapidly growing file of oceanographic stations. At present this file holds about 30,000 stations, but with the increasing global interest of Canadian oceanographers, it may well expand to ten times this size due to foreign data acquisitions. The usefulness of such a file is mainly determined by the availability of an efficient and flexible retrieval routine. The new OCEANS IV system meets these requirements, and has also been designed to extensively edit the input in an effort to make the system as "foolproof" as possible.

The OCEANS IV system fulfills the following four basic functions:

(1) Processing of reversing thermometer readings.
(2) Preparing temperature, salinity and chemical data for archival in the Oceanographic Station Data File.
(3) Printing data reports on request.
(4) Providing a flexible retrieval of data from the file.

Unlike its predecessor, OCEANS III, it can accept a fairly wide range of different physical and chemical parameters. At present it accepts 16 parameters, but it can be expanded to take up to 35 different variables.

This report will help the following categories of readers to understand the OCEANS IV system:

(1) Anyone submitting data to CODC for processing and/or archiving.
(2) Scientists or engineers using CODC's data bank.
(3) Other data centres interested in an outline of the OCEANS IV system.

A separate manual "Specifications for the OCEANS IV System", has been written by Mr. A.S. Adams of DCF Systems Limited. It gives detailed specifications on the system and all individual components, and is useful mainly for programmers and clerical staff involved in the maintenance and usage of the system. A limited number of copies of Mr. Adams' report can be made available on special request to those wishing to make a more detailed study of the system.

A brief summary of the OCEANS IV system, including flowcharts and a description of the individual programs, is given in Appendix A. The main text of this report, however, can be read without reference to the systems flowcharts. In the following sections a "black box" approach has been used to describe only the inputs to and outputs of the system with minimum reference to its actual structure.

1.2 TYPES OF DATA

The system can presently accept 16 different oceanographic parameters and a limited number of meteorological observations. The range of meteorological parameters has been limited to those which most directly influence surface conditions in the ocean, such as wind, waves, temperature, etc. Most oceanographic vessels submit regular marine weather reports to the Department of Transport, and more complete data (for the standard observation hours) are available from their files.

The oceanographic parameters include depth, temperature, salinity, soundspeed, oxygen, PO_4-P, total P, NO_2-N, NO_3-N, SiO_3-Si and pH, all included in the former OCEANS III file, and a number of new parameters. Codes have presently also been assigned to fluoride, dissolved and particulate organic carbon, total and carbonate alkalinity, and ammonia. A further 19 parameters can be added in the future up to a total of 35, making OCEANS IV far more flexible than the old system.

One of the most important newly introduced parameters is pressure. Both pressure and depth are retained in the OCEANS IV file; either one of these can be used as the "independent" variable for data retrievals. If pressure has been observed, depth will be calculated, as outlined in Section 4.2, and stored as a "dependent variable", and vice versa if depth has been observed.

Temperature and salinity data sampled with STD probes can also be entered into the system, and can be marked to distinguish them from Nansen cast data. This is described in some detail in Appendix B3. It must be noted, however, that OCEANS IV is essentially designed to handle observations from a limited number of discrete levels for each station; analog or digital traces obtained with STD's therefore must be reduced to a maximum of 99 points per station. This is sufficient detail for climatological studies, but it may be inadequate for some other demands that could be put on the data bank. Separate programs still have to be developed to convert digitized STD data into OCEANS IV input format.

All data have to be corrected and calibrated before submission, with one exception only: Reversing thermometer data can be submitted as raw readings. They will be calibrated and corrected as outlined in Section 4.1 by the Thermocheck program.

1.3 DATA OUTPUT

The data output is very flexible. Major output options are listings of data being processed, data reports ready for publication, data inventories, horizontal distributions of means and standard deviations, or just plain copies of the data on paper, punch cards or magnetic tape. These options will be discussed in detail in Section 3.

The data input forms are described in some detail in Section 2, which also outlines the error checking procedures and summarizes the resulting error messages. Copies of the input forms and of the coding instructions are shown in Appendix B.

All data are thoroughly edited before inclusion in the file, and error messages will signal all violations of the edit conditions. The identifying information is subject to "presence" checks, most data are tested for being numerical and for remaining within acceptable ranges. These checks are discussed in some detail in the Sections 2.2 and 2.3.

1.4 DATA FILES

New data are entered into the system on cards, and are, after acceptance by the Edit program, accumulated on the OCEANS IV transaction tape. This file contains all Cruise Masters, Station Masters and Observed Details in sequence of entry, but no derived or interpolated data. All information that can be obtained mathematically from the observations, is re-calculated (upon demand) when the data are retrieved from the files.

Once every six to nine months the three oceanographic master files are updated. The Cruise Master file consists of cards and is only used for internal reference. The station data are separated into two master files on magnetic tape: The Station Master and Level Master files, containing the Station Master and Observed Detail records respectively. The reason for creating two master files for the station data is twofold: reduction of overall file size and of the cost of running inventory control type of requests. The number of stations that will be extracted under a set of retrieval conditions, for example, can be determined from the Station Master file in a fraction of the time needed to pass a tape containing both Station Masters and Observed Details.

The Station Master file contains, apart from the information given on the Station Master section of the input forms, also a summary of the observations taken at the station. Major entries in this part are minimum and maximum observed depth, parameters observed and the percentage of the levels at which each of the parameters has been measured. The major reason for including this summary in the Station Master file is to decrease the cost of data extractions and the production of data inventories.

The Level Master file contains observed parameters, depth and pressure. No derived parameters, such as sigma-t, etc., are stored. These are all calculated upon demand when data are retrieved from the file.

The master files are in a geographical sequence. The traditional Marsden square system has been replaced by the more convenient COTED system described in detail in Appendix F. Marsden square numbers are only used in the output as shown in Appendix D3. Both the COTED and the Marsden ten-degree square keys are shown in the Fig. F1, and the one-degree square keys are shown in the Figs. F3 and F2 respectively.

1.5 LIMITATIONS

Within the range of input and output formats defined elsewhere, the system is also subject to some limitations set to reduce internal memory requirements and computing time. These are a maximum of 999 stations per cruise, 99 levels per station and 10 different parameters per station. The latter two limitations can be extended relatively easily if necessary.

1.6 ENVIRONMENT AND LANGUAGES

The system is written in COBOL F and FORTRAN IV G; the first of these is used for input-output, data manipulation and editing, while all calculations are written in FORTRAN. The use of special language features has been avoided as much as possible, and the system should be transferable to other computers with a minimum of modifications.

The computer presently used is the IBM System/360 Model 85, operating under MVT, at Systems Dimensions Limited in Ottawa. Internal memory requirements have been limited to 200 k bytes. The peripheral equipment needed consists of 5 tape drives (9 track, 1600 bpi), 1 card reader, 1 card punch and 1 line printer.

1.7 A COMPARISON WITH OCEANS III

The OCEANS IV system replaces the OCEANS III system in use until spring, 1970. The new system has a large number of improvements over OCEANS III and is expanded with a fairly sophisticated data retrieval program. The major improvements are:

(1) OCEANS IV has a partially open ended format, accepting up to 35 different parameters, of which 16 have been specified at present. OCEANS III had a closed format, accepting only 10 different pre-defined parameters.

(2) Reversing thermometer data can be submitted for archiving and no longer have to be recopied onto Data Summary forms after calibration in the new system.

(3) Depth and pressure are both accepted as independent variables and can both be used to retrieve data or as a reference level for dynamic height and other calculations. OCEANS III, as do systems used by most data centres, uses only depth for vertical reference.

(4) Data retrieval is much more flexible in OCEANS IV.

(5) More significant digits are allowed for several parameters to improve the accuracy of the system. Identifying information, such as location and depth, can also be specified with greater accuracy to improve the system's usefulness for storing nearshore and estuarine data.

(6) The production of regular catalogues of data holdings has been greatly facilitated.

2. INPUT AND DATA EDITING

2.1 DATA FORMS AND FORMATS

To provide some flexibility of input, a set of four forms has been designed:

The Cruise Master provides general information on a cruise and controls the conversion of "acceptable units" into OCEANS IV "file units".

The Deck Sheet is used to submit to CODC uncorrected temperature readings, obtained with reversing thermometers, for correction and subsequent archiving.

The Data Summary is used to submit, for archiving, and/or data report production, calibrated and corrected oceanographic station data such as temperature, salinity, oxygen, etc.

The Bridge Log can be used instead of the Station Master section of the Data Summary to submit station identifying information, such as time and location, and environmental data such as bottom depth and meteorological conditions.

Provisions have furthermore been made to accept data on the old OCEANS III forms and on tape in the NODC format.

The multitude of forms outlined above may, at first sight, appear to be somewhat confusing. They have been designed, however, to allow optimal flexibility. The combinations of input forms that can be used to cover various different situations is summarized in Table 2.a. The forms and their coding instructions are reproduced in Appendix B.

A separate form has also been designed to enter reversing thermometer calibration data for the Thermocheck program. This form, however, will be completed by CODC from the calibration certificates, and therefore will not be distributed to data submitting institutes. A sample of this Thermometer Calibration Sheet is also reproduced in Appendix B.

In the near future programs will be developed to accept STD data on magnetic tape. The Cruise Master and Bridge Log forms then could be used to record auxiliary information.

Table 2.a

SUMMARY OF THE ALTERNATIVE COMBINATIONS OF FORMS
THAT CAN BE USED TO SUBMIT DATA TO CODC
(AT THE OPTION OF THE DATA ORIGINATOR)

Data	Purpose	Possible Form Combinations			
		Cruise Master	Deck Sheet	Data Summary	Bridge Log
Temperature readings	Correcting	—	—		
Temperature readings	Correcting and archiving	—	—	—	
		—	—		—
Temperature readings plus other data	Correcting temp. and archiving all data	—	—	—	
		—	—	—	—
Temperature (corr.) and/or other data	Archiving	—		—	
		—		—	—

2.2 ERROR CHECKS ON REVERSING THERMOMETER DATA

Apart from a large number of edit checks performed on the input, the data is also subjected to a number of validity tests based on the results of the calculations described in Section 4.1. All terms used below are defined in Section 4.1.2. The following conditions are flagged in the output, but the data are accepted into the Thermocheck transaction file:

(1) A difference between the two readings of a main thermometer exceeding 0.02°C or of an auxiliary thermometer exceeding 5.0°C is signalled by a verbal error message.

(2) A difference between the calibrated mean temperatures of two protected thermometers, used at the same depth, exceeding 0.04°C is signalled by an asterisk following Mean Protected Temperature. If three protected thermometers have been used, all three are compared with each other.

(3) If two unprotected thermometers are used, a difference between the calculated pressures exceeding $(5.0 + \Delta P/400)$ is signalled by an asterisk following Observed Pressure.

(4) A difference between observed and smoothed pressure at any level exceeding 5 dbar or 0.5%, whichever is larger, is indicated by an asterisk following Smoothed Pressure.

(5) A smoothed pressure exceeding nominal pressure by more than 5 dbar or 0.5%, whichever is larger, is indicated by an asterisk following Wire Out.

(6) Observed main and auxiliary temperature readings more than 1.5°C and 5°C respectively outside the calibration range are flagged by a verbal error message.

A number of other errors can be picked up by the edit routines of the program, such as the occurrence of non-numerical values in a numerical field, the absence or improper coding of the thermometer serial number, the absence of essential station identifying information, etc. These will cause rejection of individual levels or stations and the printing of a verbal error message.

2.3 ERROR CHECKS ON DATA SUMMARY ENTRIES

All data entered on Data Summary forms are subject to edit checks to determine the acceptability of each entry. These tests are described in the Systems Manual. Whenever applicable, the data are also subjected to the range checks summarized in Tables 2.b and 2.c, and to the following validity tests:

(1) Time-distance checks for consecutive stations:

$$A - B \geqslant 0$$

where A is the vessel's cruising speed and B is given by:

$$B = \frac{1}{\Delta t}\left[(\Delta\, lat)^2 + (\Delta\, long \times \cos\varphi)^2\right]^{1/2}$$

where Δt is the time passed between two consecutive stations, ϕ their mean latitude (counting south latitudes as negative), and Δlat and Δlong the difference in their latitudes and longitudes respectively.

(2) Sigma-t check for consecutive levels. An error message is printed whenever:

$$\sigma_t(Z_{i+1}) - \sigma_t(Z_i) < 0$$

where $Z_{i+1} > Z_i$ are two consecutive observed levels.

Table 2.b

Code	Parameter	Doubtful data or Error Column	File Units	Pre-printed Decimal Point	Decimals Allowed	Range Check	Other Allowable Input Units (Decimals Allowed)	Remarks
-	Depth of Sample		m	yes	1	-	feet (1) fathoms (1)	Independent variable.
-	Sounding		m	yes	1	-	feet (1) fathoms (1)	Note method codes on Cruise Master.
-	Pressure (water)		db	yes	1	-	-	Can optionally be used as independent variable for retrievals. The M/C column following pressure provides room to indicate whether it is Measured or Calculated.
-	Temperature	*	°C	yes	3	$-2.0 \leq T \leq 30.0$	-	Note method codes on Cruise Master.
-	Salinity	*	g/kg	yes	3	≤ 40.0	-	Note method codes on Cruise Master.
-	Soundspeed		m/sec	yes	1			Note measured/calculated code on Observed Detail.
4	Oxygen	*	ml/l	no	2	≤ 15.0	mg-at/l (3)	Note method codes on Cruise Master.
5	PO_4-P	*	µg-at/l	no	2	≤ 4.0	-	
6	Total P	*	µg-at/l	no	2	≤ 20.0	-	
7	NO_2-N	*	µg-at/l	no	2	≤ 4.0	-	
8	NO_3-N	*	µg-at/l	no	1	≤ 45.0	-	
9	SiO_3-Si	*	µg-at/l	no	1	≤ 300.0	-	
A	pH	*	pH units	no	3	$6.5 \leq pH \leq 8.5$	-	
B	Fluoride	*	mg/l	no	2	-	-	
C	Diss. Org. C	*	mg/l	no	2	-	-	
D	Particulate C	*	mg/m^3	no	0	-	-	
E	Total Alkalinity	*	µ-eq/l	no	0	-	-	
F	Carb. Alkalinity	*	µ-eq/l	no	0	-	-	
G	NH_3-N	*	µg/l	no	2	-	-	

CODING, UNITS AND RANGE TESTS FOR OCEANOGRAPHIC PARAMETERS

Table 2.c

Parameter	File Unit	Pre-printed Decimal Point	Decimals Allowed	Other Allowable Input Units (Decimals allowed)	Remarks
Cloud Amount	WMO code 2700	N/A	-	-	
Wind Direction	WMO code 0877 ('68)	N/A	-	-	
Wind Speed	m/sec	no	0	knots (0), feet/sec (0), Beaufort, stat. miles/ hour (0)	Anemometer height must be indicated.
ww Code	WMO Code 4677	N/A	-	-	
Pressure (Air)	mbar[1)]	yes	1	mm (1)	Corrections for barometer height and outside air temperature can optionally be made. Corrections are not made by the program.
Air Temperature	°C[1)]	yes	1	°F (0)	For negative temperatures in °C add 50 to the absolute value; To enter °F, see instructions.
Wet Bulb	°C[1)]	yes	1	°F (0)	See Air Temperature; Wet Bulb must be $\leq$ Air Temp.
Wave Period	sec	no	0	-	
Wave Height	WMO code 1555	N/A	-	-	
Swell Direction	WMO code 0885	N/A	-	-	
Period	WMO code 3155 ('68)	N/A	-	sec (0)	
Height	WMO code 1555	N/A	-	-	

CODING, UNITS AND RANGE TESTS FOR METEOROLOGICAL PARAMETERS

3. DATA RETRIEVAL AND OUTPUT

Data output from the OCEANS IV system is controlled by two programs: RETRIEVE and REPORT. The first of these can extract data from the master file according to any number of conditions as described in Section 3.2. The REPORT program takes the output of the RETRIEVE program, or the OCEANS IV transaction file, and produces printed data reports, a summary of the data or a copy of the data on punch cards or magnetic tape as described in the next section. Some data summaries, such as Station Master Catalogues, Data Inventories and Station Counts are produced directly by the RETRIEVE program; these are described in Section 3.2. The operation of both programs is determined by control cards that can be coded using the Data Extraction and Data Output Forms shown in Appendix C. Sample outputs are shown in Appendix D.

The system also produces a number of secondary outputs, such as listings of processed Thermocheck data with a summary of reversing thermometer performance, and listings of edited data with error messages. A sample of all possible printed outputs is shown in Appendix D.

3.1 DATA OUTPUT

The REPORT program controls the output of data on punch cards, magnetic tape or in printed listings. Its major functions are:

a) Production of Data Reports. Note that both depth and pressure are always given in the Data Reports.

b) Computation of derived parameters and interpolated data as required for the output. The equations used are described in Chapter 4.

c) Punching of cards or writing of magnetic tapes with data in OCEANS IV format. An auxiliary program is available to translate the OCEANS IV format into the previously used OCEANS III output format.

d) Printing of tables with the means and standard deviations of data extracted from the master file by program RETRIEVE.

The choice of these functions, and some other details, is determined by control cards. A special form has been designed to code these control cards (Appendix C). Samples of all output listings and a description of all punch card and magnetic tape formats is given in Appendix D.

The interpolation is relatively flexible and includes the following features:

a) Interpolation can be requested for any of the chemical parameters specified on the Data Output Form. The code numbers to be used are defined on the Data Extraction Form. Temperature, pressure, salinity and soundspeed are always interpolated, if the interpolation control card is used, and need not be specified on the control card.

b) A choice can be made between the two interpolation techniques, Reiniger and Ross' and Rattray's, both described in the next chapter.

c) Interpolation can be requested to predefined standard depth levels (Table 7 in Fig. D.3.16) or to numerically identical standard pressure levels.

d) If desired, the standard levels can be replaced by an arbitrary set of levels by using the "Levels to be Used for Interpolation" cards defined on the Data Output Form.

3.2 DATA EXTRACTION

Data can be extracted from the master files using program RETRIEVE. This is one of the most flexible and probably most useful programs of the OCEANS IV system. Its major functions are:

a) To extract data from the master files according to a certain set of search conditions.

b) To produce a count of the number of stations that would be extracted according to certain search conditions.

c) To print a Station Master Catalogue.

d) To print a Data Inventory (3 possible formats).

The choice of these functions is determined by control cards; in the first case RETRIEVE has to be followed by program REPORT to calculate derived and interpolated parameters and to format the data for output.

A special form has been developed to code the control cards (Appendix C). The search conditions specified are additive; e.g. any station (or level) not satisfying any of the search conditions is rejected. Any arbitrary subset of the search conditions discussed in the following subsections forms a legitimate set of control cards.

On the "Request By" card the type of output desired is specified, along with requester name and address and a key used for sequencing the data. The output options ("search modes") are to:

1. Reproduce the stations successfully passing the search conditions onto an intermediate tape. Program REPORT then accepts this tape and produces punch cards, magnetic tape or a print out of the data as requested. The formats of these output options are described in Appendix D.

2. Count the number of stations and levels that meet a set of search conditions. The data are not actually retrieved in this case.

3. List a summary of all station masters accepted by the search (Appendix D). The entries are sequenced as specified on columns 65-67 on the "Request By" card. The summary shows for each station (i) the number of levels sampled, (ii) minimum and maximum sampling depth, (iii) number of samples within depth intervals delineated by the 0,75,225,500,1000, 2000,3000,5000, and 10000 metre levels, (iv) the parameters observed and (v) the percentage of levels at which each parameter is observed.

4. Print Data Inventory Type I. The data extracted from the file are counted, and for each one-degree square the totals counted for each of the up to 12 parts of the annual cycle specified in the "Time Interval or Season" search table. The data are counted over all years shown in the year-range field of the search table (Appendix D).

5. Print Data Inventory Type II. The output is similar to that of the type I inventory, except that the count within each one-degree square is broken down into up to 12 year ranges.

6. Print Data Inventory Type III. The data passing a search are counted by one-degree squares and printed in a semi-geographical format. The totals for one-degree squares within each Marsden square are printed in a two-dimensional grid as shown in Appendix D.

With the "Inventory Option" the one-degree square totals in the Data Inventories can be suppressed and only the totals by five and ten-degree squares will be printed. The five-degree squares are numbered in a counter-clockwise direction within each ten-degree square, and summarize the number of stations in the one-degree squares as shown:

five-deg. sq.	one-deg. squares
1	00-04, 10-14, 20-24, 30-34, 40-44
2	50-54, 60-64, 70-74, 80-84, 90-94

five-deg. sq.	one-deg. squares
3	55-59, 65-69, 75-79, 85-89, 95-99
4	05-09, 15-19, 25-29, 35-39, 45-49

The ten and one-degree squares are coded using the COTED squares system outlined in Appendix F.

The extracted data can be sorted in a sequence determined by the sort key specified under "Data Sequence". The geographical sequence is determined by the COTED squares system described in Appendix F. The data can be put into cruise sequence by using the identification "I" as first part of the sort key. The sequence then will be determined by country, institute code, CODC cruise number and consecutive station number.

All data extractions are based on the Station Master file unless otherwise noted. If a station is accepted, all levels will be brought forward to the intermediate output utilized by the REPORT program. In those cases where individual levels are searched, the levels not meeting the search conditions are marked by a "not acceptable" key, and these can optionally be rejected in the output of the REPORT program.

3.2.1 Area Search

Up to ten different rectangular areas can be specified for an area search. All data in the Gulf of St. Lawrence, for example, can be retrieved using the six rectangles shown in Fig. 3.a. In this case no Bay of Fundy or Atlantic Ocean data will "contaminate" the retrieved data.

3.2.2 Time Interval or Season Search

Data can be extracted for a certain continuous period or for certain seasons over all years. Up to twelve entries can be made, mainly for the purpose of controlling the Inventory Options 1 and 2. For a straight data retrieval, however, multiple entries can also be made.

3.2.3 Cruise Search

Data for up to ten individual cruises can be extracted simultaneously. Larger numbers can be retrieved if the cruise numbers can be grouped as suggested on the Data Extraction Form.

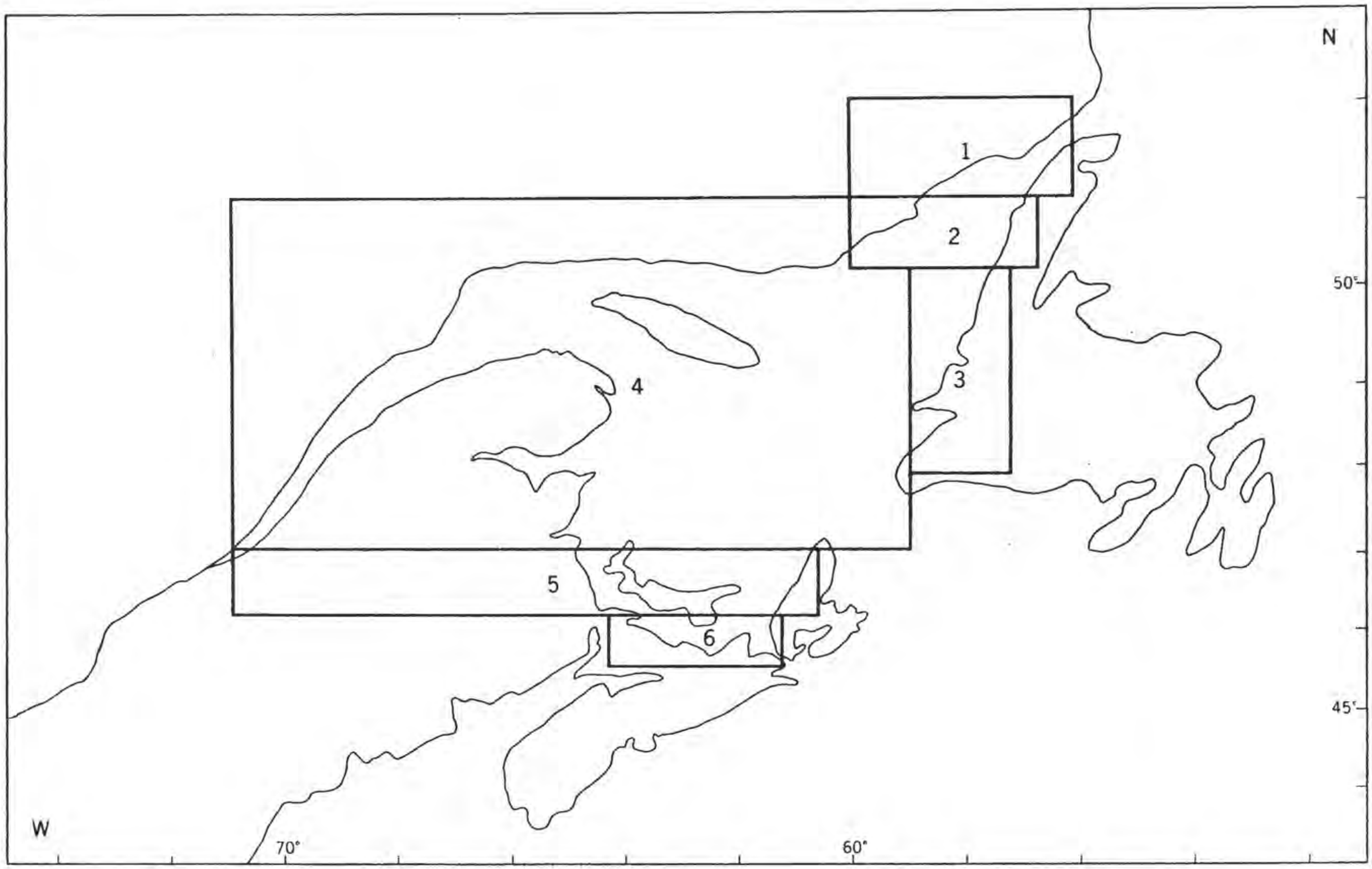

Fig. 3.a Graphical explanation of the method of setting up an area search for all data in the Gulf of St. Lawrence, which excludes from the extracted data file all data from other areas such as the Bay of Fundy or the Atlantic Ocean. The numbers 1-6 indicate the six rectangles used in this case.

3.2.4 Parameter Search

The simultaneous availability of up to 14 different parameters can be checked. Optionally, an upper and lower limit of acceptability can be assigned to each parameter. This search acts on both the Station Master and the Level Master files. If a parameter has been observed on a station, then all individual levels are checked for its presence. Any levels where the parameter in question has not been observed is marked by a "not acceptable" key, and can optionally be rejected by program REPORT when the data are punched on cards or written on magnetic tape.

3.2.5 Depth Search

Stations can be extracted from the file according to three different conditions:

1) The bottom depth must be observed and must be between the minimum and maximum values indicated.

2) Bottom depth is not always indicative of the depth to which a station extends. The sampling levels therefore can also be compared to a minimum and a maximum value. All stations with at least one observed level deeper than the minimum level and at least one level shallower than the maximum level are extracted.

3) Finally, the relation between sampling levels and bottom depth can be examined and all stations with at least one observed level within a specified distance off the bottom extracted.

This search is done on the Station Master file. A special routine can be used, however, to mark all levels, except the deepest, of the extracted stations as "not acceptable" thus deleting them from the output generated by the REPORT program.

3.2.6 Meteorological Data Search

The availability of any meteorological parameter on a Station Master can be checked, and only stations containing the desired information are extracted.

3.2.7 Data Distribution Search

For some derived parameters, such as geopotential anomaly, it is important that a sufficiently large number of adequately spaced levels have been observed. In this search the presence of at least one observed level within each of the defined intervals is checked for all levels between the surface and the deepest observed level of the station. The search condition can be made somewhat less stringent by allowing a certain number of "blank" intervals, that is intervals without any observed levels. This number can be defined under "a" (See Data Extraction form, Appendix C). If left blank, "a" is taken as zero. This is obviously a search into the Level Master File. Data outside the interval defined by the first and last levels specified are marked as "not acceptable" and can optionally be suppressed by program REPORT when the data are punched on cards or written on magnetic tape.

4. CALCULATIONS

4.1 REVERSING THERMOMETER CORRECTIONS

4.1.1 Correcting the Readings

The calibrated temperature T is calculated from the raw temperature readings R by applying two corrections. The index correction compensates for errors in the etched thermometer scale and the expansion correction compensates for the difference between reversal temperature and reading temperature (as indicated on the auxiliary thermometer). The mean temperature and pressure are then calculated for each level and, if more than one observation is taken at any level, the overall means are determined. The index and expansion corrections are calculated as follows:

4.1.1.1 Index Correction

The index correction I is added to (or subtracted from, if negative) the auxiliary and the main thermometer readings. This correction is defined for a number of points on the thermometer calibration cards. For intermediate points linear interpolation is used, for points outside the scale the nearest calibration point is used.

4.1.1.2 Expansion Correction for a Protected Thermometer

For a protected thermometer, the expansion correction C is calculated (Hansen, 1934) by:

$$C = \frac{(T_p' - t)\ (T_p' + V_o)}{K - 1/2\ (T_p' - t) - (T_p' + V_o)}$$

where T_p' is a main thermometer reading adjusted by the index correction, t the corresponding auxiliary thermometer reading adjusted by its index correction, and V_o and K calibration constants. The latter of these is the reciprocal thermal coefficient of expansion of the main thermometer, and V_o is the volume below the 0°C mark at a 0°C temperature. The corrected protected temperature then is given by: $T_p = T_p' + C = R + I + C$.

4.1.1.3 Expansion Correction for an Unprotected Thermometer

For an unprotected thermometer, the expansion correction (Keyte, 1964) is given by:

$$C = \frac{(T_u' + V_o)\ (T_p - t_u)}{K - 1/2(T_p - t_u)}$$

where T_u' is a reading of an unprotected thermometer adjusted by the index correction, t_u the corresponding auxiliary thermometer reading similarly adjusted, and T_p the mean calibrated and corrected protected thermometer temperature. The corrected unprotected temperature then is given by: $T_u = T_u' + C = R + I + C$.

4.1.2 Calculating Observed and Smoothed Pressures

"Observed" pressure is calculated for all levels where unprotected thermometers have been used. A curve is fitted to the observations and a smoothed pressure value determined for each observed level. The procedure is outlined stepwise following a definition of all variables used. All depths are in metres and pressures in decibars.

4.1.2.1 Definitions

L_T Total Wire Out = Distance in metres along the wire between the water surface and the deepest bottle. (Given on the Deck Sheet).

L_i Wire Out = Distance between the surface and bottle number i, measured along the wire.

L_{pi} Planned Wire Out = Planned distance along the wire for bottle number i; may or may not be equal to wire out. Differences occur, for example, when wire out is adjusted to get the deepest bottle at a fixed distance from the bottom. (Given on the Deck Sheet).

P_{ni} Nominal Pressure = A function of wire out.

P_{oi} Observed Pressure = A function of protected and unprotected thermometer readings.

P_{si} Smoothed Pressure = Pressure obtained after smoothing observed pressures. Alternately this term is used to describe pressures obtained by other techniques, such as straight interpolation or from depth using the hydrostatic equation.

Z_{ti} True Depth = Depth derived from smoothed pressure or, if this is not available, from Wire Out corrected for wire angle.

α Wire Angle = Angle between the vertical and the wire at the surface. (Given on the Deck Sheet)

4.1.2.2 Wire Out

Wire out L_i is calculated from total wire out and planned wire out. The difference between total wire out and planned wire out of the deepest bottle of a cast is ΔL. Wire out at any other depth then is given by:

$$L_i = L_{pi} + \Delta L = L_{pi} + (L_T - L_{pi}\ \mathrm{max})$$

4.1.2.3 Nominal Pressure

Nominal pressure P_{ni} is calculated:

$$P_{ni} = \frac{9.80665}{10} (1.02736 L_i + 2.465 \times 10^{-6} L_i^{\,2} - 1.847 \times 10^{-11} L_i^{\,3})$$

where L_i is wire out for planned wire out L_{pi}. This equation has been derived by Fofonoff (pers. communication) for the North Pacific, but it can be used anywhere as a first approximation.

4.1.2.4 Observed Pressure

Observed pressure is calculated from the mean protected temperature T_i at Z_{ni} and the unprotected temperature T_{ui}:

$$P_{oi} = \frac{T_{ui} - T_i}{Q} \times g_o$$

where the pressure coefficient Q is given in °C/kg/cm^2 and g = 9.80665 is standard gravity. If two unprotected thermometers are used at any level, P_{oi} is calculated for both observations and the mean is used for further computations.

4.1.2.5 Smoothed Pressure

Smoothed pressure is calculated from true depth as outlined in Section 4.2 if pressure has not been observed. Otherwise, it is calculated as described below.

If pressure has been observed at one level only, a second degree curve is fitted to the observation. The curve is constrained to meet the surface ($P_{n1} = P_{o1} = 0$) under the observed wire angle α:

$$P_{nk} - P_{ok} = a_2 P_{nk}^2 + (1 - \cos\alpha) \cdot P_{nk}$$

where k = 1. The unknown constant a_2 is solved exactly and the smoothed pressure P_{sj} at all other levels is then calculated using the same equation, substituting P_{ok} by P_{sj} and P_{nk} by P_{nj}.

Below the level L_K of the deepest pressure observation pressure is determined by linear extrapolation from P_{sK} and P_{sJ} at a level $L_J = 0.8\ L_K$:

$$P_{sj}\ (L_j > L_k) = \frac{P_{sK} - P_{sJ}}{L_K - L_J}\ (L_j - L_J) + P_{sJ}$$

For levels $L_j > 1.15 \times L_K$, however, smoothed pressure is calculated by:

$$P_{sj}\ (L_j \geqslant 1.15 \times L_k) = P_{sK} + (P_{nj} - P_{nk})$$

If pressure has been observed at K = 2 or 3 levels, a polynomial of order K is fitted by least squares to the difference between nominal and observed pressures. If $K \geqslant 4$, a fourth order polynomial is fitted. In all these cases the polinomial is restrained to reach the surface ($P_{n1} = P_{o1} = 0$) under the observed wire angle α:

$$P_{nk} - P_{ok} = a_4 P_{nk}^4 + a_3 P_{nk}^3 + a_2 P_{nk}^2 + (1 - \cos\alpha) P_{nk}$$

where $k = 1,\ldots,K$. The unknown constants a_2, a_3 and a_4 are solved by least squares and the smoothed pressure P_{sj} at all observed levels is then calculated using the same equation, replacing P_{ok} by P_{sj} and P_{nk} by P_{nj}.

At levels below the deepest observed pressure, P_{sj} is again determined as outlined above for the case of $K = 1$.

4.1.2.6 True Depth When Pressure Not Observed

True depth is only calculated from wire out and wire angle if pressure has not been observed. In this case, true depth is given by:

$$Z_{ti} = L_i \cos\alpha$$

down to the deepest observed depth above 110 metres, Z_{tj}, and below that by:

$$Z_{ti} = Z_{tj} + (L_i - L_j).$$

4.2 PRESSURE AND DEPTH

4.2.1 Calculations

Both the Thermocheck and the OCEANS IV Edit program convert depth to pressure and vice-versa. In the Thermocheck program pressure is calculated and smoothed before conversion to depth. If no reversing thermometers are used, depth is calculated from wire out and then converted to pressure. The OCEANS IV Edit program can accept either pressure or depth, and the missing level indicator is calculated (if both are given, no calculations are performed). The depth to pressure and pressure to depth conversions are outlined below and justified in the next subsection.

The hydrostatic equation relates depth, Z, to the pressure, P, and the density, ρ, of the water column:

$$Z_i = 10 \int_0^{P_i} \frac{1}{\rho g}\, dp \qquad 4\text{-}2\text{-}1$$

where $g = g_o = 9.80665$ is standard gravity in the Thermocheck program and $g = g(\phi z)$ in the OCEANS Edit program (see Section 4.3.1). This equation can be integrated, using Simpson's rule to find the depth of a level of known pressure. For stations with few or no observations near the surface, however, the results may become erratic, and nearby stations with differing distributions along the vertical of the observations then may give incompatible results. A fairly sophisticated logic would be required to determine the validity of the results.

For these reasons a simplified version of the hydrostatic equation is used in OCEANS IV:

$$Z_i = 10 \frac{P_i}{\rho_{mi}\, g} \qquad 4\text{-}2\text{-}2$$

where ρ_{mi} is the mean density above the level Z_i (Table 4.a). In a first approximation Z_i' is calculated for ρ_{mi} at a depth numerically equal to P_i. This is followed by a second approximation taking ρ_{mi} at the calculated depth Z_i'. The depth-density table can, for special projects, easily be substituted by another depth-density relationship.

Pressure can similarly be computed from depth by inverting equation 4-2-2:

$$P_i = \frac{\rho_{mi}\, g}{10} Z_i \qquad 4\text{-}2\text{-}3$$

using the same depth-density table.

4.2.2 Justification

Integration of the hydrostatic equation undoubtedly gives the best numerical conversion of pressure to depth, provided that density has been observed at an adequate number of levels. The difference between this and using a standard depth-density table, however, is small compared with the uncertainty in Z_i caused by errors in the pressure measurement. The argument will be carried through for pressure determinations with a

Table 4.a

DEPTH-DENSITY TABLES

The North Atlantic table for ρ_m is used as the standard depth-density relationship in OCEANS IV. The tables are taken from the "Handbook of Oceanographic Tables" (NAVOCEANO, 1966).

Depth (meters)	North Atlantic ρ_m	Northeast Pacific ρ_m	Arctic ρ_m	Mediterranean ρ_m
0...........	1.0262	....	1.0279	1.0282
100.........	1.0264	1.0248	1.0281	1.0286
200.........	1.0267	1.0255	1.0283	1.0289
300.........	1.0270	1.0261	1.0285	1.0293
400.........	1.0274	1.0267	1.0288	1.0296
500.........	1.0278	1.0272	1.0290	1.0300
600.........	1.0281	1.0276	1.0292	1.0302
700.........	1.0285	1.0280	1.0295	1.0305
800.........	1.0288	1.0283	1.0297	1.0307
900.........	1.0291	1.0286	1.0299	1.0310
1,000.......	1.0294	1.0289	1.0302	1.0312
1,500.......	1.0308	1.0304	1.0314	1.0324
2,000.......	1.0321	1.0318	1.0326	1.0335
2,500.......	1.0334	1.0331	1.0338	1.0346
3,000.......	1.0346	1.0344	1.0351	1.0358
3,500.......	1.0358	1.0356	1.0363	......
4,000.......	1.0370	1.0369	1.0375	......
4,500.......	1.0383	....	1.0387	......
5,000.......	1.0395	....	1.0400	......

reversing thermometer. The results will be valid in general unless either depth or pressure determinations can be significantly improved.

In the past decades several studies have been published relating to the accuracy of depth determinations obtained with reversing thermometers. Wüst (1933) originally estimated a mean depth error of 5 metres for levels between 100 and 1000 m and of 0.4 to 0.6% for deeper levels. This estimate is based on an estimate of the errors in Q, ρ_m and $\Delta t = T_u - T_p$ for thermometers used on the German Meteor Expedition in 1925-1927. Whitney (1957), in a more detailed analysis of possible error sources involved in the usage of reversing thermometers, but excluding the effect of ρ_m, finds a somewhat lower probable error range of 0.2 - 0.5% for depths below 1000 m. These are estimates of the depth error, but can equally well be considered as estimates of the pressure error, since the effect of gravity changes have not been taken into account.

Whitney's and Wüst's lower estimates may well be on the low side in view of the results of a recent comparison of thermometer calibrations carried out by four different laboratories (Martin et al, 1968). They found a mean error in the Q-factor determinations of 0.36% and a standard deviation of the differences between laboratories of 0.41% (for Q measurements under pressures of 2000 and 3000 db). Martin et al also found significant systematic deviations between the determinations of the index correction (S.D. = .016°C), and small deviations for V_o, but these may not affect thermometers calibrated by the same laboratory. Errors in pressure are determined by the relative errors in the index correction and V_o between the thermometers used, but by the absolute error in Q. These results suggest a 95% confidence limit for the pressure measurements of at least 0.8% instead of the 0.2 to 0.6% indicated by Whitney and Wüst.

A second source of errors originates from the horizontal and vertical variability of the gravity field. In the Thermocheck program gravity is taken as constant. In actual fact it varies with latitude (± 0.26%), increases with depth (0.1% at a depth of 5000 m) and is subject to a local variability (usually remaining well within ±0.01% over the open ocean). The major variability factor thus is dependent on latitude, which may introduce errors in the pressure to depth conversion up to plus or minus 0.26%. This effect was pointed out by Sturges (1968), who argued that equation 4-2-2 should be replaced by:

$$z_i = 10 \frac{p_i}{\rho_{mi}\, g(\phi)} \qquad 4\text{-}2\text{-}4$$

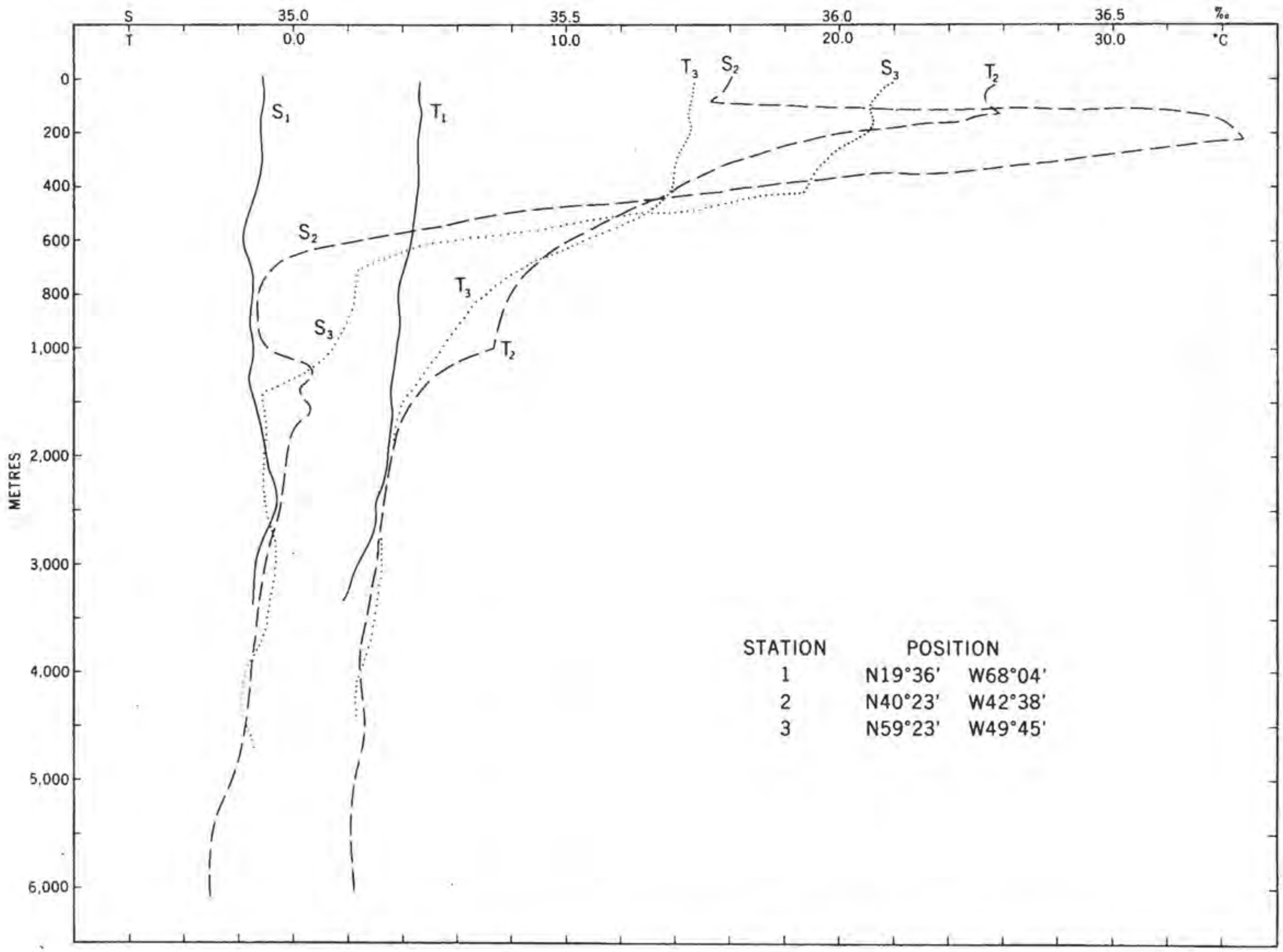

Fig. 4.a Stations used to test effect of the depth-density table on depth-pressure conversions.

Table 4.b

INFLUENCE OF ρ_m ON THE DETERMINATION OF DEPTH FROM PRESSURE.

Stat. Number	Z	ΔZ				Max. deviation in %
	Station Data	N. Atl.	Arct.	N.E. Pac.	Med.	
1	972.0	-0.6	-1.3	-0.1	-2.3	.24
	2131.2	-0.7	-1.7	-0.1	-3.4	.16
	2996.5	-0.9	-2.3	-0.3	-3.6	.12
	3953.9	-1.2	-3.0	-0.9	-	.07
	4907.3	-2.1	-4.0	-	-	.08
2	999.4	0.0	-0.7	+0.5	-1.7	.17
	1965.4	0.0	-1.0	+0.6	-2.7	.14
	2962.2	-0.1	-1.6	+0.4	-3.6	.12
	3960.4	-0.4	-2.3	+0.0	-	.06
	4664.7	-1.2	-3.2	-	-	.07
3	1002.3	+0.6	-0.2	+1.1	-1.1	.11
	2083.3	+0.6	-0.3	+1.2	-2.1	.10
	3370.1	+0.5	-1.1	+1.2	-	.04

where $g(\phi)$ is gravity as a function of latitude. In the OCEANS IV edit, the areal variability of gravity has been taken into account (see Section 4.3.1 on gravity). The Deck Sheet data do not include location, and the Thermocheck program therefore cannot include the latitude correction.

The errors due to incorrect calibrations and gravity variations can be compared with differences introduced by varying the depth-density table, which under normal conditions remain within 2.5 metres at a depth of 1000 m and less than 0.2% for deeper levels. These figures have been determined experimentally by taking three stations, one in the Labrador Sea (N59°23', W49°45') and two in the North Atlantic Ocean (N40°23', W42°38' and N19°36', W68°04'), see Fig. 4.a, and calculating the depth using the actual observations and four different depth-density tables. The depth-density tables used are given in Table 4.a and the results in Table 4.b. Errors are small even when the Mediterranean depth-density table is used. Excluding this area, where ρ_m is exceptionally high due to a high salinity, errors remain within 1.3 metres at 1000 m and within 0.08% at deeper levels.

The use of a standard depth-density table thus seems to be justified for all open ocean waters. The error introduced is less than 0.08%, which can be compared with an estimated error in the pressure measurement of 0.5 to 0.8%. If standard gravity is used, as in the Thermocheck, an additional error, increasing from 0 at latitudes of 45° to plus or minus 0.26% at the equator or the poles respectively, is introduced due to the difference between local and standard gravity.

4.3 DERIVED PARAMETERS

4.3.1 Gravity

Gravity is calculated as a function of latitude ϕ and depth z:

$$g(\phi) = 9.780356 \times \{1 + 5.2885 \times 10^{-3} \sin^2\phi - 5.9 \times 10^{-6} \sin^2(2\phi)\}$$

$$g(z\phi) = g(\phi) \times (1 + 2.28 \times 10^{-7} \times z)$$

The equations for $g(\phi)$ are, for example, given in the Smithsonian Tables (List, 1966) and in the Handbook of Physics and Chemistry (CRC, 1965); the equation for $g(z\phi)$ as a function of $g(\phi)$ in Proudman (1953, page 2).

Gravity varies over a range of 0.052 m/sec^2 with latitude, increases by 0.011 m/sec^2 at a depth of 5000 m and is subject to a local variability usually remaining within a range of plus or minus 0.001 m/sec^2 over the open ocean.

The effect of gravity on the pressure-depth conversion is discussed in some detail in Section 4.2.2. For the purpose of the pressure-depth conversions in the OCEANS IV Edit and in the calculations of the potential energy anomaly, the above equations for gravity are used.

In the pressure-depth conversions and the observed pressure calculations in the Thermocheck, however, a constant value of gravity, g_o = 9.80665, is used. It is based on early measurements of g_o at a latitude of 45°. This value is presently also used to define the relation between a kilogram-force and the Newton (Anderton et al, 1967), although more recent measurements show that it is slightly too high. List (1966) indicates a value of 9.8062 for g_o, at 45°. The difference between these two values of g_o, however, is negligibly small for the present purpose.

4.3.2 Sigma-t

4.3.2.1 Definition

The specific gravity anomaly of seawater at atmospheric pressure, sigma-t, is defined by:

$$\sigma_t = \sigma_{s,t,p=0} = 1000 \times (\rho_{s,t,p=0} - \rho_{s=0,t=4,p=0})$$

$$= 1000 \times (\rho_{s,t,p=0} - 1.0)$$

where $\rho_{s,t,p=0}$ is the specific gravity of seawater as a function of salinity S, temperature T, and oceanographic pressure P = 0.

Traditionally the terms specific gravity and density have been confused (see, for example, Cox, 1964). Strictly speaking, specific gravity is defined as the ratio of the mass of volume of water over the mass of an equal volume of pure water at a temperature of 4°C and under a pressure of one standard atmosphere; it is a dimensionless parameter. Density, on the other hand, is defined as the mass of a unit volume of water, and has a dimension of mass over volume. Up to 1964 the accepted unit of volume, the litre, was defined as the volume of 1 kilogram of pure water at 4°C and 1 atm., and the numerical values of specific gravity and density were equal. At the

General Conference of Weights and Measures in October 1964 the unit of volume has been redefined to be the volume of 1 cubic decimetre. This introduces a slight, but noticeable, difference between specific gravity and density, as the density of pure water now is equal to 1.000.027 g/cm^3 instead of unity (CRC, 1965). Sigma-t as defined above thus is larger by a factor 27 x 10^{-6} than σ_t as defined prior to 1964. This difference, however, is neglected for the present purpose, since σ_t is only calculated to four significant figures.

4.3.2.2 Equations

Tables and formulae giving σ_t as a function of temperature and salinity have been developed emperically by Knudsen (1901). His original equations have been rewritten by analytical expansion to give the polynomials presented below, rounding off the coefficients to a maximum of 10 significant digits:

$$\sigma_t = \frac{\sum a_i T^i}{T + a_0} + \sum_i \sum_j A_{ij} \sigma_0^i T^j$$

$$\sigma_0 = \sum_j b_j (S - 35)^j$$

where a_i, A_{ij} and b_j are constants given in Table 4.c. This version of Knudsen's equations was derived by Fofonoff et al. in 1958, small corrections have since been made in the coefficients a_1, a_3 and a_4.

The modified Knudsen's equations given above have originally been developed to save on memory requirements in a small computer. With the computers presently in use this is no longer necessary, and it would be theoretically more correct to use Knudsen's original equations. This however, is not done in OCEANS IV, mainly because Fofonoff's equations have been much more widely accepted for computerized routine calculations than Knudsen's.

4.3.3 Specific Volume Anomaly

4.3.3.1 Definition

Specific volume, α , is defined as the volume occupied by a unit weight of water with a salinity S, temperature T and under an oceanographic pressure P, and it is expressed in units of cubic centimetres per gram. Specific volume thus is the inverse of the density d of a sample. The relation between α, d and the specific gravity ρ, used to define σ_t, is given by:

$$\alpha_{stp} = \frac{1}{d_{stp}} = \frac{1}{\rho_{stp} \times 1.000.027}$$

The difference between specific gravity and density is discussed in the preceding section. The specific volume anomaly δ_{stp} is a measure of the difference between the specific volume of a sample and that of water with S = $35^0/00$, T = 0°C and under the same pressure P:

$$\delta_{s,t,p} = \alpha_{s,t,p} - \alpha_{35,0,P}$$

4.3.3.2 Equations

The equations for α_{stp} have been developed emperically be Ekman (1908). They have been rewritten for ease of programming on a small computer by Fofonoff et al. (1958). The derivations, which are based on an analytical expansion of the original equations and a recombination of terms, have not been fully documented, but have been thoroughly checked (personal communication, Fofonoff). The equations are:

$$\alpha_{tsp} = \frac{1}{1 + 10^{-3}\sigma_t} \left\{ 1 + \frac{a_1 P}{1 + a_2 P} + \sum_i \sum_j \sum_k A_{ijk} P^i \sigma_o^j T^k \right\}$$

$$\alpha_{35,0,P} = \frac{\sum_i d_i P^i}{a_2 + a_3 P}$$

and the specific volume anomaly is given by:

$$\delta(stp) = (\alpha_{stp} - \alpha_{35,0,p})$$

Table 4.c

SIGMA-T CONSTANTS

a_0	=	67.26	A_{20}	=	0
a_1	=	+4.53168 42620	A_{21}	=	$+1.8030 \times 10^{-5}$
a_2	=	-0.54593 91107	A_{22}	=	-8.164×10^{-7}
a_3	=	$-1.98248\ 39871 \times 10^{-3}$	A_{23}	=	$+1.667 \times 10^{-8}$
a_4	=	$-1.43803\ 0609 \times 10^{-7}$			
A_{10}	=	1.00000 00000	b_0	=	28.12634 861290
A_{11}	=	-4.7867×10^{-3}	b_1	=	+0.80597 373759
A_{12}	=	$+9.8185 \times 10^{-5}$	b_2	=	$+2.28129\ 3021 \times 10^{-4}$
A_{13}	=	-1.0843×10^{-6}	b_3	=	$+6.76786\ 1356 \times 10^{-6}$

Table 4.d

SPECIFIC VOLUME CONSTANTS

a_1	=	-4.886×10^{-6}	A_{200}	=	-6.68×10^{-14}
a_2	=	1.0	A_{201}	=	-1.24064×10^{-12}
a_3	=	1.83×10^{-5}	A_{202}	=	$+2.14 \times 10^{-14}$
A_{100}	=	-2.2072×10^{-7}	A_{210}	=	-4.248×10^{-13}
A_{101}	=	$+3.6730 \times 10^{-8}$	A_{211}	=	$+1.206 \times 10^{-14}$
A_{102}	=	-6.63×10^{-10}	A_{212}	=	-2.000×10^{-16}
A_{103}	=	$+4.00 \times 10^{-12}$			
			A_{220}	=	$+1.8 \times 10^{-15}$
A_{110}	=	$+1.725 \times 10^{-8}$	A_{221}	=	-6.0×10^{-17}
A_{111}	=	-3.28×10^{-10}			
A_{112}	=	$+4.00 \times 10^{-12}$	A_{301}	=	$+1.5 \times 10^{-17}$
A_{120}	=	-4.50×10^{-11}			
A_{121}	=	$+1.00 \times 10^{-12}$			

The constants a_i, A_{ijk} and d_i are given in Table 4.d and σ_o and σ_t have been defined in the preceding section.

Ekmen's original equations are not used in OCEANS IV for reasons similar to those leading to the rejection of Knudsen's original equations for sigma-t (see preceding section).

4.3.4 Sound Speed

4.3.4.1 Definition

Sound speed is the speed of propagation of sound waves through the water. It is independent of frequency, except in very shallow water or for very low frequencies when the wave length is of the same order of magnitude as the bottom depth.

4.3.4.2 Equation

Sound speed is a function of salinity, temperature and pressure, and is calculated using Wilson's (1960) equation:

$$V = \sum_{ijk} V_{ijk} \, Q^i (S - 35)^j T^k$$

where Q is the absolute pressure in kg/cm^2, which can be calculated from P (CRC, 1965):

$$Q = 1.003{,}23 + 0.101{,}971{,}6 \cdot P$$

The constants V_{ijk} are given in Table 4.e. Wilson's equation has been calibrated for the full range of salinities, temperatures and pressures normally occurring in the open ocean.

4.3.5 Geopotential Anomaly

4.3.5.1 Definition

Two alternate methods of calculating geopotential anomaly (frequently also called dynamic height anomaly) are available, depending on whether output is required for predetermined depth levels or isobaric surfaces.

If output is required for fixed depth levels, the same calculations formerly used in OCEANS III will be provided:

Table 4.e

SOUND VELOCITY CONSTANTS

$V_{000} = +1449.14$		$V_{110} = +7.7016 \times 10^{-5}$	
$V_{001} = +4.5721$		$V_{111} = +3.1580 \times 10^{-8}$	
$V_{002} = -4.4532 \times 10^{-2}$		$V_{112} = +1.5790 \times 10^{-9}$	
$V_{003} = -2.6045 \times 10^{-4}$			
$V_{004} = +7.9851 \times 10^{-6}$		$V_{200} = +1.0268 \times 10^{-5}$	
		$V_{201} = -2.5294 \times 10^{-7}$	
$V_{010} = +1.39799$		$V_{202} = +1.8563 \times 10^{-9}$	
$V_{011} = -1.1244 \times 10^{-2}$			
$V_{012} = +7.7711 \times 10^{-7}$		$V_{210} = -1.2943 \times 10^{-7}$	
$V_{020} = +1.69202 \times 10^{-3}$		$V_{300} = +3.5216 \times 10^{-9}$	
		$V_{301} = -1.9646 \times 10^{-10}$	
$V_{100} = +1.60272 \times 10^{-1}$			
$V_{101} = -1.8607 \times 10^{-4}$		$V_{400} = -3.3603 \times 10^{-12}$	
$V_{102} = +7.4812 \times 10^{-6}$			
$V_{103} = +4.5283 \times 10^{-8}$			

$$\Delta D(z_n) = \int_0^{P(z_n)} [\alpha_{stp} - \alpha_{35,0,p}]\, dp = \int_0^{P(z_n)} \delta(stp)\, dp$$

where $\Delta D(Z_n)$ is the geopotential anomaly in dynamic metres (10^5 ergs/g), $P(Z_n)$ the pressure at a depth Z_n, and $\delta_{stp} = \frac{1}{\alpha_{stp}}$ is defined in Section 4.3.3.

If output is required for isobaric surfaces, the following equation will be used:

$$\Delta D(P_n) = \int_0^{P_n} \delta(stp)\, dp$$

where P_n is the pressure at the desired isobaric surface. This method is presently used by Bedford (personal communication, W. Forrester; see also Reiniger et al, 1968-A).

4.3.5.2 Calculations

Both equations are evaluated using the trapezoidal rule:

$$\Delta D(Z_n) = \frac{1}{2} \sum_{i=1}^{n} \left\{ \delta(stp(z_i)) + \delta(stp(z_{i-1})) \right\} \times \left\{ P(z_i) - P(z_{i-1}) \right\} \qquad 4.3.1$$

and

$$\Delta D(P_n) = \frac{1}{2} \sum_{i=1}^{n} \left\{ \delta(stp_i) + \delta(stp_{i-1}) \right\} \left\{ P_i - P_{i-1} \right\} \qquad 4.3.2$$

where $i = 1, \ldots, n-1$ are the observed levels Z_n and P_n respectively.

The accuracy then is improved by making successive approximations. Using Reiniger and Ross' interpolation method (Section 4.4.2), the density profile is defined, and the number of points used to evaluate (4.3.1) or (4.3.2) is successively doubled until the difference between successive approximations falls below 0.001 dynamic metres. Doubling the number of points is accomplished by taking values for levels midway between each pair (Z_i, Z_{i-1}) or (P_i, P_{i-1}) respectively.

The basic assumption behind this approximation procedure is that the true profile of a parameter can be approximated better by a series of hyperbolic interpolations than by a series of straight lines connecting the observed points. No study has been made to determine whether this leads to a real improvement of the results.

4.3.5.3 Limitations

Geopotential anomaly is not calculated if the first observed depth Z_1 (or pressure P_1) exceeds 10. For $0 < Z_i \leqslant 10$ or $0 < P_i \leqslant 10$ the surface value of δ is taken to be equal to $\delta(Z_i)$ or $\delta(P_i)$ respectively.

4.3.6 Potential Energy Anomaly

4.3.6.1 Definition

The potential energy anomaly χ_n at a depth Z_n relative to the surface is defined by:

$$\chi_n = \frac{1}{g}\int_0^{P(Z_n)} P\,\delta\,dp$$

where g is the gravity acceleration (Fofonoff, 1962). It is expressed in units of 10^8 ergs/cm^2. If output for fixed pressure levels is required, $P(Z_n)$ is replaced by P_n.

4.3.6.2 Calculations

The above equation is evaluated using the trapezoidal rule:

$$\chi_n = \frac{1}{2g}\sum_{i=2}^{n}(P_n\,\delta_n + P_{n-1}\,\delta_{n-1})(P_n - P_{n-1})$$

The accuracy of the result can be improved by a similar procedure as outlined for geopotential anomaly, using successive approximations doubling the number of levels. For these intermediate levels δ is given by Reiniger and Ross' interpolation formula (Section 4.4.2).

Similar calculations can be made to standard pressure levels.

4.3.6.3 Limitations

The potential energy anomaly is not calculated if the first observation is taken at a pressure level $P_1 > 10$; for $0 < P_1 \leqslant 10$ the surface value of δ is taken equal to $\delta(P_i)$.

4.3.7 Potential Temperature

4.3.7.1 Definition

Potential temperature is the temperature that a water sample would attain if raised adiabatically to the sea surface.

4.3.7.2 Calculations

The equations to calculate the potential temperature θ have been developed by Fofonoff et al (1958). The equations below are taken from Ralya (1968).

$$\theta = T - \Delta\theta$$

$$\Delta\theta = \sum_i \sum_j \sum_k A_{ijk} P^i S^j T^k$$

where

$A_{100} = -1.60 \times 10^{-5}$

$A_{101} = +1.014 \times 10^{-5}$

$A_{102} = -1.27 \times 10^{-7}$

$A_{103} = +2.7 \times 10^{-9}$

$A_{110} = +1.322 \times 10^{-6}$

$A_{111} = -2.62 \times 10^{-8}$

$A_{120} = +4.1 \times 10^{-9}$

$A_{200} = +9.14 \times 10^{-9}$

$A_{201} = -2.77 \times 10^{-10}$

$A_{202} = +9.5 \times 10^{-13}$

$A_{300} = -1.557 \times 10^{-13}$

4.3.8 Sigma-θ

Sigma-θ is calculated as Sigma-t, replacing temperature T by the potential temperature θ.

4.4 INTERPOLATION ROUTINES

A choice of two interpolation methods is provided to interpolate observed or derived parameters to non-observed levels: the modified Rattray (1962) and the Reiniger and Ross (1968) methods. Both methods use two hyperbolic functions, fitted to partially overlapping groups of three points around the desired interpolation depth Z_i. The value A_i of the observed variable A at the depth Z_i is obtained by taking the arithmetic mean or a weighted mean of the two hyperbola respectively.

4.4.1 Modified Rattray Interpolation Method

Let the parameter A take the values A_{j-2}, A_{j-1}, A_j, A_{j+1} at the depths Z_{j-2}, Z_{j-1}, Z_j, Z_{j+1}, and let A_i be its interpolated value at a depth Z_i such that $Z_{j-2}<Z_{j-1}<Z_i<Z_j<Z_{j+1}$. Rattray (1962) then gives for A_i the following equation:

$$A_i = \frac{1}{2}(A_i^1 + A_i^2)$$

where A_i^1 and A_i^2 are obtained by three-point interpolations using Z_{j-2}, Z_{j-1}, Z_j and Z_{j-1}, Z_j, Z_{j+1} respectively:

$$A_i^1 = \gamma_{j-2}^1 A_{j-2} + \gamma_{j-1}^1 A_{j-1} + \gamma_j^1 A_j$$

$$\gamma_{j-2}^1 = \frac{(Z_i - Z_{j-1})(Z_i - Z_j)}{(Z_{j-2} - Z_{j-1})(Z_{j-2} - Z_j)}$$

$$\gamma_{j-1}^1 = \frac{(Z_i - Z_{j-2})(Z_i - Z_j)}{(Z_{j-1} - Z_{j-2})(Z_{j-1} - Z_j)}$$

$$\gamma_j^1 = \frac{(Z_i - Z_{j-2})(Z_i - Z_{j-1})}{(Z_j - Z_{j-2})(Z_j - Z_{j-1})}$$

and A_i^2 is calculated similarly from the function γ^2 by replacing j with j+1 in the above equations.

The interpolated values are assigned an error estimate P_i, which is based on the distance between the two hyperbola at the interpolation depth:

$$P_i = \frac{1}{3}\left| A_i^1 - A_i^2 \right|$$

The "goodness of interpolation" estimate P_i is coded as described in Fig. D.3.15.

4.4.2 Reiniger and Ross' Interpolation Method

Let the parameter V take the values V_1, V_2, V_3, V_4 at the depths Z_1, Z_2, Z_3, Z_4, where Z_1 through Z_4 are the levels used for the interpolation in order of increasing depth. Let V_P be the interpolated value at a depth Z such that $Z_1<Z_2<Z<Z_3<Z_4$. Reiniger and Ross (1968) then calculate a weighted mean for the two hyperbola, using the following equations:

$$V(P) = \frac{|V_R - V_{P_1}|\, V_{P_2} + |V_R - V_{P_2}|\, V_{P_1}}{|V_R - V_{P_1}| + |V_R - V_{P_2}|}$$

where:

$$V_R = \frac{1}{2}\left\{ V_{23} + \frac{(V_{23} - V_{34})^2\, V_{12} + (V_{12} - V_{23})^2\, V_{34}}{(V_{23} - V_{34})^2 + (V_{12} - V_{23})^2} \right\}$$

$$V_{P_1} = C^1_{23} V_1 + C^2_{31} V_2 + C^3_{12} V_3$$

$$V_{P_2} = C^2_{34} V_2 + C^3_{42} V_3 + C^4_{23} V_4$$

$$C^i_{jk} = \frac{(Z - Z_j)(Z - Z_k)}{(Z_i - Z_j)(Z_i - Z_k)}$$

$$V_{ij} = \frac{V_i\,(Z - Z_j) - V_j\,(Z - Z_i)}{Z_i - Z_j}$$

An error estimate P of the interpolated value is calculated by:

$$P = \frac{1}{3}\left[\left| \left\{ V(P) - V_{P_1} \right\} \left\{ V(P) - V_{P_2} \right\} \right| \right]^{1/2}$$

and the "goodness of interpolation" estimate P is coded as described in Fig. D.3.15.

4.4.3 Special Cases

In general the interpolation schemes require two observed values of a parameter A above, and two below the interpolation depth. When this is not the case, a linear interpolation is performed or the data are not interpolated at all. If linear interpolation is used, the interpolated value is followed by a W in the precision code column. The following special cases can be distinguished:

1. When less than four depths have been observed. In this case no interpolations are performed.

2. Near the surface. If less than two observations occur above Z_i, a linear interpolation using the two upper observations is performed. No extrapolations are made over a distance exceeding 13 metres or 1.3 x $(Z_2 - Z_1)$, whichever is smaller.

3. Near the bottom. If less than two observations occur below Z_i, a linear interpolation using the lowest two observations is performed. No extrapolation is performed to depths exceeding the deepest observation by more than 10% of the depth difference between the deepest two observed levels.

Other special cases occur when:

1. The desired standard depth coincides with an observed depth. In this case the observed variables are transferred without change to the standard depth. If two or more observations have been taken at this depth, only the first one will be used.

2. Observed depths are spaced too far apart or too irregularly. This can occur if bottles are purposely spaced closely at some levels, or if two or more partially overlapping casts are taken, or if values of A are missing at two or more consecutive depths. Sample spacing therefore is checked as shown below and judged unacceptable if:

$$\frac{Z_{j-1} - Z_{j-2}}{Z_j - Z_{j-1}} < 1/5 \qquad 4.4.1$$

or

$$\frac{Z_{j+1} - Z_j}{Z_j - Z_{j-1}} < 1/5 \qquad 4.4.2$$

In the first case, with too small an interval between the upper two points, interpolation is carried out using Z_{j-3}, Z_{j-1}, Z_j, Z_{j+1} instead of Z_{j-2}, Z_{j-1}, Z_1, Z_{j+1}. If the lowest interval is too small, that is if equation is not satisfied, A_{j+1} will be replaced by A_{j+2}. In either case the equations (4.4.1) and (4.4.2) are tested again before interpolation is completed, and the procedure is repeated until they are satisfied, or until surface or bottom is reached. When that happens, A_i will be determined by linear interpolation using Z_{j-1} and Z_j.

3. The interpolation error is too large. Linear interpolation will be used when the error estimator P_i exceeds 0.1 for temperature, 0.01 for salinity or 20 units for any chemical parameter.

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APPENDIX A

SYSTEM SUMMARY AND FLOW CHARTS

APPENDIX A

System Summary

The flow of data through the OCEANS IV system is summarized in the flow diagram shown in Fig. A.1. The major programs are:

1) Thermocheck (4010), which accepts reversing thermometer readings and computes corrected temperature and pressure values which are output onto the Thermocheck transaction tape. The processed data are listed with, when necessary, the appropriate error messages and a summary of thermometer performance.

2) Edit (4022), which accepts all data entered on Data Summary and other input forms and the output of the Thermocheck program. All data are thoroughly edited for validity, reasonableness, existence where necessary (for example, for identifying information), and consistency. Editing of the data continues as long as possible even if errors are found invalidating individual cruises, stations or levels. Such data, however, are not passed on into the OCEANS IV transaction file. All processed data are listed, together with error messages and, for data not entered onto the transaction file, rejection messages.

3) Update (4041), which updates the Station Master and Level Master files. The OCEANS IV Transaction file is first sorted into geographical sequence, using the COTED key described in Appendix F. The Update program also prints a one-line summary of each cruise transferred onto the master files (Cruise Master Summary) and extends the Station Master records to include a summary of available information for each station. This summary shows minimum and maximum observed depth, parameters observed, etc. (see Station Master Catalogue for details).

4) Report (4052), which prints a Data Report from the OCEANS IV transaction file or from the Extracted Data file produced by program Retrieve. It can also reproduce the data on cards or magnetic tape in OCEANS IV format. A separate program, Convert (4002), is available to convert the data to the previously used OCEANS III format. The Report program calculates, upon demand, derived and interpolated data. (See sections 3.1, 4.3 and 4.4)

5) Retrieve (4050), which can selectively extract data from the master files. If Data Reports or data on cards or magnetic

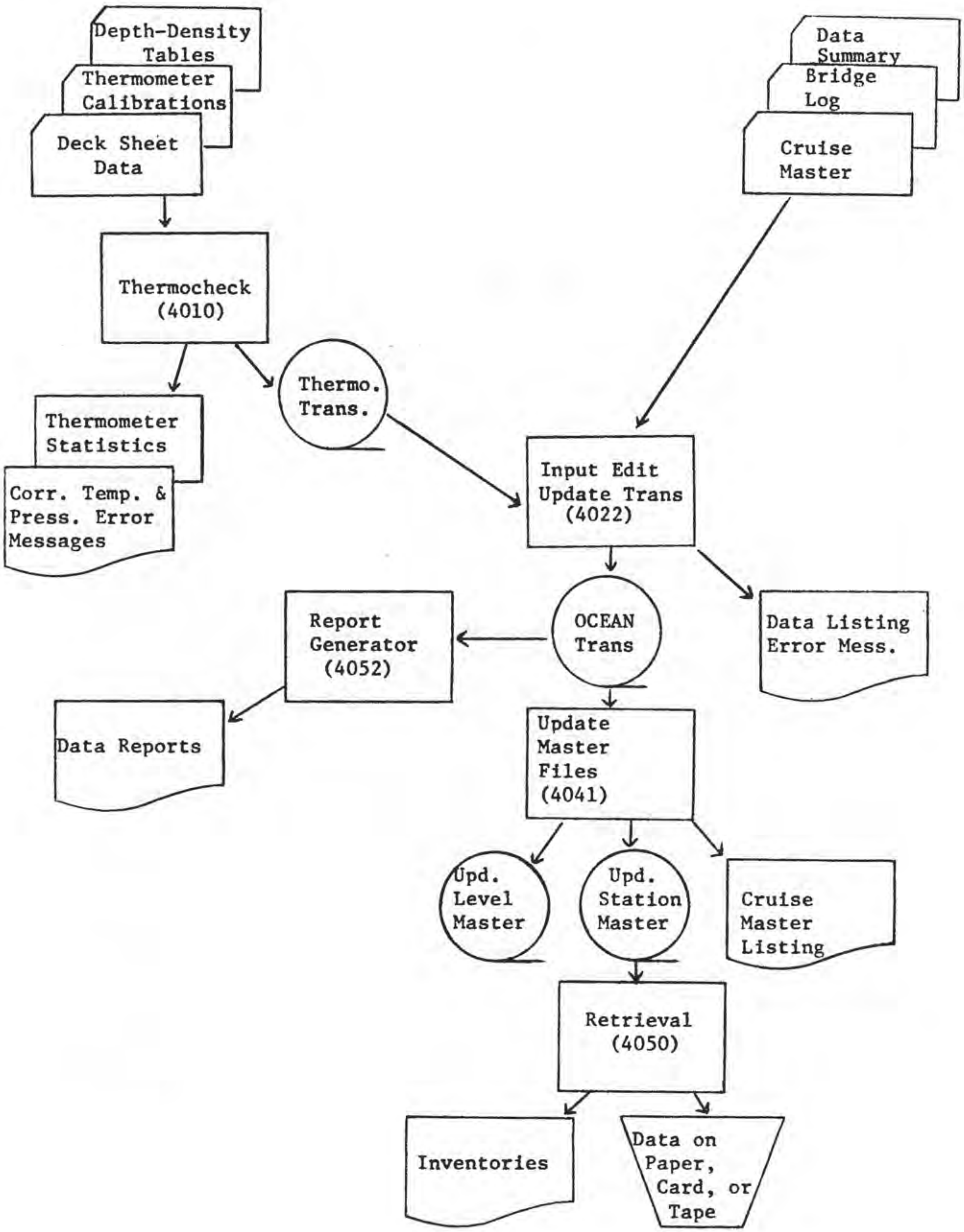


Fig. A.1 Summary Flow Diagram for OCEANS IV.

tape are required, this program can be followed by two further steps as described in Section 3.2.

A number of minor programs, such as a card-to-tape program preceding the Edit, or sort programs preceding several of the major programs, also form part of the system. For a discussion of these, however, reference must be made to the systems manual; their function is not essential for basic understanding of the OCEANS IV system.

The system utilizes strictly sequential processing. The Thermocheck and OCEANS IV transaction files are in cruise sequence and the master files in geographical sequence.

APPENDIX B

INPUT FORMS AND CODING INSTRUCTIONS

1. Cruise Master
2. Deck Sheet
3. Data Summary
4. Bridge Log
5. Thermometer Calibration Sheet

CODC CRUISE MASTER

CODC REF.	LOC. REF.

COUNTRY	INSTITUTE see Table 1	CRUISE NUMBER: year of 1st stat'n	CRUISE NUMBER: consec	VESSEL (PLATFORM) NAME	PLATFORM CODE see Table 2	CRUISING SPEED (knots)	NUMBER OF STATIONS OCCUPIED
1 8							

REMARKS

SOUNDING CORRECTION	SOUNDING UNITS	DEPTH OF SAMPLE UNITS	SEA SURFACE TEMPERATURE METHOD	SUB SURFACE TEMPERATURE METHOD	SALINITY METHOD	OXYGEN UNITS	OXYGEN METHOD
1 soundspeed of 1463 m/s 2 soundspeed of 1500 m/s 3 Matthews Tables 4 measured or calculated soundspeed profile	1 metres* 2 feet 3 fathoms	1 metres* 2 feet 3 fathoms	1 same as subsurface temperatures 2 bucket 3 water intake 4 tow frame	1 reversing therm. 2 thermal probe (e.g. STD) 3 both, used alternately	1 titration 2 conductance 3 inductance 4 refrac. index 5 in situ probe (e.g. STD) 6 hydrometer Note: If two methods used, indicate both code numbers	1 1 μg-atom/l 2 10 μl/l*	1 Winkler 2 probe

METEOROLOGICAL DATA CODING	YEAR OF PUBLICATION OF THE DOT CODE CARD USED	ANEMOMETER HEIGHT IN M ABOVE SEALEVEL	WIND SPEED UNITS	AIR PRESSURE UNITS	PRESSURE CORRECTIONS	AIR AND WET BULB TEMPERATURE UNITS	SWELL PERIOD	FOR CODC USE	CARD TYPE
1 according to DOT code card 2 other see Note 5 on the back			1 m/sec*‡ 2 knots 3 feet/sec 4 Beaufort 5 statute miles per hour	1 mbar*‡ 2 mm	1 uncorrected 2 corr. for barometer height 3 corr. for barometer height and temperature	1 °C*‡ 2 °F	1 P_w code ‡ 2 $P_w P_w$, period in seconds*		
									1

* File Units in CODC's Oceanographic Station Data File.
‡ Codes Specified by the 1968 DOT Code Card (See Explanation 1).

PARAMETERS OBSERVED		
CODE	NAME	CHECK IF OBSERVED
	Temperature	
	Salinity	
	Soundspeed	
4	Oxygen	
5	$PO_4 - P$	
6	Total P	
7	$NO_2 - N$	
8	$NO_3 - N$	
9	SiO – Si	
A	pH	
B	Fluoride	
C	Diss. Org. C	
D	Part. C	
E	Total Alk.	
F	Carb. Alk.	
G	NH_3	

Units see Data Summary Coding Instructions

Table 1 INSTITUTE CODE

01 Marine Ecology Laboratory, Bedford Institute
02 Pacific Oceanographic Group
03 Biological Station, St. Andrews, N.B.
04 Arctic Biological Station, Ste. Anne de Bellevue, P.Q.
05 Biological Station, St. John's Nfld.
06 Station de Biologie Marine, Grande Rivière
07 Marine Sciences Branch, Central Region
08 Defence Research Establishment, Atlantic
09 Defence Research Establishment, Pacific
10 Atlantic Oceanographic Laboratory, Bedford Institute
11 Polar Continental Shelf Project
12 Great Lakes Institute
13 Institute of Oceanography, University of British Columbia
14 Institute of Oceanography, Dalhousie University
15 Marine Sciences Branch, Pacific Region
16 Department of Transport
17 Marine Sciences Centre, McGill University
18 Canadian Forces Maritime Command, East Coast
19 Canadian Forces Maritime Command, West Coast
20 Ontario Water Resources Commission
21 Dept. of National Health and Welfare
22 Inland Waters Branch, Dept. of Energy, Mines and Resources
23 Arctic Institute of North America

Table 2 OBSERVATION PLATFORM CODE

1 Vessel assigned to oceanographic duty, vessel of oceanographic institution.
2 Vessel occupying restricted position. (Weathership, light-vessel.)
3 Naval vessel other than sub-surface craft.
4 Submarine, bathyscaphe, etc.
5 Ice-island, drifting platform.
6 Telemetering buoy, Texas (type) tower, fixed position platform.
7 Helicopter, airplane, etc.
8 Land based survey party, using small craft.

Fig. B.1.1 Cruise Master coding sheet. The coding instructions are given in Fig. B.1.2. The Cruise Master is designed as a cardboard wallet in which all coding sheets made up during a cruise can be stored.

CODC CRUISE MASTER CODING INSTRUCTIONS

GENERAL NOTES

1. A new Cruise Master must be made up for each cruise.

2. Acceptable units must be consistent throughout the entire cruise with the code entered on the Cruise Master.

3. If certain observations have not been made throughout an entire cruise, the appropriate columns may be left blank.

4. Up to 10 different coded parameters, plus any of the four uncoded parameters, can be entered for one cruise. Parameter codes are given on the reverse side; units on the Data Summary Coding Instructions. Additional codes can be supplied by CODC upon written request.

5. Meteorological data can be coded according to the Department of Transport's "International Meteorological Code for Selected and Supplementary Ships" or as indicated in the columns 41-45 of the Cruise Master. If the DOT code card is used, the last two digits of its year of publication must be entered in the columns 37-38, and columns 41-45 can be left blank. The data fields on the CODC Data Summary and the CODC Bridge Log have been arranged to facilitate copying of the data from DOT's "Selected and Supplementary Ships Meteorological Log".

N.B. According to the 1968 DOT code card, wind speed is given in m/sec, air and wet bulb temperatures in degrees Celsius, pressure in mbar corrected for barometer height and outside air temperature, and swell period in the P_W code.

SPECIFIC NOTES

· See reverse side of this envelope.

OCEANS IV

CODC'S NEW SYSTEM FOR HANDLING OCEANOGRAPHIC STATION DATA

The OCEANS IV system will replace the OCEANS III system in April 1970. It is designed to increase the flexibility of CODC's data handling capabilities, and will fulfill such functions as:

1) Processing of reversing thermometer readings,
2) Preparing data for archival in the Oceanographic Station Data File,
3) Printing data reports on request,
4) Providing a flexible retrieval of data from the file.

The system is described fully in a separate report; below follows a summary of the input forms. Data submitted on different forms are merged by the system; no manual transcribing of data from form to form is necessary at any stage.

FORMS FOR THE OCEANS IV SYSTEM

Form	Purpose
Cruise Master	To provide general information on a cruise and to control conversion of "acceptable units" into OCEANS IV "file units" (marked by a star on the Cruise Master form, see reverse).
Deck Sheet	To submit to CODC uncorrected temperature readings, obtained with reversing thermometers, for correction and subsequent archiving.
Data Summary	To submit to CODC, for archiving and/or data report production, calibrated and corrected oceanographic station data such as temperature, salinity, oxygen, etc.
Bridge Log	Can be used instead of the Station Master section of the Data Summary to submit station identifying information, such as time and location, and environmental data such as bottom depth and meteorological conditions.

SUMMARY OF THE ALTERNATIVE COMBINATIONS OF FORMS THAT CAN BE USED TO SUBMIT DATA TO CODC (AT THE OPTION OF THE DATA ORIGINATOR)

Data	Purpose	Possible Form Combinations			
		Cruise Master	Deck Sheet	Data Summary	Bridge Log
Temperature readings	Correcting	■	■		
Temperature readings	Correcting and archiving	■	■	■	
		■	■		■
Temperature readings plus other data	Correcting temp. and archiving all data	■	■	■	
		■	■	■	■
Temperature (corr.) and/or other data	Archiving	■		■	
		■		■	■

Fig. B.1.2 Cruise Master coding instructions. This is printed on the back of the Cruise Master wallet.

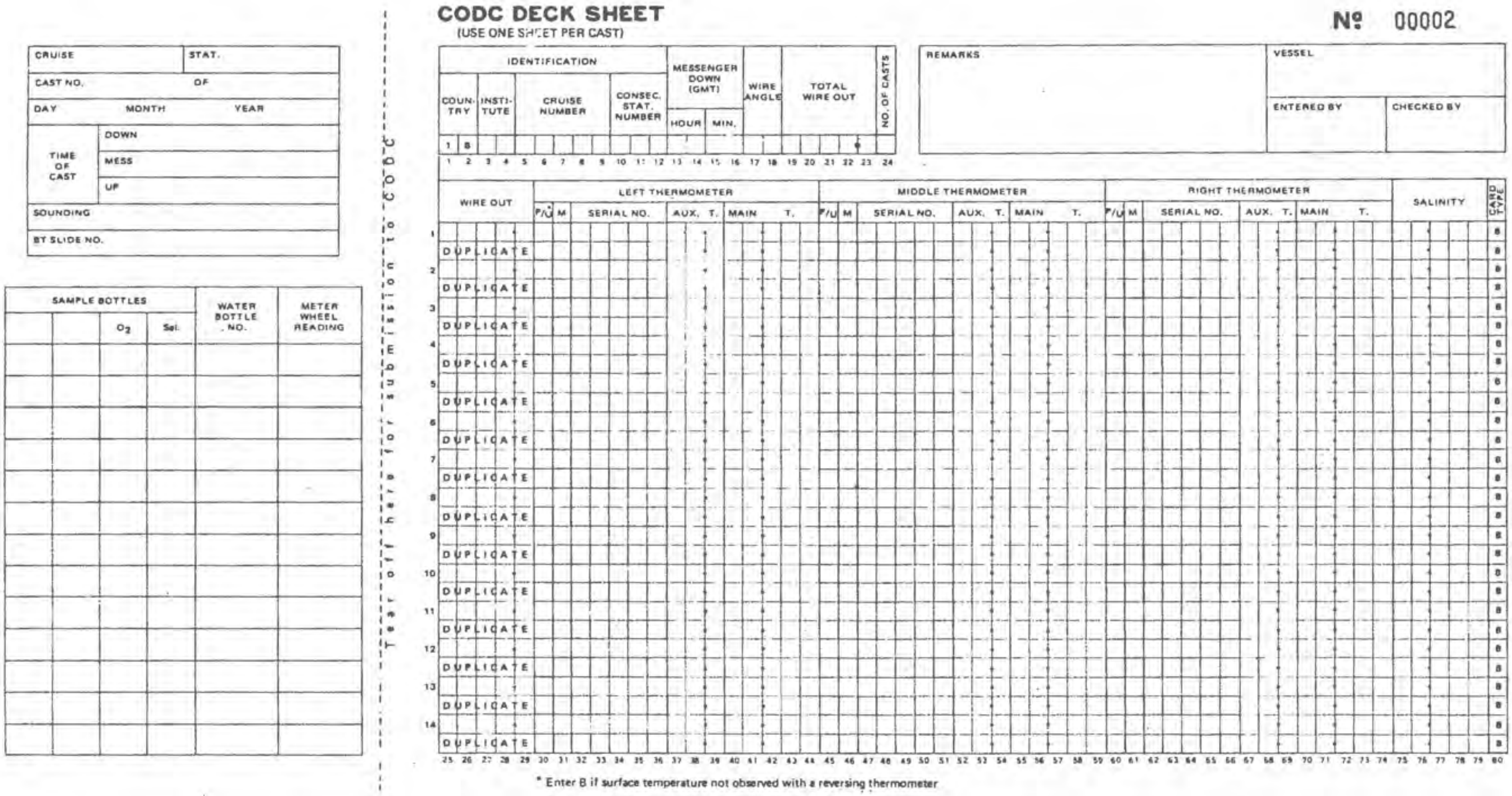


Fig. B.2.1 Deck Sheet. The coding instructions are given in Figs. B.2.2 and B.2.3. The form is bound in pads of 50 with "no carbon" copies.

CODC DECK SHEET – CODING INSTRUCTIONS

USING THIS FORM

The CODC Deck Sheet is used to submit to CODC, for correction and/or archiving, temperature readings obtained with reversing thermometers. If salinity has been measured simultaneously, it may be entered on the same form or alternately, together with any other observations, on the CODC Data Summary.

COMPLEMENTARY FORMS

If the Deck Sheet is used to submit data to CODC only for correction of temperature readings, it must be accompanied by a CODC Cruise Master. If it is used to submit data for both correction and archiving, the CODC Bridge Log or the CODC Data Summary must be used to submit Station Master data such as sampling location, time, etc. In all cases thermometer calibration data should be made available to CODC.

GENERAL NOTES

1. The lines in the main part of the form are grouped in pairs, providing space for entering first and second readings of each thermometer on the two lines respectively. **Second readings** must be entered.

2. The left hand side of the form is provided for the user's convenience. It need not be returned to CODC.

3. **Leading and trailing blanks** are allowed in all fields except in the Cruise Number field, which must start with the last two digits of the year of observation of the first station. The last figure before a decimal point, however, must be entered; e.g. a temperature of 0.1 °C can **not** be coded as ".1".

4. Never enter data for **different casts** on the same sheet.

5. **Shaded** portions must be left blank.

6. **Surface temperatures** not observed with a reversing thermometer can, if desired, be entered in the Main Temperature field. In that case a "B" must be placed in the P/U column and columns 31 through 39 may be left blank.

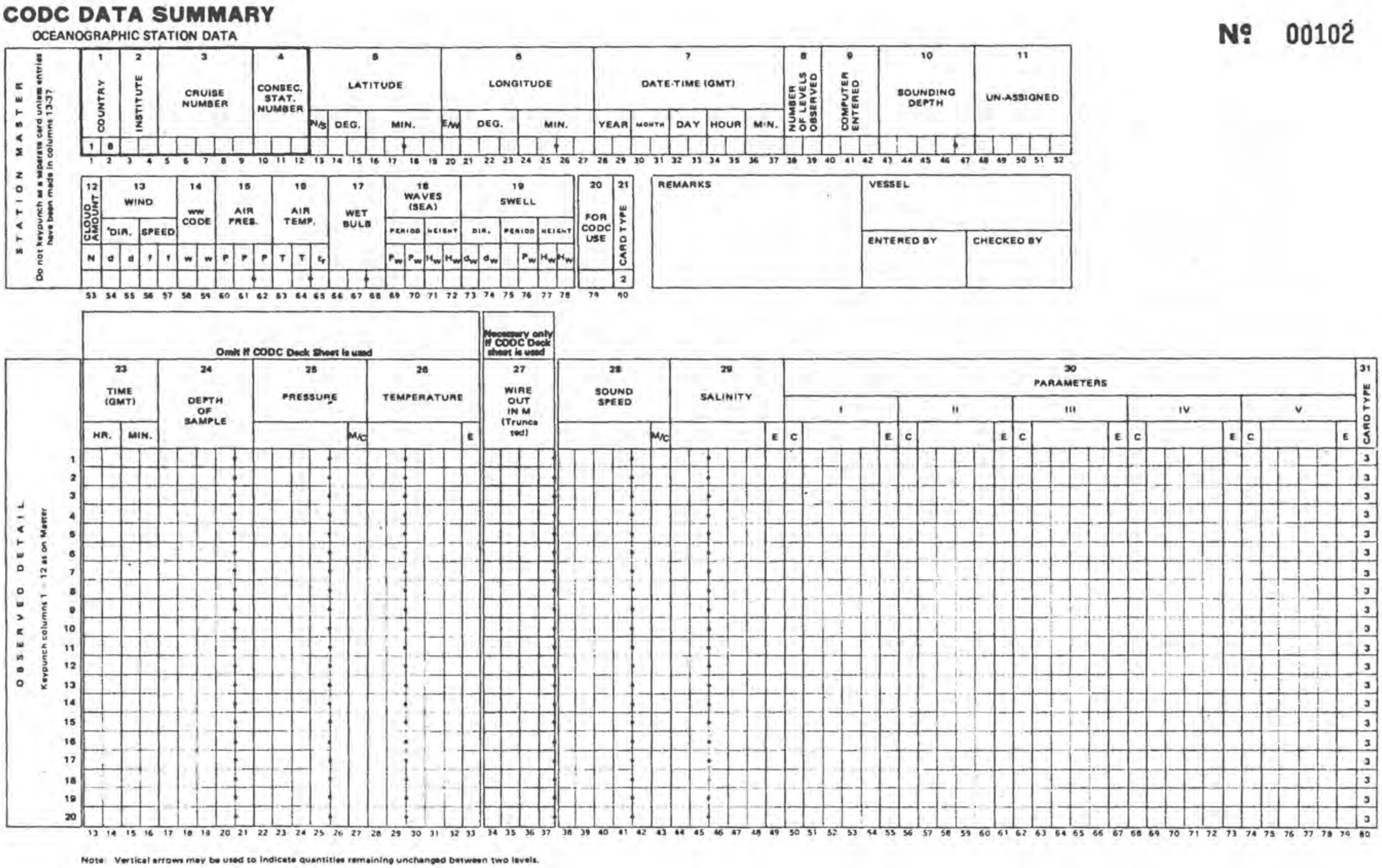
SPECIFIC NOTES

Field Name	Column	Explanation
Country	1 – 2	Same as on CODC Cruise Master; always 18 for Canadian Cruises.
Institute	3 – 4	Same as on CODC Cruise Master.
Cruise Number	5 – 9	Same as on CODC Cruise Master.

Fig. B.2.2 Deck Sheet coding instructions.

Field Name	Column	Explanation
Consecutive Station Number	10 – 12	Stations are numbered chronologically throughout the cruise; for the Thermocheck Program stations have to be in ascending order but not necessarily consecutive.
Messenger Down	13 – 16	Messenger time in hours and minutes GMT.
Wire Angle	17 – 18	Wire angle in degrees measured at Messenger Down time.
Total Wire Out	19 – 23	Distance in metres along the wire between the water surface and the deepest bottle on the cast.
Number of Casts	24	Number of casts taken on this station.
Wire Out	25 – 29	Distance between the surface and the bottle depth measured in metres along the wire. Note position of the decimal point.
Left Thermometer	30 – 44	See following breakdown by sub-fields.
P/U Code	30	Enter P or U to indicate whether the thermometer is protected or unprotected, or B when the temperature has been determined other than with a reversing thermometer. In this case columns 31-39 may be left blank, but the Main Temperature Field must be completed on both the first-and second-reading cards.
M Code	31	Enter manufacturer code: R = Richter & Wiese Y = Yoshino N = Negretti and Zambra (See also explanation of column 30).
Serial Number	32 – 36	Five digit thermometer number assigned by the manufacturer. (See also explanation of column 30).
Auxiliary Temp.	37 – 39	Enter Auxiliary Thermometer Reading in degrees Celsius. Minus signs, if applicable, should be entered in column 37. (See also explanation of column 30).
Main Temp.	40 – 44	Enter Main Thermometer Reading in degrees Celsius. Minus signs, if applicable, should be entered in column 40. (See also explanation of column 30).
Middle Thermometer	45 – 59	See instructions for Left Thermometer.
Right Thermometer	60 – 74	See instructions for Left Thermometer.
Salinity	75 – 79	Salinity may be entered if desired, in parts per thousand; note position of the decimal point. Alternately, salinities can be submitted on the CODC Data Summary sheets.
Card Type	80	Preprinted.

Fig. B.2.3 Deck Sheet coding instructions (continued).


CODC DATA SUMMARY
OCEANOGRAPHIC STATION DATA
Nº 00102

STATION MASTER
Do not keypunch as a separate card unless entries have been made in columns 13-37
1 COUNTRY
2 INSTITUTE
3 CRUISE NUMBER
4 CONSEC. STAT. NUMBER
5 LATITUDE: N/S, DEG., MIN.
6 LONGITUDE: E/W, DEG., MIN.
7 DATE-TIME (GMT): YEAR, MONTH, DAY, HOUR, MIN.
8 NUMBER OF LEVELS OBSERVED
9 COMPUTER ENTERED
10 SOUNDING DEPTH
11 UN-ASSIGNED
12 CLOUD AMOUNT
13 WIND: DIR., SPEED
14 ww CODE
15 AIR PRES.
16 AIR TEMP.
17 WET BULB
18 WAVES (SEA): PERIOD, HEIGHT
19 SWELL: DIR., PERIOD, HEIGHT
20 FOR CODC USE
21 CARD TYPE
REMARKS
VESSEL
ENTERED BY
CHECKED BY

OBSERVED DETAIL
Keypunch columns 1 - 12 as on Master
Omit if CODC Deck Sheet is used
Necessary only if CODC Deck sheet is used
23 TIME (GMT): HR., MIN.
24 DEPTH OF SAMPLE
25 PRESSURE
26 TEMPERATURE
27 WIRE OUT IN M (Truncated)
28 SOUND SPEED
29 SALINITY
30 PARAMETERS: I, II, III, IV, V
31 CARD TYPE

Note: Vertical arrows may be used to indicate quantities remaining unchanged between two levels.

Fig. B.3.1 Data Summary. The coding instructions are given in Figs. B.3.2 through B.3.7. The form is bound in pads of 50 with "no carbon" copies.

CODC DATA SUMMARY CODING INSTRUCTIONS

USING THIS FORM

The CODC Data Summary is used to submit calibrated and corrected Oceanographic Station data to CODC. The form consists of two parts, the Station Master and the Observed Detail. The **Station Master** contains all information identifying the station in space and time as well as Sounding Depth and Meteorological Data. The **Observed Detail** contains all information observed at each sampling level.

COMPLEMENTARY FORMS

The Data Summary forms must be submitted together with a **CODC Cruise Master** for each cruise, and can, if desired, be combined with CODC Deck Sheets and/or CODC Bridge Logs.

The CODC Deck Sheet can be used to submit uncorrected Reversing Thermometer readings. After correction by our Thermocheck Program, the temperatures will be merged with other data contained on the CODC Data Summary. In this case field 27 on the Data Summary must be completed to match it with input from the Deck Sheet, whereas fields 23 through 26 can be left blank.

The **CODC Bridge Log** can be used instead of the Station Master section of the Data Summary to enter position, time, bottom depth and meteorological data. The first four fields on the Station Master, however, must still be completed to identify the station.

GENERAL NOTES

1. **Leading and trailing blanks** are allowed in all fields except the cruise number field.

2. Any **non-observed fields** can be left blank; only the first seven fields on the Station Master must be completed.

3. The location of **decimal points**, whenever applicable, is indicated on the form.

4. A provision has been made to enter **arbitrary station codes** or any other alphanumeric information in the "Unassigned" field. (This information is reproduced in data listings, but cannot be used to search for a station in CODC's files.)

5. Any parameter for which a **choice of units** can be made, must, throughout the entire cruise, be entered in the units specified on the Cruise Master.

6. **Meteorological data** can, if desired, be taken from the appropriate columns in the **Department of Transport's "Selected and Supplementary Ships' Meteorological Log"**, which is coded using DOT's "International Meteorological Code Card for Selected and Supplementary Ships". (See also Note 5 on the Cruise Master.) These codes have been set by the World Meteorological Organization. The codes accompanying the present instructions are based on DOT's coding instructions of January 1, 1968. If these are modified, data can be entered according to either the revised DOT Code Card or the 1968 Code Card, provided that the year of publication of the code card used is indicated. Optionally, data can also be entered in **units specified on the Cruise Master.**

7. If an entry in a certain column or field remains the same at a number of subsequent levels, it is sufficient to enter it in the highest and lowest of these levels only, connected by a **vertical arrow.**

8. **Depth and Pressure** need not both be entered; either one of the two can be left blank.

9. Up to ten **different parameters** can be entered for any one station. If **more than five** are given, enter parameters 6 through 10 on the next line of the form, repeating the level indication (Depth, Pressure or Wire Out, depending on which is used on the preceding line) on the second line. All other fields can be left blank on the second line.

10. The error columns following the Temperature and Salinity fields can be used to indicate **data sampled with a MPR** by entering a "P" (MPR = Multiple Probe Recorder such as STD, etc.).

Fig. B.3.2 Data Summary coding instructions.

SPECIFIC NOTES

STATION MASTER

Field No.	Field Name	Column	Explanation
1.	Country	1 – 2	Same as on CODC Cruise Master; always 18 for Canadian cruises.
2.	Institute	3 – 4	Same as on CODC Cruise Master.
3.	Cruise Number	5 – 9	Same as on CODC Cruise Master.
4.	Consecutive Station Number	10 – 12	Stations must be numbered consecutively throughout the cruise in a chronological order. A new consecutive number is required each time the station is reoccupied, even if no other locations are sampled in the intervening period. Other station code numbers can be entered in the "unassigned" field (number 11) if the data originator so desires.
5.	Latitude	13 – 19	Latitude of the station. Enter N or S in column 13 to indicate north or south latitude. Position is given in degrees and minutes with up to two decimals.
6.	Longitude	20 – 27	Longitude of the station. Enter E or W in column 20 to indicate east or west longitude. Position is given in degrees and minutes with up to two decimals.
7.	Date – Time	28 – 37	Sampling time of the first observed level is given in Greenwich Mean Time (GMT). The last two digits of the year (e.g. 70 for 1970) are followed by month (coded 01 through 12), day, hour and minute.
8.	Number of Depths Observed	38 – 39	Enter the number of levels at which observations are made.
9.	Blank	40 – 42	These columns are reserved to insert a computer-calculated Marsden Square number.
10.	Sounding Depth	43 – 47	Sounding depth in units indicated on the CODC Cruise Master. Note location of the decimal point.
11.	Unassigned	48 – 52	These columns can be used to enter any alphanumeric information the data originator wishes to be printed in provisional or published Data Reports produced by CODC.
12.	Cloud Amount	53	Fraction of the sky covered by clouds of any type is coded on an octal scale where 0 stands for no clouds and 8 for a completely clouded sky. (Table 1)
13.	Wind Direction	54 – 55	True direction from which the wind is blowing, in tens of degrees. Enter 00 for calm, 01 for 10°, 02 for 20° and so on by ten-degree steps right around to 36 for a north wind.
	Wind Speed	56 – 57	Windspeed can be measured in metres per second, knots, feet per second or statute miles per hour, or estimated on the Beaufort scale (Table 2). It must be entered as indicated on the Cruise Master. N.B. The DOT meteorological Log code gives windspeed in knots.
14.	ww Code	58 – 59	Coded according to Table 3.
15.	Pressure	60 – 62	Enter the last three digits of the barometer reading, or of sea level pressure, in units indicated on the Cruise Master. For example: 1026.4 mbar is coded as 264; 987.3 mbar as 873 and 768.3 mm as 683. Sea level pressure can be obtained from the barometer reading by applying corrections for barometer height and outside air temperature using Table 4. N.B. The WMO code gives sea level pressure in mbars.
16.	Air Temperature	63 – 65	Enter air temperature in units stated on the Cruise Master. Negative Celsius temperatures are coded by adding 50 to the absolute value of the measurement (WMO) code). Negative Fahrenheit temperatures are coded by placing a minus sign in the last column (65). Omit decimals when coding in Fahrenheit. For example: 14.2°C → 14.2 | 14.2°F → 14. –14.2°C → 64.2 | –14.2°F → 14.–
17.	Wet Bulb	66 – 68	Coding as for Air Temperature.
18.	Wave Period	69 – 70	Enter the estimated period of sea waves in seconds. When the sea is calm, or the period indeterminate, enter // or leave blank.
	Wave Height	71 – 72	Estimate the average height of the larger well-formed waves of the sea wave system in multiples of 0.5 metres. The height is then coded in units of half-metres. For example, an observed wave height of 5 metres is coded as 10.
19.	Swell Direction	73 – 74	True direction from which the waves are coming in tens of degrees. Enter 00 for calm, 01 for 10°, 02 for 20° and so on by ten degree steps right around to 36 for a wave from due north.
	Swell Period	75 – 76	Code as Wave Period, see instructions for field 18, or according to Table 5 as indicated on the Cruise Master. N.B. The WMO code gives swell as P_W.
	Swell Height	77 – 78	Code as Wave Height.
20.	For CODC Use	79	To be entered by CODC staff.
21.	Card Type	80	Preprinted.

Fig. B.3.3 Data Summary coding instructions (continued).

OBSERVED DETAIL

Field No.	Field Name	Column	Explanation
23.	Time GMT	13 – 16	Sampling time at each observed level in hours and minutes Greenwich Mean Time.
24.	Depth of Sample	17 – 21	Enter sampling depth in units indicated on the Cruise Master. Can be left blank if Pressure is entered in field 25 or if Temperature and Depth are obtained from Reversing Thermometer observations submitted on the CODC Deck Sheet.
25.	Pressure	22 – 26	Enter pressure in decibars. Can be left blank if Depth is entered in the preceding field or if Temperature and Pressure are obtained from Reversing Thermometer observations submitted on the CODC Deck Sheet.
		27	If both Pressure and Depth are completed, enter an M or a C to indicate whether Pressure is measured or calculated from depth. It can be left blank if either Depth or Pressure is blank for the entire station.
26.	Temperature	28 – 32	Temperature in degrees Celsius. Insignificant decimals can be left blank.
		33	To be left blank unless the preceding datum is: 1) doubtful, or 2) the mean of a duplicate measurement, or 3) measured with an MPR. Doubtful data can be marked with an X by the originator or a Y by CODC. Error estimates are coded A through I as follows: Let P be the difference between the two measurements. P then is coded in multiples of the last digit allowed for on the coding form as follows: $P \leq 1$ Code A $1 < P \leq 2$ Code B $2 < P \leq 5$ Code C $5 < P \leq 10$ Code D $10 < P \leq 20$ Code E $20 < P \leq 50$ Code F $50 < P \leq 100$ Code G $100 < P \leq 200$ Code H $200 < P$ Code I A temperature error P=0.003°C is coded as C, an error P=0.02°C as E, and a salinity error P=0.08 per mille as G, etc. If the datum is based on a triple measurement, P is taken equal to the standard deviation: $P = \left\{\frac{1}{2}\sum_{i=1}^{3}(A_i - \bar{A})^2\right\}^{1/2}$ where A_i are the measurements and $\bar{A}$ the mean value of the observed parameter. MPR data can be marked with a "P" in this column. This is necessary only if more than one measurement technique is indicated on the Cruise Master.
27.	Wire Out	34 – 37	Has to be completed only if the temperatures are submitted on the CODC Deck Sheet. Wire out is entered in metres, no provision is made to enter fractions of metres. **Do not round decimals, truncate them!** 127.0 and 127.9 should both be entered as 127.
28.	Soundspeed	38 – 42	Entered in metres per second.
		43	Enter an M or a C to indicate whether soundspeed is measured or calculated at any level.
29.	Salinity	44 – 48	Enter in parts per thousand. The third decimal place can be left blank if not observed.
		49	Enter doubtful mark or error code as explained under field 26, column 33, above.
30.	Parameter I	50	Enter code number or letter in the first column; see Table 6.
		51 – 54	Enter measured quantity in units specified in Table 6.
		55	Enter doubtful mark or error code as explained under field 26, column 33, above.
	Parameter II – V	56 – 79	Enter as specified for Parameter I.
	Parameter VI – X	Second card	Enter on next line in field 30, as specified for Parameter I above. The level identifier (Depth, Pressure or Wire Out) used on the preceding line must be repeated; all other fields may be left blank. The maximum number of parameters that can be entered per station is 10.
31	Card Type	80	Preprinted.

Table 1 CLOUD AMOUNT (N – Code)

Fraction of the sky covered by clouds

Code	Cloud Cover	Code	Cloud Cover
0	Cloudless	6	6/8
1	1/8 or less but not zero	7	7/8 or more but not 8/8
2	2/8	8	8/8, sky totally covered
3	3/8	9	Sky obscured by dense fog, heavy snow, etc., or amount cannot be estimated.
4	4/8		
5	5/8		

Fig. B.3.4 Data Summary coding instructions (continued).

Table 2 WIND SPEED IN KNOTS (ff – Code)

The Beaufort force of the wind is estimated from the appearance of the sea surface according to the table below. This table is only intended as a guide to show roughly what may be expected on the open sea, remote from land. Factors which must be taken into account are the 'lag' effect between the wind increasing and the sea getting up; and the influence of 'fetch', depth, swell, heavy rain and tide effect on the appearance of the sea. Estimation of the wind speed by this method becomes unreliable in shallow water or when close inshore, owing to the tidal effect and the shelter provided by the land.

Speed in m/sec	Code ff (Speed in Knots)	Mean Speed (Knots)	Beau-fort	Description	Appearance of Sea if the Fetch and Duration of the Blow Have Been Sufficient to Develop the Sea Fully	Probable ht. of seas in metres	
						Aver.	Max.
0.0 – 0.1	00	00	0	Calm	Sea like a mirror	–	–
0.2 – 1.8	01 – 03	02	1	Light Air	Ripples with the appearance of scales are formed, but without foam crests. .	0.1	0.1
1.9 – 3.3	04 – 06	05	2	Light Breeze	Small wavelets; crests have a glassy appearance and do not break	0.1	0.3
3.4 – 5.3	07 – 10	09	3	Gentle Breeze	Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses	0.6	0.9
5.4 – 8.4	11 – 16	14	4	Modt. Breeze	Small waves, becoming longer; fairly frequent white horses	1.0	1.5
8.5 – 10.6	17 – 21	19	5	Fresh Breeze	Moderate waves; many white horses are formed (chance of some spray). . .	1.8	2.5
10.6 – 14.1	22 – 27	25	6	Strong Breeze	Large waves; white foam crests everywhere (probably some spray) . . .	2.8	3.9
14.2 – 17.2	28 – 33	31	7	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind	4.0	5.7
17.3 – 20.7	34 – 40	37	8	Gale	Moderately high waves; edges of crests begin to break into the spindrift; foam is blown in well-marked streaks along the direction of the wind.	5.4	7.5
20.8 – 24.4	41 – 47	44	9	Strong Gale	High waves; dense streaks of foam along wind; crests begin to topple, tumble and roll over; spray may affect visibility	6.9	9.6
24.5 – 28.5	48 – 55	52	10	Storm	Very high waves with long overhanging crests; foam in great patches blown in dense white streaks along wind; sea surface takes a white appearance tumbling becomes heavy and shock-like; visibility affected	8.7	12.3
28.6 – 32.4	56 – 63	60	11	Violent Storm	Exceptionally high waves (medium sized ships may be lost to view behind waves); sea covered with long white patches of foam lying along wind; everywhere edges of crests are blown into froth; visibility affected	8.1	15.6
32.5 –	64 – 71	68	12	Hurricane	Air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected	13.5	–

Table 3 PRESENT WEATHER (ww – Code)

Use the highest code figure applicable except that 17 has preference over 20 to 49 inclusive.

00–49 NO PRECIPITATION AT SHIP AT TIME OF OBSERVATION

00–03 CHANGE OF SKY DURING PAST HOUR

Code		Code
00	Cloud development not observable	
01	Clouds dissolving or becoming less developed	
02	State of sky on the whole unchanged	
03	Clouds generally forming or developing	

04–09 SMOKE, HAZE, SAND OR DUST

Code		
04	Visibility reduced by smoke (not ship's smoke)	
05	Dry Haze	
06	Widespread dust suspended in air	
07	Blowing spray at ship	
08	Dust whirls in past hour (not for marine use)	
09	Dust or sandstorm in sight, or at ship in past hour	

10–12 MIST AND SHALLOW FOG

Code		Code
10	Mist (visibility 1100 yds. or more)	
11	Shallow fog in patches	*Fog not deeper than 33 ft.*
12	Shallow fog-more or less continuous	*Fog not deeper than 33 ft.*

13–16 PHENOMENA WITHIN SIGHT BUT NOT AT SHIP

Code		
13	Lightning visible, no thunder heard	
14	Precipitation in sight, not reaching surface	
15	Precip. beyond 3 naut. miles, reaching surface	
16	Precip. within 3 naut. miles, reaching surface	

17–19 THUNDER, SQUALLS, FUNNEL CLOUDS

Code		
17	Thunder at time of obsn. – no precip. at ship	
18	Squalls (no precip.) in past hour or at time of obsn.	

Fig. B.3.5 Data Summary coding instructions (continued).

Table 3 (Cont'd.)

17–19 THUNDER, SQUALLS, FUNNEL CLOUDS (Cont'd.)

Code		Code
19	Funnel cloud(s) seen in past hour or at time of obsn.	

20–29 PHENOMENA IN PAST HOUR BUT *NOT* AT TIME OF OBSN.

Code		
20	Drizzle (not freezing) or snow grains	*Not falling as showers*
21	Rain (not freezing)	*Not falling as showers*
22	Snow	*Not falling as showers*
23	Rain and snow, or ice pellets	*Not falling as showers*
24	Freezing drizzle or freezing rain	*Not falling as showers*
25	Shower(s) of rain	
26	Shower(s) of snow, or of rain and snow mixed	
27	Shower(s) of hail*, or of rain and hail* mixed	
28	Fog (in past hour but not at time of observation)	
29	Thunderstorm, with or without precipitation	

*Includes hail, ice pellets, or snow pellets

30–39 (Not likely to be used in ship reports)

Slight or Moderate		Heavy
30	Duststorm or sandstorm, decreasing	33
31	Duststorm or sandstorm, unchanging	34
32	Duststorm or sandstorm, increasing	35
36	Drifting snow, generally low	37
38	Blowing snow, generally high	39

40–49 FOG AT THE TIME OF OBSERVATION

40	Fog at a distance but not at ship during past hour	
41	Fog in patches	
Sky Visible	**Visibility less than 1100 yards at time of observation**	**Sky Invisible**
42	Fog, has become thinner in past hour	43
44	Fog, no change in past hour	45
46	Fog, has begun or thickened in past hour	47
48	Fog, depositing rime	49

50–99 PRECIPITATION AT SHIP AT TIME OF OBSERVATION

50–59 DRIZZLE

Intermittent		Continuous
50	Slight Drizzle	51
52	Moderate Drizzle	53
54	Heavy Drizzle	55
Slight		**Moderate or Heavy**
56	Freezing drizzle	57
58	Drizzle and rain mixed	59

60–69 RAIN (NOT FALLING AS SHOWERS)

Intermittent		Continuous
60	Slight rain	61
62	Moderate rain	63
64	Heavy rain	65
Slight		**Moderate or Heavy**
66	Freezing rain	67
68	Rain or drizzle with snow	69

70–79 SOLID PRECIPITATION NOT FALLING AS SHOWERS

Intermittent		Continuous
70	Slight snow in flakes	71
72	Moderate snow in flakes	73
74	Heavy snow in flakes	75
76	Ice prisms (with or without fog)	
77	Snow grains (with or without fog)	
78	Isolated starlike snow crystals (with or without fog)	
79	Ice pellets	

80–84 RAIN SHOWERS

80	Slight rain shower
81	Moderate or heavy rain shower
82	Violent rain shower
83	Shower of rain and snow mixed, slight
84	Shower of rain and snow mixed, moderate or heavy

85–90 SOLID PRECIPITATION IN SHOWERS

Slight		Moderate or Heavy
85	Shower of snow	86
87	Shower of snow pellets or ice pellets*	88
89	Shower of hail, no thunder	90

*With or without rain and/or snow

91–94 THUNDERSTORM DURING THE PAST HOUR BUT NOT AT THE TIME OF OBSERVATION

Note: Use 29 if there is no precip. at observation time

91	Slight rain	*Thunderstorm in past hour but not now – precip. occurring at time of obsn.*
92	Moderate or heavy rain	*Thunderstorm in past hour but not now – precip. occurring at time of obsn.*
93	Slight snow, or rain and snow mixed, or hail*	*Thunderstorm in past hour but not now – precip. occurring at time of obsn.*
94	Moderate or heavy snow, or rain and snow mixed, or hail*	*Thunderstorm in past hour but not now – precip. occurring at time of obsn.*

*Includes hail, ice pellets or snow pellets

95–99 THUNDERSTORM AT TIME OF OBSERVATION

95	Slight or modt. thunderstorm with rain and/or snow, but no hail*
96	Slight or modt. thunderstorm with hail*
97	Heavy thunderstorm with rain and/or snow, no hail*
98	Thunderstorm with dust or sandstorm
99	Heavy thunderstorm with hail*

*Includes hail, ice pellets or snow pellets

Fig. B.3.6 Data Summary coding instructions (continued).

Table 4 PRESSURE CORRECTION (MBARS)

The sea level correction must be added to the barometer reading.

Height of Barometer above Sea Surface (Ft.)	Outside Air Temperature in °C. -20°C	-10°C	0°C	10°C	20°C	30°C
15	0.6	0.6	0.6	0.6	0.5	0.5
20	0.8	0.8	0.8	0.7	0.7	0.7
25	1.0	1.0	1.0	0.9	0.9	0.9
30	1.2	1.2	1.2	1.1	1.1	1.0
35	1.5	1.4	1.4	1.3	1.3	1.2
40	1.7	1.6	1.5	1.5	1.4	1.4
45	1.9	1.8	1.7	1.7	1.6	1.6
50	2.1	2.0	1.9	1.9	1.8	1.7
55	2.3	2.2	2.1	2.0	2.0	1.9
60	2.5	2.4	2.3	2.2	2.2	2.1
65	2.7	2.6	2.5	2.4	2.3	2.3
70	2.9	2.8	2.7	2.6	2.5	2.4
75	3.1	3.0	2.9	2.8	2.7	2.6
80	3.3	3.2	3.1	3.0	2.9	2.8
85	3.5	3.4	3.3	3.2	3.1	3.0
90	3.7	3.6	3.5	3.3	3.2	3.1
95	4.0	3.8	3.7	3.5	3.4	3.3
100	4.2	4.0	3.9	3.7	3.6	3.5
105	4.4	4.2	4.1	3.9	3.8	3.7
110	4.6	4.4	4.2	4.1	4.0	3.8
115	4.8	4.6	4.4	4.3	4.1	4.0
120	5.0	4.8	4.6	4.5	4.3	4.2
125	5.2	5.0	4.8	4.7	4.5	4.3

Table 5 SWELL (P_W – code)

Code	Period in sec.	Code	Period in sec.
5	5 sec. or less	1	11 sec.
6	6 sec.	2	12 sec.
7	7 sec.	3	13 sec.
8	8 sec.	4	14 sec. or more
9	9 sec.	/	Period not determined.
0	10 sec.		

Table 6 PARAMETER CODES

Code	Parameter	Units
4	Oxygen*	10 μl/l *or* 1 μg-at/l
5	PO_4 – P	0.01 μg-at/l
6	Total P	0.01 μg-at/l
7	NO_2 – N	0.01 μg-at/l
8	NO_3 – N	0.1 μg-at/l
9	SiO_3 – Si	0.1 μg-at/l
A	pH	0.001 pH units
B	Fluoride	0.01 mg/l
C	Dissolved organic carbon .	0.01 mg/l
D	Particulate carbon	mg/m^3
E	Total Alkalinity	1 μ-eq/l
F	Carbonate Alkalinity	1 μ-eq/l
G	NH_3 – N	0.01 μg/l

For example: A Total Phosphate value of 17.12 μg-at/l is entered as [1|7|1|2], a Silicate (SiO_3 – Si) value of 12 μg-at/l is [|1|2|], a pH value of 7.82 as [7|8|2|].

*Oxygen units must correspond to those indicated on the Cruise Master.

CANADIAN OCEANOGRAPHIC DATA CENTRE

OTTAWA

APRIL 1970

Fig. B.3.7 Data Summary coding instructions (continued).

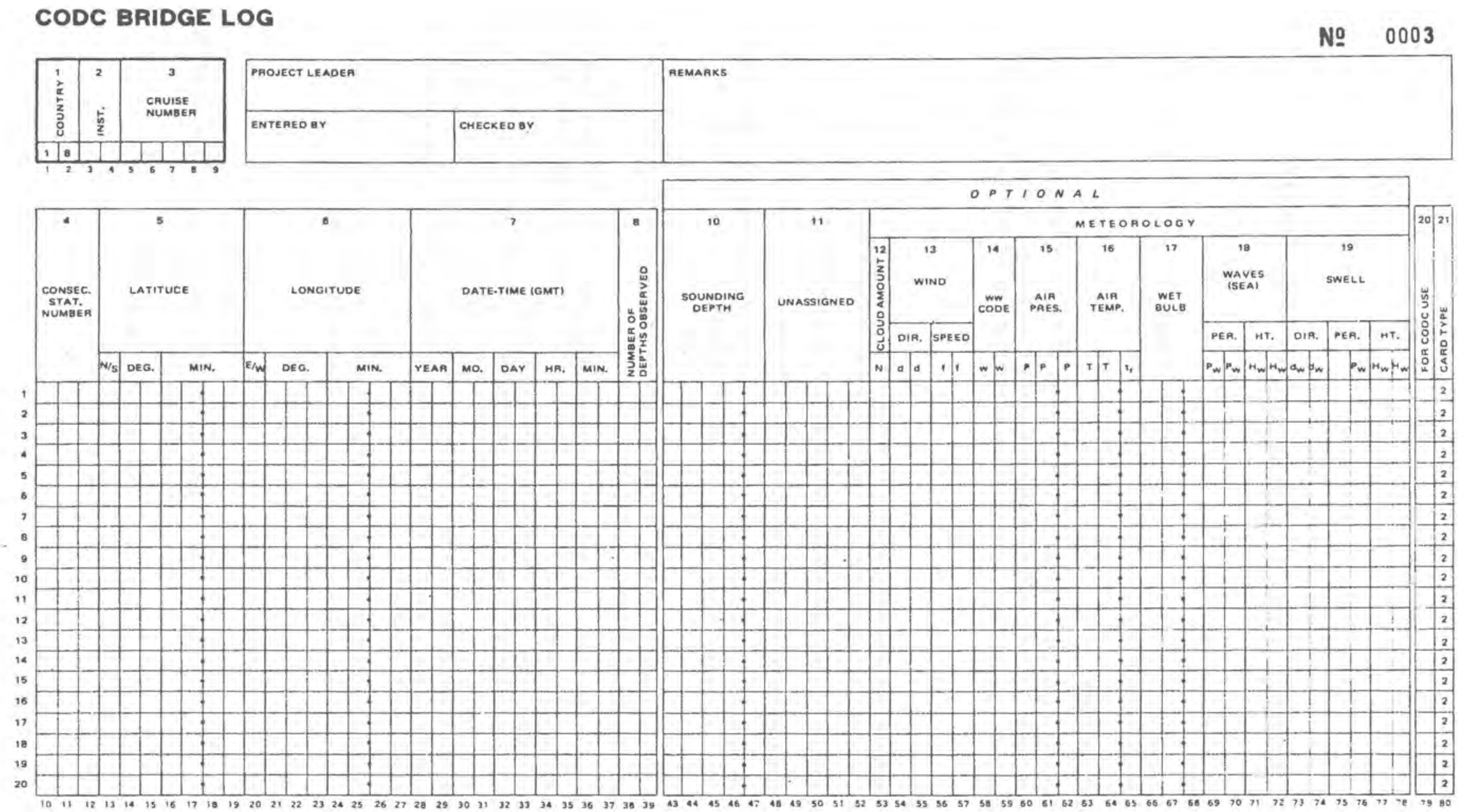


Fig. B.4.1 Bridge Log. The coding instructions are given in Figs. B.4.2 through B.4.4. The form is bound in pads of 50 with "no carbon" copies.

CODC BRIDGE LOG — CODING INSTRUCTIONS

USING THIS FORM

The CODC Bridge Log is used to submit information identifying Oceanographic Stations in space and time and giving environmental data such as Bottom Depth and Meteorological Conditions.

COMPLEMENTARY FORMS

The Bridge Log is identical to the Station Master portion of the **CODC Data Summary**, and can be used optionally instead of the latter to submit the Station Master information. It can be used also in conjunction with **CODC Deck Sheets.** Bridge Log forms must be submitted together with a **CODC Cruise Master** for each cruise.

GENERAL NOTES

1. **Leading and trailing blanks** are allowed in all fields except the cruise number field. Note, however, that the last figure before a decimal point must be entered; e.g. 0.3 must **not** be entered as, ".3".

2. Any **non-observed** field can be left blank; only the first seven must be completed.

3. The location of **decimal points**, whenever applicable, is indicated on the form.

4. A provision has been made to enter **arbitrary station** codes or any other alphanumeric information in the "Unassigned" field. (This information is reproduced in data listings, but cannot be used to search for a station in CODC's files.)

5. Any parameter for which a **choice of units** can be made (see Cruise Master), must, throughout the entire cruise, be entered in the units specified on the Cruise Master.

6. **Meteorological data** can, if desired, be taken from the appropriate columns in the **Department of Transport's "Selected and Supplementary Ships' Meteorological Log"**, which is coded using DOT's "International Meteorological Code Card for Selected and Supplementary Ships". (See also Note 5 on the Cruise Master.) These codes have been set by the World Meteorological Organization. The codes accompanying the present instructions are based on DOT's coding instructions of January 1, 1968. If these are modified, data can be entered according to either the revised DOT Code Card or the 1968 Code Card, provided that the year of publication of the code card used is indicated. Optionally, data can also be entered in **units specified on the Cruise Master.**

7. If an entry in a certain column or field remains the same at a number of subsequent levels, it is sufficient to enter it in the highest and lowest of these levels only, connected by a **vertical arrow.**

SPECIFIC NOTES

Field No.	Field Name	Column	Explanation
1.	Country	1 – 2	Same as on CODC Cruise Master; always 18 for Canadian cruises.
2.	Institute	3 – 4	Same as on CODC Cruise Master.
3.	Cruise Number	5 – 9	Same as on CODC Cruise Master.

Fig. B.4.2 Bridge Log coding instructions.

Field No.	Field Name	Column	Explanation
4.	Consecutive Station Number	10 – 12	Stations must be numbered consecutively throughout the cruise in a chronological order. A new consecutive number is required each time the station is reoccupied, even if no other locations are sampled in the intervening period. Other station code numbers can be entered in the "unassigned" field (number 11) if the data originator so desires.
5.	Latitude	13 – 19	Latitude of the station. Enter N or S in column 13 to indicate north or south latitude. Position is given in degrees and minutes with up to two decimals.
6.	Longitude	20 – 27	Longitude of the station. Enter E or W in column 20 to indicate east or west longitude. Position is given in degrees and minutes with up to two decimals.
7.	Date – Time	28 – 37	Sampling time of the first observed level is given in Greenwich Mean Time (GMT). The last two digits of the year (e.g. 70 for 1970) are followed by month (coded 01 through 12), day, hour and minute.
8.	Number of Depths Observed	38 – 39	Enter the number of levels at which observations are made.
9.	Blank	40 – 42	These columns are reserved to insert a computer-calculated Marsden Square number.
10.	Sounding Depth	43 – 47	Sounding depth in units indicated on the CODC Cruise Master. Note location of the decimal point.
11.	Unassigned	48 – 52	These columns can be used to enter any alphanumeric information the data originator wishes to be printed in provisional or published Data Reports produced by CODC.
12.	Cloud Amount	53	Fraction of the sky covered by clouds of any type is coded on an octal scale where 0 stands for no clouds and 8 for a completely clouded sky (Table 1).
13.	Wind Direction	54 – 55	True direction from which the wind is blowing, in tens of degrees. Enter 00 for calm, 01 for 10°, 02 for 20° and so on by ten degree steps right around to 36 for a north wind.
	Wind Speed	56 – 57	Windspeed can be measured in metres per second, knots, feet per second or statute miles per hour or estimated on the Beaufort scale (Table 2). It must be entered as indicated on the Cruise Master. N.B. The DOT Meteorological Log code gives windspeed in knots.

Fig. B.4.3 Bridge Log coding instructions (continued).

SPECIFIC NOTES (Cont'd)

Field No.	Field Name	Column	Explanation
14.	ww Code	58 – 59	Coded according to Table 3.
15.	Pressure	60 – 62	Enter the last three digits of the barometer reading, or of sea level pressure, in units indicated on the Cruise Master. For example 1026.4 mbar is coded as 264; 987.3 mbar as 873 and 768.3 mm as 683. Sea level pressure can be obtained from the barometer reading by applying corrections for barometer height and outside air temperature using Table 4. N.B. The WMO code gives sea level pressure in mbars.
16.	Air Temperature	63 – 65	Enter air temperature in units stated on the Cruise Master. Negative Celsius temperatures are coded by adding 50 to the absolute value of the measurement. Negative Fahrenheit temperatures are coded by placing a minus sign in the last column (65). Omit decimals when coding in Fahrenheit. For example: 14.2°C → 14.2 –14.2°C → 64.2 14.2°F → 14. –14.2°F → 14.–
17.	Wet Bulb	66 – 68	Coding as for Air Temperature.
18.	Wave Period	69 – 70	Enter the estimated period of sea waves in seconds. When the sea is calm, or the period indeterminate, enter // or leave blank.
	Wave Height	71 – 72	Estimate the average height of the larger well-formed waves of the sea wave system in multiples of 0.5 metres. The height is then coded in units of half-metres. For example, an observed wave height of 5 metres is coded as 10.
19.	Swell Direction	73 – 74	True direction from which the waves are coming in tens of degrees. Enter 00 for calm, 01 for 10°, 02 for 20° and so on by ten degree steps right around to 36 for a wave from due north.
	Swell Period	75 – 76	Code as Wave Period, see instructions for field 18, or according to Table 5 as indicated on the Cruise Master. N.B. The WMO code gives swell as P_W.
	Swell Height	77 – 78	Code as Wave Height.
20.	For CODC use	79	To be entered by CODC staff.
21.	Card Type	80	Preprinted.

Fig. B.4.4 Bridge Log coding instructions (continued).

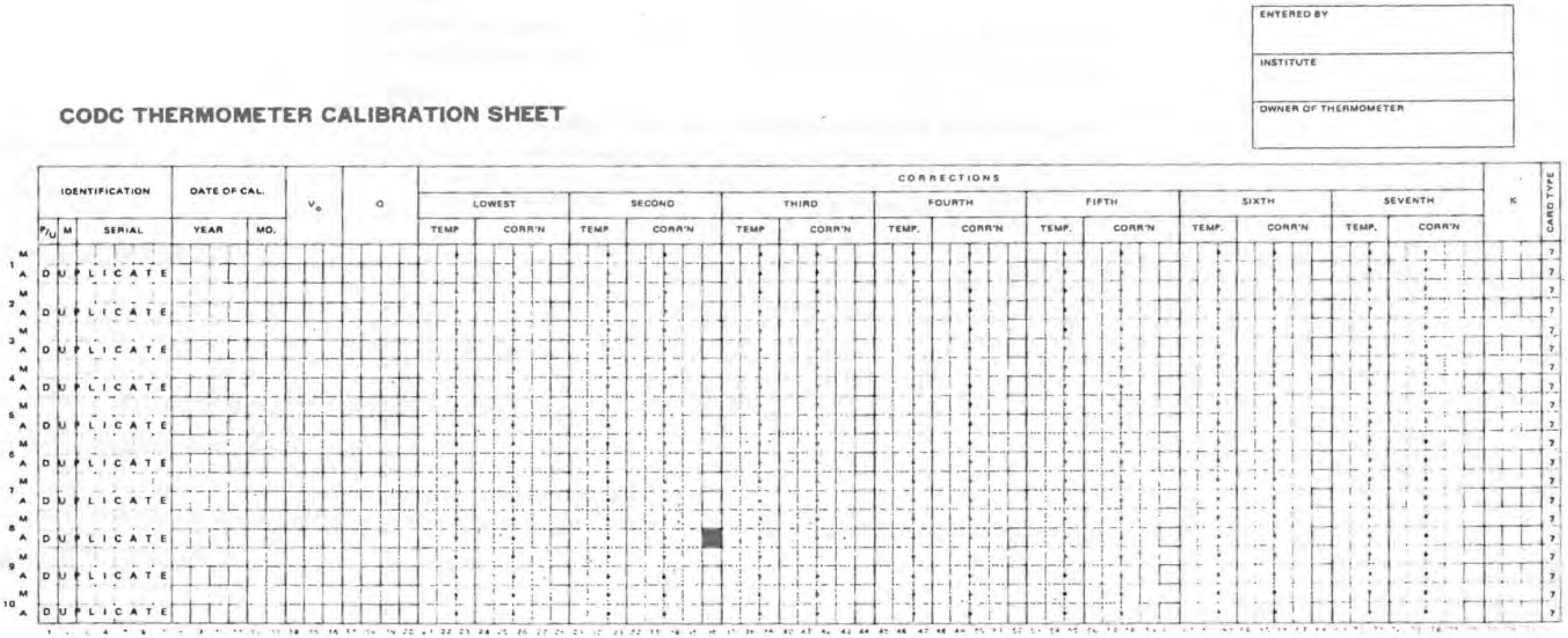


Fig. B.5.1 Thermometer Calibration Sheet. The coding instructions are given in Figs. B.5.2 and B.5.3. The form is bound in pads of 50.

CODC THERMOMETER CALIBRATION SHEET CODING INSTRUCTIONS

USING THIS FORM

The CODC Thermometer Calibration Sheet is used to code calibration constants for reversing thermometers. It is used in combination with the CODC Deck Sheet by the Thermocheck Program to calculate corrected and calibrated temperatures from reversing thermometer readings.

GENERAL NOTES

1. The rows on the form are grouped in pairs. The first of each, indicated by an M, contains Main Thermometer data, the second, indicated by an A, contains Auxiliary Thermometer data.

2. **Shaded portions** must be left blank.

3. **Leading and trailing blanks** are allowed in all fields.

SPECIFIC NOTES

Field Name	Column	Main Thermometer	Auxiliary Thermometer
Identification	1	Enter P or U to indicate whether the thermometer is protected or unprotected.	Will be copied from the Main Thermometer entry by the keypunch operator.
	2	Enter manufacturer code: R = Richter and Wiese Y = Yoshino N = Negretti and Zambra	Will be copied from the Main Thermometer entry by the keypunch operator.
	3 – 7	Five digit thermometer number as assigned by the manufacturer.	Will be copied from the Main Thermometer entry by the keypunch operator.

Fig. B.5.2 Thermometer Calibration Sheet coding instructions.

Field Name	Column	Main Thermometer	Auxiliary Thermometer
Date of Calibration	8 – 13	Year and month of last calibration.	Leave blank
V_o	14 – 16	A calibration constant for individual thermometers, representing in degrees the volume of mercury below the 0° C mark when the thermometer is in a reversed position at 0° C. Enter in whole degrees Celsius.	Leave blank
Q	17 – 20	Pressure coefficient of an unprotected thermometer, expressed in units of 0.0001 °C/kg/cm².	Leave blank
Correction, lowest	21 – 23	Enter the **lowest** temperature at which a calibration is made in units of °C. Note the position of the decimal point. Enter a minus sign, if applicable, in column 21.	Same as for Main Thermometer.
	24 – 28	Enter the corresponding calibration correction in units of °C. Note the position of the decimal point. Enter a minus sign, if applicable, in column 24.	Same as for Main Thermometer.
Correction: second, third, etc.	29 – 76	Enter information for subsequent calibration points in ascending order. Not all fields need be used.	Same as for Main Thermometer.
K	77 – 79	Reciprocal efficient of thermal expansion of the glass of which the thermometer is made, given in units of 10°C. Usually 610 x 10°C unless otherwise indicated on the thermometer certificate.	Leave blank
Card Type	80	Pre-printed	Pre-printed.

Fig. B.5.3 Thermometer Calibration Sheet coding instructions (continued).

APPENDIX C

DATA RETRIEVAL FORMS

1. Data Extraction Form
2. Data Output Form

DATA EXTRACTION FORM for OCEANS IV

GENERAL INSTRUCTIONS

(1) Use of all cards, except the Request card, is optional. Any number of cards within a subgroup, such as AREA, can be used up to the maximum number of cards shown.
(2) Any entry on a card can be left blank if a search for a particular option is not required.
(3) The output will only contain data meeting all search requirements specified. If an option is left blank, it will not be tested for.
(4) The Data Extraction Cards must be followed by the Data Output Cards specified on the Data Output Form.

REQUEST BY (obligatory):

CODE	NAME	ADDRESS
R Q S T		
1 2 3 4 5	6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62

OUTPUT OPTI NS AND SEQUENCE

SEARCH MODE	INVENTORY OPTION	DATA SEQUENCE
1: Retrieve 2: Station count 3. Station, Master Catalogue 4: Data Inventory I 5: Data Inventory II (See Report) 6: Data Inventory III	blank: if Search Modes 1, 2 or 3 are used 1: optional with Search Modes 4, 5, 6, see Report	This is determined by a sort key consisting of the elements L, I and T in the sequence entered below, where: L = Location = Ten-degree square + One-degree square I = Identification = Country + Institute + Cruise + Station T = Time = Year + Month + Day + Hour + Minute If left blank, data will be sorted in standard file sequence L - I - T
63	64	65 66 67

AREA (optional)

the program searches for data west of the "From" but east of the "To" longitude. The "From" atitude must be south of the "To" latitude

CODE	LAT.						LONG.					
	FROM			TO			FROM			TO		
	N/S	DEG.	MIN.	N/S	DEG.	MIN.	E/W	DEG.	MIN.	E/W	DEG.	MIN.
A R E A												
A R E A												
A R E A												
A R E A												
A R E A												
A R E A												
A R E A												
A R E A												
A R E A												
A R E A												
1 2 3 4	5	6 7	8 9	10	11 12	13 14	15	16 17 18	19 20	21	22 23 24	25 26 27

TIME INTERVAL OR SEASON (optional)

	CODE	YEAR RANGE		BLANK	DATE RANGE			
					LOW		HIGH	
		LOW	HIGH		MO.	DAY	MO.	DAY
20	T I M E							
21	T I M E							
22	T I M E							
23	T I M E							
24	T I M E							
25	T I M E							
26	T I M E							
27	T I M E							
28	T I M E							
29	T I M E							
30	T I M E							
31	T I M E							
	1 2 3 4 5	6 7 8 9	10 11 12 13	14	15 16	17 18	19 20	21 22

If all data for a season are required, regardless of the year of observation, leave "Year Range" fields blank.

If only data for one year or one day are required, the "High" fields can be left blank

See reverse side

Fig. C.1.1 Data Extraction form. See Section 3.

CRUISES TO BE RETRIEVED (optional)

If only one c . .se or station is required, the "High" fields can be left blank

	CODE				COUNTRY	INST.	BLANK	CRUISE RANGE LOW	CRUISE RANGE HIGH	BLANK	STATION RANGE LOW	STATION RANGE HIGH
60	I	D	E	N								
61	I	D	E	N								
62	I	D	E	N								
63	I	D	E	N								
64	I	D	E	N								
65	I	D	E	N								
66	I	D	E	N								
67	I	D	E	N								
68	I	D	E	N								
69	I	D	E	N								
	1	2	3	4	5 6 7	8 9	10	11 12 13 14 15	16 17 18 19 20	21	22 23 24	25 26 27

PARAMETER CODES

0	Temperature
1	Pressure
2	Salinity
3	Sound Speed
4	Oxygen
5	PO_4 - P
6	Total P
7	NO_2 - N
8	NO_3 - N
9	SiO - Si
A	pH
B	Fluoride
C	Diss. Org. C
D	Part. C
E	Total Alk.
F	Carb. Alk.
G	NH_3

PARAMETERS TO BE RETRIEVED (optional)

If left blank, presence of the parameters will not be checked.
If one or more parameters are specified, stations will be returned only if all parameters listed have been observed. A station is accepted if each parameter has been observed at least at one level.
Code range values as on Data Summary forms, leave columns 8 and 13 blank for parameters coded in 4 digits.

	CODE					PARAMETER CODE	BLANK	RANGE MIN.	RANGE MAX.
40	P	A	R	M					
41	P	A	R	M					
42	P	A	R	M					
43	P	A	R	M					
44	P	A	R	M					
45	P	A	R	M					
46	P	A	R	M					
47	P	A	R	M					
48	P	A	R	M					
49	P	A	R	M					
50	P	A	R	M					
51	P	A	R	M					
52	P	A	R	M					
53	P	A	R	M					
	1	2	3	4	5	6	7	8 9 10 11 12	13 14 15 16 17

SAMPLING LEVELS REQUIRED (optional)

Any one or more of the following options can be searched for. (metres)

	CODE					BOTTOM DEPTH MIN.	BOTTOM DEPTH MAX.	BLANK	SAMPLING DEPTH MIN.	SAMPLING DEPTH MAX.	BLANK	MAX. DISTANCE FROM BOTTOM
70	D	P	T	H								
	1	2	3	4	5	6 7 8 9	10 11 12 13	14	15 16 17 18	19 20 21 22	23	24 25 26 27

METEOROLOGICAL DATA REQUIREMENTS (optional)

Enter 1 in each box below the parameters desired leave blank for all others

	CODE					CLOUD AMOUNT	WIND	W W CODE	AIR PRES.	AIR TEMP.	WET BULB	WAVES	SWELL
80	M	E	T	Y									
	1	2	3	4	5	6	7 8	9	10	11	12	13 14	15 16 17

DATA INVENTORY REPORT HEADINGS (optional)

Used only if Data Inventories are required, See Search Modes 4, 5, 6 on RQST card

	CODE					HEADING TO BE PRINTED IN POSITIONS 41 TO 100 OF THE DATA INVENTORY (41 45 50 55 60 65 70 75 80 85 90 95 100)
81	H	E	A	D		
82	H	E	A	D		
	1	2	3	4	5	6 … 65

DATA DISTRIBUTION ALONG THE VERTICAL (optional)

One data point has to be present in each interval specified on this card.
This requirement can be relieved by entering under "a" the number of "empty" intervals allowed.
A blank or zero entry under "a" both mean no empty intervals allowed.
Lead zeros must be entered, any number of fields can be left blank, enter from left to right.

	CODE					a	BLANK	DELINEATION LEVELS IN METRES BETWEEN DEPTH INTERVALS
100	L	E	V	L				
101	L	E	V	L				
102	L	E	V	L				
	1	2	3	4	5	6	7	8 … 63

Fig. C.1.2 Data Extraction form (continued).
Note: On the "Sampling Levels Required" card (70) the legend of columns 15-22 should be modified to read: "Retrieve if observations available at levels below:" for columns 15-18 and "...above:" for columns 19-22. Also: on cards 100-102 depths should be entered as four-digit numbers in metres.

DATA OUTPUT FORM for OCEANS IV

To be used:
1. To control data output or Data Report formats generated from the Transaction File
2. To control output of data retrieved from the Master File. In this case Data Extraction Cards must precede the Data Output Cards

REQUESTER IDENTIFICATION (obligatory)

CODE	REQUESTER NAME	REQUESTER ADDRESS
1–5	6–22	23–62

OUTPUT OPTIONS

OUTPUT MEDIUM Enter X below output required			DERIVED PARAMETER OPTION Blank: No derived par. 1: Derived par. required	GEOGRAPHICAL DISTRIBUTION OF MEANS Use only with Master File and RQST options 4, 5, 6 (see Data Retrieval Form) Blank: Not required 1: One-degree sq. 2: Ten-degree sq.	Fill in code of parameter concerned	FILE TO BE USED 1: Transaction 2: Master
CARD	TAPE	PRINT				
63	64	65	66	67	68	69

INTERPOLATION CONTROL (optional)
This card need be present only if interpolation is required

CODE	CODES OF PARAMETERS TO BE INTERPOLATED	Blank	INTERPOLATION METHOD 1: Rattray 2: Reiniger & Ross	BASIS FOR INTERPOLATION D: Depth Levels P: Pressure levels
C A . . .				
1–5	6–15	16	17	18

SPECIFICATION OF STANDARD LEVELS (optional)
If this card is not used, interpolations will be carried out to Standard Levels (Table 1)

CODE	LEVELS TO BE USED FOR INTERPOLATION Fill out from left to right
. N T R	
. N T R	
. N T R	
1–5	6–61

CRUISE IDENTIFICATION (optional)
Use only if a Data Report is printed from the Transaction File

	CODE	COUNTRY	INST.	CRUISE NUMBER	PAGE NUMBER OF FIRST PAGE
230	C R U S				
231	C R U S				
232	C R U S				
233	C R U S				
234	C R U S				
235	C R U S				
236	C R U S				
237	C R U S				
238	C R U S				
239	C R U S				
	1–5	6–7	8–9	10–14	15–16

Table 1
STANDARD LEVELS

0	225	2,000	7,500
10	250	2,500	8,000
20	300	3,000	8,500
30	400	3,500	9,000
50	500	4,000	9,500
75	600	4,500	
100	700	5,000	
125	800	5,500	
150	1,000	6,000	
175	1,200	6,500	
200	1,500	7,000	

Fig. C.2 Data Output form. See Section 3.
Note: On the "Requester Identification" card (200), a new column (70) should be added to indicate whether levels marked as not acceptable by program Retrieve should be rejected (blank) or accepted (mark "S") in the output produced by program Report. Also: on cards 220-222 depths should be entered as four digit numbers in whole metres.

APPENDIX D

DATA OUTPUT PRINT OUTS

1. Thermocheck Listing
2. OCEANS IV Edit Listing
3. Data Report
4. Cruise Master Catalogue (Data Acquisitions)
5. Data Counts
6. Station Master Catalogue
7. Data Inventory Type I
8. Data Inventory Type II
9. Data Inventory Type III
10. Distribution of Means and Standard Deviations

```
                            CODC THERMOCHECK                                PAGE   1

OUTPUT  CONSISTS  OF  1  DENSITY-DEPTH TABLE USED FOR THERMOMETRIC DEPTH CALCULATIONS

                      2  CALIBRATION DATA FOR THE THERMOMETERS USED

                      3  CORRECTED TEMPERATURES AND CALCULATED PRESSURES

                      4  STATISTICS ON THERMOMETER PERFORMANCE
```

Fig. D.1.1 Output of the Thermocheck program. The output consists of the four elements listed above and shown in the Figs. D,1.2 through D.1.6.

CODC THERMOCHECK PAGE 2

DENSITY-DEPTH TABLE FOR THERMOMETRIC DEPTH CALCULATION

DEPTH	DENSITY
0	1.0262
100	1.0264
200	1.0267
300	1.0270
400	1.0274
500	1.0278
600	1.0281
700	1.0285
800	1.0288
900	1.0291
1000	1.0294
1500	1.0308
2000	1.0321
2500	1.0334
3000	1.0346
3500	1.0358
4000	1.0370
4500	1.0383
5000	1.0395

Fig. D.1.2 Depth-density table used for the pressure-depth conversions. See Section 4.2.

CODC THERMOCHECK PAGE 3

THERMOMETER CALIBRATION DATA

		SERIAL	VO	Q	K	SCALE CORRECTIONS													
						TEMP	CORR	TEMP	CORR	TEMP	CORR	TEMP	CORR	TEMP	CORR	TEMP	CORR	TEMP	CORR
1	MAIN	PR 1635	098	0000	6100	0.0	0.000	15.0	0.000										
	AUX					0.0	0.000	40.0	0.000										
2	MAIN	PR 1638	103	0000	6100	0.0	0.010	15.0	0.010										
	AUX					0.0	0.000	40.0	0.000										
3	MAIN	PR 1640	099	0000	6100	0.0	-0.010	15.0	-0.010										
	AUX					0.0	0.000	40.0	0.000										
4	MAIN	PR 1641	099	0000	6100	0.0	-0.010	15.0	-0.010										
	AUX					0.0	0.000	40.0	0.000										
5	MAIN	PR 1657	105	0000	6100	-2.0	0.000	3.0	0.000										
	AUX					0.0	0.000	40.0	0.000										
6	MAIN	PR 1659	101	0000	6100	-2.0	0.000	4.0	0.000										
	AUX					0.0	0.000	40.0	0.000										
7	MAIN	PR 1660	110	0000	6100	-2.0	0.000	0.0	0.000	1.0	0.010	4.0	0.010						
	AUX					0.0	0.000	40.0	0.000										
8	MAIN	PY 2753	106	0000	6100	0.0	-0.090	5.0	-0.070	10.0	-0.060	15.0	-0.090	20.0	-0.100	25.0	-0.090		
	AUX					0.0	0.000	10.0	0.000	25.0	0.000	30.0	0.010						
9	MAIN	PY 2756	108	0000	6100	0.0	0.020	5.0	0.010	10.0	0.020	15.0	0.020	20.0	0.010	25.0	0.020		
	AUX					0.0	0.000	20.0	0.000	25.0	0.100	30.0	0.000						
10	MAIN	PY 2765	097	0000	6100	0.0	0.000	5.0	0.000	10.0	0.000	15.0	0.000	20.0	0.000				
	AUX					0.0	0.000	10.0	0.000	25.0	0.000	30.0	-0.100						
11	MAIN	UY 2954	100	0920	6100	0.0	0.000	5.0	0.000	10.0	-0.020	25.0	0.050	30.0	0.010	40.0	0.030		
	AUX					0.0	0.000	30.0	-0.100	35.0	0.000	40.0	0.000						
12	MAIN	UY 2963	097	0928	6100	0.0	-0.010	20.0	-0.010	25.0	-0.050	30.0	-0.020	35.0	-0.030	40.0	-0.030		
	AUX					0.0	0.200	10.0	0.000	30.0	0.100	40.0	0.000						
13	MAIN	PY 2992	084	0000	6100	-2.0	-0.010	0.0	-0.010	5.0	-0.030	10.0	-0.020	15.0	0.000				
	AUX					-2.0	-0.100	15.0	0.200	25.0	0.000	30.0	0.000						
14	MAIN	PR 2995	067	0000	6100	-2.0	0.020	0.0	-0.010	5.0	0.020	10.0	-0.020	15.0	0.000				
	AUX					-2.0	0.020	10.0	0.400	15.0	0.300	30.0	0.200						
15	MAIN	PY 3095	099	0000	6100	0.0	-0.020	5.0	-0.020	10.0	-0.010	15.0	-0.040	20.0	-0.020				
	AUX					0.0	0.000	15.0	0.100	20.0	0.100	30.0	0.000						
16	MAIN	PY 3097	112	0000	6100	0.0	-0.010	5.0	-0.030	10.0	0.000	15.0	-0.040	20.0	-0.050				
	AUX					0.0	0.000	10.0	0.100	20.0	-0.100	30.0	0.000						
17	MAIN	PY 3104	112	0000	6100	0.0	-0.040	5.0	-0.070	10.0	-0.020	15.0	-0.070	20.0	-0.070				

Fig. D.1.3 Sample listing of the thermometer calibration data used with the Thermocheck program.

CODC THERMOCHECK PAGE 8

CORRECTED TEMPERATURES AND CALCULATED PRESSURES

COUNTRY 18 INSTITUTE 02 CRUISE 99002

CNS STN	TIME HR-MIN	WIRE ANGLE	TOTAL WIRE OUT	PLANNED WIRE OUT	SERIAL NUMBER	RDNG 1 TEMP	RDNG 2 TEMP	OBS TEMP OR PRESSURE E		MEAN TEMP E	AVG OBS PRESS E	SMOOTH PRESS E	OBS-SM PRESS E	CALC DEPTH	ERR	OBS SALIN E
001	1111	000	400.0	0.0	BUCKET	8.600	0.000	TEMP	8.600G	8.600	0.0	0.0		0.0		
001	1111	000	400.0	10.0	PR 3438	8.404	8.403	TEMP	8.403D	8.405	0.0	10.1		10.0		
					PR 6239	8.403	8.410	TEMP	8.406D							
001	1111	000	400.0	20.0	PR 1641	7.819	7.828	TEMP	7.823D	7.827	0.0	20.2		20.0		
					PR 3685	7.831	7.830	TEMP	7.830D							
001	1111	000	400.0	30.0	PR 8881	6.282	6.281	TEMP	6.281D	6.283	0.0	30.2		30.0		
					PR 9273	6.282	6.290	TEMP	6.286D							
001	1111	000	400.0	50.0	PR 8876	5.583	5.591	TEMP	5.587D	5.587	0.0	50.4		50.0		
001	1111	000	400.0	75.0	PR 6246	5.339	5.362	TEMP	5.350D	5.352	0.0	75.6		75.1		
					PR 8878	5.356	5.354	TEMP	5.355D							
001	1111	000	400.0	100.0	PR 6241	4.944	4.973	TEMP	4.958D	4.960	0.0	100.8		100.1		
					PR 5383	4.956	4.969	TEMP	4.962D							
001	1111	000	400.0	125.0	PR 9276	4.809	4.811	TEMP	4.810D	4.826	0.0	126.1		125.2		
					PY 3104	4.849	4.837	TEMP	4.843D							
001	1111	000	400.0	150.0	PR 9278	4.836	4.837	TEMP	4.836D	4.833	0.0	151.3		150.3		
					PR 8746	4.814	4.824	TEMP	4.819D							
					PR 1635	4.838	4.849	TEMP	4.843D							
001	1111	000	400.0	175.0	PY 2756	4.711	4.679	TEMP	4.695D	4.685	0.0	176.6		175.4		
					PY 3720	4.712	4.680	TEMP	4.696D							
					PR 1638	4.661	4.671	TEMP	4.666D							
001	1111	000	400.0	200.0	PR 1640	4.345	4.355	TEMP	4.350D	4.360	0.0	201.8		200.4		
					PR 6245	4.333	4.343	TEMP	4.338D							
					PY 3095	4.402	4.382	TEMP	4.392D							
001	1111	000	400.0	250.0	PY 2765	4.034	4.025	TEMP	4.029D	4.003	0.0	252.4		250.6		
					PR 9264	3.985	3.985	TEMP	3.985D							
					PY 3097	4.006	3.988	TEMP	3.997D							
001	1111	000	400.0	300.0	PR 8883	3.787	3.787	TEMP	3.787D	3.789	300.8	303.0	-2.2	300.8		
					PR 7749	3.787	3.796	TEMP	3.791D							
					UR 8517	7.895	7.903	PRES	7.899D							
001	1111	000	400.0	400.0	PR 6451	3.711	3.718	TEMP	3.714D	3.711	405.4	404.2	1.2	401.1		
					PR 6455	3.711	3.705	TEMP	3.708D							
					UR 8518	9.153	9.160	PRES	9.156D							
001	2222	000	4200.0	500.0	PR 7756	3.679	3.686	TEMP	3.682D	3.677	507.7	502.7	5.0	498.7		
					PR 6461	3.667	3.677	TEMP	3.672D							
					UR 6161	10.518	10.545	PRES	10.531D							

Fig. D.1.4 Sample output of the corrected temperatures and calculated pressures for each level. Columns containing error indicators are headed by an "E". See Section 4.1 for a detailed explanation.

THERMOCHECK STATISTICAL ANALYSIS PAGE 19

FREQUENCY DISTRIBUTION OF TEMPERATURE DIFFERENCES

COUNTRY 18 INSTITUTE 02 CRUISE 99002

THERM 1	THERM 2	-.11	-.10	-.09	-.08	-.07	-.06	-.05	-.04	-.03	-.02	-.01	0.00	+.01	+.02	+.03	+.04	+.05	+.06	+.07	+.08	+.09	+.10	+.11
PP 3438	PR 6239	.	.	.	.	.	.	.	.	.	.	2	1	2	.	.	.	.	.	.	.	.	.	.
PR 1641	PR 3685	.	.	.	.	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.
PR 8881	PR 9273	.	.	.	.	.	.	.	.	.	.	1	.	4	.	.	.	.	.	.	.	.	.	.
PR 6246	PR 8878	.	.	.	.	.	.	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.
PR 6241	PR 5383	.	.	.	.	.	.	.	.	.	2	2	1	.	.	.	.	.	.	.	.	.	.	.
PR 9276	PY 3104	.	.	.	.	.	.	.	.	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.
PR 9278	PR 8746	1	.	.	.	.	.	.	.	.	.	.	.	2	2	1	.	.	.	.	.	.	.	.
PR 9278	PR 1635	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.
PR 8746	PR 1635	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.
PY 2756	PY 3720	.	.	.	.	.	.	.	.	1	.	2	2	.	.	.	.	.	.	.	.	.	.	.
PY 2756	PR 1638	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.
PY 3720	PR 1638	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.
PR 1640	PR 6245	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	.	.	.	.	.	.	.	.
PR 1640	PY 3095	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PR 6245	PY 3095	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PY 2765	PR 9264	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	.	.	.	.	.	.
PY 2765	PY 3097	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	1	.	.	.	.	.	.	.
PR 9264	PY 3097	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.
PR 8883	PR 7749	.	.	.	.	.	.	.	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.
PR 6451	PR 6455	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.
PR 7756	PR 6461	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
PR 8742	PR 7760	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.
PR 6464	PR 8886	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.
PR 7748	PY 3721	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PR 7595	PY 2753	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PY 2995	PR 8888	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.
PR 9265	PR 6454	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
PR 9266	PR 8890	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.
PR 9277	PR 9367	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
PY 2992	PR 5384	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.
PR 9261	PR 6414	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
PR 3689	PR 8739	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
PR 8876	PR 8877	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.
PR 1659	PR 1660	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
PR 1659	PR 1657	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
PR 1660	PR 1657	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.

NUMBER OF PAIRS OF THERMOMETERS USED MORE THAN ONCE IS 35
TOTAL NUMBER OF PAIRED THERMOMETER READINGS IS 134
MEAN OF THE ABSOLUTE VALUE OF ALL DIFFERENCES NOT EXCEEDING 0.10 IS 0.020
STANDARD DEVIATION OVER ALL OBSERVATIONS NOT EXCEEDING 0.10 IS 0.026
NUMBER OF PAIRED OBSERVATIONS WITH A DIFFERENCE EXCEEDING 0.10 IS 2

Fig. D.1.5 Statistical analysis of the performance of paired thermometers (part 1), showing the distribution of observed differences over the interval -0.11°C to +0.11°C in steps of 0.01°C. The outer columns contain a count of all observations deviating by plus or minus 0.105°C or more respectively.

THERMOCHECK STATISTICAL ANALYSIS PAGE 20

COUNTRY 18 INSTITUTE 02 CRUISE 99002

STATISTICS ON PAIRED THERMOMETER PERFORMANCE

THERM 1	THERM 2	NO.	MEAN T	DIFF	SD	SE	NO. OF OBSERVATIONS IN EACH DEPTH INTERVAL 0–40	40–125	125–225	225–450	450–1100	1100–2750	OVER 2750
PR 3438	PR 6239	1	9.390	0.001	0.001	0.000	5	•	•	•	•	•	•
PR 1641	PR 3685	2	9.001	0.007	0.007	0.003	5	•	•	•	•	•	•
PR 8881	PR 9273	3	8.592	0.006	0.006	0.002	5	•	•	•	•	•	•
PR 6246	PR 8878	4	5.625	0.013	0.014	0.006	•	5	•	•	•	•	•
PR 6241	PR 5383	5	5.299	0.012	0.013	0.005	•	5	•	•	•	•	•
PR 9276	PY 3104	6	5.024	0.024	0.026	0.011	•	5	•	•	•	•	•
PR 9278	PR 8746	7	4.769	0.026	0.028	0.011	•	•	6	•	•	•	•
PR 9278	PR 1635	8	4.527	0.075	0.091	0.052	•	•	3	•	•	•	•
PR 8746	PR 1635	9	4.561	0.007	0.008	0.004	•	•	3	•	•	•	•
PY 2756	PY 3720	10	4.933	0.012	0.013	0.005	•	•	5	•	•	•	•
PY 2756	PR 1638	11	4.796	0.037	0.042	0.021	•	•	4	•	•	•	•
PY 3720	PR 1638	12	4.802	0.049	0.056	0.028	•	•	4	•	•	•	•
PR 1640	PR 6245	13	4.723	0.020	0.022	0.009	•	•	5	•	•	•	•
PR 1640	PY 3095	14	4.594	0.048	0.055	0.027	•	•	4	•	•	•	•
PR 6245	PY 3095	15	4.584	0.067	0.077	0.038	•	•	4	•	•	•	•
PY 2765	PR 9264	16	4.266	0.042	0.046	0.020	•	•	•	5	•	•	•
PY 2765	PY 3097	17	4.166	0.024	0.027	0.013	•	•	•	4	•	•	•
PR 9264	PY 3097	18	4.144	0.019	0.021	0.010	•	•	•	4	•	•	•
PR 8883	PR 7749	19	5.995	0.005	0.005	0.002	•	•	•	5	•	•	•
PR 6451	PR 6455	20	3.725	0.008	0.008	0.003	•	•	•	5	•	•	•
PR 7756	PR 6461	21	3.681	0.011	0.013	0.007	•	•	•	•	3	•	•
PR 8742	PR 7760	22	3.506	0.004	0.004	0.002	•	•	•	•	3	•	•
PR 6464	PR 8886	23	3.153	0.027	0.033	0.019	•	•	•	•	3	•	•
PR 7748	PY 3721	24	2.860	0.056	0.068	0.039	•	•	•	•	3	•	•
PR 7595	PY 2753	25	2.588	0.030	0.036	0.020	•	•	•	•	•	3	•
PY 2995	PR 8888	26	2.293	0.031	0.037	0.021	•	•	•	•	•	3	•
PR 9265	PR 6454	27	1.916	0.008	0.009	0.005	•	•	•	•	•	3	•
PR 9266	PR 8890	28	1.712	0.002	0.002	0.001	•	•	•	•	•	3	•
PR 9277	PR 9367	29	1.574	0.003	0.003	0.001	•	•	•	•	•	•	3
PY 2992	PR 5384	30	1.523	0.029	0.035	0.020	•	•	•	•	•	•	3
PR 9261	PR 6414	31	1.505	0.018	0.022	0.012	•	•	•	•	•	•	3
PR 3689	PR 8739	32	1.507	0.010	0.000	0.000	•	•	•	•	•	•	1
PR 8876	PR 8877	33	6.533	0.018	0.022	0.012	•	3	•	•	•	•	•
PR 1659	PR 1660	34	1.518	0.007	0.009	0.006	•	•	•	•	•	•	2
PR 1659	PR 1657	35	1.518	0.006	0.008	0.005	•	•	•	•	•	•	2
PR 1660	PR 1657	36	1.521	0.001	0.001	0.000	•	•	•	•	•	•	2

Fig. D.1.6 Statistical analysis of the performance of paired thermometers (part 2), showing the mean temperature observed with each pair, the mean difference, the standard deviation of the differences, the standard error of the observed mean difference, and the number of observations in each of 7 depth intervals.

```
                                      CDDC  OCEANOGRAPHIC  DATA  EDIT                                PAGE  73

1807 65001  LAND BASED 8 99   027      1 1 2 1 2  2              1 1   1 2                  1
1807 65001 001 N812290 W0771700  65 05 11 2000    12 02290  8 0407            562           2   SOUND CORR CRUISE MST MISSING
              2000 00030       -168                                                         3
              2000 00050       -167         14353C 30487                                    3   SIGMA-T LESS THAN PREVIOUS
              2000 00100       -164         14356C 30567                                    3
              2000 00150       -163         14357C 30551                                    3   SIGMA-T LESS THAN PREVIOUS
              2000 00200       -085         14397C 30739                                    3
              2000 00250       -090         14402C 31195                                    3
              2000 00300       -090         14408C 31546                                    3
              2000 00510       -114                                                         3
              2000 00760       -119         14426C 33249                                    3
              2000 01010       -159         14415C 33510                                    3
              2000 01520       -077         14471C 34145                                    3
              2000 02020       -039         14500C 34409                                    3
1807 65001 002 N812190 W0771500  65 05 11 2330    09 00900  8 0410            516           2   SOUND CORR CRUISE MST MISSING
              2330 00030       -161         14353C 30344                                    3
              2330 00050       -160         14347C 29849                                    3   SIGMA-T LESS THAN PREVIOUS
              2330 00100       -164         14352C 30289                                    3
              2330 00150       -160         14355C 30258                                    3   SIGMA-T LESS THAN PREVIOUS
              2330 00210       -080         14395C 30415                                    3
              2330 00260       -086         14398C 30708                                    3
              2330 00310       -090         14407C 31462                                    3
              2330 00520       -112         14408C 32026                                    3
              2330 00770       -115         14422C 32801                                    3
```

Fig. D.2 Sample output of the Edit program. All data are accepted into the transaction file unless marked as "level rejected", "station rejected" or "cruise rejected". An error correction procedure is available to correct the anomalies signalled on the right hand side of the page.

3

CRUISE NUMBER 58725 STATION NUMBER 002

LAT	N50 10.00	YEAR	1958	WAVE-P/H	03	WIND-DIR	190	WW	51	COUN	18
LONG	W145 15.00	MONTH	8	SWEL-P/H		WIND-SPD	09	CLD-A	8	INST	02
DEPTH		DAY	27	SWEL-D		AIR-TEM	13.2			RESTR	
MARSD SQ	195	H/M	2018	BARO	1011.0	WET-BLB	13.1			UNAS	302

C B S E R V E D

GMT	DEPTH	PRESS	TEMP		POT. T	SAL	SGMT	SGPT	SOUND	GECA	CHI	SVA
2018	0.0	0.0C	13.0	G	13.000	32.6159	2457	2457	1497.9C	0	0	3377
2018	10.0	10.1C	12.77	D	12.769	32.6148	2461	2461	1497.3C	34	2	3340
2018	29.0	29.2C	12.52	D	12.516	32.6078	2466	2466	1496.7C	98	15	3298
2018	48.0	48.4C	6.96	D	6.956	32.9159	2581	2581	1476.9C	151	35	2203
2018	67.0	67.5C	6.21	D	6.204	32.9429	2592	2593	1474.3C	191	59	2100
2018	72.0	72.6C	6.03	D	6.024	32.9618	2596	2596	1473.7C	202	67	2062
2018	76.0	76.6C	5.86	D	5.854	32.9528	2598	2598	1473.0C	210	73	2043
2018	86.0	86.7C	5.77	D	5.763	32.9859	2601	2601	1472.9C	231	90	2016
2018	96.0	96.8C	5.72	D	5.712	33.0018	2603	2603	1472.9C	251	109	1998
2018	105.0	105.9C	5.68	D	5.671	33.0728	2609	2609	1473.0C	259	127	1942
2018	120.0	121.0C	5.36	D	5.350	33.3659	2636	2636	1472.3C	296	159	1687
2018	144.0	145.2C	4.99	D	4.979	33.6743	2665	2665	1471.6C	334	209	1414
2018	168.0	169.4C	4.71	D	4.697	33.7488	2674	2674	1470.9C	367	252	1330
2036	192.0	193.6C	4.17	D	4.156	33.7769	2682	2682	1469.1C	398	320	1254
2036	240.0	242.0C	3.86	D	3.843	33.8418	2690	2690	1469.7C	457	451	1181

DEPTH	PRESS	OXY	NO2	SI
0.0	0.0C	657A	10	160
10.0	10.1C	630A	7	130
29.0	29.2C	616A	8	130
48.0	48.4C	633A	9	270
67.0	67.5C	698A	66	270
72.0	72.6C	631A	60	280
76.0	76.6C	685A	65	330
86.0	86.7C	688A	45	330
96.0	96.8C	662A	4	340
105.0	105.9C	698A	0	300
120.0	121.0C	591A	0	400
144.0	145.2C	482A	0	510
168.0	169.4C	474A	0	5[illegible]0
192.0	193.6C	406A	0	640
240.0	242.0C	285A	15	760

Fig. D.3.1 Sample Data Report page. This listing is generated with program Report. It can show up to 10 different chemical parameters per station. The entries are explained in Figs. D.3.3 through D.3.8.

21

CRUISE NUMBER 68017 STATION NUMBER 021

LAT	N44 30.00	YEAR	1968	WAVE-P/H	04	WIND-DIR	310	WW	03	COUN	18
LONG	W 66 31.00	MONTH	11	SWEL-P/H		WIND-SPD	12	CLD-A	7	INST	03
DEPTH	179.0	DAY	21	SWEL-D		AIR-TEM	0.6			RESTR	
MARSD SQ	151	H/M	2000	BARO	1011.0	WET-BLB	0.0			UNAS	

O B S E R V E D

GMT	DEPTH	PRESS	TEMP	POT. T	SAL	SGMT	SGPT	SOUND	GEOA	CHI	SVA
2000	0.0	0.0C	8.70 D	8.700	33.04 D	2565	2565	1483.0C	0	0	2349
2000	9.0	9.1C	8.84 D	8.839	33.04 D	2563	2563	1483.7C	21	1	2369
2000	19.0	19.1C	8.82 D	8.818	33.12 D	2570	2570	1483.9C	45	4	2304
2000	28.0	28.2C	8.86 D	8.857	33.10 D	2567	2568	1484.2C	66	9	2335
2000	46.0	46.3C	8.89 D	8.885	33.12 D	2569	2569	1484.6C	108	25	2319
2000	69.0	69.5C	9.29 D	9.282	33.17 D	2566	2566	1486.6C	162	58	2351
2000	93.0	93.7C	9.30 D	9.290	33.39 D	2583	2583	1487.3C	217	103	2195
2000	139.0	140.1C	9.33 D	9.314	33.55 D	2595	2595	1488.3C	316	221	2090
2000	162.0	163.3C	9.34 D	9.322	33.60 D	2599	2599	1488.8C	364	295	2056

I N T E R P O L A T E D

GMT	DEPTH	PRESS	TEMP	POT. T	SAL	SGMT	SGPT	SOUND	GEOA	CHI	SVA
	0.0	0.0	8.700	8.700	33.040	2565	2565	1483.0	0	0	2349
	10.0	10.1A	8.841C	8.840	33.049C	2564	2564	1483.7A	23	1	2362
	20.0	20.1A	8.823B	8.821	33.119B	2570	2570	1483.9A	47	4	2306
	30.0	30.2A	8.859D	8.856	33.100B	2567	2568	1484.2A	71	10	2335
	50.0	50.3A	8.959E	8.953	33.122C	2568	2568	1484.9A	117	30	2329
	75.0	75.6A	9.312E	9.303	33.221D	2570	2570	1486.8A	176	68	2318
	100.0	100.8A	9.305A	9.294	33.428D	2586	2586	1487.5A	232	118	2169
	125.0	126.0A	9.321A	9.307	33.524D	2593	2593	1488.0A	287	181	2106
	150.0	151.2W	9.335W	9.318	33.574W	2597	2597	1488.5W	339	256	2074

Fig. D.3.2 Sample Data Report page showing interpolated data but no chemical parameters. The entries are explained in Figs. D.3.3 through D.3.8.

GENERAL INFORMATION ON THE CRUISE

CODC Cruise Identification (country, inst., crn.):. . . . .

Originating Institute: . . . .

Originator's Cruise Number (if applicable): . . . .

Area: . . . .

Observation Platform:. . . . .

Period:. . . . .

PARAMETERS MEASURED

1	9 . . . .
2	10 . . . .
3	11 . . . .
4	12 . . . .
5	13 . . . .
6	14 . . . .
7	15 . . . .
8	16 . . . .

INTERPOLATION

Interpolation Technique

_ Rattray
_ Reiniger and Ross

Interpolation to "Standard" Levels of:

_ Depth
_ Pressure

METHODS USED

Sea Surface Temperature

_ Same as subsurface
_ Bucket
_ Water Intake
_ Tow Frame

Sub Surface Temperature

_ Reversing Thermometer
_ Thermal Probe

Salinity

_ Titration
_ Conductance
_ Inductance
_ Refrac. Index
_ In Situ Probe
_ Hydrometer

Oxygen

_ Winkler
_ In Situ Probe

Anemometer Height in M Above Sea Level: ____

Sounding Corrections Applied

_ Soundspeed of 1463 m/sec
_ Soundspeed of 1500 m/sec
_ Matthews Tables
_ Measured or Calculated In Situ Soundspeed Profile

Air Pressure

_ Barometer Reading Uncorrected
_ Corrected for Barometer Height
_ Corrected For Bar. Height and Outside Air Temperature

Fig. D.3.3 Explanation of the Data Record headings.

DESCRIPTION OF THE DATA RECORDS

GENERAL REMARKS

This Data Report contains oceanographic station data for the cruise indicated on the title page. The data have been edited and processed by CODC's OCEANS IV program, and are archived in our Oceanographic Station Data File. Copies of the data can be provided in computer-compatible form on card or magnetic tape. A description of the OCEANS IV program and/or an outline of available output formats are available upon request. (OCEANS IV; A Processing, Archiving and Retrieval System for Oceanographic Station Data).

Most entries in the observed portion of the Data Records can be accompanied by an error code or doubtful marker. Errors are indicated only if the entry is based on duplicate or multiplicate measurements and are coded A through I in multiples of the last digit shown in the printout (see Table 6).

The Data Records are broken into three "blocks": the station master, observed data, and interpolated data blocks. The station master contains the identification, position, time and bottom depth of the station plus meteorological data and some general information. In the observed data block the temperature and salinity observations and derived parameters such as sigma-t, specific volume anomaly, etc. are given. It may be followed or replaced by a second group of Observed data containing all observed parameters but no derived quantities. The third block contains interpolated values of all parameters at specified depth or pressure levels. It also can be replaced or followed by a second group of interpolated data containing all observed parameters but no derived quantities. This data block is included in the listing only if specifically requested by the data originator.

Interpolations can be carried out to standard oceanographic depth or pressure levels (see Table 7) or to depth or pressure levels specified by the data originator. Both observed and derived parameters are interpolated individually, using the nearest two observations (or calculated values) above and below the desired interpolation levels. Two hyperbola are fitted to these points and a weighted mean is determined as described by Reiniger and Ross (1968)* or by Rattray (1962).** Linear interpolation is used in all cases when fewer than two points above and two below the required level are available. On page 1 the interpolation technique used is specified (if applicable).

*Deep Sea Res., *15*, p 185–193
**Deep Sea Res., *9*, p 25–37

Fig. D.3.4 Explanation of the Data Record headings (continued).

EXPLANATION OF DATA RECORD HEADINGS

Insignificant trailing digits of any parameter can be left blank on the data entry forms, but will be shown as zeros in the listings of all data except temperature and salinity.

STATION MASTER HEADINGS

		1. CRUISE NUMBER	2. STATION NUMBER		
3. LAT	7. YEAR	11. WAVE–P/H	15. WND–DIR	19. WW	21. COUN
4. LONG	8. MONTH	12. SWEL–P/H	16. WND–SPD	20. CLD–A	22. INST
5. DEPTH	9. DAY	13. SWEL–D	17. AIR–TEMP		23. RESTR
6. MARSD SQ	10. H/M	14. BARO	18. WET BLB		24. UNAS

(1) CRUISE NUMBER	The first two digits indicate the year of the first station of the cruise; the next three digits are assigned consecutively by each institute commencing at 001 each year.
(2) CONSECUTIVE STATION NUMBER	Indicates the chronological order in which the stations are occupied.
(3) LATITUDE (4) LONGITUDE	Position of the platform at the sampling time in degrees and minutes with two decimals. Non-observed decimals are printed as zero's; e.g. observed latitudes of N36°25′ and N36°25.00′ will both be printed as N36 25.00.
(5) DEPTH	Bottom depth in metres with one decimal; adjusted for soundspeed as indicated on page 1.
(6) MARSDEN SQUARE	A code to designate the ten-degree square in which the samples have been taken (Figure 1).
(7) YEAR (8) MONTH (9) DAY (10) HOUR and MINUTE	Time-date group defining the moment at which the shallowest level is observed in GMT (Greenwich Mean Time).
(11) WAVE PERIOD and HEIGHT	Sea wave period in seconds (2 digits), followed by wave height (2 digits) in multiples of 0.5 metres; e.g. a wave height of 3 m is coded as 06.
(12) SWELL PERIOD and HEIGHT	See explanation of (11)
(13) SWELL DIRECTION	Direction *from* which swell waves are coming. A calm is indicated by 000, waves from due north by 360.
(14) BAROMETER	Air pressure in mbar with one decimal. Corrections for barometer height and/or outside air temperature have been applied as indicated on page 1.
(15) WIND DIRECTION	Direction *from* which the wind is blowing in degrees. A calm is indicated by 000, wind from due north by 360.

Fig. D.3.5 Explanation of the Data Record headings (continued).

(16) WIND SPEED	Wind speed is given in m/sec; original observations made on the Beaufort scale are converted to metres per second according to the scale given in Table 1.
(17) AIR TEMPERATURE (18) WET BULB	In degrees Celsius with one decimal.
(19) WW CODE	Present weather in WMO code 4677 (Table 2)
(20) CLOUD AMOUNT	Sky coverage in eighths according to WMO code 2700 (Table 3)
(21) COUNTRY	Country in which the institute responsible for collecting the data is situated (Table 4).
(22) INSTITUTE	A code identifying the institute responsible for collecting the data (Table 5).
(23) RESTRICTION	If desired, a restriction can be placed on the data by inserting a numerical code. Blank or zero stand for unrestricted and non proprietory data.
(24) UNASSIGNED	In this field any alphanumeric information, entered in the corresponding field on the Data Summary form used to submit the data to CODC, is reproduced. It can, for example, be used to indicate an arbitrary station coding.

OBSERVED OR INTERPOLATED DATA;

1. GMT	2. DEPTH	3. PRESS	4. TEMP	5. POT.T
6. SAL	7. SGMT	8. SGPT	9. SOUND	10. GEOA
11. CHI	12. SVA	13. . . . . . .CHEMICAL PARAMETERS		

(1) GMT	Time in GMT of in situ observation, e.g. time of reversal of a reversing thermometer. When a multiple cast is initiated prior to and continued after midnight, time may be indicated as 24, 25, 26, etc., hours plus up to 59 minutes. Note that the station date is determined by the date of the shallowest observed level.
(2) DEPTH	Sample depth in metres with one decimal.
(3) PRESSURE	Pressure at the sampling level, in dbar with one decimal, with reference to a surface pressure of zero. It may be followed by an "M" or a "C" to indicate whether pressure is measured or calculated from a depth observation.
(4) TEMPERATURE	In degrees Celsius with three decimals, measured as indicated on page 1. It can be followed by one of the alphabetic doubtful data markers and error codes shown in Table 6, or by a "P" to indicate temperatures measured with an in situ probe.

Fig. D.3.6 Explanation of the Data Record headings (continued).

(5) POTENTIAL TEMPERATURE

Potential temperature is the temperature that a water sample would attain if raised adiabatically to the sea surface. It is defined by:

$$\Theta_i = T_i + \int_0^{P_i} \left(\frac{\partial T}{\partial p}\right)_\eta dp$$

where T_i is the in situ temperature, $\left(\frac{\partial T}{\partial p}\right)_\eta$ the derivate of temperature with respect to pressure under constant entropy, and P_i the pressure at the observed level. Θ_i is given in degrees Celsius with three decimals.

(6) SALINITY

In parts per thousand (g/kg) with three decimals, measured as indicated on page 1. It may be followed by the alphabetic error codes shown in Table 6, or by a "P" to indicate salinities measured with an in situ probe.

(7) SIGMA-T

The specific gravity anomaly, sigma-t, of seawater at atmospheric pressure is defined by:

$$\sigma_t = 1000 \times (\rho_{s,t,p=o} - 1.0)$$

where $\rho_{s,t,p=o}$ is the specific gravity of seawater as a function of salinity S, temperature T, and sea surface pressure. Sigma-t is given with two decimals; e.g. an entry of 2485 corresponds to σ_t = 24.85 or ρ = 1.024,85.

(8) SIGMA POTENTIAL TEMPERATURE

See definition of sigma-t, but substitute the potential temperature Θ for the in situ temperature T.

(9) SOUNDSPEED

Soundspeed is reported in m/sec with one decimal. It may be followed by an "M" or a "C" to indicate whether it is measured directly or calculated as a function of temperature, salinity and pressure using Wilson's equations.

(10) GEOPOTENTIAL ANOMALY

Geopotential anomaly is defined as:

$$\Delta D = \int_0^P \delta \, dp$$

where δ is specific volume anomaly. The integration over pressure is carried out either down to the pressure at the required depth level, or down to the required pressure level, as specified on page 1. The geopotential anomaly is expressed in dynamic metres (10^5 ergs/gram) with three decimals: a value of 0215 corresponds to ΔD = 0.215 dynamic metres.

Fig. D.3.7 Explanation of the Data Record headings (continued).

(11) POTENTIAL ENERGY ANOMALY (CHI) — Potential energy anomaly is defined by

$$\chi_\eta = \frac{1}{g}\int_0^{P(z_n)} p\,\delta\,dp$$

where g is local gravity as a function of latitude and depth, p is pressure and δ the specific volume anomaly. It is expressed in units of 10^8 erg/cm^2 and recorded with two decimals, e.g. a value of 11644 corresponds to $\chi = 116.44 \times 10^8$ erg/cm^2.

(12) SPECIFIC VOLUME ANOMALY — The specific volume anomaly is defined by:

$$\delta_{stp} = \alpha_{stp} - \alpha_{35,0,p}$$

where α_{stp} and $\alpha_{35,0,p}$ are the specific volume at the in situ salinity, temperature and pressure, or a standard salinity of 35.0‰, standard temperature of 0°C, and in situ pressure respectively, δ is expressed in 10^5 ml/gr with one decimal place; e.g. a reading of 1234 corresponds to $\delta = 123.4 \times 10^{-5}$ ml/gr.

(13) OXY — Dissolved oxygen in ml/l with two decimals.

(14) PO_4 — Phosphate-phosphorus in μ g-atoms per litre with two decimals.

(15) T–P — Total phosphorus in μg-atom per litre with two decimals.

(16) NO_2 — Nitrate-nitrogen in μg-atom per litre with two decimals.

(17) NO_3 — Nitrate-nitrogen in μg-atom per litre with one decimal.

(18) SI — Silicate-silicon in μg-atom per litre with one decimal.

(19) pH — The pH value with three decimals.

(20) F — Fluoride in mg/l with two decimals.

(21) D.C. — Dissolved organic carbon in mg/l with two decimals.

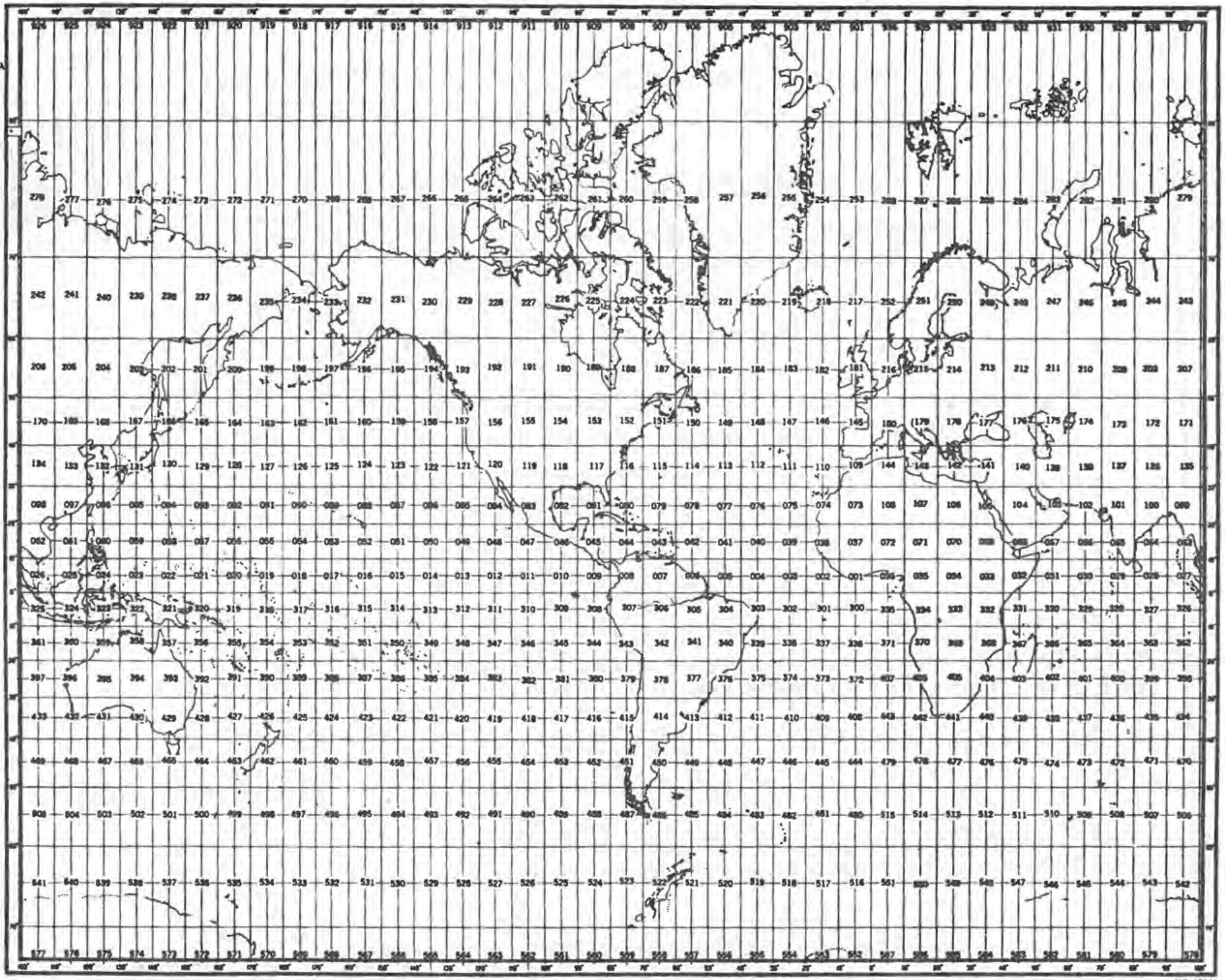
(22) P.C. — Particulate organic carbon in mg/m^3 with zero decimals.

(23) T ALK — Total alkalinity in micro-equivalents per litre with zero decimals.

(24) C ALK — Carbonate Alkalinity in micro-equivalents per litre with zero decimals.

NH_3 — Ammonia in micrograms NH_3 per litre with two decimals.

8 Explanation of the Data Record headings (continued).



MARSDEN SQUARE CHART

Fig. D.3.9 Explanation of the Data Record headings (continued).

CODE TABLES

TABLE 1

CONVERSION OF BEAUFORT ESTIMATE TO WINDSPEED IN M/SEC

Beaufort	Windspeed in m/sec	Beaufort	Windspeed in m/sec
0	00	7	15
1	01	8	19
2	02	9	22
3	04	10	26
4	07	11	30
5	09	12	34
6	12		

TABLE 2

PRESENT WEATHER (ww – Code)

Use the highest code figure applicable except that 17 has preference over 20 to 49 inclusive.

00–49 NO PRECIPITATION AT SHIP AT TIME OF OBSERVATION

00–03 CHANGE OF SKY DURING PAST HOUR

Code	
00	Cloud development not observable
01	Clouds dissolving or becoming less developed
02	State of sky on the whole unchanged
03	Clouds generally forming or developing

Code

04–09 SMOKE, HAZE, SAND OR DUST

04	Visibility reduced by smoke (not ship's smoke)
05	Dry Haze
06	Widespread dust suspended in air
07	Blowing spray at ship
08	Dust whirls in past hour (not for marine use)
09	Dust or sandstorm in sight, or at ship in past hour

Fig. D.3.10 Explanation of the Data Record headings (continued).

Table 2 (cont'd.)

Code		
10–12 MIST AND SHALLOW FOG		
10	Mist (visibility 1100 yds. or more)	
11	Shallow fog in patches	*Fog not deeper than 33 ft.*
12	Shallow fog-more or less continuous	*Fog not deeper than 33 ft.*
13–16 PHENOMENA WITHIN SIGHT BUT NOT AT SHIP		
13	Lightning visible, no thunder heard	
14	Precipitation in sight, not reaching surface	
15	Precip. beyond 3 naut. miles, reaching surface	
16	Precip. within 3 naut. miles, reaching surface	
17–19 THUNDER, SQUALLS, FUNNEL CLOUDS		
17	Thunder at time of obsn. – no precip. at ship	
18	Squalls (no precip.) in past hour or at time of obsn.	
19	Funnel cloud(s) seen in past hour or at time of obsn.	
20–29 PHENOMENA IN PAST HOUR BUT *NOT* AT TIME OF OBSN.		
20	Drizzle (not freezing) or snow grains	*Not falling as showers*
21	Rain (not freezing)	*Not falling as showers*
22	Snow	*Not falling as showers*
23	Rain and snow, or ice pellets	*Not falling as showers*
24	Freezing drizzle or freezing rain	*Not falling as showers*

Code		Code
25	Shower(s) of rain	
26	Shower(s) of snow, or of rain and snow mixed	
27	Shower(s) of hail*, or of rain and hail* mixed	
28	Fog (in past hour but not at time of observation)	
29	Thunderstorm, with or without precipitation	

*Includes hail, ice pellets, or snow pellets

30–39 (Not likely to be used in ship reports)

Slight or Moderate		Heavy
30	Duststorm or sandstorm, decreasing	**33**
31	Duststorm or sandstorm, unchanging	**34**
32	Duststorm or sandstorm, increasing	**35**
36	Drifting snow, generally low	**37**
38	Blowing snow, generally high	**39**

40–49 FOG AT THE TIME OF OBSERVATION

40	Fog at a distance but not at ship during past hour	
41	Fog in patches	

Sky Visible	Visibility less than 1100 yards of time of observation	Sky Invisible
42	Fog, has become thinner in past hour	**43**
44	Fog, no change in past hour	**45**
46	Fog, has begun or thickened in past hour	**47**
48	Fog, depositing rime	**49**

Fig. D.3.11 Explanation of the Data Record headings (continued).

Table 2 (cont'd.)

50–99 PRECIPITATION AT SHIP AT TIME OF OBSERVATION

50–59 DRIZZLE

Code Intermittent		Code Continuous
50	Slight Drizzle	51
52	Moderate Drizzle	53
54	Heavy Drizzle	55
Slight		**Moderate or Heavy**
56	Freezing drizzle	57
58	Drizzle and rain mixed	59

60–69 RAIN (NOT FALLING AS SHOWERS)

Intermittent		Continuous
60	Slight rain	61
62	Moderate rain	63
64	Heavy rain	65
Slight		**Moderate or Heavy**
66	Freezing rain	67
68	Rain or drizzle with snow	69

70–79 SOLID PRECIPITATION NOT FALLING AS SHOWERS

Code Intermittent		Code Continuous
70	Slight snow in flakes	71
72	Moderate snow in flakes	73
74	Heavy snow in flakes	75
76	Ice prisms (with or without fog)	
77	Snow grains (with or without fog)	
78	Isolated starlike snow crystals (with or without fog)	
79	Ice pellets	

80–84 RAIN SHOWERS

80	Slight rain shower
81	Moderate or heavy rain shower
82	Violent rain shower
83	Shower of rain and snow mixed, slight
84	Shower of rain and snow mixed, moderate or heavy

85–90 SOLID PRECIPITATION IN SHOWERS

Slight		Moderate or Heavy
85	Shower of snow	86
87	Shower of snow pellets or ice pellets*	88
89	Shower of hail, no thunder	90

*With or without rain and/or snow

Fig. D.3.12 Explanation of the Data Record headings (continued).

Table 2 (Cont'd.)

Code

91–94 THUNDERSTORM DURING THE PAST HOUR BUT NOT AT THE TIME OF OBSERVATION

Note: Use 29 if there is no precip. at observation time

Code	Description	
91	Slight rain	*Thunderstorm in past hour but not now – precip. occurring at time of obsn.*
92	Moderate or heavy rain	
93	Slight snow, or rain and snow mixed, or hail*	
94	Moderate or heavy snow, or rain and snow mixed, or hail*	

*Includes hail, ice pellets or snow pellets

Code	Description
95	Slight or modt. thunderstorm with rain and/or snow, but no hail*
96	Slight or modt. thunderstorm with hail*
97	Heavy thunderstorm with rain and/or snow, no hail*
98	Thunderstorm with dust or sandstorm
99	Heavy thunderstorm with hail*

*Includes hail, ice pellets or snow pellets

TABLE 3

CLOUD AMOUNT (N – Code)

Fraction of the sky covered by clouds

Code	Cloud Cover	Code	Cloud Cover
0	Cloudless	6	6/8
1	1/8 or less but not zero	7	7/8 or more but not 8/8
2	2/8	8	8/8, sky totally covered
3	3/8	9	Sky obscured by dense fog, heavy snow, etc., or amount cannot be estimated.
4	4/8		
5	5/8		

Fig. D.3.13 Explanation of the Data Record headings (continued).

TABLE 4

COUNTRY CODES (abbreviated table)

Complete table see OCEANS IV Systems' Description.

06 Germany
09 Australia
18 Canada
26 Denmark
31 United States
35 France
46 Iceland
49 Japan
58 Norway
64 Netherlands
74 United Kingdom
90 Union of Soviet Socialist Republics

TABLE 5

INSTITUTE CODE

01 Marine Ecology Laboratory, Bedford Institute
02 Pacific Oceanographic Group
03 Biological Station, St. Andrews, N.B.
04 Arctic Biological Station, Ste. Anne de Bellevue, P.Q.
05 Biological Station, St. John's Nfld.
06 Station de Biologie Marine, Grande Rivière
07 Marine Sciences Branch, Central Region
08 Defence Research Establishment, Atlantic
09 Defence Research Establishment, Pacific
10 Atlantic Oceanographic Laboratory, Bedford Institute
11 Polar Continental Shelf Project
12 Great Lakes Institute
13 Institute of Oceanography, University of British Columbia
14 Institute of Oceanography, Dalhousie University
15 Marine Sciences Branch, Pacific Region
16 Department of Transport
17 Marine Sciences Centre, McGill University
18 Canadian Forces Maritime Command, East Coast
19 Canadian Forces Maritime Command, West Coast
20 Ontario Water Resources Commission
21 Dept. of National Health and Welfare
22 Inland Waters Branch, Dept. of Energy, Mines and Resources
23 Arctic Institute of North America

Fig. D.3.14 Explanation of the Data Record headings (continued).

TABLE 6

DOUBTFUL DATA MARKERS AND ERROR CODES

Code	Explanation
X	Considered doubtful by the data originator.
Y	Considered doubtful by CODC.
A–I	Error estimates coded as shown below. The codes are used only as a measure of the spread between duplicate or multiplicate measurements at the same location and time.

Let P be the difference between two measurements. P is then coded in multiples of the last digit allowed for on the coding form as follows:

$P \leqslant 1$	Code A
$1 < P \leqslant 2$	Code B
$2 < P \leqslant 5$	Code C
$5 < P \leqslant 10$	Code D
$10 < P \leqslant 20$	Code E
$20 < P \leqslant 50$	Code F
$50 < P \leqslant 100$	Code G
$100 < P \leqslant 200$	Code H
$200 < P$	Code I

A temperature error P=0.003°C is coded as C, an error P=0.02°C as E, and a salinity error P=0.08 per mille as G, etc.

If the datum is based on a triple measurement, P is taken equal to the standard deviation:

$$P = \left\{ \frac{1}{2} \sum_{i=1}^{3} (A_i - \bar{A})^2 \right\}^{1/2}$$

where A_i are the measurements and $\bar{A}$ the mean value of the observed parameter.

Fig. D.3.15 Explanation of the Data Record headings (continued).
Note: A code "W" may follow interpolated data, indicating that linear instead of hyperbolic interpolation has been used.

TABLE 7

STANDARD LEVELS

0000	0200	1200	5500
0010	0225	1500	6000
0020	0250	2000	6500
0030	0300	2500	7000
0050	0400	3000	7500
0075	0500	3500	8000
0100	0600	4000	8500
0125	0700	4500	9000
0150	0800	5000	9500
0175	1000		

Note: The standard levels can refer to standard depths or to standard pressure levels as indicated on page 1.

Fig. D.3.16 Explanation of the Data Record headings (continued).

C R U I S E   M A S T E R   C A T A L O G U E

CN	CRUISE IN	CRUISE NO	VESSEL	PLAT	LATITUDE FROM	LATITUDE TO	LONGITUDE FROM	LONGITUDE TO	TOT STNS	STNS UNDER 1000	STNS UNDER 3000	CLASS	TEM	SAL	SND	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q Z
18	03	66021	MALLOTUS	1	N44	N45	W066	W067	12	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67002	A T CAMERON	1	N41	N45	W064	W067	111	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67004	E E PRINCE	1	N36	N39	W069	W076	30	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67006	E E PRINCE	1	N42	N45	W064	W069	87	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67008	E E PRINCE	1	N43	N45	W057	W062	16	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67009	E E PRINCE	1	N46	N49	W059	W065	84	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67010	HARENGUS	1	N46	N49	W061	W064	24	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67013	E E PRINCE	1	N42	N45	W059	W063	49	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67014	HARENGUS	1	N45	N49	W060	W065	43	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67016	E E PRINCE	1	N41	N45	W064	W069	111	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67018	HUDSON	1	N46	N52	W055	W067	41	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67020	HARENGUS	1	N46	N49	W060	W065	43	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67021	E E PRINCE	1	N45	N49	W061	W066	42	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67023	A T CAMERON	1	N45	N48	W044	W049	30	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67025	E E PRINCE	1	N47	N49	W063	W065	13	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67026	E E PRINCE	1	N41	N45	W064	W069	102	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	67027	MALLOTUS	1	N44	N45	W066	W067	12	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	68001	KAPUSKASING	1	N42	N46	W054	W068	92	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	68002	E E PRINCE	1	N42	N45	W054	W058	92	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	68004	E E PRINCE	1	N46	N49	W059	W065	99	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	68005	HARENGUS	1	N47	N49	W064	W066	12	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	03	68006	JUDITH R	1	N37	N41	W066	W067	38	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. D.4. Cruise Master Catalogue. A list of the cruises merged into the master files. The latitudes and longitudes shown indicate the cornerpoints of a "rectangular" grid surrounding all stations observed on a cruise. The number of stations down to depths exceeding 1000 or 3000 metres is given as well as the total number of stations. A data restriction can be entered in the "CLASS" field. In the remaining columns the number of stations at which any parameter has been observed at least once is summarised, using a code from 0 to 9 for non-observed to observed at 90% or more of all stations. The parameters are temperature (TEM), salinity (SAL), sound speed (SND) and the chemical parameters 4 through G listed in the table in Fig. C.1.2. The parameters H through Z have not yet been assigned.

```
                    RUN CONTROL TOTAL SUMMARY                                                   PAGE     1

                            STATIONS SEARCHED        35,957
                              LEVELS SEARCHED             0

                 NUMBER OF SUCCESSFUL STATIONS        4,267
                   NUMBER OF SUCCESSFUL LEVELS            0

                             STATIONS WRITTEN         4,267
                               LEVELS WRITTEN        29,469
                              RECORDS WRITTEN             0

***** IMPORTANT  -  PLEASE NOTE  *****
AN EXTRACTED DATA FILE WAS NOT CREATED  -  THE (WRITTEN) RECORD COUNTS INDICATE THE SIZE OF THE FILE IF YOU HAD REQUESTED CREATION
```

Fig. D.5. Sample Data Count, showing the number of data that satisfy a given set of data extraction conditions as specified on the Data Extraction form shown in Figs. C.1.1 and C.1.2.

S T A T I O N   M A S T E R   C A T A L O G U E PAGE 1

AREA	MSQ	IDENTIFICATION C/I CRS STN	DATE-TIME	NO.OF DPTHS	OCEAN DEPTH	SAMPLES LO	SAMPLES HI	0 75	70 225	226 500	501 1000	1001 2000	2001 3000	3001 5000	OVER 5000	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E Z
1306-00	151	1801 356 047	62-03-18 1818	18	4645		2308	3	4	3	4	3	1			9	9	9	9	7										
1306-00	151	1801 356 048	62-03-18 2218	18	4750		2139	4	4	3	3	3	1			9	9	9	9	7										
1306-00	151	1801 356 049	62-03-19 0206	18	4628		1969	3	4	3	5	3				9	9	9	9	7										
1306-00	151	1803 178 001	54-03-30 1336	1				1									9	9												
1306-00	151	1810 361 012	62-07-25 1806	18	4389		2065	4	3	4	3	3	1			9	9	9	9	8										
1306-00	151	1810 361 013	62-07-25 2200	19	4023		2462	4	3	4	4	3	1			9	9	9	9	8										
1306-00	151	1810 361 014	62-07-26 0206	19	4481		2388	4	3	4	4	3	1			9	9	9	9	8										
1306-00	151	1810 361 020	62-07-29 1406	14	4682		996	2	3	4	5					9	9	9	9	9										
1306-00	151	1810 361 021	62-07-29 1618	3	4682		50	3								9	9	9	9											
1306-00	151	1810 361 022	62-07-29 1824	3	4682		50	3								9	9	9	9											
1306-00	151	1810 361 023	62-07-29 2024	3	4582		50	3								9	9	9	9											
1306-00	151	1810 361 024	62-07-30 0412	3	4755		50	3								9	9	9	9											
1306-00	151	1810 361 025	62-07-30 0818	3	4572		50	3								9	9	9	9											
1306-00	151	1810 361 025	62-07-30 1706	15	4389		1008	3	3	4	4	1				9	9	9	9											
1306-10	151	1801 319 009	58-08-01 2048	22	4770		3881	6	3	3	4	3	2	1		9	9	9	9	6	6		6		5					
1306-10	151	1801 330 086	60-12-03 1324	15	4390		861	6	4	3	2					9	9	9	9	1										
1306-10	151	1801 001 008	63-01-17 1400	16	4206		780	6	3	4	3					9	9	9	9											
1306-10	151	1801 029 041	66-11-26 1130	16	1828		790	6	4	4	2					9	9	9	9											
1306-10	151	1803 114 008	49-11-17 0330	7			300	4	2	1						9	9	9	9											
1306-10	151	1803 140 026	51-11-22 2106	11			400	6	3	2						9	9	9	9											
1306-10	151	1803 143 018	52-02-27 1600	11			386	6	3	2						9	9	9	9											
1306-10	151	1803 159 077	52-11-11 0924	10			280	6	3	1						9	9	9	9											
1306-10	151	1803 209 028	56-02-12 0036	12			478	6	3	3						9	9	9	9											
1306-10	151	1803 241 056	57-06-25 1442	12	2559		356	6	3	3						9	9	9	9											
1306-10	151	1803 296 009	59-02-26 1312	14			2380	6	3	2	1	1	1			9	9	9	9											
1306-10	151	1813 352 008	61-11-01 0330	10	4353		300	6	3	1						9	9	9	9											
1306-20	151	1801 029 040	66-11-26 0518	16	1828		980	6	3	4	3					9	9	9	9											
1306-20	151	1803 146 026	52-05-07 1142	11	4243		362	6	3	2						9	9	9	9											
1306-20	151	1803 266 106	58-04-04 0600	1	3658			1								9	9	9	9											
1306-20	151	1803 287 008	58-10-19 1424	19	2606		1620	6	3	2	5	3				9	9	9	9											
1306-20	151	1803 297 008	59-05-30 1554	20			3460	6	3	3	3	2	2	1		9	9	9	9											
1306-20	151	1803 301 006	59-07-26 1400	16	4298		1425	6	3	2	3	2				9	9	9	9											
1306-20	151	1808 009 001	67-08-18 1712	13	4755	50	2000	1	3	2	4	3				9	9	9	9											
1306-21	151	1813 352 007	61-10-31 2148	9	4041		200	6	3							9	9	9	9											

Fig. D.6. Station Master Catalogue, showing a summary of the stations that satisfy a given set of data extraction conditions as specified on the Data Extraction form. The area is given in the COTED square code (Appendix F), followed by the Marsden square number. Note that only the last three digits of the cruise number are shown; the first two digits are, for Canadian data, equal to the year of observation of the first station of a cruise. Minimum and maximum sampling depth are shown under "SAMPLES LO" and "HI" respectively; a blank under "LO" indicates a minimum sampling depth of zero metres. The number of observed levels is broken down over the intervals shown (0-75, 76-225, etc.). The number of levels at which each of the parameters is observed is summarized by a scale of 0 through 9. The zero is suppressed and stands for not-observed at any level, the 9 for observed at 90% or more of all levels. The parameters are temperature (0), pressure (1), salinity (2), soundspeed (3) and the chemical parameters listed in the table shown in Fig. C.1.2.

CODC DATA INVENTORY

PAGE 1

TEN-DEG SQUARE	FIVE-DEG SQUARE	ONE-DEG SQUARE	TOTAL STATIONS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FIVE-DEG SQUARE	TEN-DEG SQUARE
					TOTAL STATIONS BY MONTH (YEAR-RANGE)												
1306	0	00	14	0	0	4	0	0	0	10	0	0	0	0	0	0	1306
1306	0	01	8	0	0	5	0	0	0	1	2	0	0	0	0	0	1306
1306	0	02	5	0	0	4	0	1	0	0	0	0	0	0	0	0	1306
1306	0	03	2	0	0	1	0	0	0	0	0	0	0	0	1	0	1306
1306	0	04	4	0	0	0	1	0	0	0	2	1	0	0	0	0	1306
1306	3	05	1	0	0	0	0	0	0	0	1	0	0	0	0	3	1306
1306	0	10	12	1	3	0	0	0	1	0	1	0	0	5	1	0	1306
1306	0	11	20	0	0	5	0	5	0	4	1	0	1	4	0	0	1306
1306	0	12	7	0	1	2	0	0	0	0	2	0	0	2	0	0	1306
1306	0	13	23	0	2	9	3	0	2	2	0	1	2	2	0	0	1306
1306	0	14	9	0	0	1	5	0	0	2	0	0	0	0	1	0	1306
1306	3	15	2	0	0	0	0	0	0	0	2	0	0	0	0	3	1306
1306	0	20	11	0	0	0	1	3	0	1	2	0	1	3	0	0	1306
1306	0	21	172	6	23	9	10	15	9	15	25	9	19	22	10	0	1306
1306	0	22	64	0	7	16	3	4	2	24	8	0	0	0	0	0	1306
1306	0	23	137	0	10	19	8	9	6	28	16	6	17	18	0	0	1306
1306	0	24	91	2	4	13	6	4	8	22	22	1	1	6	2	0	1306
1306	3	25	20	2	2	0	2	2	0	4	4	0	0	4	0	3	1306
1306	0	30	99	0	0	17	0	19	8	45	8	0	0	2	0	0	1306
1306	0	31	174	2	13	23	26	36	5	50	16	1	0	2	0	0	1306
1306	0	32	371	8	64	52	51	40	18	32	24	13	24	30	15	0	1306
1306	0	33	183	6	39	18	24	11	18	24	23	7	8	3	2	0	1306
1306	0	34	261	10	33	11	15	40	19	13	47	19	14	38	2	0	1306
1306	3	35	11	1	1	0	1	1	0	1	3	1	0	2	0	3	1306
1306	0	40	123	4	16	13	7	10	10	52	9	1	0	1	0	0	1306
1306	0	41	93	3	8	8	15	17	6	11	9	1	4	11	0	0	1306
1306	0	42	76	2	5	2	1	9	11	10	18	7	7	4	0	0	1306
1306	0	43	1338	48	155	76	88	134	90	159	157	139	100	130	62	0	1306
1306	0	44	451	18	38	27	37	44	26	71	59	38	35	41	17	0	1306
1306	1	50	2	0	0	1	0	0	0	0	0	0	0	1	0	1	1306
1306	1	52	12	0	0	0	0	0	0	4	4	2	2	0	0	1	1306
	0		3748	110	421	335	301	401	239	576	451	244	233	324	113	0	1306
	1		14	0	0	1	0	0	0	4	4	2	2	1	0	1	1306
	2		0	0	0	0	0	0	0	0	0	0	0	0	0	2	1306
	3		34	3	3	0	3	3	0	5	10	1	0	6	0	3	1306
1306			3796	113	424	336	304	404	239	585	465	247	235	331	113		1306

Fig. D.7. Data Inventory Type I, showing a summary by one-degree squares (COTED system) and by month of the available data. The inventory can show all available data or all data satisfying a given set of data extraction conditions.

CCDC DATA INVENTORY PAGE 1

TEN-DEG SQUARE	FIVE-DEG SQUARE	ONE-DEG SQUARE	TOTAL STATIONS	TOTAL STATIONS BY MONTH (YEAR-RANGE) 1900 1949	1950 1954	1955 1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	FIVE-DEG SQUARE	TEN-DEG SQUARE
1306	0	00	14	0	1	0	0	0	13	0	0	0	0	0	0	0	1306
1306	0	01	8	0	6	0	0	0	2	0	0	0	0	0	0	0	1306
1306	0	02	5	0	5	0	0	0	0	0	0	0	0	0	0	0	1306
1306	0	03	2	0	0	0	1	0	1	0	0	0	0	0	0	0	1306
1306	0	04	2	0	0	0	0	0	0	2	0	0	0	0	0	0	1306
1306	0	10	12	1	3	4	1	1	0	1	0	0	1	0	0	0	1306
1306	0	11	20	2	3	3	0	2	10	0	0	0	0	0	0	0	1306
1306	0	12	7	1	5	0	0	1	0	0	0	0	0	0	0	0	1306
1306	0	13	23	1	13	6	1	1	1	0	0	0	0	0	0	0	1306
1306	0	14	9	2	6	0	1	0	0	0	0	0	0	0	0	0	1306
1306	0	20	11	1	2	5	0	1	0	0	0	0	1	1	0	0	1306
1306	0	21	168	4	38	30	4	9	30	14	15	6	5	6	7	0	1306
1306	0	22	63	0	3	8	5	3	1	0	5	15	14	1	8	0	1306
1306	0	23	135	7	58	16	5	0	2	1	16	20	6	1	3	0	1306
1306	0	24	90	6	22	0	10	0	4	4	3	9	11	12	9	0	1306
1306	3	25	18	0	0	0	0	0	1	0	0	0	1	8	8	3	1306
1306	0	30	99	10	3	7	13	12	2	0	0	18	26	8	0	0	1306
1306	0	31	174	20	2	14	17	23	20	3	0	14	40	18	3	0	1306
1306	0	32	353	3	52	74	30	34	52	21	26	17	19	18	7	0	1306
1306	0	33	173	43	1	5	11	0	4	0	23	34	32	10	10	0	1306
1306	0	34	261	61	73	20	11	3	0	8	9	10	2	46	18	0	1306
1306	3	35	10	0	0	0	0	2	0	0	0	0	0	4	4	3	1306
1306	0	40	123	27	3	0	16	3	7	0	18	10	22	8	0	0	1306
1306	0	41	93	24	18	9	6	8	13	0	1	5	6	3	0	0	1306
1306	0	42	73	63	3	2	1	0	0	0	2	2	0	0	0	0	1306
1306	0	43	1287	161	32	34	11	7	19	11	16	4	29	431	532	0	1306
1306	0	44	451	54	0	0	1	0	0	0	0	0	17	204	175	0	1306
1306	1	50	2	1	0	0	1	0	0	0	0	0	0	0	0	1	1306
1306	1	52	12	12	0	0	0	0	0	0	0	0	0	0	0	1	1306
	0		3656	491	352	246	145	109	181	65	134	164	231	767	772	0	1306
	1		14	13	0	0	1	0	0	0	0	0	0	0	0	1	1306
	2		0	0	0	0	0	0	0	0	0	0	0	0	0	2	1306
	3		28	0	0	0	0	2	1	0	0	0	1	12	12	3	1306
1306			3698	504	352	246	146	110	182	65	134	164	232	779	784		1306

Fig. D.8. Data Inventory Type II, showing a summary by one-degree squares (COTED system) and by year or year-ranges of the available data. The inventory can show all available data or all data satisfying a given set of data extraction conditions. The year (ranges) are specified with the TIME cards coded on the Data Extraction form.

C O D C   G E O G R A P H I C A L   D A T A   I N V E N T O R Y

TEN-DEGREE SQUARE 1305 — TOTAL 4202

	9	8	7	6	5	4	3	2	1	0
9-	78	194	18	4	16	4	14	24	41	44
8-	126	66	0	0	0	1	40	109	7	35
7-	347	30	57	16	26	18	42	306	36	44
6-	159	79	52	78	42	67	94	41	24	3
5-	111	55	38	51	37	100	45	12	14	58
4-	97	119	74	12	31	22	74	207	61	28
3-	84	19	36	16	16	13	17	33	81	60
2-	5	13	22	7	7	10	6	4	22	39
1-	0	4	5	6	1	2	3	14	3	4
0-	0	4	3	2	1	3	0	5	1	3

TEN-DEGREE SQUARE 1306 — TOTAL 16068

	9	8	7	6	5	4	3	2	1	0
9-	0	2	171	182	41	390	128	49	78	56
8-	248	213	71	10	93	668	524	129	164	116
7-	14	1	0	4	418	370	373	438	185	390
6-	0	0	0	0	10	539	201	184	389	140
5-	0	0	218	419	178	50	11	66	170	110
4-	0	12	331	2140	116	451	1338	76	93	123
3-	7	42	84	195	156	261	183	371	174	99
2-	14	16	114	200	289	91	137	64	172	11
1-	10	31	21	107	73	9	23	7	20	12
0-	6	7	58	75	5	4	2	5	8	14

Fig. D.9.1. Data Inventory Type III, showing a summary of available data in a semi geographical lay-out by one-degree squares (COTED system, Appendix F).

CODC GEOGRAPHICAL INVENTORY BY 10-DEGREE SQUARE

LATITUDE WEST

LONG	170 180	160 170	150 160	140 150	130 140	120 130	110 120	100 110	090 100	080 090	070 080	060 070	050 060	040 050	030 040	020 030	010 020	000 010
N80-90	1	0	0	0	0	0	1	1	9	81	126	15	0	0	0	0	0	0
N70-80	0	0	13	1	17	65	68	66	334	215	189	98	15	0	0	0	0	0
N60-70	0	0	0	0	18	150	193	35	52	422	395	331	244	11	43	57	2	3
N50-60	8	15	173	547	1658	1546	0	0	55	91	84	260	1186	124	29	13	0	0
N40-50	7	19	64	393	484	6544	0	0	0	0	55	15941	4188	582	20	1	0	0
N30-40	0	1	0	8	6	10	6	0	0	6	67	113	20	87	25	7	6	0
N20-30	0	0	1	0	0	0	1	0	0	7	21	13	0	0	0	0	0	0
N10-20	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0
N00-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S00-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S20-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S30-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S40-50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S50-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S60-70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S70-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S80-90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. D.9.2. Data Inventory Type III, showing a summary of available data in a semi geographical lay-out by ten-degree squares.

CODC GEOGRAPHIC DISTRIBUTION OF MEANS
FOR PARAMETER CODE 0

TEN-DEGREE SQUARE 1305 — TOTAL OBSVNS 94, OVERALL MEAN 14135, OVERALL S.D. 3549

	9	8	7	6	5	4	3	2	1	0
	3	1	1	0	0	0	0	0	0	0
9	16666	18600	12500	0	0	0	0	0	0	0
	1156	0	0	0	0	0	0	0	0	0
	4	4	0	0	0	0	0	0	0	0
8	14900	15800	0	0	0	0	0	0	0	0
	1882	1419	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0
7	14933	0	0	0	0	0	0	0	0	0
	4700	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
6	10933	0	0	0	0	0	0	0	0	0
	3940	0	0	0	0	0	0	0	0	0
	0	0	2	0	0	0	0	0	0	0
5	0	0	9850	0	0	0	0	0	0	0
	0	0	50	0	0	0	0	0	0	0
	0	6	11	0	0	0	0	1	0	0
4	0	8983	15363	0	0	0	0	15700	0	0
	0	474	2803	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	8	9	0
3	11252	0	0	0	0	0	0	15837	13977	0
	3401	0	0	0	0	0	0	363	1911	0
	0	4	0	0	0	0	0	0	5	7
2	0	18300	0	0	0	0	0	0	15330	15614
	0	0	0	0	0	0	0	0	1151	1621
	0	0	0	0	0	0	0	0	0	2
1	0	0	0	0	0	0	0	0	0	20000
	0	0	0	0	0	0	0	0	0	200
	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

TEN-DEGREE SQUARE 1306 — TOTAL OBSVNS 2780, OVERALL MEAN 13455, OVERALL S.D. 3879

	9	8	7	6	5	4	3	2	1	0
	0	0	0	1	2	13	6	2	4	2
9	0	0	0	7300	12600	12330	12300	12500	13825	13300
	0	0	0	0	600	1734	2026	2200	1271	1900
	15	5	0	16	8	77	61	22	6	4
8	7110	6866	0	11772	13251	12937	10377	9958	12383	14350
	2120	1742	0	1986	4660	3258	3962	4115	4152	2892
	3	0	0	8	206	210	95	102	57	37
7	11030	0	0	14196	15490	14619	12846	13391	13337	12710
	2729	0	0	586	3263	3335	4077	4987	4051	3515
	0	0	0	0	16	100	44	75	74	16
6	0	0	0	0	15795	13826	13625	14261	14851	12673
	0	0	0	0	2901	3516	3812	3862	4375	4692
	0	0	81	100	15	12	0	65	75	0
5	0	0	11262	12297	11236	12792	0	13500	13374	0
	0	0	2297	3384	2291	912	0	3743	3388	0
	0	1	93	111	10	155	204	84	1	0
4	0	9800	11064	11481	12530	13243	13210	11677	15200	0
	0	0	2165	2088	2259	3842	4580	4010	0	0
	0	2	7	55	84	21	20	0	15	0
3	0	16700	15423	10096	13575	15209	16639	0	14953	0
	0	1100	1348	1649	3588	1850	3409	0	2247	0
	0	0	14	34	77	15	5	7	3	0
2	0	0	15242	13597	15167	16506	17820	14971	15366	0
	0	0	1722	1930	1709	1460	2161	453	452	0
	0	10	2	30	21	0	0	0	0	0
1	0	15670	14800	15450	16619	0	0	0	0	0
	0	1096	800	1469	2361	0	0	0	0	0
	1	5	13	44	0	0	0	0	0	0
0	14500	19520	20169	19313	0	0	0	0	0	0
	0	2172	1381	2456	0	0	0	0	0	0

Fig. D. 10 Distribution of Means and Standard Deviations, showing per one-degree square (COTED system) a count, mean and standard deviation of all data retrieved as specified on the Data Extraction form.

APPENDIX E

DATA OUTPUT CARD AND TAPE FORMATS

1. OCEANS IV
2. OCEANS III

APPENDIX E

Appendix E.1 Format of OCEANS IV Cards or Tape

Five types of records occur in the OCEANS IV output:

Cruise Master (format type 1). This record will appear only in outputs from the transaction file. Cruise Master information is not included in the master files, and therefore cannot be retrieved from them.

Station Master (format type 2).

Observed Detail (format type 3).

Observed Detail Continuation (also format type 3).

Derived Parameters (format type 4). A sample output card for record types 2,3 and 4 is shown in Fig. E1.

The format types 1,2 and 3 are identical to the input formats of OCEANS IV described in Appendices B1 and B3. Values in a number of fields, however, may differ, since all data are converted to the OCEANS IV file units. The parameters concerned, and their file units, are shown in Table E1. All other parameters are given in the units specified on the data submission forms.

Minor differences also occur in the following fields of the Observed Detail record:

a) Temperature, soundspeed and salinity fields are filled with 99999 if not observed.

b) If more than five chemical parameters have been observed at a level, continuation records are used. These can be recognized by blanks in the temperature, salinity and soundspeed fields. Otherwise the format is identical to that of the Observed Detail record.

c) If card type 3 is used for interpolated data, the letters "INTR" appear in columns 34-37.

In the Station Master one difference occurs: for non-observed soundings (columns 43-47), blanks are replaced by zero's.

The Derived Parameters record (type 4) contains the same information as the printed data records described in Appendix D3. The columns used for each record are shown in

Fig. E1. Note that the sign for potential temperature is given as an overpunch over its last digit, whereas the sign for temperature in record type 3 is given in the first column of its field. The latter is, strictly speaking, not an overpunch, since temperature never goes below -9.00°C.

The data can be in cruise, time or geographical sequence. In the latter case the COTED squares system is used to sequence the data (see Appendix F).

Data on magnetic tape are in card image, record length 80, blocking factor 1, BCD, not labelled, seven track, 556 b.p.i. unless otherwise indicated. Any alternative option standard to IBM system 360 is available on request.

Overpunches are not used on card types 1,2, and 3. Card type 4 may contain an overpunch in column 27 to indicate a negative value for potential temperature.

Table E1

FILE UNITS FOR PARAMETERS THAT HAVE A CHOICE OF UNITS THAT CAN BE USED FOR SUBMISSION OF THE DATA

Parameter	Unit	Display	Remarks
sounding depth	m	XXXX.X	
depth of sample	m	XXXX.X	
oxygen	ml/l	XX.XX	
wind speed	m/sec	XX	Wind force estimates are converted to m/sec as shown in table E2.
air pressure	mbar	XX.X	The first one or two digits are dropped, e.g. 1026.4 mbar is shown as 264 and 987.3 mbar as 873. If the high order digit shown is <5, pressure is assumed to be over 1000 mbar, if it is $\geqslant 5$, pressure is assumed to be between 950 and 1000 mbar. Pressures are not corrected for barometer height or outside air temperature unless this has been done by the data originator.
air and wet bulb temperature	°C	XX.X	Negative temperatures are coded by adding 50°C to the absolute value of the measurement.
swell period	sec	XX	P_w codes have been converted as shown in Table E3.

Table E2

CONVERSION OF BEAUFORT ESTIMATE TO WINDSPEED IN M/SEC

Beaufort	Windspeed in m/sec
0	00
1	01
2	02
3	04
4	07
5	09
6	12
7	15
8	19
9	22
10	26
11	30
12	34

Table E3

CONVERSION OF P_w CODE (WMO3155) TO PERIOD IN SECONDS (P_wP_w)

P_w	P_wP_w
5	5
6	6
7	7
8	8
9	9
0	10
1	11
2	12
3	13
4	14
/	blank

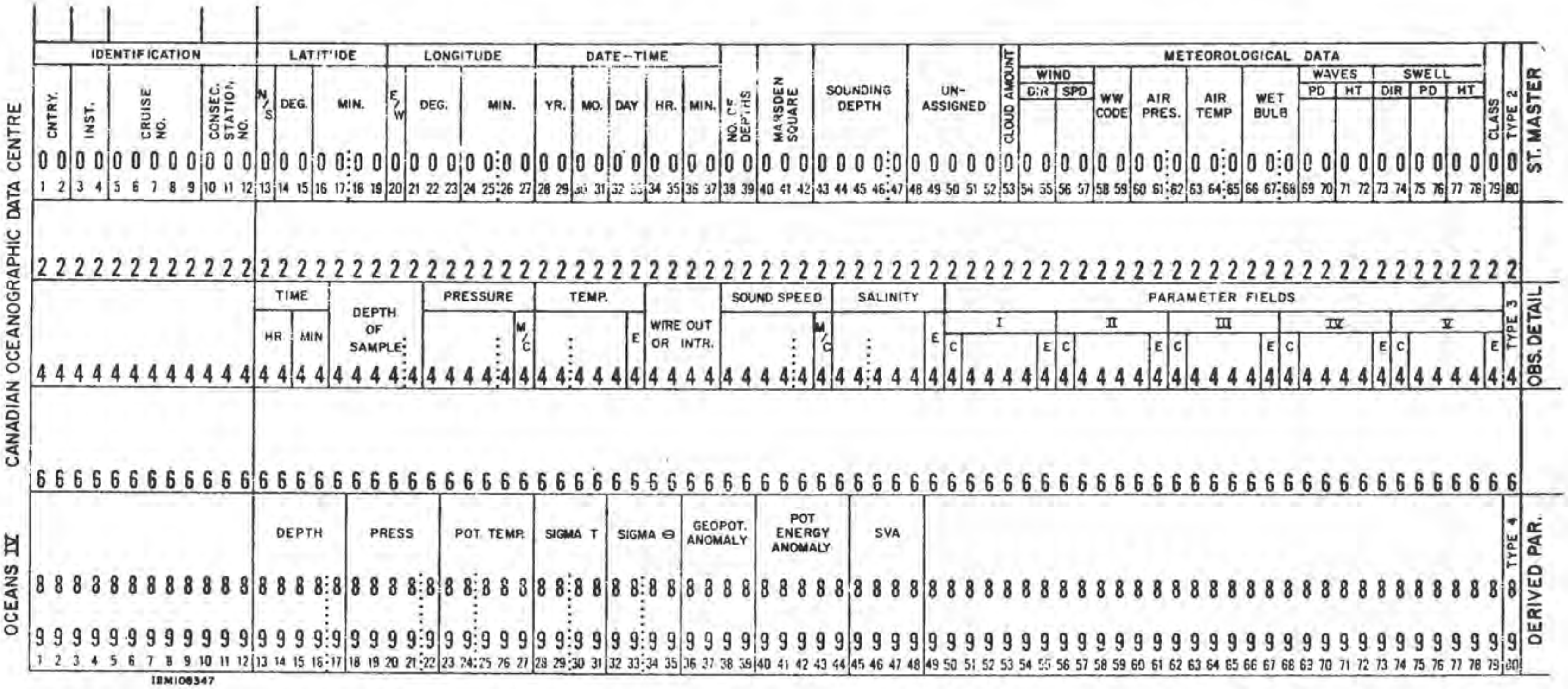


Fig. E.1. Sample OCEANS IV input or output card.

Appendix E.2 Format of OCEANS III Cards or Tape

Only a brief summary of the OCEANS III record formats will be given here, since it is not an essential output of the OCEANS IV system. Further details can be obtained by writing to the Canadian Oceanographic Data Centre.

The old OCEANS III system has four basic record types:

Cruise Master (type 0)

Station Master (type 1)

Observed Detail (type 3)

Standard (type 6).

A sample lay-out of the latter three records is shown in Fig. E2. The Cruise Master record will, unless specifically requested, not be included in the data punched on cards or written on magnetic tape.

No continuation records are used in OCEANS III. Interpolated data are written in a separate "standard" format (type 6). A summary of units used and overpunches is given in Tables E4, E5 and E6.

Data on magnetic tape are in card image, record length 80, blocking factor 1, BCD, not labelled, seven track and 556 b.p.i. unless otherwise indicated. Any alternative option standard to IBM system 360 is available on request.

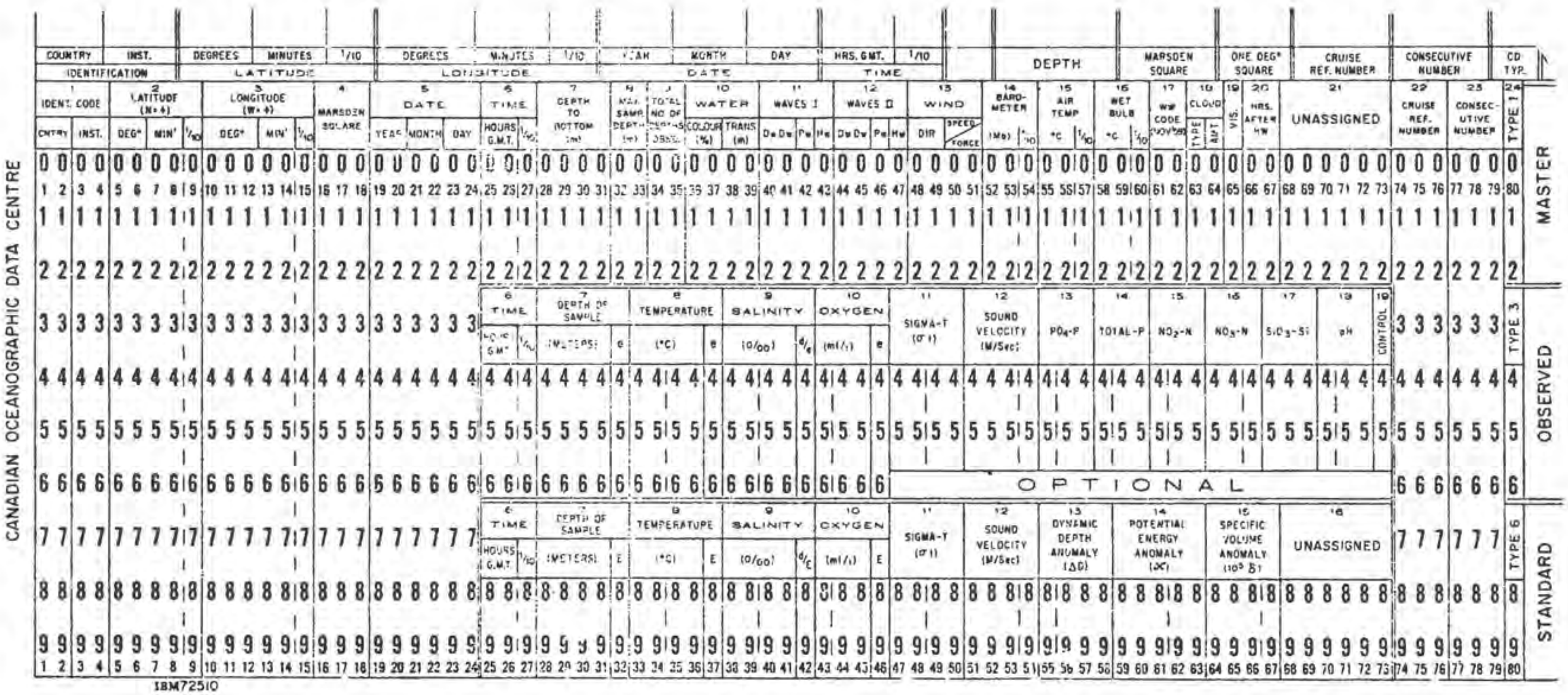


Fig. E.2. Sample OCEANS III input or output card.

Table E4

OCEANS III STATION MASTER RECORD (TYPE 1)

Field No.	Column	Contents	Remarks
1	1-4	Country and Institute	See Tables 4 and 5 of Appendix D3.
2	5-9	Latitude	
	5-6	degrees	An overpunch (11 zone) in column 5 indicates south latitudes.
	7-8	minutes	
	9	1/10 minute	
3	10-15	Longitude	
	10-12	degrees	An overpunch (11-zone) in column 10 indicates east longitudes.
	13-14	minutes	
	15	1/10 minute	
4	16-18	Marsden Square	
5	19-27	Date-time	Last two digits of the year, followed by month, day, hour and 1/10 hour in GMT.
6	28-31	Sounding depth	In metres.
7	32-33	Max. sample depth	Blank
8	34-35	No. of depths	
9	36-39	Water	Blank
10	40-43	Waves I	
	40-41	direction	Same as wind direction except that the value is increased by 50 for wave heights in excess of 4.5m (code 9). Indeterminate or non-observed is coded 49 (or 99 for waves in excess of 4.5m).
	42	period	One digit P_W code, see Table E1.

Table E4 (cont'd)

Field No.	Column	Contents	Remarks
	43	height	Wave height is coded in multiples of 0.5m, e.g. a wave height of 3m is coded 6. If the wave height code exceeds 9, 50 is added to wave direction and the high order digit of the wave height code is dropped.
11	44-47	Waves II	
	44-45	direction	Coded as columns 40-41, but giving true swell direction.
	46	period	Same as column 42.
	47	height	Same as column 43.
12	48-49	Wind Direction	Direction from which the wind is coming in tens of degrees. A calm is coded as 00.
13	50-51	Wind Speed	Units of m/sec.
14	52-54	Barometer	In mbars; if air pressure < 1000 mbar, an overpunch (11-zone) is inserted in column 52.
15	55-57	Air Temp.	In °C; negative temperatures are indicated by an overpunch (11-zone) in column 55.
16	58-50	Wet Bulb	In °C; negative values are indicated by an overpunch (11-zone) in column 58.
17	61-62	WW Code	See Table 2 in Appendix D3.
18	63-64	Cloud	
	63	cloud type	Blank.
	64	cloud amount	See Table 3, Appendix D3.
19	65	Visibility	Blank.
20	66-67	Hours after HW	Blank.
21	68-73	Unassigned	May contain miscellaneous alphanumeric information inserted by the data originator.
22	74-76	Cruise Ref. No.	
23	77-79	Consec Station No.	

Table E5

OCEANS III OBSERVED DETAIL RECORD (TYPE 3)

Field No.	Columns	Contents	Remarks
1	1-24	Station Data	Same as on Station Master record columns 1-24.
2	25-27	Time	In hours and tenths of hours.
3	28-31	Depth	In metres
	32	Error of Depth	Blank.
4	33-37	Temperature	
	33-36	value	In 0.01°C, negative temperatures are indicated by an 11-zone in column 33.
	37	error code	See Table 6, Appendix D3. If numerical, it is a third decimal of temperature. Measurements with an STD are indicated by a P.
5	38-42	Salinity	
	38-41	value	In ppm.
	42	error code	See Table 6, Appendix D3. May also contain a P for measurements obtained with an STD or similar instrument.
6	43-46	Oxygen	
	43-45	value	In 0.01 ml/l; the high order digit for oxygen values between 10.00 and 19.99 ml/l is dropped and oxygen values $\geqslant$ 10 ml/l are implied by an 11-zone in column 43.
	46	error code	See Table 6, Appendix D3.
7	47-50	Sigma-T	In 10^{-5} gr/gr.
8	51-54	Sound Velocity	In 0.1 m/sec; the high order "1" is dropped.
9	55-57	PO4-P	In hundredths of µg-at/l
10	58-60	Total-P	In hundredths of µg-at/l

Table E5 (cont'd)

Field No.	Columns	Contents	Remarks
11	61-63	NO2-N	In hundredths of μg-at/l
12	64-66	NO3-N	In tenths of μg-at/l
13	67-69	SIO3-Sl	In tenths of μg-at/l
14	70-72	pH	In hundredths
15	73		Blank
16	74-79	Station Data	Same as on Station Master Record.
17	80	Code	Code 3.

Table E6

OCEANS III INTERPOLATED RECORD (TYPE 6)

This record is constructed in the same way as the Observed Detail record previously described, up to and including field number 8 (Sound Velocity). The remainder of the card is set up as follows, using OCEANS IV interpolated data:

Field No.	Columns	Contents	Remarks
1-8	1-54		Same as on Observed Detail Card.
9	55-58	Dynamic Height Anomaly	In dynamic metres with three decimals.
10	59-63	Potential Energy Anomaly	In units of 10^6 ergs/cm^2
11	64-67	Specific Volume	In units of 10^{-6} ml/gr.
12	68-73	-	Blanks
	74-79		Same as on Station Master Record.
	80		Code 6.

APPENDIX F

THE COTED SQUARES SYSTEM FOR SEQUENCING DATA IN GEOGRAPHICAL ORDER ON MAGNETIC TAPE.

APPENDIX F

The COTED Squares System for Sequencing Data in Geographical Order on Magnetic Tape*

In a recent review of the oceanographic station data file of the Canadian Oceanographic Data Centre, we considered several methods of sequencing the data, in some geographical order, on magnetic tape. The traditional Marsden square system, being too cumbersome due to its irregularity, was rejected. A new system was designed, numbering the ten-degree squares consecutively in a two-dimensional grid. This system, called the Consecutive Ten-Degree, or COTED, squares system, greatly simplifies the logic of the data retrieval programs used to extract data on a geographical basis from our files, thereby reducing both complexity and running times for these programs.

Both the Marsden and COTED square systems divide the globe into 648 ten-degree squares and subdivides each of these into 100 one-degree squares, and a five or six digit key uniquely defines each one-degree square. In the Marsden system the ten-degree squares are numbered increasing from 1 to 288 and from 901 to 936 north, and from 300 to 587 south of the equator (Fig. F.1); the one-degree squares from 0 to 99 increasing away from an origin at the equator and the Greenwich meridian (Fig. F.2). In the COTED system, four instead of three digits are used to number the ten-degree squares. The first two increase from 00 to 17 northwards from the south pole, the second two increase from 00 to 35 westward from the Greenwich meridian (Fig. F.1, bold numbers). The one-degree squares are numbered from 00 to 99 with the lowest number always in the southeast corner (Fig. F.3). The major advantage of this is that the relative geographical position of two one-degree squares is immediately obvious from their COTED numbers.

It may be noted here that the apparently simpler solution of numbering the ten-degree squares from -9 to +8 in a north-south direction, and from -18 to +17 in an east-west direction, leads to problems in sorting the data sequentially on the computer. The COTED square key numbers cause the data to be sorted in a continuous "strip" spiralling from pole to pole. A combination of positive and negative key numbers, on the other hand, may lead to a different sequence of the sorted data, unless the available software has special features.

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*This appendix will also be published, under a different title, as a letter to the editor in "Limnology and Oceanography".

The COTED square key NN WW D_N D_W for any station of known latitude (Lat.) and longitude (Long.) can easily be calculated, as outlined in Table F.1. For the Marsden square key $MMMB_1B_2$ a similar table can be constructed. The number of program steps is approximately 10 in both cases.

Table F.1

Decision table to calculate the COTED square number of a station. All variables are integers; NN and WW are obtained by truncation.

is latitude north	Y	Y	N	N
is longitude west	Y	N	Y	N
X = Lat. + 90	X	X		
X = 90 - Lat.			X	X
Y = Long.	X		X	
Y = 360 - Long.		X		X
NN = X/10	X	X	X	X
D_N = X - NN x 10	X	X	X	X
WW = Y/10	X	X	X	X
D_W = Y - WW x 10	X	X	X	X
COTED square = $NNWWD_ND_W$	X	X	X	X

A major advantage of the COTED system is the simplicity of the numerical relation between the keys of one and ten-degree squares situated along an E-W or N-S line. As a result, the presence of a station within an arbitrary rectangular area can be established by only two range tests. This can best be explained by an example: Given a "rectangular" area between the latitudes 2°S and 11°N and longitudes 28°W and 35°W, and a station in the one-degree square $N^1N^1W^1W^1D_N{}^1D_W{}^1$, determine whether it falls within the defined area. This can be solved in two steps:

(1) Calculate the COTED square numbers of the four one-degree squares in the corners: 080288, 080384, 100208, 100304.

(2) Test whether $N^1N^1D_N{}^1$ and $W^1W^1D_W{}^1$ fall within the two ranges
$088 \leq N^1N^1D_N{}^1 < 100$ and
$028 \leq W^1W^1D_W{}^1 < 034$.

To answer the same question for a unit area $M^1M^1M^1B_1{}^1B_2{}^1$ in the Marsden square system, a much more elaborate system of tests is required.

A second advantage is that only one discontinuity line occurs, the Greenwich Meridian, instead of five at 0°W, 180°W,80°S, 0°N and 80°N. This also simplifies the writing of retrieval routines and saves computing time. Furthermore, the COTED system extends down to the south pole, and thus can also be used to store data obtained over the Antarctic land mass.

In our new Oceanographic Station Data File, OCEANS IV, the data are therefore sequenced in ascending order of the COTED key. This leaves the grouping of the data in basic units of one-degree squares unmodified, but the sequence of the one-degree squares is different from that determined by the Marsden square keys (except in the northwestern quadrant of the globe, south of 80°N).

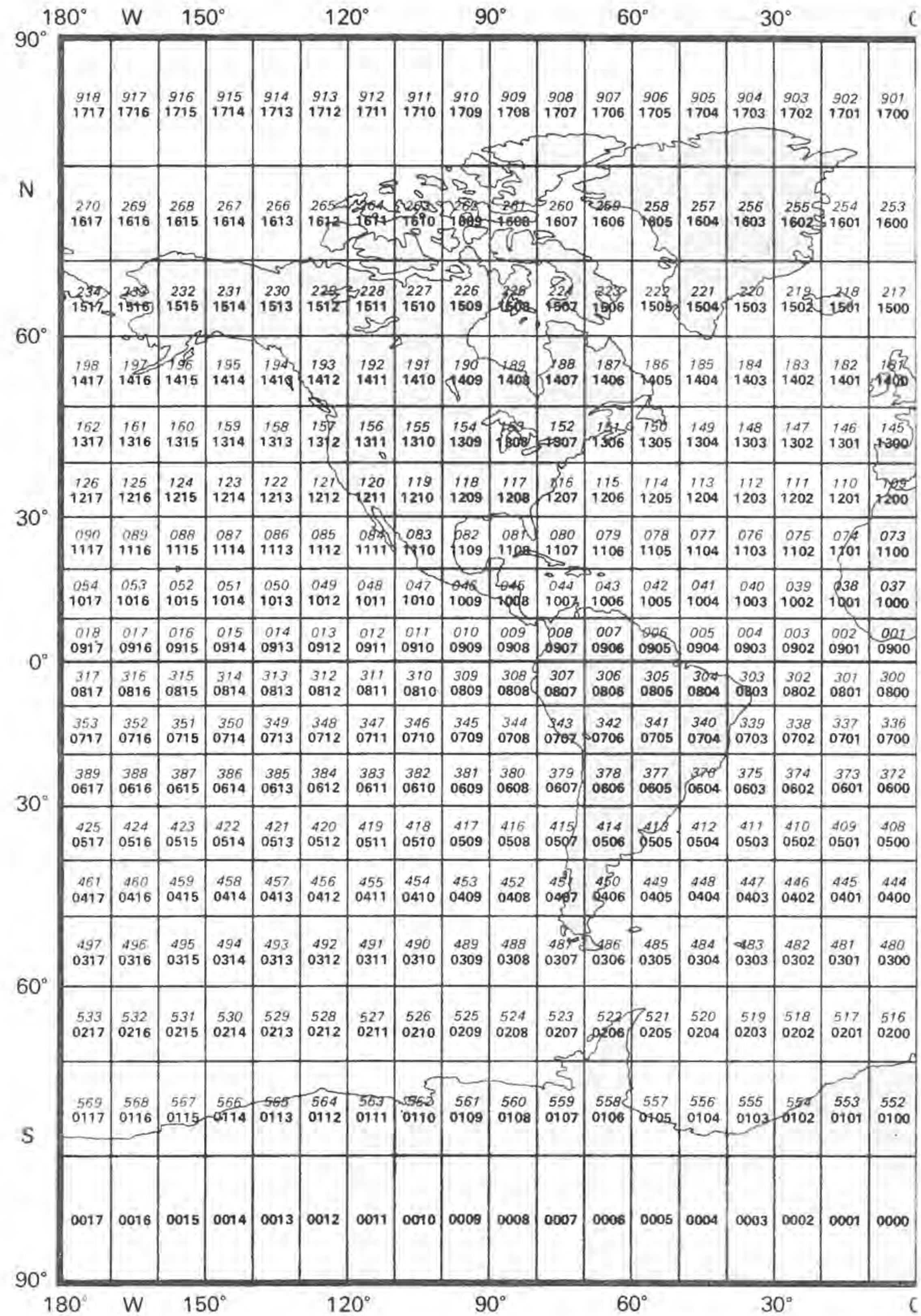

Fig. F.1 Key to the Marsden and COTED ten-degree square numbers. The COTED square numbers are in bold print.

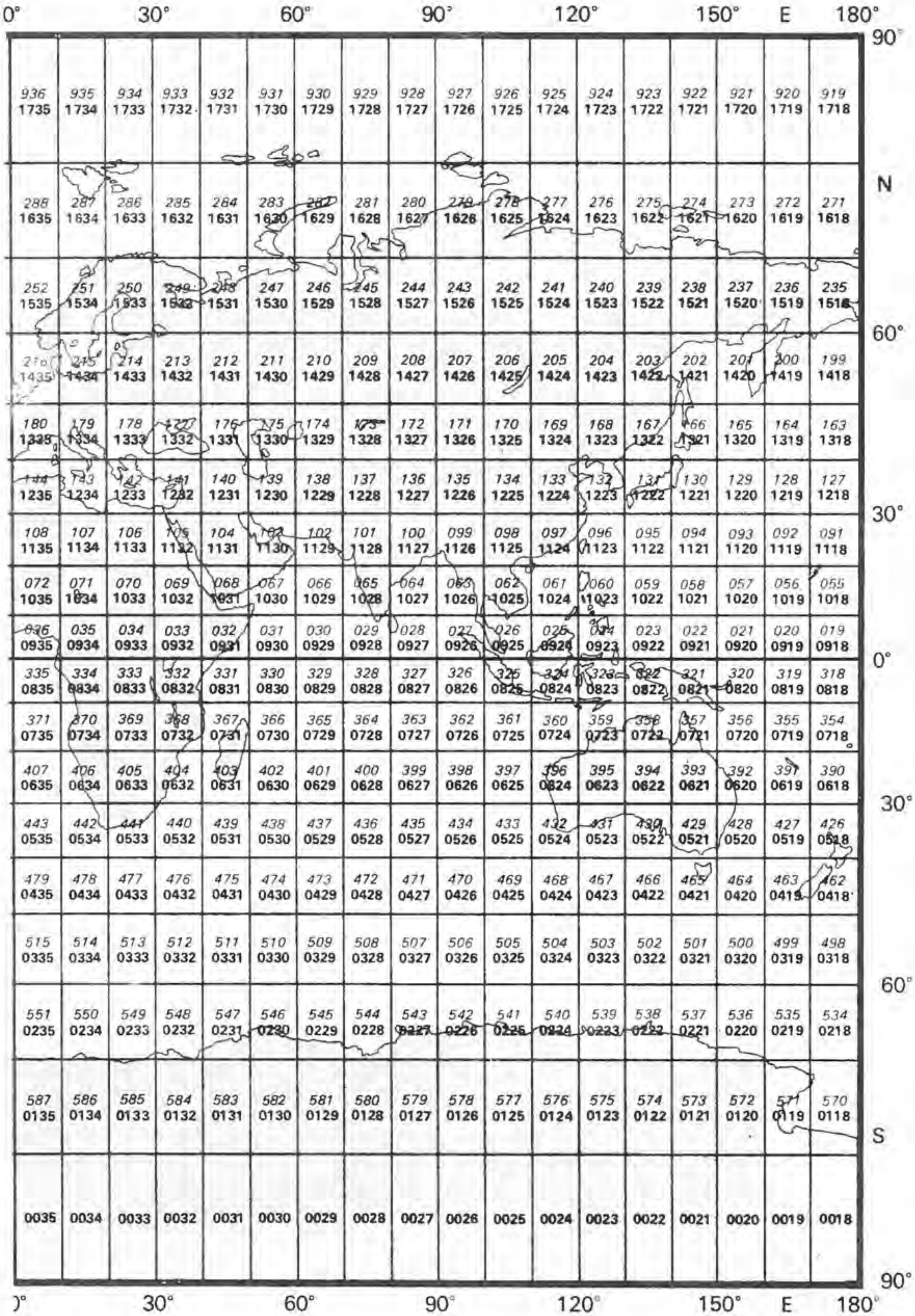

Fig. F.1 (cont'd) Key to the Marsden and COTED ten-degree square numbers.

10° WEST LONGITUDE 0° EAST LONGITUDE 10°

NORTH LATITUDE (10° to 0°)

99	98	97	96	95	94	93	92	91	90	90	91	92	93	94	95	96	97	98	99
89	88	87	86	85	84	83	82	81	80	80	81	82	83	84	85	86	87	88	89
79	78	77	76	75	74	73	72	71	70	70	71	72	73	74	75	76	77	78	79
69	68	67	66	65	64	63	62	61	60	60	61	62	63	64	65	66	67	68	69
59	58	57	56	55	54	53	52	51	50	50	51	52	53	54	55	56	57	58	59
49	48	47	46	45	44	43	42	41	40	40	41	42	43	44	45	46	47	48	49
39	38	37	36	35	34	33	32	31	30	30	31	32	33	34	35	36	37	38	39
29	28	27	26	25	24	23	22	21	20	20	21	22	23	24	25	26	27	28	29
19	18	17	16	15	14	13	12	11	10	10	11	12	13	14	15	16	17	18	19
09	08	07	06	05	04	03	02	01	00	00	01	02	03	04	05	06	07	08	09

001 (West longitude, North latitude) — **036** (East longitude, North latitude)

0°

SOUTH LATITUDE (0° to 10°)

09	08	07	06	05	04	03	02	01	00	00	01	02	03	04	05	06	07	08	09
19	18	17	16	15	14	13	12	11	10	10	11	12	13	14	15	16	17	18	19
29	28	27	26	25	24	23	22	21	20	20	21	22	23	24	25	26	27	28	29
39	38	37	36	35	34	33	32	31	30	30	31	32	33	34	35	36	37	38	39
49	48	47	46	45	44	43	42	41	40	40	41	42	43	44	45	46	47	48	49
59	58	57	56	55	54	53	52	51	50	50	51	52	53	54	55	56	57	58	59
69	68	67	66	65	64	63	62	61	60	60	61	62	63	64	65	66	67	68	69
79	78	77	76	75	74	73	72	71	70	70	71	72	73	74	75	76	77	78	79
89	88	87	86	85	84	83	82	81	80	80	81	82	83	84	85	86	87	88	89
99	98	97	96	95	94	93	92	91	90	90	91	92	93	94	95	96	97	98	99

300 (West longitude, South latitude) — **335** (East longitude, South latitude)

10° WEST LONGITUDE 0° EAST LONGITUDE 10°

Fig. F.2 Key to the numbering of one-degree squares in the Marsden system.

99	98	97	96	95	94	93	92	91	90
89	88	87	86	85	84	83	82	81	80
79	78	77	76	75	74	73	72	71	70
69	68	67	66	65	64	63	62	61	60
59	58	57	56	55	54	53	52	51	50
49	48	47	46	45	44	43	42	41	40
39	38	37	36	35	34	33	32	31	30
29	28	27	26	25	24	23	22	21	20
19	18	17	16	15	14	13	12	11	10
09	08	07	06	05	04	03	02	01	00

N ↑

W ←

Fig. F.3 Key to the numbering of one-degree squares in the COTED system.

ERRATA

to

Manuscript Report Series No. 15

(January, 1971)

OCEANS IV: A Processing, Archiving and Retrieval System for Oceanographic Station Data, by H.E. Sweers, Marine Sciences Branch, Department of Energy, Mines and Resources, Ottawa.

1	P. 14 - second line from bottom	Replace five degree square number 1 by 0.
2	P. 15 - third line	Replace five degree square number 4 by 1.
3	P. 17 - 3.2.5 2) last sentence should read	All stations with at least one observed level deeper than the minimum level but shallower than the maximum level are extracted.
4	P. 30 - footnote to the words "oceanographic pressure"* last line second paragraph from the bottom.	*Pressure for oceanographic calculations is normally expressed as oceanographic pressure, which equals true pressure minus atmospheric pressure.
5	P. 31 - insert in line 5 between words "water" and "now"	at 4°C and under atmospheric pressure.
6	P. 31 - replace lines 6 through 9 by	The influence of this on sigma-t is negligibly small, since the latter is defined as the difference between two specific gravity or two specific density values, respectively.
7	P. 32 - third line, add one word. It should read	...specific gravity and specific density is discussed...
8	P. 32 - add between second equation and section 4.3.3.2	and is usually given in units of 10^5 cm^3/gr. The difference in the definitions of specific density on δ thus is a negligibly small, second order effect.
9	P. 44 - Reference "Keyte, F.K. 1964" the second line should read	...Deep Sea Res...
10	P. 63 - right hand side of the page in column "Explanation" after second paragraph which starts "MPR data...."	XBT data can be marked with a Q in column 33. Inclusion of XBT data in the file is not recommended but can be done if desired.

11	P. 77, 78, 79 - Replace by new pages 77, 78, 79.	
12	P. 131 - footnote should read	This appendix will also be published in "Limnology and Oceanography" under the title "An Improved Code to Classify the Location of Marine and Terrestrial Data".
13	P. 132 - in table F1 change lines 4 and 6 as shown	X = 90-(Lat. + 1) Y = 360-(Long. + 1)

DATA EXTRACTION FORM for OCEANS IV

GENERAL INSTRUCTIONS

(1) Use of all cards, except the Request card, is optional. Any number of cards within a subgroup, such as AREA, can be used up to the maximum number of cards shown.
(2) Any entry on a card can be left blank if a search for a particular option is not required.
(3) The output will only contain data meeting all search requirements specified. If an option is left blank, it will not be tested for.
(4) The Data Extraction Cards must be followed by the Data Output Cards specified on the Data Output Form, if data are to be retrieved. This is not necessary for Search Modes 2-6.

REQUEST BY (obligatory):

CODE	NAME	ADDRESS
00 R Q S T		
1 2 3 4 5	6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62

OUTPUT OPTIONS AND SEQUENCE

SEARCH MODE
1: Retrieve
2: Station count
3: Station, Master Catalogue
4: Data Inventory I
5: Data Inventory II } See Report
6: Data Inventory III

INVENTORY OPTION
blank: if Search Modes 1, 2 or 3 are used
1: optional with Search Modes 4, 5, 6, see Report

DATA SEQUENCE
This is determined by a sort key consisting of the elements L, I and T in the sequence entered below, where:
L = Location = Ten-degree square + One-degree square
I = Identification = Country + Institute + Cruise + Station
T = Time = Year + Month + Day + Hour + Minute
If left blank, data will be sorted in standard file sequence L-I-T

ONT'D

63	64	65	66	67

AREA (optional)
The program searches for data west of the "From" but east of the "To" longitude.
The "From" latitude must be south of the "To" latitude.

CODE	LAT. FROM N/S	DEG.	MIN.	LAT. TO N/S	DEG.	MIN.	LONG. FROM E/W	DEG.	MIN.	LONG. TO E/W	DEG.	MIN.
10 A R E A												
11 A R E A												
12 A R E A												
13 A R E A												
14 A R E A												
15 A R E A												
16 A R E A												
17 A R E A												
18 A R E A												
19 A R E A												
1 2 3 4 5	6	7 8	9 10	11	12 13	14 15	16	17 18 19	20 21	22	23 24 25	26 27

TIME INTERVAL OR SEASON (optional)

CODE	YEAR RANGE LOW	YEAR RANGE HIGH	BLANK	DATE RANGE LOW MO.	LOW DAY	HIGH MO.	HIGH DAY
20 T I M E							
21 T I M E							
22 T I M E							
23 T I M E							
24 T I M E							
25 T I M E							
26 T I M E							
27 T I M E							
28 T I M E							
29 T I M E							
30 T I M E							
31 T I M E							
1 2 3 4 5	6 7 8 9	10 11 12 13	14	15 16	17 18	19 20	21 22

If all data for a season are required, regardless of the year of observation, leave "Year Range" fields blank.

If only data for one year or one day are required, the "High" fields can be left blank.

For inventory types I and II the successive month and year ranges respectively can be entered, each line determining one column in the print out.

See reverse side

Fig. C.1.1 Data Extraction form. See Section 3.

CRUISES TO BE RETRIEVED (optional)

If only one cruise or station is required, the "High" fields can be left blank

	CODE					COUNTRY	INST.	BLANK	CRUISE RANGE LOW	CRUISE RANGE HIGH	BLANK	STATION RANGE LOW	STATION RANGE HIGH
10	I	D	E	N									
11	I	D	E	N									
12	I	D	E	N									
13	I	D	E	N									
14	I	D	E	N									
15	I	D	E	N									
16	I	D	E	N									
17	I	D	E	N									
18	I	D	E	N									
19	I	D	E	N									
	1	2	3	4	5	6 7	8 9	10	11 12 13 14 15	16 17 18 19 20	21	22 23 24	25 26 27

PARAMETER CODES

Code	Parameter
0	Temperature
1	Pressure
2	Salinity
3	Sound Speed
4	Oxygen
5	PO_4 - P
6	Total P
7	NO_2 - N
8	NO_3 - N
9	SiO - Si
A	pH
B	Fluoride
C	Diss. Org. C
D	Part. C
E	Total Alk.
F	Carb. Alk.
G	NH_3

PARAMETERS TO BE RETRIEVED (optional)

If one or more parameters are specified, stations will be returned only if all parameters listed have been observed. A station is accepted if each parameter has been observed at least at one level.

Code range values as on Data Summary forms; leave columns 8 and 13 blank for parameters coded in 4 digits. If ranges are requested all levels with parameters out of range or without parameter will be flagged "no".

	CODE					PARAMETER CODE	BLANK	RANGE MIN.	RANGE MAX.
40	P	A	R	M					
41	P	A	R	M					
42	P	A	R	M					
43	P	A	R	M					
44	P	A	R	M					
45	P	A	R	M					
46	P	A	R	M					
47	P	A	R	M					
48	P	A	R	M					
49	P	A	R	M					
50	P	A	R	M					
51	P	A	R	M					
52	P	A	R	M					
53	P	A	R	M					
	1	2	3	4	5	6	7	8 9 10 11 12	13 14 15 16 17

SAMPLING LEVELS REQUIRED (optional)

Any one or more of the following options can be searched for (meters)

	CODE					BOTTOM DEPTH: Retrieve only if depth Below:	BOTTOM DEPTH: Not more than:	BLANK	SAMPLING DEPTH: Retrieve if observations available at levels Below:	SAMPLING DEPTH: Above:	BLANK	MAX. DISTANCE FROM BOTTOM
70	D	P	T	H								
	1	2	3	4	5	6 7 8 9	10 11 12 13	14	15 16 17 18	19 20 21 22	23	24 25 26 27

METEOROLOGICAL DATA REQUIREMENTS (optional)

Enter 1 in each box below the parameters desired leave blank for all others

	CODE					CLOUD AMOUNT	WIND	W W CODE	AIR PRES.	AIR TEMP.	WET BULB	WAVES	SWELL
80	M	E	T	Y									
	1	2	3	4	5	6	7 8	9	10	11	12	13 14	15 16 17

DATA INVENTORY REPORT HEADINGS (optional)

Used only if Data Inventories are required; See Search Modes 4, 5, 6 on RQST card

	CODE					HEADING TO BE PRINTED IN POSITIONS 41 TO 100 OF THE DATA INVENTORY (41 45 50 55 60 65 70 75 80 85 90 95 100)
91	H	E	A	D		
92	H	E	A	D		
	1	2	3	4	5	6 – 65

DATA DISTRIBUTION ALONG THE VERTICAL (optional)

One data point has to be present in each interval specified on this card.

This requirement can be relieved by entering under "a" the number of "empty" intervals allowed.

Levels outside the range of intervals specified are marked with a "no" flag and can optionally be rejected in the output (see "Level Reject" entry).

A blank or zero entry under "a" both mean no empty intervals allowed.

Lead zeros must be entered; any number of fields can be left blank; enter from left to right.

	CODE					a	BLANK	DELINEATION LEVELS IN METRES BETWEEN DEPTH INTERVALS
100	L	E	V	L				
101	L	E	V	L				
102	L	E	V	L				
	1	2	3	4	5	6	7	8 – 63

Fig. C.1.2 Data Extraction form (continued).

DATA OUTPUT FORM for OCEANS IV

To be used: 1. To control data output or Data Report formats generated from the Transaction File
2. To control output of data retrieved from the Master File. In this case Data Extraction Cards must precede the Data Output Cards

REQUESTER IDENTIFICATION (obligatory)

CODE	REQUESTER NAME	REQUESTER ADDRESS
200 R P R T		
1 2 3 4 5	6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62

OUTPUT OPTIONS

OUTPUT MEDIUM (Enter 1 below output required)			DERIVED PARAMETER OPTION	GEOGRAPHICAL DISTRIBUTION OF MEANS		FILE TO BE USED	LEVEL REJECT	Page number of first page; can be left blank
CARD	TAPE	PRINT	Blank: No derived par. 1 : Derived par. required	Use only with Master File and ROST option 1 (see Data Retrieval Form) For means of standard levels or derived parameters use INGE card (290) If INGE is not used, means are given for all data extracted but not flagged. Blank: Not required 1 : One-degree sq. 2 : Ten-degree sq.	Fill in code of parameter concerned	1: Transaction 2: Master	Blank: reject levels marked "no" by the extract program S : Suppress the "no" flag and accept all levels of each station extracted	
63	64	65	66	67	68	69	70	71 72 73

ONT'D

INTERPOLATION CONTROL (optional)
This card need be present only if interpolation is required

CODE	CODES OF PARAMETERS TO BE INTERPOLATED	Blank	INTERPOLATION METHOD	BASIS FOR INTERPOLATION
	Temp., sal. and sound speed are always interpolated if this card is used		1: Rattray 2: Reiniger & Ross	D: Depth Levels P: Pressure levels
210 C A L C				
1 2 3 4 5	6 7 8 9 10 11 12 13 14 15	16	17	18

SPECIFICATION OF STANDARD LEVELS (optional)
If this card is not used, interpolations will be carried out to Standard Levels (Table 1)

CODE	LEVELS TO BE USED FOR INTERPOLATION (Fill out from left to right)
220 I N T R	
221 I N T R	
222 I N T R	
1 2 3 4 5	6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61

CRUISE IDENTIFICATION (optional)
Use only if a Data Report is printed from the Transaction File

CODE	COUNTRY	INST.	CRUISE NUMBER	PAGE NUMBER OF FIRST PAGE
230 C R U S				
231 C R U S				
232 C R U S				
233 C R U S				
234 C R U S				
235 C R U S				
236 C R U S				
237 C R U S				
238 C R U S				
239 C R U S				
1 2 3 4 5	6 7	8 9	10 11 12 13 14	15 16 17

GEOGRAPHICAL DISTRIBUTION OF MEANS CONTROL

CODE	Indicate level for which means are required	
		Blank: If the observed parameter defined in column 68, card 200 is required 1: If a derived parameter is to be output; in this case a code 0-5 has to be entered in column 68, card 200, See table 2.
240 I N G E		
1 2 3 4 5	6 7 8 9 10	11

Table 1
STANDARD LEVELS

0	225	2,000	7,500
10	250	2,500	8,000
20	300	3,000	8,500
30	400	3,500	9,000
50	500	4,000	9,500
75	600	4,500	
100	700	5,000	
125	800	5,500	
150	1,000	6,000	
175	1,200	6,500	
200	1,500	7,000	

Table 2
Expl. see card 240 col. 11

0	potential temp.
1	sigma-t
2	sigma-⊝
3	geopot. anomaly
4	pot. energy anomaly
5	SVA

Fig. C.2 Data Output form. See Section 3.