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MARINE HEATFLOW SYSTEM - INSTRUMENTATIONS AND TECHNIQUE

Y.S.B.LIU, D.R.CHOI, H.M.J.STAGG and M.SWIFT

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May 1987
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1. Introduction

Early in 1986, BMR acquired an thermal gradient probe that measures the temperature gradient of the first few metres of the sea-bottom sediment. A thermal conductivity measurement system developed in-house enables determination of cored sediment conductivity. These two parameters are combined to give the heatflow at a particular location.

The first heaflow cruise undertaken by the BMR survey vessel R/V Rig Seismic in January 1986 in the Queensland Trough and on the Exmouth Plateau yielded 56 new heatflow values. Four other cruises during the past 12 months (Exmouth Plateau, North Perth Basin, Great Australian Bight, and Otway Basin) also recorded heatflow data. Therefore within a short space of 12 months, over 117 new heatflow values were determined around the Australian continental margin, resulting in a 120% increase in the oceanic heatflow data base in Australia.

The purpose of this Record is to present a comprehensive manual describing the BMR heatflow system, to serve as a reference and operating handbook for BMR scientists and technicians undertaking heatflow measurements. Some brief circuit description and maintenance procedures are included to aid trouble-shooting during surveys.

As well as introducing the heatflow measurement methods, technique, operating, and maintenance procedures, improvements made by others reported in several of the heatflow cruise reports are also incorporated here.

We wish to acknowledge the contributions of staff of the BMR Marine Division, in particular Dr Chao Shing Lee, and Ken Marshall of the Geophysics Division for his role in the development of the conductivity measurement equipment.

2. Concept and Methodology

Surface heatflow, when interpreted in conjunction with other geological and geophysical information, becomes an important constraint for most theories regarding the constitution and history of the earth, and for assessing the maturity of sediments for generation of hydrocarbons.

The regional variation of heatflow is generally correlated with major geological structures. For instance, areas of uniformly high heatflow may be associated with a shallow Moho (as often observed beneath marginal seas), oceanic rises, areas of active volcanism, or major deep-seated fault systems. In contrast, low heatflow anomalies are typically associated with ancient continental shields and their thick crust. These general trends may be modified by local environments (e.g. sea floor topography, or irregular distribution of sediments and rocks), variations in the heat transfer mechanism (localized conduction and convection anomalies), or time-dependent phenomena at the sea floor, such as sedimentation rates or bottom water temperature.

Local anomalies in heatflow may indicate a variety of factors, including geothermal energy prospects, coal field boundaries, or mineral deposits undergoing exothermic reactions. Localized heatflow studies are also necessary for the analysis of the thermal and burial history of sedimentary basins, a technique referred to as geohistory analysis. Thus heatflow analysis enables improved accuracy in assessing the favourability or otherwise of thermal history and the timing of structure (relative to migration), and to a lessser extent, the existance of effective traps and seals and the potential for protection of reservoirs from flushing.

Methodology

Measurement of terrestrial heatflow through the sea floor involves the in-situ measurement of thermal gradient in a particular locality and the determination of thermal conductivity of the sediment in which the thermal gradient is established. In general, thermal gradient measurements are far more difficult to obtain accurately than conductivity measurements. Not only do the temperature sensors needed to be calibrated to a high accuracy, but it also requires regular calibration to maintain its accuracy. On the other hand, measurement of conductivity of cored sediment samples, though requiring less sensor resolution, is difficult to verify due to non in-situ nature of the measurement.

The basic requirement for a underwater heatflow probe is for an instrument package capable of resolving 0.001°C. For this reason, special precaution must be exercised in the handling of cable connectors and sensor calibration.

The heatflow probe can be configured both as a Bullard type probe with a solid lance, or as an Ewing probe which can take temperature measurements and a core simultaneously. The data recorded in both cases include temperature, elapsed time, tilt angles, and standard reference resistances.

Conductivity measurement should be ideally carried out in-situ. The BMR-designed needle probe system is for an interim stop gap measurement. Techniques developed during the fiveRig Seismic cruises enable consistent and repeatable recording to be obtained in most instances.

3. Thermal Gradient Measurement

3.1 General Description

The NTS-11 underwater heatflow probe is desined to measure and record the temperature gradient in the top few metres of deep sea sediment. The system is normally operated with 8 thermistor sensors, although fewer sensors may be used with a shorter lance. Usually either a 4 metre or 2 metre lance is used, with thermistors mounted on outriggers spirally along the lance at 0.45m separation. As well as recording temperatures, 3 standard resistances, 2 tilt angles, and elapsed time are also recorded.

The system is fully solid state with 64k bytes of CMOS memory. This memory is sufficient for about 13 hours of continuous operation at a 30 seconds measurement interval. Total current consumption is only 75 mA at 12 volts, making it possible to operate continuously for several days before recharging the batteries. The memory and the internal clock are protected by a lithium 2.8V battery as power supply backup.

Sampling interval, temperature reading range, and the number of sensors are preset on a programmable switch within the data logger, and seldom require changing.

When the power switch is turned on, the data logger is in the 'sleeping' mode with less than half the normal power being consumed. When the data logger is initialised under software command by an external computer, normal data acquisition will take place with all modules powered up. Data acquisition can also be started with an external magnetic actuator located on the top end of the pressure housing. This can be set off by the trigger arm of the pilot piston corer when the heatflow probe is used in that mode.

3.2 Block Diagram

The internal electronics comprise four printed circuit boards which can be sub-divided into two sections: the data logger section and the analogue bridge/multiplexer front end section.

The data logger section comprises two circuit boards measuring 250 x 100mm. Board A is the microprocessor board which includes a surface-mounting device microprocessor module, programmable Input/out, UART, clock and timer chips etc. Board B is the memory board, this board houses 64k bytes of memory divided into 8k pages.

The bridge/multiplexer section provides a precision bridge amplifier to measure the thermistor and to convert into digital output via an 4½ digit A/D converter. The multiplexer section can accept up to 32 channels thermistor sensors although normally only 8 will be used. The multiplexer selection and A/D command are derived from the PIO No2 of the data logger section. The A/D output is connected to the PB port of the PIO No1.

3.3 Circuit Description

Board 1 Microprocessor Board

The heart of the microprocessor board is an HC-Unit, a surface mounting device module combining VLSI (very large scale integration) functions of the 82C85 microprocessor, 8k bytes of EPROM, 2k bytes of RAM and an Intersil 12 bit A/D convertor. Two 8-bit I/O latches provide multplexing control, memory addressing and start-up of DAS.

The processor has an 8 bit data bus which is also used for the lower address byte (A0-A7). The higher address byte (A8-A15) has its own dedicated address bus. The lower byte address is latched within the HC-Unit by an 8 bit tri state D type latch. As a result, there is a 13 bit address bus (A0-A12) and 5 bit chip select lines (C51-C55) which selects major functional blocks within the DAS.

Table 1 is a memory map of the HC-unit which shows the location of the EPROM, RAM, I/O and A/D addresses.

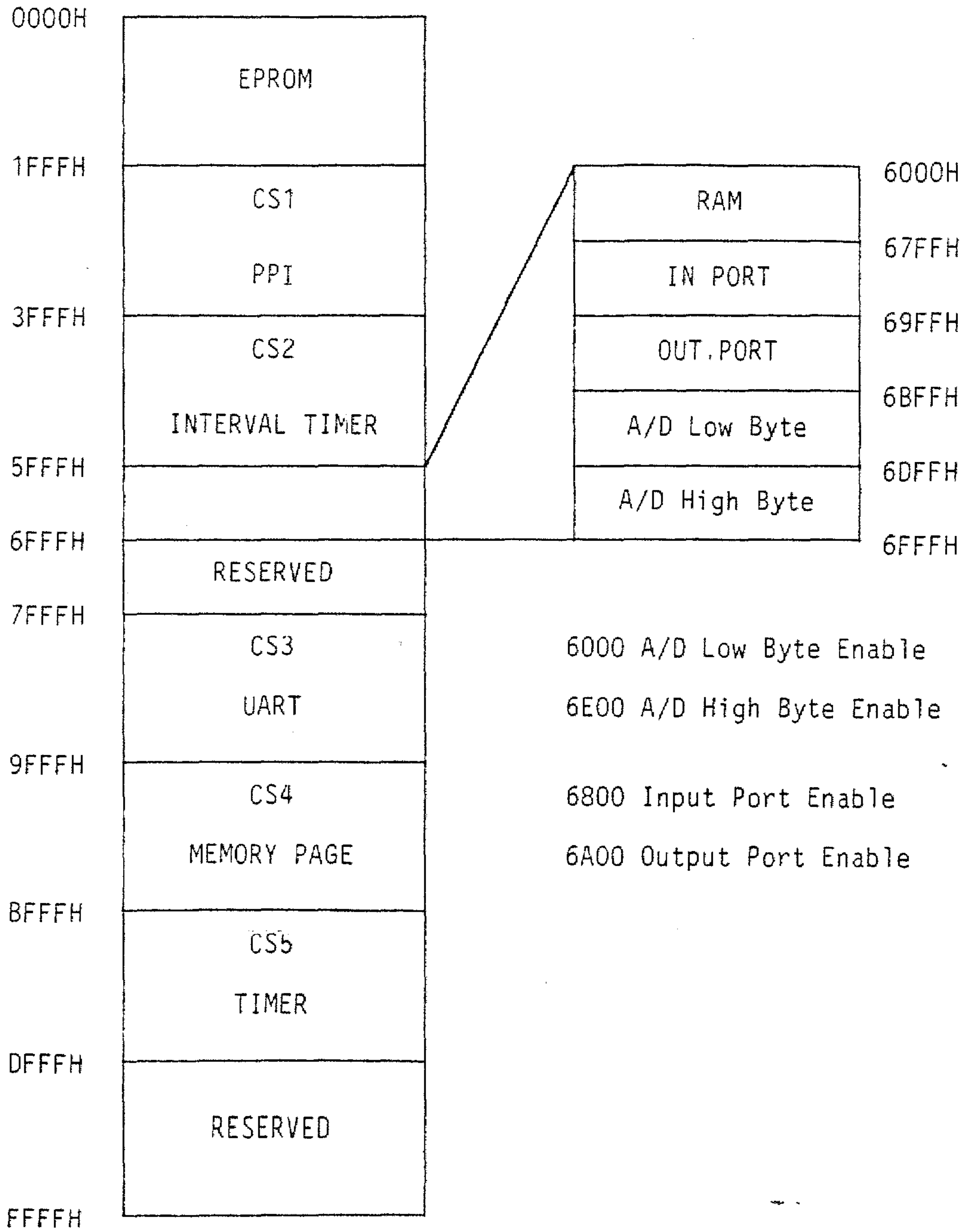


TABLE 1 MEMORY MAP

The A/D within the HC-Unit is a 12 bit device. This A/D is used for the x-y tilt sensors and should not be confused with the precisions $4\frac{1}{2}$ digit A/D which is reserved for the thermistor bridge amplifier in circuit board 4.

The lower bits of output port P0-P2 are used for multplexing of X-Y sensors to the A/D. The higher bits P3-P7 are used for memory page decoding in conjuntion of chip select CS4. The input port P1 is used for external start of the DAS.

The programmable peripheral interface (PPI) No 1 (U15) is used as 3 independent ports, with port B as output port to the thermistor A/D multiplexer, port C as input port for the programmable switch that controls the thermistor input channels, sampling interval and temperature range, and port A as the output port that control power to the transducers.

The PPI No2 (U16) is used as an input port with ports A and B accepting BCD outputs, ranges and conversion status from the thermistor A/D.

The UART U3 handles the parallel/serial conversion and communication protocol between the DAS and external device via the RS 232 interface box. Its baud rate is selectable via switch SW 1 at 1.2 KHz, 2.4 KHz, 4.8 KHz.

The timer U2 provides an alarm output via software control for power up control of CPU module.

Circuit Board 2 Memory Board

The memory board has 64 K bytes of CMOS membory subdivided into 8 pages of 8 K bytes. The microprocessor used the memory mapped I/O technicque with an area of memory address space assigned for I/O address. The main memory is associated with the chip select lines CS4. Each of the 8 K bytes memory page is selected by a page decoder U9 which has its inputs from the HC-Unit CPU module of circuit board 1. U19 is a clock which supplies 10 Hz to the interval time U17 for delay and samling intervals.

Control lines from output port A of PPI No1 (PA0-PA4) and the alarm output of timer U2 in Board 1 are used in this board for DAS and transducers power up control.

Board 3 Mutliplexer Board

The multiplexer board has 32 reed relays which can connect up to 32 thermistors to the bridge amplifier. Each relay is driven by an relay driver whose input is derived from the decoder in board 4.

The on resistance of each relay is tabulated in the handbook. This on resistance value of the relay must be used in correction and calcultaion of thermistor termperature.

Board 4 Bridge Amplifier

The front end of the bridge amplifier is a Wheaston Bridge with precision resistors RF1-RF4 forming three arms of the bridge, thermistors and reference resistors are connected to the remaining arm. The lower arms of the bridge are switched with additional resistors in parallel for the higher temperature range via U12. The Wheaston Bridge derives its reference voltage via a stable 2.5V zener diode and buffer UA5. An instrument amplifier UA2, UA1 with a fixed gain of 40 amplifies the incoming signal before digitisation by the four and half digit A/D converter. The output of the A/D consists of serialised BCD (B1-B4) and 5 digits indicators (D1-D5). U7 to U11 decodes the 5 bits output of PPI No1 from Board 1 to provide multiplexing of 32 channel inputs to the bridge amplifier via the reed relays of Board 3.

3.4 Heatflow Probe Deployment

Deployment of the heatflow probe involves the choosing of a configuration, assembly of the DAS and pressure housing, system initialisation, and finally the actual deployment.

3.4.1. Choosing a configuration

Deployment of the NTS-11 system can be done either using a lance or in combination with a coring system (corer-type: Figs. 1,2). In the shallow water, although at present the true thermal gradient is difficult to obtain due to influence of fluctuation of the bottom water temperature on the sediment, the deployment could be done by vibrocoring systems with either diver-operated hydraulic jack-hammer or conventional vibrocoring system.

The corer-type has an advantage over the lance-type in that (1) the corer can attain deeper penetration of hard sediment, and (2) that the corer can take a sediment sample together with the thermal gradient measurement. The disadvantages of the corer-type are its heavy weight which causes difficulty in handling, occasional bending of the barrel, and increased damage to thermistors due to the heavier impact on bottom arrival.

On the other hand, the needle-probe type is easy to handle due to its lighter weight (maximum 200 kg), and can be deployed without using a coring cradle. However, this type has a chronic bending problem apparently caused by incomplete penetration of the probe due to its lighter weight and the drift of the ship, and is susceptible to the bottom current and the ship movements which cause instability at the time of penetration, resulting in incomplete or non-penetration. These problems can be solved to some extent by reinforcing the lance with flanges along its length. The influence of increased frictional heat on thermistors by increased size of the lance must be carefully assessed.

3.4.2 Assembly of Data Acquisition Systems

Assembly of the data acquisition system of the NTS-11 consists of setting up of the DIP switch on internal circuit board, inspection assembly of pressure housing and outer frame etc.

Within the NTS-11, the DIP Switch-3 pre-sets the sampling rate, temperature range and sampling channels.

Switch prositions 1-5 of SW3 are for setting of sampling channels. They are binary coded with the LSB (2^0) in position 1, and MSB (2^4) in position 5. Setting for acquiring 8 channels of thermistor data is therefore as below:

SW3	1	2	3	4	5
On				X	
Off	X	X	X		X

SW3 Switch postion 6-7 are for setting of sampling intervals.

SW3 6	7	Intervals
On	On	30 seconds
Off	On	60 seconds
On	Off	90 seconds
Off	Off	120 seconds

SW3 position 8 is for setting of temperature range, with the ON positin for low range (-2-20°C) and OFF position for high range (10-32°C).

Inspection of the DAS prior to assembly should mainly concentrate on components and boards mountings, especially the heavier components such as batteries, relays, and switches. Wiring looms and connectors should also be thoroughly examined for evidence of loose or faulty interconnection due to mishandling or jarring during deployment.

Maximum care should be exercised for assembly of pressure housing, as any mishandling could result in a catastrophy. The list of steps in Appendix 1 should be followed with the utmost attention to every detail.

3.4.3. System Initialisation

Systems Initialisation involves down loading of starting parameters for the DAS by the computer. Details of the procedures are listed in Appendix 2.

During the initialisation sequence, the most commonly observed fault is in the communication link between the computer and the DAS, either there is no response or the response is erratic. The most probable cause for this is either due to a low battery charge inside the DAS, or problems in the physical links (cable connectors and RS232 box)

Data format as displayed on the screen should give a good indication of the health status of the DAS after initialisation. Sampling numbers, tilts (x,y) and reference resistors (RF, RF2, RF3) should give proper readings, whereas the thermistors will display overflow readings (0000) as the temperature on deck is generally higher than the low temperature range (-2 to 20°C) setting. Any thermistor reading deviating from the others could indicate a faulty unit, damaged cable or salt water contamination of underwater connector.

3.4.4. Deployment

Log Sheet: accurate log sheets must be kept for each heatflow station. An example of a log sheet is shown in Table 2. Successful data recovery and processing rely largely on the accuracy of the log sheet.

Deployment Vehicle: This is the winch cradle for the corer probe or the hand-held cradle for the lance probe. The lance with a special flange reinforcement may be deployed without a cradle with due care.

Entry Style: This can be multiple entry ('pogo' style) or single entry depending on the requirements reliability of the lance. For pogo operations, care must be exercised for the terrain of the ocean floor to avoid damage to the probe during transit between stations. Sufficient time should be allowed for the probe to settle (usually 10 minutes) into its vertical position before its final descent.

Stabilisation: The probe is normally stablised for about 10 minutes at about 100 metres above the ocean floor. Temperature readings obtained during the stabilisation period are used for calibration of the thermistors.

Final Descent Speed: various descent speed for the final plunge have been experimented with, the most favoured speed is around 60-70 m/min. In stiff sediments, such as clay, it is suggested that deeper penetration may be achieved with slower final descent speed.

Measurement: after bottom penetration, about 15 minutes should be allowed for the temperature measurement during which time the ship must maintain as accurate as possible to its station. Bending of the lance usually occurs on pull-out if the probe cable is not vertical due to excessive drifting of the ship from its initial deployment position.

To prevent premature pull-out of the probe caused by unavoidable drifting of the ship, the winch should spool out slowly (5-20 m/min) while the probe is in the sediment. Pull out of the probe at the end of the measurement cycle should be very slow to avoid bending of the lance.

4. Data Retrieval and Processing

After recovery of the heatflow probe, the next step is the downloading of data to a computer, and data processing to compute the thermal gradient.

Any computer with a CP/M operating system can be connected to the NTS-11 probe for data down-loading. The BMR system normally uses the Fujitsu FM16 pi personal computer. Interconnection of the computer and the heatflow probe is through a RS-232 interface box which enables the low power CMOS logic of the DAS to communicate with the TTL logic of the computer.

It may be worth to remember that what is stored inside the NTS-11 probe memory is some meaningless numbers representing the voltage readings of the Wheaston Bridge that the temperature sensing thermistors form one of its arms. These raw data have to be down-loaded first to the computer before further processing can take place.

There are five programs to be used in connection with data retrieval and processing. These are, in order of execution:

1) READ.BAS
2) AUST5.BAS
3) KCAL.BAS
4) STAT1.BAS
5) STAT.BAS

READ This program is for down loading of the raw data from the heatflow probe to the computer memory buffer, 8k byte at a time. The down loading can be terminated at any time by pressing with CTL-C. Each 8k bytes of data are assigned an individual file name. These files are later combined together into a single data file.

AUST5 This program is for conversion of raw data files into temperatures. A table loaded at the end of this program tabulates the thermistor parameters at 0, 10, 20, and 30°C. It is important that this table be up-dated regularly after re-calibration of thermistors.

KCAL This is for temperature data analysis by graphic display and calculation of calibration factor for each thermistor during stabilisation. The data used for calibration purposes must be visually inspected to make sure there is no spurious data set.

STAT1 This is a graphic display program of corrected data. It enables the performance of thermistors to be assessed and the thermistors to be discarded if any prove to be faulty.

STAT This is the final print out of the corrected temperatures of each sensor after calibration. Sensors with large correction factors should be examined closely and discarded if they are faulty.

A linear regression analysis program is then used to compute the thermal gradient from the corrected temperature readings. An x-y linear plot of temperature gradient should be attempted first to decide the number of thermistors to be included in regression analysis.

Figure 3 is a graphic presentation of one measurement cyce. The temperature drops as soon as the probe is plunged into the water and then continues to decrease until it reaches the stabilising zone near the bottom. Any faulty thermistors can be identified by noting any erratic movement or drift of the termperatures during the time of stabilization. The temperature rises at penetration due to frictional heating, but it should then stabilise within 2 to 3 minutes of penetration. Thermistors that do not show stabilzation can be faulty or due to some other physical and/or geological factors. The latter case needs further clarification. In most cases thermistors that do not show a temperature rise at the time of penetration probably did not penetrate the sedient. This is a reliable criterion in determining how many thermistors penetrated into sediment.

The thermal gradient are deduced by the temperature differences among the penetrated thermistors after the influence of frictional heat subsides.

5. Conductivity Measurement

Equipment

The thermal conductivity of sediment is measured on a core sample taken from the seabed using a BMR-constructed needle probe (Fig. 4). The needle probe is 5 cm long, this being the same as the core diameter. The external diameter of the needle is 1mm, giving a diameter to length ratio of 1:50. A Fenwal bead thermistor type CL32L10 is fitted internally to the needle, together with the heating wire.

The needle probe is used in conjunction with the thermal conductivity bridge (also constructed in BMR). It provides a constant current source to drive the needle heating element, and a precision Wheaston Bridge to measure the temperature rise of the thermistor sensors.

Two types of data logging system have been developed to accompany with the needle probe/bridge. The first system is based on a HP9825 desk top computer in conjunction with a precision HP3546 DVM. A x-y plotter can be used to display the temperature rises versus logarithmic time (seconds) from which the quality (linearity) of data and the number of points to be used for linear regression analysis can be determined.

The second data logging system uses a BBC Computer and its internal 12 bits A/D converter. In terms of accuracy this second system is not as good, but it is obviously more portable.

The contstant current source supplies 200mA to the heater element, corresponding to an output of 2.6W/m. The heatr is turned on for 100 seconds, during which time the temperature is sampled once per second.

Other parameters required for the computation include the Beta-constant (nominally 3000) of thermistor and reference voltage (nominally 185mV). Both of these constants should be checked regularly to ascertain their accuracy and stability.

Measurement

The conductivity measurement should ideally be made in situ in conjunction with the thermal gradient measurement in the seabed. However, we have no system in BMR at present that can do this. Therefore, a core must be taken in the viciity of the gradient measurement.

After labelling, the core is split into halves; of which one goes to the core storage room for archiving, while the other half is brought to the laboratory where it stays for minimum 6 hours to bring the sediment to thermal equilibrium the room temperature. Our on-board experiments showed that the center of an unsplit core can reach equilibrium with room temperature after 3.5 to 4 hours.

The conductivity is measured either at a regular interval along the core, or in each different lithology. Combination of both methods seems to be ideal: Where lithology is monotonous, regular interval measurement is made, but where layered, alternated, or disturbed, each lithology must be measured. The needle probe needs to have full penetration into sediment;

any part of the needle exposed in the air causes decrease in measured conductivity.

Any problems with core and probe motion caused by the ship rolling may be partially solved by making a stand to hold the probe steady at each test point; the core also needs to be kept stationary with a core holding rack. Very wet sediment should not be measured on board the ship because of the problem of movement of the sediment or movement of pore water in wet sediments.

Computer operation for the conductivity measurement is summarized in Appendix 5. The needle probe is very fragile and therefore should be handled with care. The heater element within the needle can fuse easily under excess or prolonged heating. Under no circumstances should the heater current be turned on with the dial reading in excess of 200mA.

The measured conductivity data must be incorporated with the core logging chart (Fig. 5) which is made by geologists after the conductivity measurement.

In general, the conductivity of marine sediment ranges from 0.6 to 1.2W/mc. Values outside this range should be treated with caution and may be due to unusual sediment type, mechanical failure of equipment, or operational errors.

Variation of the thermal conductivity derives from the variation in porosity, water content, burial depth, and mineralogical composition of the sediment. Sediments with low porosity and low water content tned to higher thermal conductivity. Quartz is also a good heat conductor, thus sediment rich in quartz also tends to have high conductivity. Clay minerals and peat have low conductivity, and calcite is intermediate. These trends should be kept in mind.

6. HEATFLOW VALUE CALCULATION

$$Q \text{ (milliwatt/sq. meter)} = G \text{ (C/km)} \times K \text{ (watt/mC)}$$

That is, if the thermal gradient is 50 C/km and the conductivity is 0.8W/m/C, the heatflow is 50 x 0.8 = 40 mW/sq. meter.

Appendix 1 PREPARATION AND MAINTENANCE OF THE PRESSURE CYLINDER

1. PREPARATION OF HEAT-FLOW PROBE FOR DEPLOYMENT

1) Clean 'O' rings with rags.

2) Apply silicon grease G30M to 'O' rings and pressure case contact areas.

3) Set the number of sensors, the sample interval rate, and the sensor temperature range on DIP switch-3 in the electronics package.

4) Push inner electronic package into pressure case from computer/charger connector end.

5) Turn on DAS power.

6) Engage 'D'-type connector from sensor end and engage locating pin, push in sensor end cap gently, tighten central stud by hand and then by small screwdriver (total of about 8 turns). <u>Do not overtighten or bend screwdriver</u>.

7) Clean assembled pressure housing with rags.

8) Assemble pressure housing to cylindrical outer frame.

9) Assemble frame lifting end assembly. Assemble with screw, washer, split washer, and double nut; use only small spanner. Do not over-tighten.

10) Put on dead-weights; tighten gripping ring.

11) Connect sensors and locking sleeves.

Yellow	-	sensors 1 & 2
Blue	-	sensors 3 & 4
Red	-	sensors 5 & 6
Black	-	sensors 7 & 8

Apply silicon grease lightly.

12) Arrange sensor cables into slotted plate.

13) Assemble end cone cap.

14) Load DAS starting parameters.

2. MAINTENANCE OF THE NTS-11 PRESSURE CYLINDER

1) After contact with sea water, rinse off with fresh water. The surface of the pressure case is treated with teflon. Care in handling the pressure-tight cylinder will greatly increase its life. Scratched areas will corrode very quickly.

2) If the pressure case is not to be used for a long time, remove the four bolts that fix the magnetic switch. Rinse sea water from the bolt-holes with fresh water. Blow off the fresh water with compressed air, and then apply silicon grease to the bolt holes before replacing the bolts.

3) Do not touch the electronic components in the pressure case unnecessarily. The LSI IC's use CMOS logic which is easily destroyed by static electricity passed from the human body.

4) If the system is not to be used for a couple of months during storage, fully charge the batteries and store in a cold place. Charging the battery once every few months during storage will extend the life of the battery.

Appendix 2 LOADING OF STARTING PARAMETERS

Note: operator responses at the keyboard in these notes are indicated by the Bold type face.

Turn power on to disc drive, printer, interface box, and computer (always turn on power to computer last!). With a bit of luck the CP/M-86 prompt will appear on the screen. If however the word "Ready" appears you are in BASIC; in this case type SYSTEM - RETURN. If the screen contains anything else, try pressing the key PF10 successively until the A appears. If this fails, talk nicely to an expert. Ask for the menu to appear on the screen, as follows -

A MENU - RETURN

Use the right-pointing arrow at the top right-hand corner of the keyboard to move the cursor to 'TERM': press RETURN. The following table will now appear on the screen -

PARAMETER TABLE

Baud rates: 1200	Data length: 8	Stop bits: 1 bit
Parity: non	Busy control: off	JIS Code: 8-bit
Duplex mode: full	Auto LF: off	Order mode: FBASIC
Download EOF: on	Unload EOF: on	CR delaytime: 0
Break time: 1	Recieve size: 65534 bytes	

Press the key PF1 to enter terminal mode, then press RETURN to get the asterisk (*) prompt from the DAS. If the DAS is still running (an assortment of letters and numbers wends its way slowly down the screen), type CRTL/C. A right-pointing arrow ( ) should now appear on screen; now proceed with the following replies -

C RETURN (clear DAS memory to all one's (F's in hex))

*$ RETURN (enter heatflow intialisation routine)

You will now set the idle time - ie the delay in minutes between completing system initialisation and the start of the recording.

DO YOU WANT IDLE TIME [Y OR N] Y (or N) RETURN

PLEASE PUT IN IDLE TIME

eg 20 min

20 RETURN

INPUT DATA OK? [Y OR N] Y (or N) RETURN

SENSOR NUMBER = 8

RANGE = -5 - 20°C

IDLE TIME = 20 MINUTES

MEASUREMENT INTERVAL = 30 SECONDS

MEASUREMENT ITEM OK? [Y OR N] Y (or N) RETURN

? (DAS program starts with delay time. WARNING: hit any key on FM-16 will cause return to monitor of DAS)

Unplug computer cable from DAS on the back deck, and replace dummy plugs.

If the answer to the question "MEASUREMENT ITEM OK?" is N, then the following will be printed -

ALTERATION

Sensor numbers

Measurement interval time and temperature is DIPSW-3 SET?

Idle time is RESTART (any key hit!!)

At this point, if you wish to reset one of the values, remove the electronics package from the pressure case, turn the DAS power off, and set the values on DIP Switch-3. When you have restarted the DAS power and replaced the electronics in the pressure case, hit any key on the FM-16 keyboard; the follwing message will then appear -

HEATFLOW SYSTEMS

*

To start initialising the DAS again, type * RETURN, and proceed as before.

Appendix 3 DATA RETRIEVAL AND PROCESSING

Turn on the equipment and obtain the A prompt as outlined in the previous section. When you get the prompt, proceed as follows (operator keyboard entries are again bold type) -

A **Menu**

Select TERM with the cursor and press RETURN.

The parameter table will now appear on the screen.

PF1

Turn on power on the interface box (RS-232C), connect the cable to DAS. Measurements from the DAS will appear on the screen.

To stop the DAS recording,

either - (1) Restart the interface box - Restart on, wait for display of "Heat flow system", then Restart to off,

or (2) Wait for ? in display, then hit any key.

* (now we are in DAS monitor)

FROM NOW ON, AT ANY TIME THAT AN ASTERISK PROMPT APPEARS, IT IS VITAL THAT YOU DO NOT PRESS THE KEY 'C' AND RETURN, UNTIL ALL THE DATA HAVE BEEN DOWN-LOADED TO THE FM-16. IF YOU DO, YOU WILL WIPE ALL OF THE DAS DATA MEMORY AND EARN EVERLASTING ABUSE FROM YOUR COLLEAGUES.

PF10

PF10

PF10 (until you get A prompt)

A **DIR RETURN** (to get directory of RAM disc A)

A **ERA *.DAT RETURN** (to erase all data files from RAM disc)

A **MENU RETURN** (select TERM mode as above)

PF1 (back to DAS monitor)

PF7 (to down-load DAS to RAM disc)

Download file name = **HEATO.DAT RETURN** (no prompt will appear when this is completed)

?**0** (down load data block '0')

(takes about 5 minutes, CC lines)

Data lines will appear on screen until % appears. Data line is now in FM16 buffer.

CTRL/C to interrupt the down-loading

PF10 (if you interrupted the down loading; to go to RAM disc in CP/M term mode)

*PF10 (if you did not interrupt; to go to RAM disc in CP/M term mode)

ARE YOU SURE TO SAVE FILE [Y/N] Y

(The data in the FM16 buffer has now been transferred to RAM disc)

PF10

DOWNLOAD FILE NAME = HEAT1.DAT RETURN

?1 (Down load data block 1)

(Repeat until all data blocks are down-loaded - takes about 5 minutes per block)

PF10

PF10

PF10

A BASIC RETURN

(Now insert data disc in disc drive D)

RUN "C:READ.BAS"

*LINKING OF MEASUREMENT DATA BLOCKS

**NEW FILE NAME [D:xxxxxx.DAT]? "D:QT-18.DAT"

**DATA BLOCK FILE NAME [xxxxxx.DAT] OR EXIT [E]? "HEAT1.DAT"

Continue until all data blocks have been read in. When finished, answer the last question with E RETURN

READY

FILES "D:"

READY

RUN "C:AUST5.BAS"

DATA ANALYSIS FOR HEAT-FLOW SYSTEM

!MEASUREMENT RANGE OF TEMP Hi or Lo (1/0)? 0

!INTERVAL TIME (SECONDS) = 30

USED MAX SENSOR NUMBERS = 8

SENSOR LABEL	(1)	400A	(Sensor labels may change every time depending on availability of good thermistors)
	(2)	355A	
	(3)	310A	
	(4)	265A	
	(5)	220A	
	(6)	175A	
	(7)	130A	
	(8)	85A	

ARE YOU SURE [Y/N]? Y

!DATE XX/XXX/XX 04/JAN/86

!COMMENT? QUEENSLAND TROUGH STATION 18 RAW DATA

!DISPLAY FILE NAME [D:xxxxxx.DAT]? "D:QT-18.DAT"

!PLEASE SPECIFY NUMBER OF BLOCK? 1   (block means line here)

!IS THIS THE RIGHT BLOCK [Y/N]? Y

HOW MANY BLOCKS DO YOU WANT TO PRINT? n

(Printing continues until EOF or break)

For further processing you need to run the following program;

READY

RUN "C:KCAL.BAS"

Computer operation of this program is almost the same as the above AUST5.BAS. Follow the instructions appear on the display screen.

Next to this, go to STAT1.BAS and STAT.BAS programs successively for complete data analysis and thermal gradient calibration.

Appendix 4 DAS MONITOR COMMANDS

1. Setting the time

The NTS-11 contains an internal clock. Unfortunately, however, there is no way of transferring the clock time with the data on play-back - ie setting the clock is an interesting exercise, but it serves no useful purpose. To set the clock proceed as follows -

*T cr/lf

860106155230	(The current clock time will be printed in the form YYMMDDHHmmSS - year, month, day, hour, minute, second)

Time OK Y or N Y

If the answer is Y, then on further action will be taken, and an asterisk prompt will be returned.

If the answer N, you will then type in the correct time on the next line in exactly the same form as it was printed. The clock will be reset when you press the cr/lf key.

2. To read the time

To read the time set in the internal clock, just type R after an asterisk prompt. The time will be printed in the same way as for the T option.

3. Other commands

Dxxxx The computer will display the contents of 128 bytes of memory starting at the location xxxx. The contents are displayed in hexadecimal and ASCII.

Pxxxx The computer will display 1kb of memory starting at the location xxxx (hex). The contents are displayed in Hexadecimal and ASCII.

Fxxxx yyyy The computer will display the contents of memory between the addresses xxxx and yyyy. The contents are displayed in hexadecimal and ASCII.

?n The DAS computer outputs the contents of memory block 'n' in the form of a file.

The data storage address range within the DAS is limited to 8kb. To incease the data storage capacity to the full 64kb, a total of 8 'banks' of memory are available in 'parallel'. The 'n' refers to the particular bank of memory which is required.

Crtl/C When any of the D, P, F, or ? commands is being processed, processing can be interrupted by typing Crtl/C, In general, on normal termination of a command to the DAS an asterisk (*) will be returned as the prompt. However, on termination of a DAS command with Crtl/C, the prompt will be returned.

Xxxxx The contents of memory location xxxx is output, and it is possible to change the content. (This does not apply to the ROM memory, of course). To change the memory value, input one byte of data at this point. To exit from the 'X' command without making a change, type X cr/lf.

Mxxxx You can write continuously one byte of new data into the location xxxx. To exit from this command, a cr/lf.

Gxxxx Don't use this command!!

Appendix 5 CONDUCTIVITY MEASUREMENT

1) Turn on equipment: computer, printer, screen and TTC-1.

2) Set up computer programs.

   Type in - *FX5,1

   - *ROM

   - *CAT

   - CHAIN "THERM2"

   Then answer the following questions.

Date:	
Location:	
Probe no:	
Beta:	(usually 3000)
Q Factor:	(usually 2.4)
Heater current:	(usually 200)
E. reference:	(usually 184)
Ambient temperature:	(insert a thermometer into the core sample and measure)

3) Calibrate TTC-1 with probe in core sample

   (1) Set meter to zero

   Set meter mode to volt
   Set meter to zero using the volt null adjustment

   (2) Connect the preamplifier box to TTC-1 (read the warnings on the box!)

   Red to +
   Black to -

   (3) Reset voltage using screen (for fine adjustment).

   Use volt nul adjustment to set the V on the screen to the middle of the range.

   (4) Check heater current by setting the meter to current mode. It should read 200mA. Adjust if necessary.

4) Turn on heater current and press space bar at a fraction of a second later. The screen will indicate when it has finished taking the readings (100 readings = 1 minute and 40 seconds).

5) Turn the heater current off. If you forget this, the thermistor probe will be damaged.

6) Take out probe

7) Press space bar on the computer

8) No of points to be sampled: 100

9) Press the space bar quickly to print out the data. If your action is slow, you will lose all the data!

Appendix 6 ON-BOARD THERMISTOR CHECKING AND CALIBRATION

It is important at all times during the survey that the thermistors in use are in a healthy condition. This requires continuous monitoring of themistor performance and replacement of those considered faulty. To assist the monitoring, two graphic programs (KCAL and STAT1) have been added to our data processing flow.

There are three methods of checking thermistors:

(1) by measuring the resistance of the thermistors with a multimeter;

(2) by checking the stability in an ice-bath; and

(3) by checking the temperature records from actual station.

(4) change in calibration factors.

Multimeter testing

The thermistor resistance is measured directly through the connector with a multimeter at room temperature for 20-30 seconds. Althought the air temperature will be changing slightly, faulty thermistors will show a more erratic drift than healthy thermistors. The typical reaction of a healthy thermistor to this test is for the resistance to decrease during the first few seconds of the test, then to stabilize. The decrease in resistance (ie increase in temperature) is caused by self-heating effects due to the current flowing through the thermistor from the multimeter. The amount of heating (and hence the resistance drop) depends on the current output of the multimeter (which varies between multimeters and, for a particular multimeter, with the resistance scale being used) and the actual resistance of the thermistor being tested. Any variation from the typical reaction is indicative of a faulty thermistor.

Although this method is not 100% reliable, it is perhaps 80% reliable for the detection of faulty thermistors, and 100% reliable for the detection of dead thermistors. It is also quicker to apply than the following two methods.

Ice test

Faulty thermistors can also be detected by testing in an ice bath. This test requires the thermistors to be connected to the electronic DAS, as in normal operations, and submerged in a bucket of finely and uniformly crushed ice for a period of at least several minutes. Healthy thermistors should show a temperature between +0.05°C and -0.05°C. Faulty thermistors will usually show a temperature far different to this. It is important that the ice is in a state of partial melting and that there are no air pockets or warm spots around the thermistor. This test unfortunately will give no indication if a themistor will function at higher temperature, or in deep water.

Checking temperature records

As a final check, the actual temperature records at each station should be examined; processing programs KCAL and STAT1 provide a graphic method of accomplishing this. Figure 7 shows the temperature records during the stabilization time 100m above the seabed for each heatflow station.

From Figure 6, for example, it can be seen that thermistors 3, 4, 7 and 8 appear healthy at station HF13, but gradually diverge at the succeeding stations and the noise for each thermistor also increases.

Change in calibration factor

Figure 7 shows the change of thermistor calibration factors with increasing station number (i.e. increasing time). Changes in the calibration factors indicate fundamental changes in the thermistors themselves. Three patterns of change can be seen;

- gradual change
- rapid change
- abrupt change.

Of these changes the abrupt change indicates total failure of the thermistor. The period of rapid change (e.g. thermistors 130B, 175B, and 220B) may be related to the water depth, as this change started at the time of deepest station. Thermistors showing a gradual change in calibration factor may recover after a few days with no use; however, such thermistors appear to quickly deteriorate with further deployment.

At least some thermistors' deterioration may be caused by the leakage of seawater. Thermistor 175B, for example, showed a very unstable resistance of about 4.4-5.4 kOhm in a 30°C stabilized water bath. When the cable connector was cut on the electronics side of the in-line connector, a resistance of 4.426 +/-0.03 kOhm was measured - a little unstable, but close to the original value of 4.475 kOhm. Finally, when the cable was cut in the thermistor side of the in-line connector, the resistance was measured at 4.40 +/-0.01 kOhm, and very stable. Leakage of seawater causes the resistance to decrease - and hence increase in temperature, which is a common fault as thermistors deteriorate. We therfore consider it likely that many cases of thermistor deterioration are caused by salt water leakage. If this is correct, then faulty thermistors should be repaired by re-cabling and re-termination.

(This section modified from Willcox, Stagg, Davies, et al.: BMR Cruise Report, in press)

Appendix 7   CP/M COMMANDS

1.1 General Information

COMP (Compare files)
COPYDISK (to copy all the files on a disc)
DUMP (to display the contents of a file as hex numbers and ASCII characters)
FORMAT (to format a disc)
PIP (copy the contents of a file)
SUBMIT (to carry out file submitting)

All of these commands enhance the functions of file formation and file operation, and are convenient commands. For further basic information on CP/M-86, refer to the "Users Manual, Operating Guide".

1.2 Explanation of Commands

1.2.1 COMP (compare)

Function; Compare the contents of two files and display the result.

Composition: COMP (filspec1 filespec2)

Explanation: The contents of the files specified by filespec1 and filespec2 are compared byte-by-byte, and if different bytes are found, the contents of those bytes are displayed by record number, offset within record, and content of bytes by ?????????? numbers. When an EOF is found in one of the files under comparison, the COMP is terminated.

Example of Operation

First designate two files that you want to compare. When you input COMP cr/lf, input the file name as follows -

```
C  COMP
File Compare Ver 1.0
Source Filename = filespec1 ..............(1)
Destination filename = filespec2 .........(2)
```

Input the filenames for 1 and 2 respectively.
When the contents of the files compared are equal, the following will be displayed -

```
C COMP filespec1 filespec2
File Compare Ver 1.0
End of Compare.  Number of errors = 0000
C
```

Note that filespecs can be input with the COMP command or separately. When the contents of the files are not equal, the following is printd on the screen -

```
C COMP
File Compare Ver 1.0
```

```
Source filename = filespec1
Destination filename = filespec2
    ******* ERROR INFORMATION **********
Record          Offset          Drive[B]        Drive[B]
0000             00               61              41
0000             06               63              43
END OF COMPARE.  Number of errors = 2
Continue? [Y/N] N
C
```

The display of different bytes is made consecutively. When you want to stop the display, input Ctrl/S. If you input Crtl/S again, or any key, the display continues. But if you input the key other than Crtl/S, the display finishes at that point.

If you input COMP cr/lf and carry out the COMP command, the "Conintue? [Y/N]" will be displayed after the display of different keys. When you input N cr/lf, the performance of the command is over; but when you input Y cr/lf, the computer returns to the input of filename.

If you want to print the comparison results, first input Crtl/P, then perform the COMP command (when the printing is finished, type Crlt/P again).

1.2.2 COPYDISK (copy a disk)

Function: All contents of a disc are copied to another disc. The copy disc contains exactly the same information as the original one.

Composition: COPYDISK

Explanation: When you input COPYDISK cr/lf, the original command is initiated. Following the direction on the screen, input the drive names of the source and destination (copy) discs. COPYDISK works only between the same kinds of discs. COPYDISK will also work on only one disk drive; follow the instructions on the screen and exchange the discs at the appropriate time.

Example of Operation

When you input COPYDISK cr/lf, the command starts. Put in each parameter as follows -

```
C COPYDISK
CP/M-86 Full disk copy utility
          Version 2.0
Enter Source Disk Drive (C-D)? C............(1)
Destination Disk Drive (C-D)?D..............(2)
Is this what you want to do [Y/N] Y.........(3)
Copy started
     Reading track 0                 .............(4)
Copy completed
     Copy another disk [Y/N]  N...............(5)
```

(1) Enter Source Disk Drive (C-D)?

Input the drive name for the source disk (C or D).

(2) Destination Disk Drive (C-D)?
Input the drive name for the destination disc. If you have only one disc drive, answer the same as for (1).

(3) Is this what you want to do [Y/N]?
After properly inserting source and destination discs, press Y cr/lf. The copying starts. If you input N cr/lf, the copying is interrupted, and message (5) is printed.

(4) Copy Started
The copying proceeds automatically, displaying the track number in the order "Reading track", "Writing track" and "Verifying track".

(5) Copy anothe disc [Y/N]?
Answer is obvious.

If you have only one disc drive, designate the same drive name for source and destination discs. The copy is performed by exchanging soure and destination discs. When the screen displays the following, insert the source disc into drive C, and answer Y cr/lf.

```
Insert source disc on Drive C
Ready [Y/N]? Y
```

When the screen indicates the following, insert the destination disc into the drive, and press Y cr/lf.

```
Insert destiation disc on Drive D
Ready [Y/N]?   Y
```

1.2.3 DUMP

Function: A file is dumped as Hex numbers and ASCII characters.

Composition: DUMP (filespec)

Explanation: The contents of the file "filespec" is displayed as Hex numbers and ASCII characters. To dump the file to a printer, type Crtl/P before the DUMP command, and again on completion.

Example of Operation

Designate the file that you want to dump with "Filespec". If you input DUMP cr/lf, input the name of the file as follows -

```
C DUMP
DUMP Utility Version 1.0
Enter Filename = filespec ..............(1)
```

(1) Enter filename =
Input the file name to be dumped. An example of the DUMP output is given in the original manual.

The DUMP display is done continuously. To interrupt the display, type Crtl/S. Crtl/S again at this point resumes the display, while any other key will terminate it.

At completion of the DUMP, you will be asked if you wish to conitnue with another DUMP. Answer Y cr/lf or N cr/lf, as appropriate.

1.2.4 FORMAT

Function: To format a floppy disc used in CP/M-86.

Comosition: FORMAT (d:)

Explanation

When you input FORMAT d: cr/lf, the main command starts to operate, and the floppy disc in the drive specified by d is formatted. If you want to omit designating the disc drive, confirm the drive name.

```
FORMAT C: cr/lf     (format the disc in drive C)
FORMAT D: cr/lf     (format the dice in drive D)
```

You need not designate the kind (medium) of disc that you want formatting. The FORMAT command automatically discriminates the medium of the drive that was nominated.

Example of Operation

```
FORMAT D:

3.5 inch Disk format Program
     Set Disk to Drive D:
     Execution OK?  [Y/N]  Y
```

Insert the disc to be formatted into drive D, then press Y cr/lf. If you press N cr/lf, the screen returns to be ready for accptance of CP/m-86 commands.

```
Confirmation of Drive
3.5 inch Disc Format Program
Format Drive is C:  OK? [Y/N]  Y
```

When you omit the drive name d:, the screen will seek confirmation of the drive name. If you press Y cr/lf, the screen moves to "selection of performance"; if you press N cr/lf, the screen moves to "selection of drive".

```
Selection of Drive
Key in Drive (C:-D:)     D:
```

Drive C: or D: can be selected.

```
Performance of Formatting
3.5 inch Disc Format Program
Drive d: Formatting now
```

```
                Track     Side
Format Track     nn        n

3.5 inch Disk Format Program
Drive d: Formatting now

                Track     Side
Verifying Track  nn        n
```

End of Command

When formatting is over, the computer is ready for the next input, as follows -

```
3.5 inch Disk Format Program

        ****************   Format End   *****************
```

If you want to continue formatting other disks, answer Y cr/lf, and the program will return to the "selection of performance". If you have completed formatting, answer N cr/lf.

1.2.5 PIP

PIP is a program for copying files. Files can be copied within one disc or from disc to disc. PIP is the only command that supercedes the user number of files, and is able to change the user number of files. PIP is capable not only copy the files on a disc, but it can also transfer files in and out of the system. By these various optional functions and can perform diversified and specified functions when copying.

1.2.5.1 Copying Single File

Function: Make a copy of a file.

Composition: PIP filespec1 = filespec2

If filespec1 and filespec2 are the same, though on different discs, you can omit the name of one file. However, you cannot omit the nomination of Drive (d:) in this case -

```
PIP d: = filespec2
PIP filespec1 = d:
```

Explanation

Copy the file specified by filespec1 to the destination file filespec2. If the file names are the same, you may omit the name of one of them. For example.

```
PIP A=C:MYPROG.CMD
```

is the same as

PIPA:MYPROG.CMD=C:MYPROG.CMD

The characteristics of SYS/DIR and RW/RD are copied together with the file (ie the source and destination files have the same characteristics).

Verification Check After Copying

You can compare and verify the contents of two files after copying, to check if the copying was done properly. This is the verification function. When you verify, add [V] after the destination file (filespec2) and designate the V (verify) option as follows -

```
C PIP NEWFILE.TXT=OLDFILE.TXT [V]
```

The verification of the copy takes time. However, it is wise to do so when you copy important files.

Change of User Number

When we copy between the different user number (Security codes) we use the G (group) option. Put [Gn] (n= user number) next to filespec2, and readout the file of user nubmer that was designated regardless of the present user number. This can also be done by adding [Gn] (n = user number) next to filespec1 and by typing the file into the designated user number, as follows -

```
C PIP C:NEWFILE.TXT=C:OLDFILE.TXT[G1]
C PIP C:YOURFILE.TXT[G2]=C:MYFILE.TXT
C PIP C:MYDATA.DAT[G2]=C:MYDATA.DAT[G1]
```

File Copy of SYS (System) Characteristics

The PIP command disregards the characteristics of SYS (System). So you cannot copy the file of SYS characteristics as it stands. If you want to copy the file of SYS characteristics, add [R] after filespec2.

```
C PIP A:=C:SYSFILE.CMD[R]
```

Copy of Files that already exist

When yu copy a file, and the file designated as the destination already exists, the PIP command discards the old file and replaces it with the new file. However, if the destination file is R/O (read only), the screen will ask you if it can eliminate the file by typing -

```
Destination is R/O, Delete [Y/N]? Y
```

If you input Y, the file is deleted and the copy is made. If you input N, the copy is not made

1.2.5.2 Copy Mulitple Files

Function: Copy the multiple file designated by ambiguous (unspecified) designation.

Composition: PIP d:=filespec

Explantion

Files designated by an ambiguous designation are copied into the disc nominated by d: under the same name as the destination file. Once the command is input, the computer automatically copies the files giving their names as they are copied.

```
C PIP d:=filespec
Copying
filename.typ
filename.typ
      .
      .
filename.typ
C
```

SYS characteristics and RW/RO characteristics are copied together with files - ie the destination file has the same characteristics as the source file. For a verification check, change of user numbers, copying the SYS characteristics, see the previous section.

1.2.5.3 Connection of File

Function: copies connecting multiple files that were designated as destination.

Composition: PIP filespec1=filespec2,filespec3,filespec4....

Explanation

Files designated by filespec2, filespec3, etc, are copied into the source file consecutively the connection of the files is in the order filespec2, filespec3. No specific limitations are present in the number of files to be connected. However, the number of command letters must be less than 128 (including the PIP command name).

When you press a key while the copy is being done, the continuous copy terminates.

In connecting the files, you can designate the [Gn] option after the source file and one or more options after the destination file. The following is an example -

```
C PIP FILE1[G1]=FILES2[2],FILES3,FILES4[G2U]
```

1.2.5.4 File Copy Between Input and Output Systems

Function: The FM16 can copy not only between discs but also the I/O system and disc files, as well as between the input and output systems.

Composition

PIP filespec1=filespec2

CON: CON:
PRN: NUL:
LST: EOF:

Explanation

This form is unique form of the PIP command, and makes it possible to transfer files from disc to input/ouput systems, from I/O systems to disc, or from the I/O system to another I/O system,

The designation of I/O system is represented by the name of the logical I/O system. The following are the four types of I/O system -

(1) CON - Console I/O system, Input is generally keyboard and output is to screen.

(2) LST - List ouptut system, normally the printer.

NUL:, EOF:, and PRN: are not actually I/O systems; however, they have specific meanings under PIP commands and are special input system. The meanings are -

(1) NUL: I/O system that makes 40 NULL code ($*00 code).

(2) EOF: I/O system that makes one Crtl/Z character ($1A). Crtl/Z character is used to indicate the end of CP/M-86 file (EOF).

(3) PRN: has the function of expanding 8-digit, printing line number, and is a print system with a capability of changing page at 60+ lines. The real output is compatible with printer as LST:.

If you designate CON: as the source input system, the data are normally input through a Keyboard. When you finish the input, press Crtl/Z. When the input system is other than the keyboard, press any letter while copying. Then the CP/M-86 finishes copying and returns to be ready for command acceptance.

When the output is disc file, you can designate option [Gn] and when the input is disc file CON: you can designate one or more options.

1.2.5.5 Multiple Command Mode

Function: When you use the PIP command repeatedly, you can command transformation by placing the PIP command into multiple command mode. Under this mode, PIP command program itself is not absorbed into the memory, you can enhance the efficiency.

Composition: PIP

Explanation

As you input PIP cr/lf, the PIP command is connected to multiple command mode. The screen shows an asterisk (*) as the PIP prompt when the computer is ready for command acceptance.

```
C PIP
CP/M-86 PIP Version 1.1
*
```

When this PIP prompt is displayed, the user can input the portion of command tail of each format (portions except command name PIP). If you press cr/lf key after the * prompt, the PIP command is terminted, and the computer is ready to accept CP/M-86 commands.

Example of Operation

```
C PIP
CP/M-86 PIP Version 1.1
*A:MYFILE.TXT=C:YOURFILE.TXT
*NEWFILE.DAT=OLDFILE.TXT
*D:=PROG.*[V]
*LST:=MYTEXT.TXT
*CR/LF
C
```

1.2.5.6 PIP Option

By using the option function, you can manipulate the contents of file and can confirm if the copying was made correctly. The option must be designated right after the I/O system or file that is affected. Also, the option can simultaneously designate the multiple functions, in this case, using parentheses ([]) covering the whole part. You may designate only [Gn] options for the source file.

The options used by the PIP command are as follows -

Dn - delete letters in a word after the nth letter. This is specifically used in such cases as the long sentence that is difficult to be handled by the printer or console screen is included in the destination file.

E - indication of content that is being in console screen. The source file copied must be the text file.

F - this prevents the form feed being done. Deleting the form feed ($12) from the destination file, and copy to the source file.

Gn - this sets the user number to 'n'. If this option is designated after the destination file, the machine copies the user number in the file regardless of the present user number. If the option is set after the source file, it sets the user number copied source file 'n'.

H - when you copy a file of Hex format, it tests if it is the proper format or not, and indicates on the screen if there is any mistake.

I - this disregards :00 record while copying Intel 16-bit format. This option also assumes H option automatically.

L - capital letters in source file are all transferred into lower case letters and copied.

N - this adds line number at the start of each line. The line number starts at 1 and increments by 1. A colon is placed after the line number.

N2 - this adds a line number at the start of each line. Each number has two digits with 0 preceded, and TAB is placed after line number.

O - When CP/M-86 finds a Crtl/Z ($1A) code in file while designated the file of machine code, connecting files under the PIP command, and transferring files between I/O systems, it stops attached, CP/M-86 will disregard the Crtl/Z code. The Crtl/Z code shows the EOF.

PN - this option sets the page length. For this option, we insert the form feed code ($12) in every nth line in the destination file. If we designate this option with the F option, you can change the length of page because we insert the form feed in every nth line after deleting the form feed in the destination file.

Qs - stops copying after copying the letter string 's'. The letter string 's' is optional letter string delimited by Crtl/Z. It copies up to the letter string 's' in the source file.

R - reads SYS characteristics. PIP command generally disregards SYS characteristics in a file. However, by using 'R' option, you can copy the file of SYS characterisitcs like that of DIR characteristics.

Ss - this finds the letter string 's' in the destination file, and starts to copy from that string. The letter string 's' is the optional string of letters delimited by Crtl/Z. The source file is copied starting from letter string 's'.

Tu - this expands TAB in every nth line.

U - this option converts all lower case letters into upper case and copies.

V - verification

W - this copies into the RO files. Normally, if the source file already exists and has RO characterisitcs, the computer asks the user if it can over-write the file. However, by designating this option, the computer over-writes the file without confirmation.

Z - this masks the uppermost bit of each byte (letter) of the destination file and makes it zero.

1.2.6 SUBMIT

Function: Automatically and successively performs the multiple CP/M-86 commands stored in the submit files.

Composition: SUBMIT filespec (parameter)

Explanation

Automatically performs the multiple CP/M-86 commands included in submit files which were designated by filespec. The [filetype] of a submit file must be SUB.

You can designate up to 9 parameters composed of English numerals and alphabet after filespec with one space. These parameters are replaced with those of $1 to $9 in the submit file. Assume that there were submit file as follows -

```
A TYPE TEST.SUB
PIP $1. A86=$2,$3
ERA $1. BAK
ASM $1
PIP LST:=$1.PRN
A
```

If you input SUBMIT TEST MYPROG FILE1.A86FILE2.A86, $1 is replaced with MYPROG, and $2, $3 are replaced with FILE1.A86 and FILE2.A86, respectively, as shown below -

```
PIP MYPROG.A86=FILE1.A86,FILE2.A86
ERA MYPROG.BAK
ASM  MYPROG
PIP LST:=MYPROG.PRN
```

If the number of parameters input into the command tail (behind the filespec) is less than the number of temporal parameters ($1-$9) in the submit file, the rest of the temporal parameters ($n) are erased (blank letter). If the case is reversed, the rest of the parameters of the command tail, are disregarded.

If you want to include the real dollar mark ($) in the submit file, you must write it as $$. This is to distinguish it from $ in the temporal parameters ($1-$9).

You cannot designate the SUBMIT command in the submit file. However, you can designate the SUBMIT command at the last line of a submit file and you can connect it to the other submit file.

<u>End of SUBMIT Command</u>

The SUBMIT command automatically ends when the last line treatment of the submit file is completed. It returns to be ready for acceptance of CP/M-86 commancs. Also, even if it is processing a submit file, as soon as any key is touched during system prompt indication, the processing is interrupted and the system returns to basic position.

<u>Caution:</u> SUBMIT command makes $$$.SUB (temporal file) in Drive A: (memory disc) while processing. This $$$.SUB file disappears automatically when the processing of the SUBMIT command is completed.

Appendix 8 GENERAL SPECIFICATION OF THE NTS-11

Maximum pressure...............600 kg/sq cm (6000m water)
Outside dimensions.............170 x 815 mm
Weight in air..................87.5 kg
Weight in water................59.0 kg
Anti-corrosion treatment.......Almite and teflon
CPU............................80C85 (INTEL 8085 software compatible)
ROM............................27C64 (8 kb)
Stack RAM......................6116 (2 kb)
Data RAM.......................6264 (64 kb)
I/O ports
    Serial...........82C51
    Parallel.........82C55 (2)
Programmable timer.............RP5C15
Input power....................12V DC +/- 2V
Current consumed...............75 mA @ 12V DC
Data maintenance function......Lithium battery (2.8Vx5AH)
Power source...................Dry lead battery (12V x 9.5AH)
Temperature range
    Low range........-2°C to +20°C
    High range.......+10°C to +32°C
Accuracy of absolute temperature.....+/-0.2°C
Relative accuracy of thermistors.....+/-0.°2C
    0 to 10 C (after correction)....+/- 0.01°C
Analysable termperature........1/1000C
Reference resistance...........3 points
    L...............about 18.8 kOhm
    M...............about 7.95 kOhm
    H...............about 3.70 kOhm

Battery Charger
Method of charging...............stable voltage charging
Charging Voltage.................13.8V DC
Charging current.................2 A maximum
Power source voltage.............100V AC +/-10%
Power consumption................70 watts
Input voltage frequency..........50-60Hz

Pressure-tight cylinder (Fig. 8)
Material.........................Alminium alloy
Maximum pressures................600 kg/sq cm

Data logger system
Data logging method..............data written to RAM
Method of control................under CPU control
CPU..............................80C85
ROM capacity.....................8 kb maximum
Data storage capacity............64 kb maximum
External communication...........After passing through the signal-level converter, the data are converted into RS-232C signals and sent to FM-16 pi personal computer.
Baud rate: 1200 bits/sec
Word length: 8 bits

Parity: none
Stop bits: 1

Two-axis tilt sensor.............effective measurable angle +/-30°
Power source....................Dry lead battery (12v x 9.5AH)
Current Consumption.............60 mA @ 12V

Thermistors (Fig. 9)

Thermistor type.................Bead type (SSB)
General Shape...................Enclosed in FEP wire
Resistance......................15 kOhm @ 0°C

Data reduction system

The data reduction system can be any personal computer that has the following requirements

1) a serial RS-232C port
2) a memory capcity greater than 32kb after loading the data reduction program.
3) an external memory system
4) a printer port
5) capable of running BASIC software.

We use Fujitsu FM-16 pi personal computer that has all the above requirements.

Data analysis software

Language.....................F-BASIC
Software medium...............2 high-density floppy disc
Program required..............2 (downloading of data from NTS-11 and conversion of basic data to temperature).

12-bit A/D converter

A/D Converter................ICL7109 (Intersil)
Configuration................combined with CPU module
Number of input ports.........5 channel (2 of which are used for RF check)
Input voltage................0-2V
Resolution...................488 microV/1LSB
Two reference voltages are connected with the input port of the A/D converter to confirm the quality of the A/D converter.

Tilt Sensor

Angle of measurement..............+/- 45 degrees (vertical 0)
Direction of angle measurement.....X-Y. two axes
Accuracy...........+/- 3 degrees (slightly off-centered due to the lack of space within cylinder, and has low accuracy)
Capability of analysis............0.1 degree
Method of tilt sensing............Potentiometer

HEAT FLOW LOG SHEET

DATE: GMT- ; LOCAL-

STATION NUMBER: WATER DEPTH:

LOCATION: AT START; LAT- LONG-
AT BOTTOM ARRIVAL; LAT- LONG-

NAVIGATION: T-SET; DEAD RECKONING; HI-FIX; OTHER

TYPE OF PROBE USED: NEEDLE; CORER

TYPE OF EQUIPMENT: NTS-11; OTHER (SPECIFY)

	GMT TIME	CUMUL. TIME (in minutes)
DAS INITIALIZED		
DAS STARTED		0
STABILIZATION		
FINAL DROP		
BOTTOM ARRIVAL		
OFF BOTTOM		
BACK ON DECK		

SENSOR		DEPTH FROM TOP OF THE LANCE (m)
ORDER	NEMBER	
8		
7		
6		
5		
4		
3		
2		
1		

OBSERVED DEPTH OF PENETRATION:

NUMBER OF SENSORS PENETRATED:

CORE NUMBER:

RECOVERY:

DESCRIPTION (ABSTRACT FROM CORE-LOGGING SHEET):

REMARKS AND THERMAL GRADIENT:

LOGGED BY:

Table 2

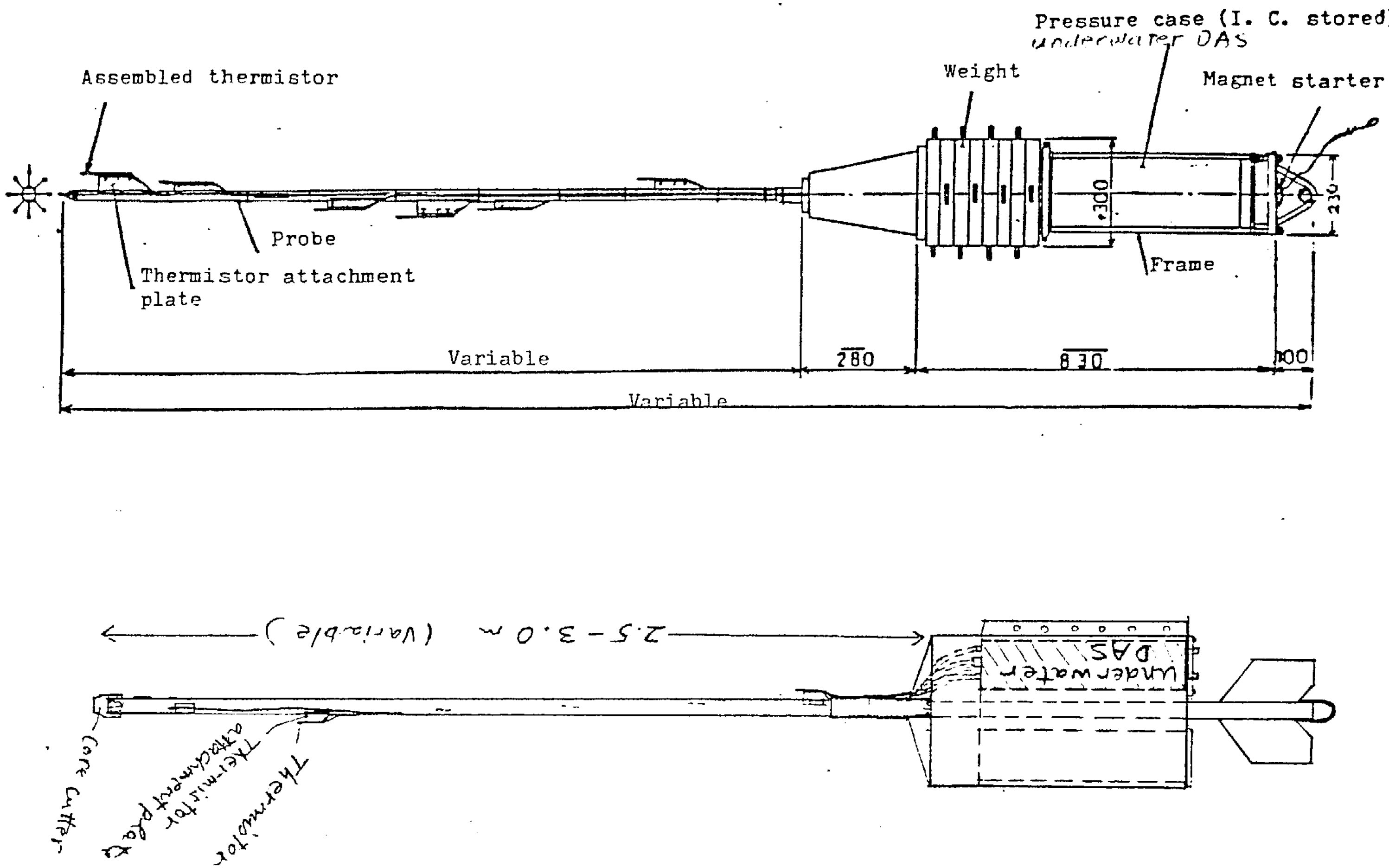

Pressure case (I. C. stored)
underwater DAS
Weight
Magnet starter
Assembled thermistor
300
230
Probe
Frame
Thermistor attachment plate
Variable
280
830
100
Variable
2.5 - 3.0 m (Variable)
Underwater DAS
Core Cutter
Thermistor attachment plate
Thermistor

Fig 1

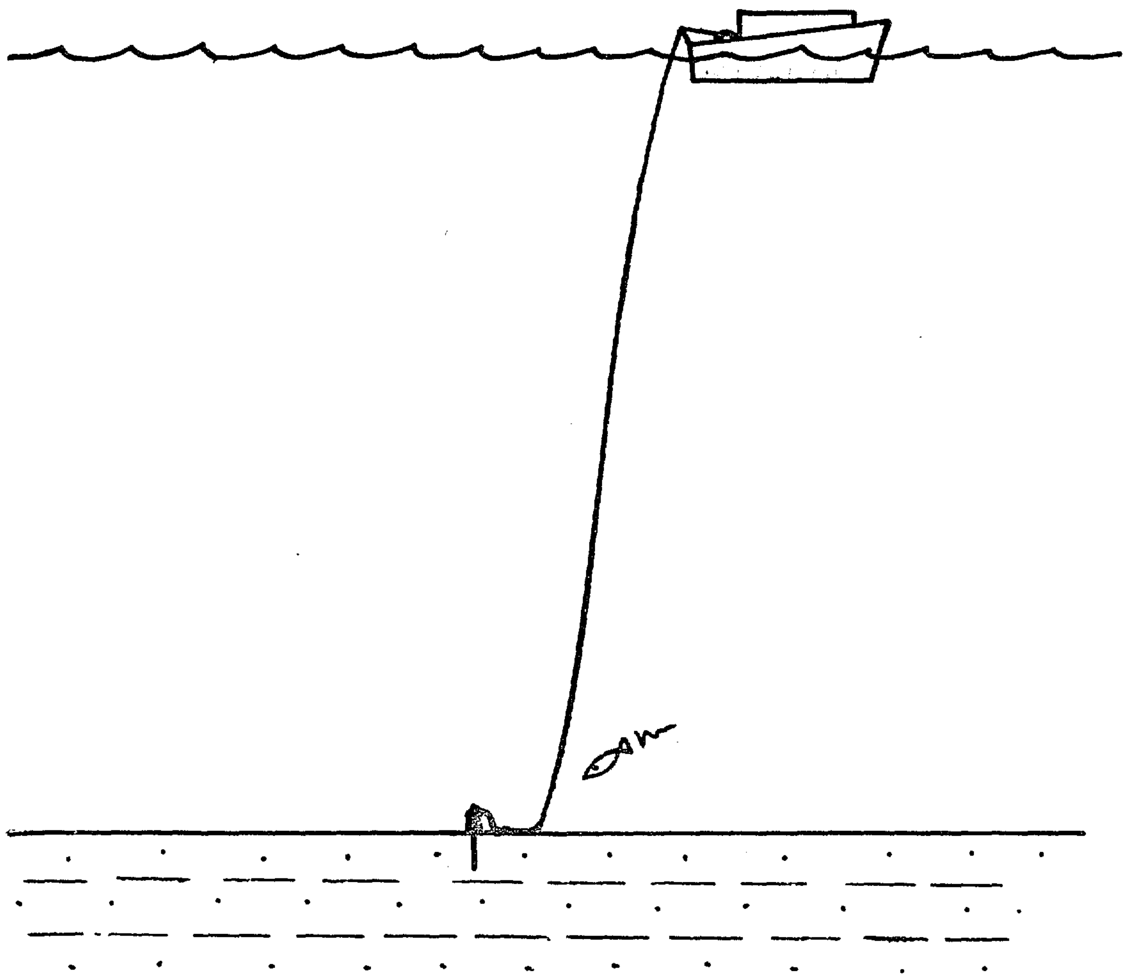


Fig 2

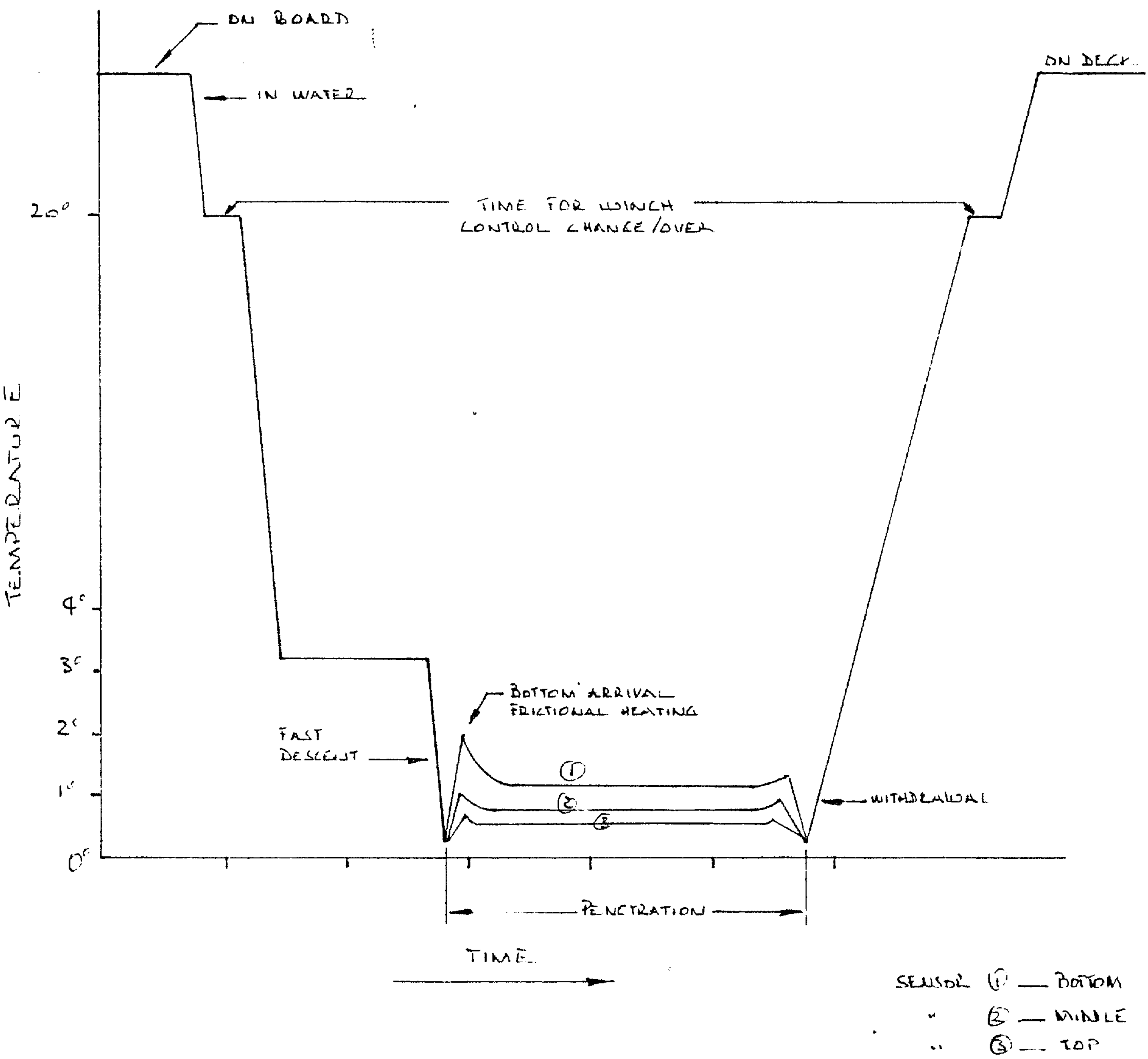
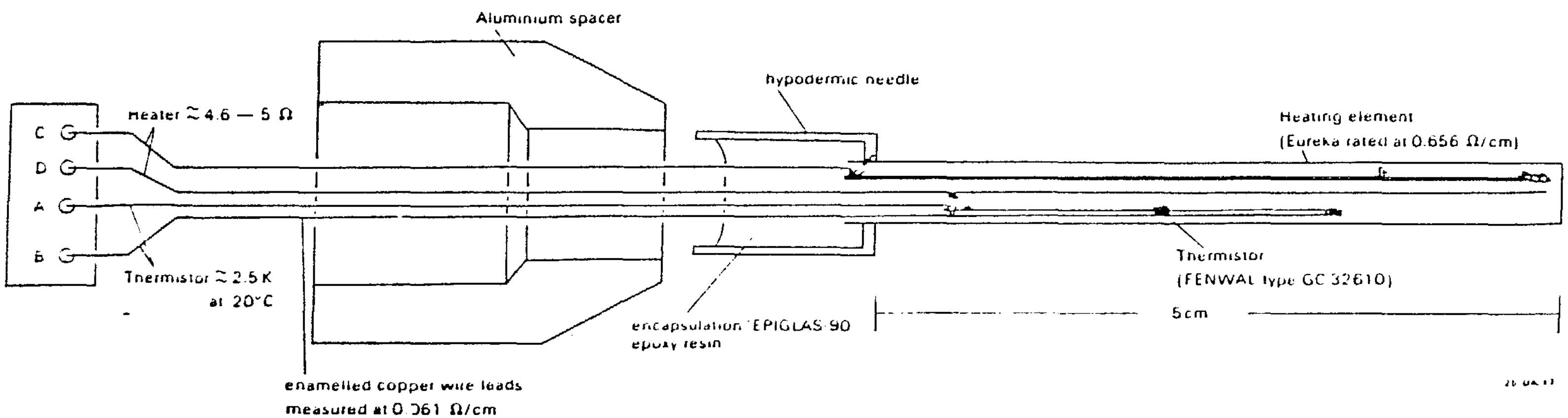
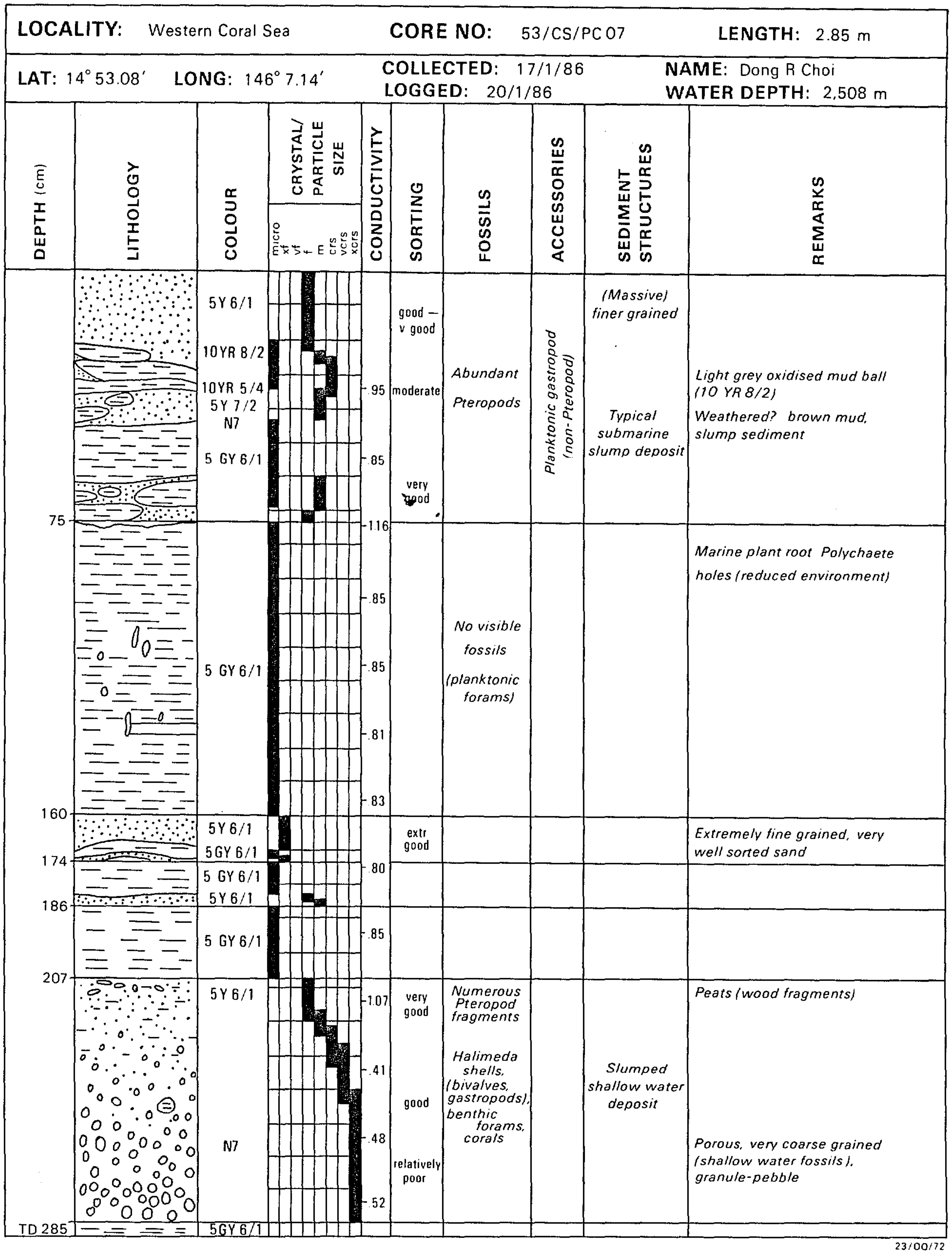

ON BOARD
IN WATER
ON DECK
20°
TIME FOR WINCH
CONTROL CHANGE/OVER
TEMPERATURE
4°
3°
2°
1°
0°
BOTTOM ARRIVAL
FRICTIONAL HEATING
FAST
DESCENT
1
2
3
WITHDRAWAL
PENETRATION
TIME
SENSOR 1 — BOTTOM
" 2 — MIDDLE
" 3 — TOP

Fig 3



THERMAL CONDUCTIVITY PROBE

Fig 4



(From Choi, Stagg, and others, 1987: BMR Cruise Report No. 274)

Fig 5

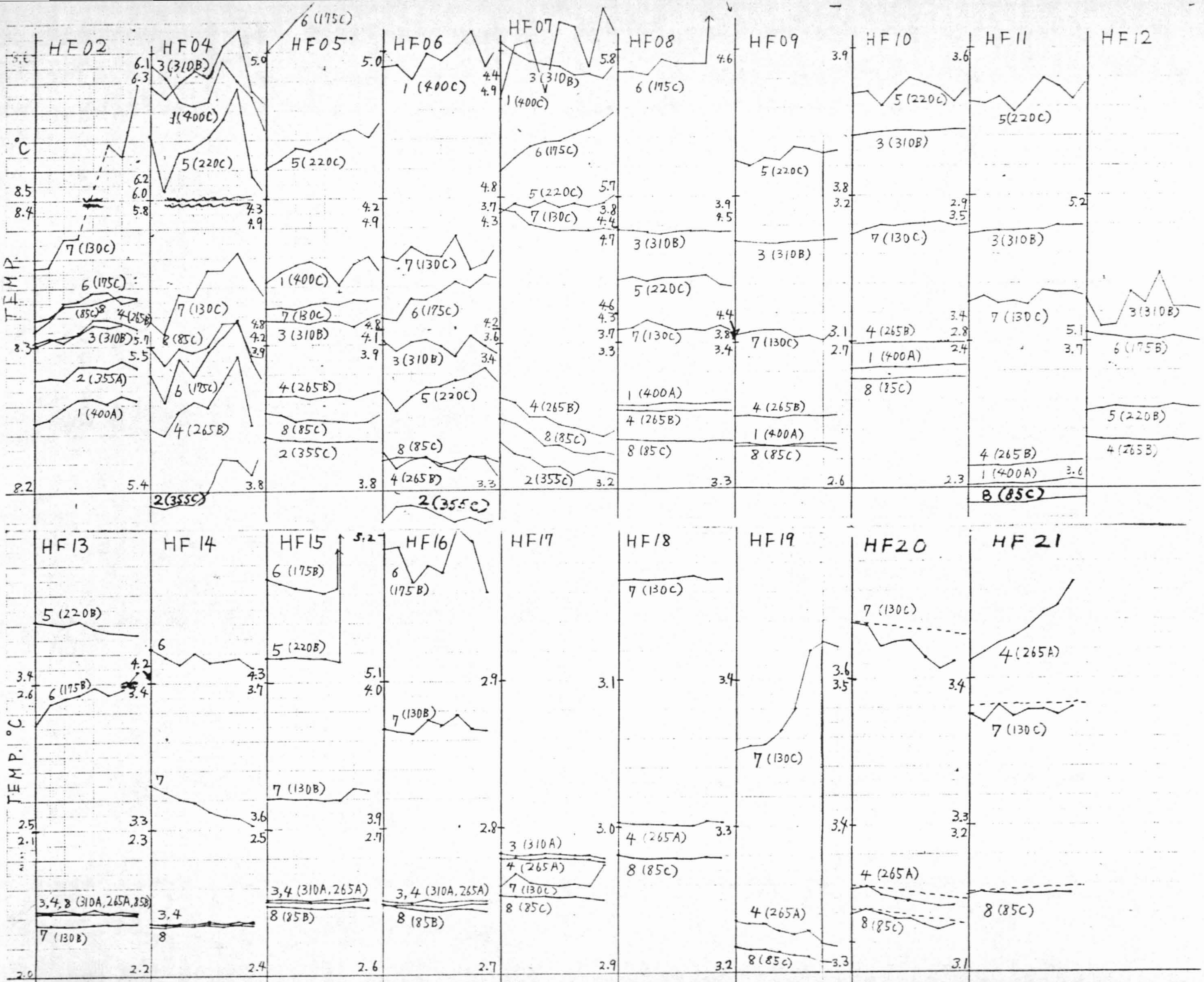

HF02
HF04
HF05
HF06
HF07
HF08
HF09
HF10
HF11
HF12
TEMP. °C
7 (130C)
6 (175C)
3 (310B)
2 (355A)
1 (400A)
3 (310B)
1 (400C)
5 (220C)
7 (130C)
8 (85C)
6 (175C)
4 (265B)
2 (355C)
6 (175C)
5 (220C)
1 (400C)
7 (130C)
3 (310B)
4 (265B)
8 (85C)
2 (355C)
1 (400C)
7 (130C)
6 (175C)
3 (310B)
5 (220C)
8 (85C)
4 (265B)
2 (355C)
3 (310B)
1 (400C)
6 (175C)
5 (220C)
7 (130C)
4 (265B)
8 (85C)
2 (355C)
6 (175C)
3 (310B)
5 (220C)
7 (130C)
1 (400A)
4 (265B)
8 (85C)
5 (220C)
3 (310B)
7 (130C)
4 (265B)
1 (400A)
8 (85C)
5 (220C)
3 (310B)
7 (130C)
4 (265B)
1 (400A)
8 (85C)
5(220C)
3 (310B)
7 (130C)
4 (265B)
1 (400A)
8 (85C)
3 (310B)
6 (175B)
5 (220B)
4 (265B)
HF13
HF14
HF15
HF16
HF17
HF18
HF19
HF20
HF21
TEMP. °C
5 (220B)
6 (175B)
3,4,8 (310A, 265A, 85B)
7 (130B)
6
7
3,4
8
6 (175B)
5 (220B)
7 (130B)
3,4 (310A, 265A)
8 (85B)
6 (175B)
7 (130B)
3, 4 (310A, 265A)
8 (85B)
3 (310A)
4 (265A)
7 (130C)
8 (85C)
7 (130C)
4 (265A)
8 (85C)
7 (130C)
4 (265A)
8 (85C)
7 (130C)
4 (265A)
8 (85C)
4 (265A)
7 (130C)
8 (85C)

Fig 6

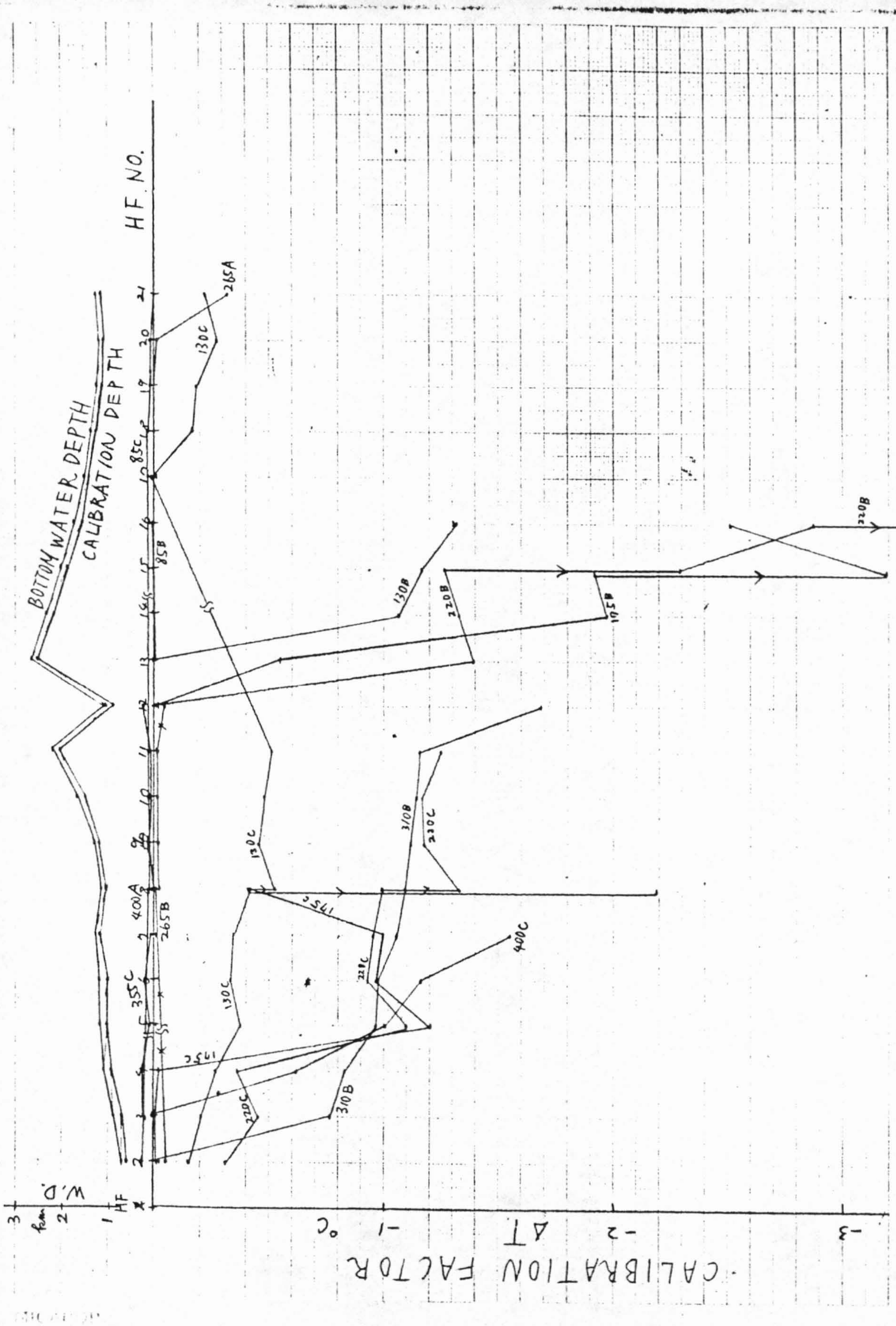
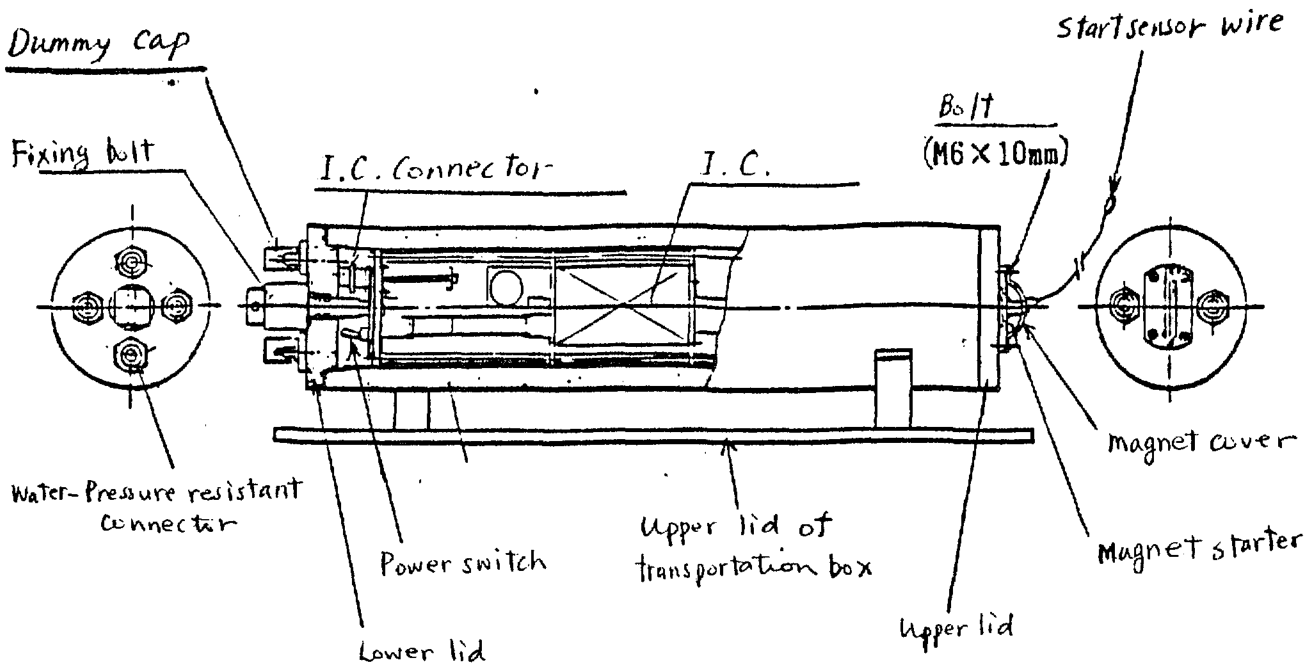
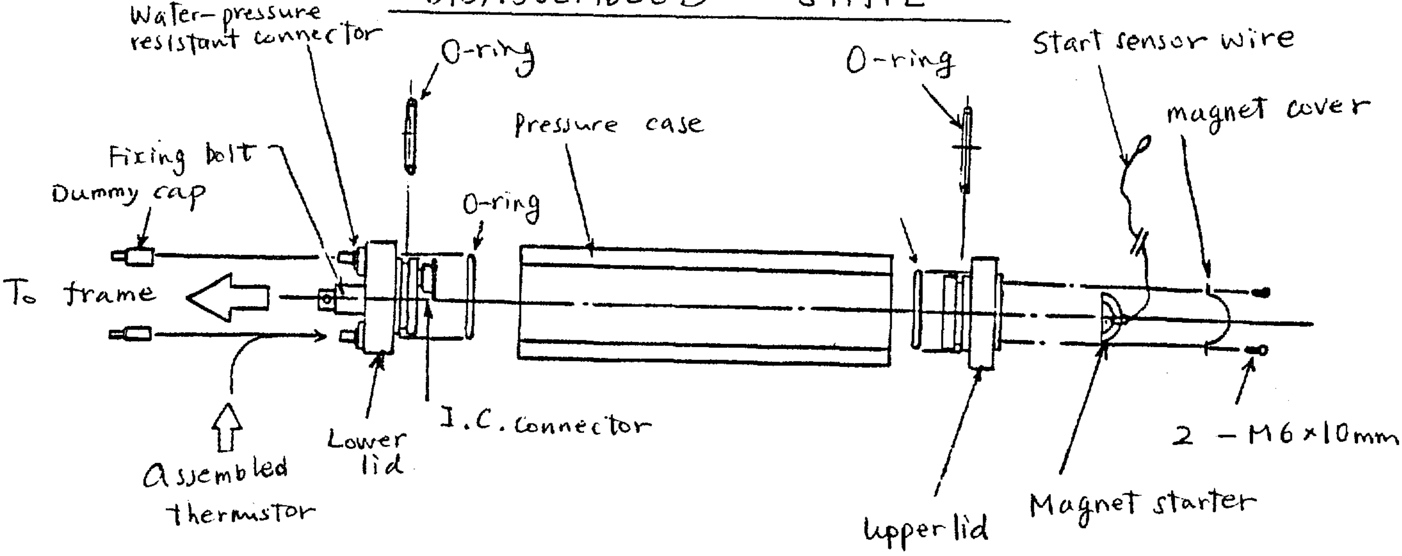

BOTTOM WATER DEPTH
CALIBRATION DEPTH
H.F. NO.
CALIBRATION FACTOR
ΔT
°C
W.D.
km
HF

Fig 7

PRESSURE-TIGHT CYLINDER



DISASSEMBLED STATE



INTEGRAL CIRCUIT

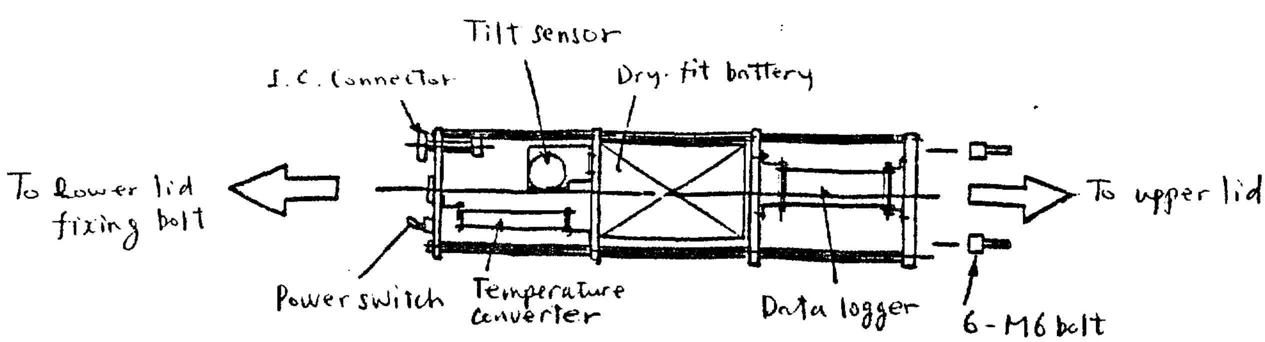


Fig 8

ASSEMBLED THERMISTOR

Colour of cable	Thermistor number	Thermistor	Water-pressure resistant cable	Total length
		A (mm)	B (mm)	L (mm)
黄 Yellow	01	4000	600	4600
	02	3550	600	4150
青 Blue	03	3100	600	3700
	04	2650	600	3250
赤 Red	05	2200	600	2800
	06	1750	600	2350
黒 Black	07	1300	600	1900
	08	850	600	1450

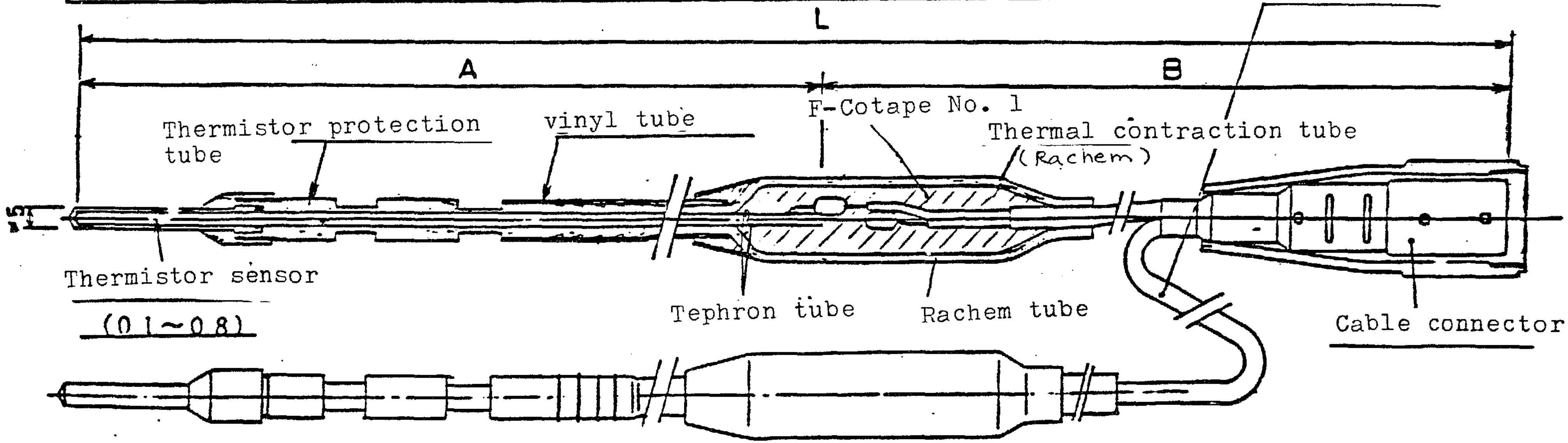


Fig 9