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The IOSDL Neil Brown CTD systems
Operation and maintenance manual

J Smithers

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Natural Environment Research Council

INSTITUTE OF OCEANOGRAPHIC SCIENCES
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ABSTRACT

This manual provides a description of the IOSDL CTD systems and their development, with notes on operation and maintenance at sea.

KEYWORDS

CONDUCTIVITY CELL
CTD
OXYGEN SENSOR
PLATINUM RESITANCE THERMOMETER
ROSETTE MULTISAMPLER

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1.INTRODUCTION.

The IOSDL CTD system up to 1990.

During late 1973 it was decided to replace the Bisset Berman 9040 Salinity, Temperature and Depth (STD) systems used by NIO as it was then, with a newer instrument of higher resolution and accuracy. To achieve these aims 3 sets of Neil Brown MKIIIb Conductivity, Temperature and Depth (CTD) electronics/sensors and a deck unit were purchased. One set of electronics/sensors was housed in a stainless steel pressure case of 7 inches diameter and 24 inches in length with a full ocean depth capability of 6500 metres and another in a reduced diameter aluminium pressure case of 1000 metre capability. These instruments measured Conductivity, Temperature and Depth respectively, using a small 1 cm four electrode conductivity cell, platinum resistance thermometer, bonded strain gauge and included a fast response thermistor.

The deck unit featured FSK demodulator (Frequency Shift Keyed), binary to BCD converter with drivers for 12, 5 digit displays of measured parameters in engineering units, 3, 12 bit D/A converters for analogue output to a chart recorder, parallel and serial data computer outputs. The parallel outputs were used to drive an IBM 1800 shipborne computer system and the serial output a Hewlett Packard 2100 system. The serial data link was standard Teletype format that ran at the FSK clock frequency of 3.3 Khz Ie non-standard Baud rate. The original Batfish system was purchased in 1974 and was used with the shallow CTD.

During 1976 a General Oceanics Rosette Multisampler with a capacity of 12,1.7 L Niskin Bottles was added to the system and a second deck unit purchased.

A second full ocean depth CTD was constructed at IOS in early 1978. This CTD included a Beckman Dissolved Oxygen probe. Further developments were made to the shallow CTD to interface a Plessey Irradiance meter and Variosens Fluorimeter.

These were respectively a counter and A/D converter circuit. The Fluorimeter was later replaced with one manufactured by Chelsea Instruments Ltd. A Seatech Transmissometer was added and an improved A/D converter designed, for use by this and the Fluorimeter. A dissolved oxygen sensor and interface were also added to this CTD.

During 1976 modifications were made to the CTD deck units and a set of electronics designed to allow storage of the raw data in Ascii format, onto 9 track magnetic tape instead of the original audio tape recording method.

In 1978 a second CTD with an Aluminium pressure case was added to the system. The dissolved oxygen sensor, fluorimeter and transmissometer interfaces were also included in this CTD.

From about 1984 it was decided to abandon the use of the fast response thermistor circuit in the CTDs. This was partly on economic grounds, as the mounted thermistors were both fragile, short lived and expensive to purchase.Secondly it was felt that the performance was not entirely satisfactory.

If we look at the fast response thermistor circuit in a simplified way, it behaves as follows:-

The platinum resistance thermometers have a time constant varying from about 180-250 msecs depending upon the probe used. The conductivity cell has a flushing time constant of 30 msec. Salinity is computed from pressure, temperature and conductivity according to well defined algorithms. It can easily be seen, that at any instant the temperature of the water volume sampled by the conductivity cell is not quite the same as that measured by the platinum thermometer, due to this difference in response times, thus computed salinity will be incorrect.

The thermistor chosen, has a rise time constant of 30msec, Ie the same as the flushing time constant of the conductivity cell. Using carefully designed filters, the decay time of the thermistor is matched to the rise time of the platinum thermometer. The thermistor circuit output is AC coupled to remove DC steady state conditions and then summed with that of the thermometer, giving a response that has the same time constant as the conductivity cell, but with the stability of the platinum thermometer.

From intensive SeaSoar work carried out during the Jasin cruises in 1984, it was realised that the fast thermistor circuit had some shortcomings. Whilst it could match the platinum thermometer time constants to that of the conductivity cell well enough for the slower vertical casts, the rapid transit of SeaSoar through large temperature gradients produced errors that required large amounts of processing time to produce reasonable data. It was decided that a better result could be obtained by using the more powerful computing facilities available, to make the appropriate lag corrections to the temperature data.

From that time on, all of the CTDs were operated without the fast thermistor circuit. This equipment was used extensively until the present day.

2. Description of the present CTD system.

The original deck units, although fairly versatile, were beginning to show their age and were expensive to replace in their original form. With the advent of powerful desktop PC,s, it was decided to adopt the new Neil Brown/Eg&G CTD deck units and recommended CTD power supplies.

Basically, the deck units consist of an FSK demodulator board running at 5/10 Khz instead of the older 3.3/6.6 Khz arrangement. Only a small alteration to the CTDs has been necessary to implement this change. A microprocessor then controls the data flow and format to 3 serial ports, namely host, data and terminal.

A PC with the necessary software is used to display real time data graphically or in engineering units, and log it as a back-up to the main data processing being carried out by the RVS level A, B and C systems. Data logged by the PC are also backed up onto an integral tape streamer, replacing the rather cumbersome 9 track tape system. This new equipment has been operated with the existing CTDs on 2 cruises, for both vertical CTD profiling and SeaSoar surveys. The system has proved to be both reliable and easy to operate.

The Rosette Multisampler electronics and Firing module have also been replaced with Neil Brown electronics. This allows the Niskin bottles to be fired without data interruption. Previously the General Oceanics firing unit interrupted the power supply and data from the CTD. This made it difficult to calibrate the oxygen sensor, due to its long recovery time after disconnection. Triggering of the bottles can be from either the firing module or from the PC, as and when required, or to some predetermined specification.

The CTD deck unit, power supply and Rosette firing module are doubled up and racked in purpose built cabinets featuring shock absorbing mounts.

A new Neil Brown MKV CTD has been purchased but not operated as yet. The MKV CTD does have the fast temperature option but this is digitised separately.

CTD No. Shall1 has been modified to include two sensor head assemblies. A second Conductivity cell and interface has been fitted with the appropriate modifications to the Memory and Multiplexer board, to allow storage of the two extra conductivity data words. The Eg&G software package has also been modified to incorporate the two new parameters, CON2 and SAL2.

CTD No. Deep02 has been fitted with Oxygen sensor, Fluorimeter interfaces and the present version of Signal Generator board.

3. MKIIIB CTD OPERATING INSTRUCTIONS FOR VERTICAL WIRE CASTS.

3.1 Terminating the vertical profiling sea-cable.

On joining the ship you will probably find that the sea-cable has been terminated with a connector other than the one you require.

Start by cutting the cable back to an unused part inboard of the old termination.

To make up the new joint you will need a hard eye or heart thimble and four or five 3/8 inch Bulldog clamps. The hard eye or heart thimble should be large enough to comfortably allow the sea-cable to bend around it without undue stress on the armouring.

Self-amalgamating and PVC tapes, 'Cow-gum' or 'Silastic', soldering equipment, heavy duty cutters etc will be required. Use a soldering iron with at least a 1/4 inch bit as you are going to solder to the cable armouring. Bend about 6 feet of the sea-cable around the hard eye and fasten in place as close to the eye as possible with a Bulldog clamp. At 6 inch intervals fasten at least two more clamps around the cable.

The loads applied to the cable have been increasing over the years with the larger Rosette Multisampler and Instrument packages being used. On this basis a total of at least three clamps should be used, a fourth being added if dynamic loads are likely to be high due to the sea states expected. The cable is now bent back towards the eye and fastened with another clamp to the inboard side of the previous clamps. The distance between the hard eye and the top bend will be about 3 feet.

One of the perennial problems with sea-cables is protecting the soldered joint from damage during subsequent lowerings. In order to alleviate this problem, try to make the joint occur somewhere between the hard eye and the top loop. It can then be taped back onto the doubled sea-cable giving some strengthening and protection. Cut the cable to correctly position the joint and wrap several turns of PVC tape around it, about 6 inches from the end. Unwind each of the outer strands and cut back to the tape. Cover the cut ends with tape to prevent the sharp ends causing injury. Wrap PVC tape around the cable about 3 inches from the end and do the same with the inner strands of armouring but leave 2 or 3 strands full length. This will expose the insulated single/multi-stranded centre electrical conductor. Strip 6-8 mm of the insulation being careful not to cut into the conductor/s. It is a good idea to cut the conductors to unequal lengths so that the soldered joints do not occur side by side. Clean the strands of armouring that have been left full length with emery cloth, and tin these and the centre conductor with solder. You will now see the need for the large soldering iron bit. Cut a 42 inch double ended Brantner 2 pin connector in half, remove the outer sheath for about 2 inches. Cut and strip back the conductor insulation by 6-8 mm matching the lengths to those of the sea-cable. Remember the white covered conductor is connected to the larger of the two Brantner pins and will be used for the ground connection to the outer armouring of the sea-cable. The grey one will be connected to the centre conductor and is used for the CTD power/signal supply. The Brantner cable will not be long enough on its own to reach the CTD junction box that links the instrument packages together.

A proprietary underwater 2-core cable will be necessary to join the Brantner to the sea-cable. It has been found from experience that 2-core Metvin can also be used for this application. Whichever is used, prepare the cable ends for joining, staggering them as before. Use heat shrink sleeving on each conductor and solder the joints together. Start with the inboard joint first. When the joints have been soldered and before taping up, check the electrical continuity of the wiring.

Cover the whole joint area and 5 or 6 inches of the cables either side,with 'Cow-gum' or 'Silastic' as preferred. 'Cow-gum' adheres better to the Neoprene sheaths of the Brantner and similar cables. Allow the solution used to become tacky before proceeding further. Wrap the whole area with self-amalgamating tape being careful to stretch this to about half of its original width, and overlap the turns by about half their width. Build up the tape in the soldered joint area to make a neat finished product of uniform cross section. Cover the whole with several layers of good quality PVC tape. Make up the second joint in the same way and check the electrical continuity before taping up.

The inboard joint can now be taped back along the doubled cable with PVC tape. Protection of the second joint may not be quite so straightforward, but usually it can be taped back to part of the Instrument frame after the sea-cable is shackled up. It is best to leave this until all slack in the sea-cable can be taken up on the winch. It will then be more obvious how the cable will lead, and allow the best position for fastening to be chosen. Once again check the electrical continuity. Allow at least 12 hours if possible for the joint to cure before deploying the package.

From experience it has been found that using the termination straight away, can result in the ingress of sea water into the joint. This does not usually cause failure immediately , but some time later after 'fizzing' has occurred, the joint then fails.

3.2 Testing the MKIIIb CTD system.

Mount the CTD and other instrument packages to be used in the CTD/Multisampler frame. Connect the sea-cable to the instrument package and connect the instruments together as shown in Figs 1-4.

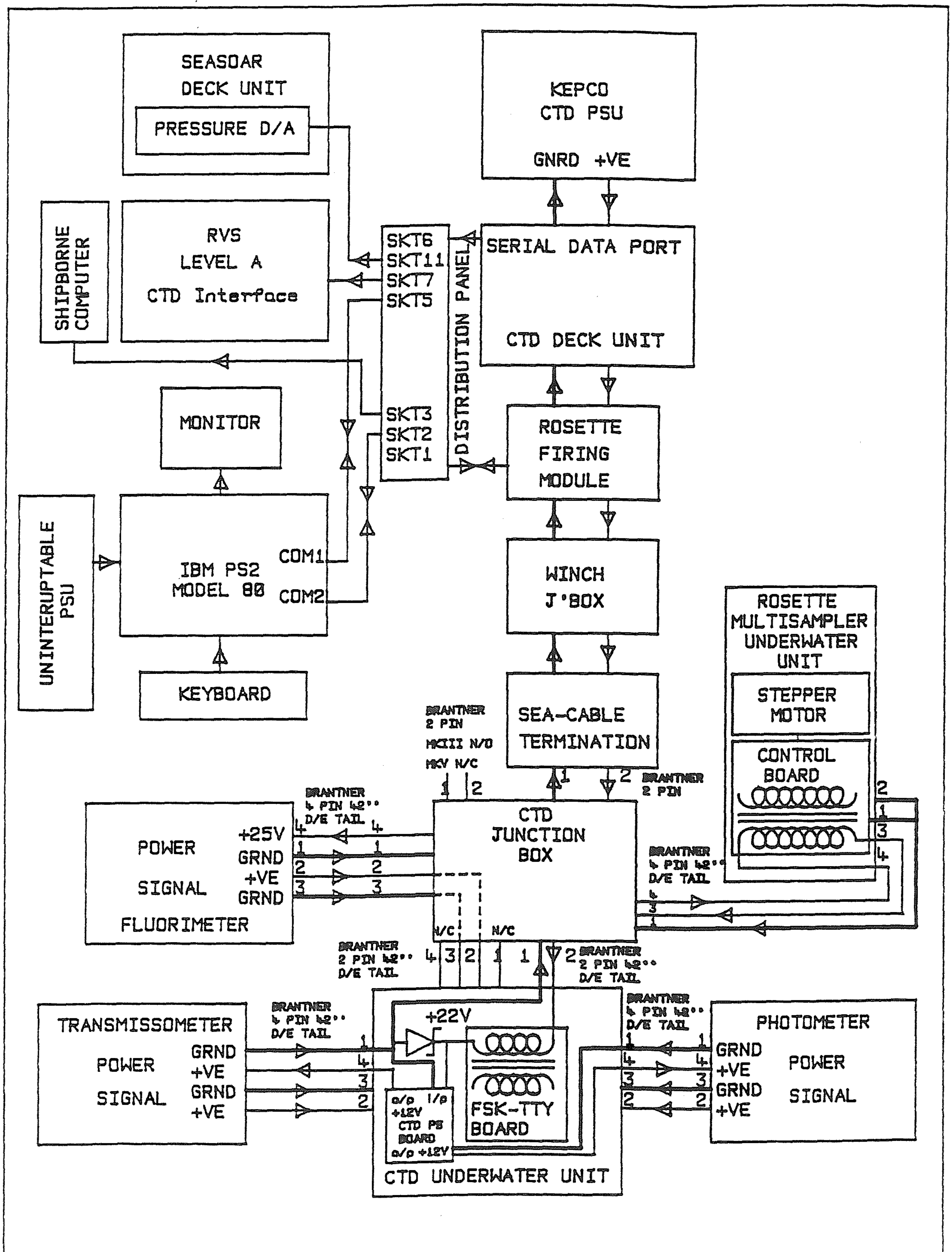

FIG. 1. CTD VERTICAL PROFILING BLOCK SCHEMATIC.

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DATE	09-01-91

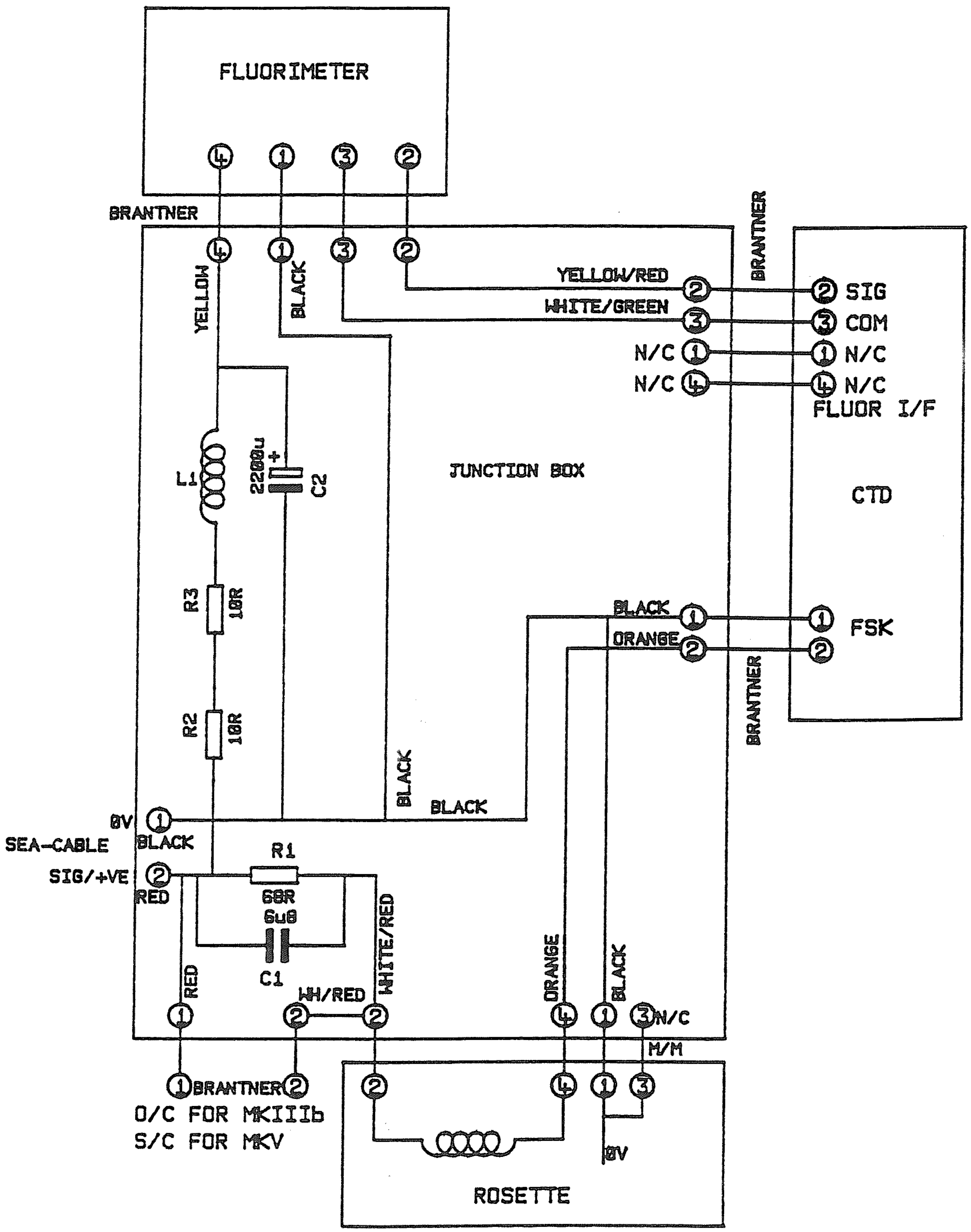

FIG.	2.	CTD JUNCTION BOX.	DRAWN	J.SMITHERS
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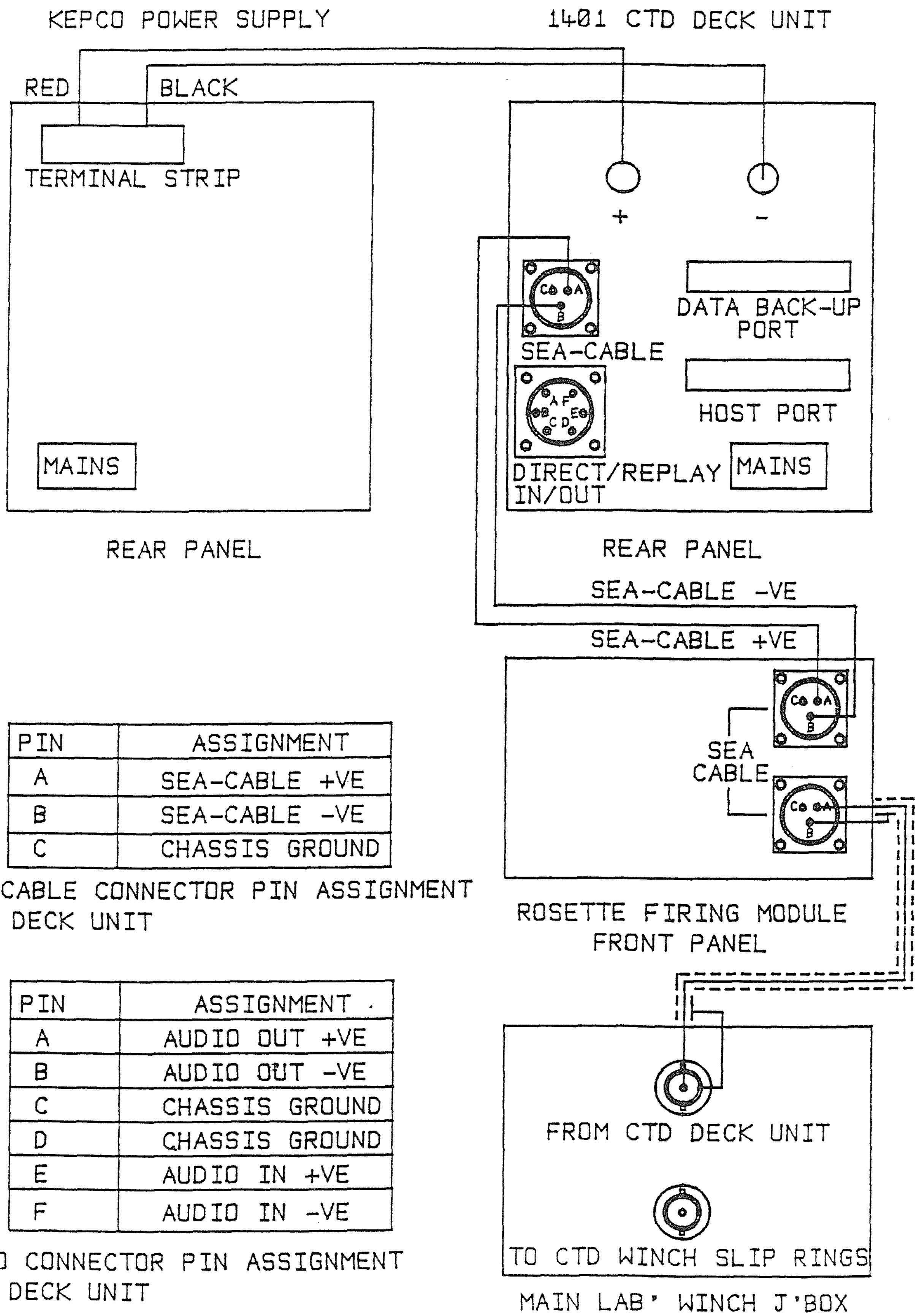

PIN	ASSIGNMENT
A	SEA-CABLE +VE
B	SEA-CABLE -VE
C	CHASSIS GROUND

SEA-CABLE CONNECTOR PIN ASSIGNMENT
1401 DECK UNIT

PIN	ASSIGNMENT
A	AUDIO OUT +VE
B	AUDIO OUT -VE
C	CHASSIS GROUND
D	CHASSIS GROUND
E	AUDIO IN +VE
F	AUDIO IN -VE

AUDIO CONNECTOR PIN ASSIGNMENT
1401 DECK UNIT

FIG.	3.	SCHEMATIC WIRING DIAGRAM FOR VERTICAL PROFILING CTD.	DRAWN	J.SMITHERS
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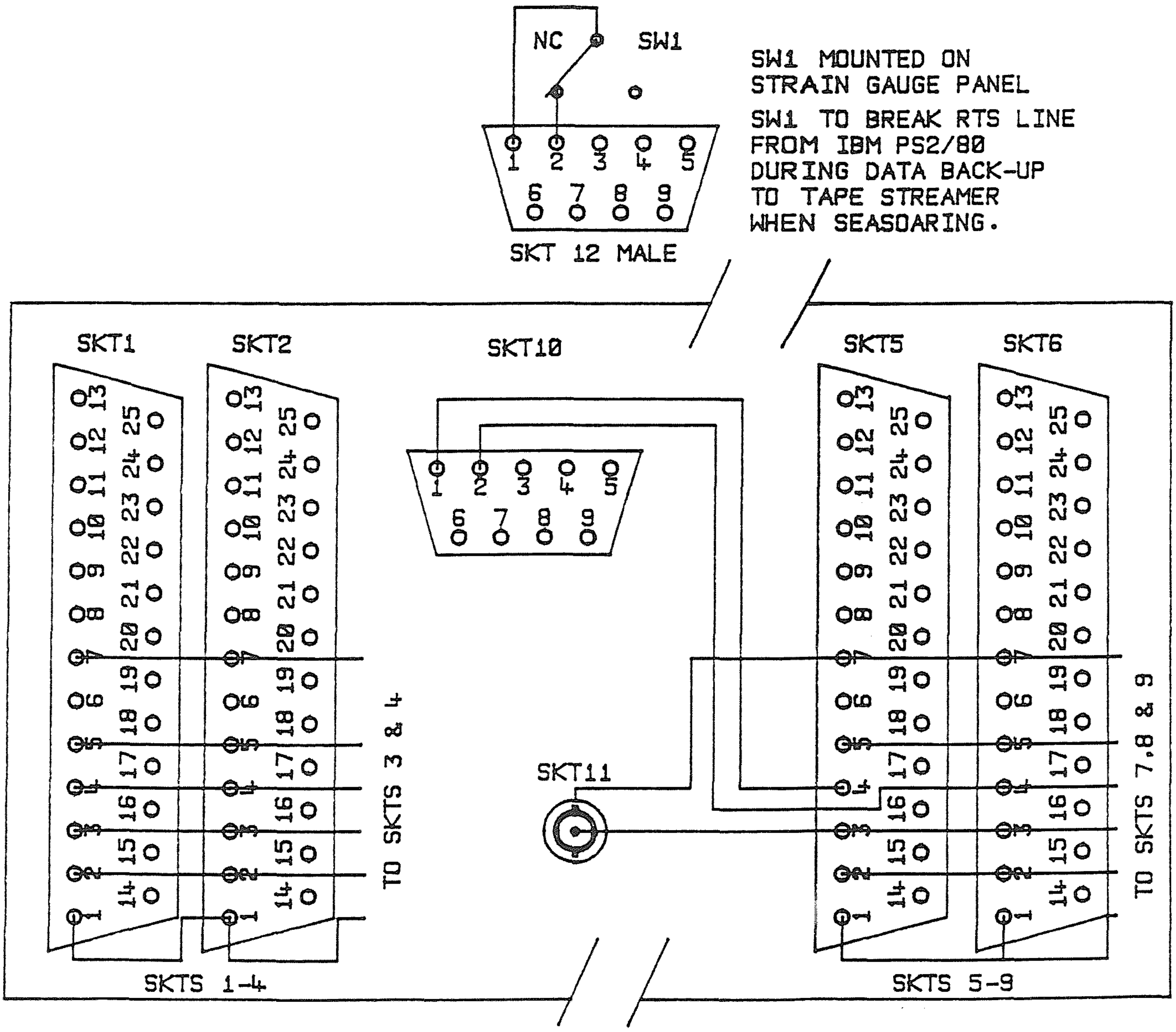
SKT	CONNECTED TO
1	ROSETTE FIRING MODULE
2	IBM PS2/80 COM PORT2 (9 WAY D)
3	RVS SHIPBORNE COMPUTER
4	SPARE
5	IBM PS2/80 COM PORT1
6	1401 DECK UNIT DATA BACK-UP PORT
7	RVS LEVEL A
8	SPARE
9	SPARE
10	SW1 VIA SKT12 STRAIN GAUGE PANEL
11	SEASOAR CONT'R MODULE 4



SKT PANEL REAR SEASOAR CONT'R CABINET

FIG.	4.	1401 CTD DECK UNIT & ROSETTE FIRING MODULE DISTRIBUTION PANEL SCHEMATIC.	DRAWN	J.SMITHERS
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The CTD deck unit must be started up in AUTOSTART MODE 22.

The 8 pole DIP switch on the right front of the CTD deck unit is used to set the start-up mode.

A switch is on when the left hand side is depressed.

Switches 2,3,5 and 9 on.

Switches 1,4,6,7 and 8 off.

Switch on the CTD deck unit and CTD power supply.

If the instrument package does not include a Fluorimeter and the Rosette Firing Module, then adjust the power supply voltage until a load current of 110 mA is obtained. The voltage should be approximately 35 VDC, but will vary depending upon the length of sea-cable in use. If there is a voltage but no load current then refer to the CTD trouble shooting guide section 5.

With the Rosette Firing Module and underwater unit in circuit, the load current should be increased by 150mA ; Ie, 75mA each, for deck and underwater units. See table below for deck compliance voltages for various CTD configurations.

If a Fluorimeter is installed then adjust the power supply voltage until a load current of 350 mA or 510mA is obtained. The voltage should be approximately as shown below. Similarly, if there is no load current refer to the CTD trouble shooting guide section 5..

Deck Compliance Voltage for various CTD configurations.

Instrument	Cable Length	2,500M	5,000M	10,000M
	Load Current	DCV	DCV	DCV
MKIIIb only	110mA	30	36	47
+Rosette only	270mA	39	52	79
+Fluorimeter only	360mA	43	1	97
+R and F	510mA	51	76	127
MKV only	370mA	50	68	105
+Rosette only	520mA	57	83	135

Assumes a sea-cable resistance of 20 Ohm/1000M.

3.3 Setting up the Acquisition software for testing a CTD.

To check the operation of the CTD, load and run the Eg&G Oceansoft Data Acquisition software package as follows:-

Type in the lines below, the necessary keystrokes are shown thus < key >

A number of options are available for handling the deep CTD stations and SeaSoar operations. Standard deep stations can use the original version of the software residing in the directory C:\CTD
CD\CTD <return>to select the CTD directory.
CTDACQ/M <return>.

This selects and runs the software with a lower monitor resolution .When using the List data option as opposed to a Graphical one , the display will roll if the /M option is not added. This seems to be a feature of the PS2/80 and may not happen if some other type of PC is used.

This is the standard version of the software. There is a second version primarily for SeaSoar operations, which resides in the C:\CTD directory. SEASOAR or SEASOAR/M <return> to run.

This version allows semi automatic data back-up to tape streamer during acquisition, but with only one Conductivity Cell.

A third option is available for handling the double Conductivity cell version for use in SeaSoar. The directory is;
C:\CTDCON2
CTDCON2 or CTDCON2/M <return> to run.

Before starting any SeaSoar operations and when running either SEASOAR or CTDCON2 you need to alter some of the batch files in the PS2TAPE directory. See section 4.4 Backing-up data files for information on how to do this.

The left and right arrowed cursor keys,<TAB>,<SHIFT-TAB> and <return> are used to select options from the menu-bar. Selection of any option will present a pull-down menu of the choices available within that option.

Information is supplied to the program via 'Data Entry' or 'Set-up Forms'. Each form contains fields into which the operator can type the appropriate information.

Alphanumeric' fields allow any Ascii character to be entered, whereas 'numeric' fields will only allow numbers.

Numbers may be entered in scientific notation. Both types of field can be edited using the INS and DEL keys. When the cursor is first moved to a field and a number or letter typed, then the original contents of that field will be erased. If the arrow keys are used to move the cursor within the field, the contents will not be erased and can be edited.

'Pop-up Multiple Choice' fields are used where only certain choices are available, in this case none of the editing procedures will apply.

The <F1>, <F2>, <F5> and <ESC> keys provide single key-stroke functions for the set-up forms as follows:-

<F1> provides a data entry help screen giving instructions about cursor movement and field entry.

<F2> saves the form set-up information. Data information in each field is checked for errors. If there are none, then pressing <F2> will save the data and return to the Menu-bar.

If any error is present then a warning will be signalled and the cursor placed at the start of the offending data field. Control will not be returned to the menu whilst an error still remains.

<F5> clears data from the selected field.

<ESC> Leaves the form without saving any changes made and returns to the menu.

Use the left and right cursor keys to select the 'Settings' option, then the up and down cursor, <return> keys to select the 'Cast - Set-Up' option.

At this stage it is not necessary to enter all of the required information into the set-up form. However, the appropriate 'Instrument' and 'Calibration' files must be chosen.

Move the cursor to the 'Instrument Ser.#' field using <tab> <return>.

A list of available instruments will be shown.

Use the up and down cursor, <return> to select the appropriate Instrument.

The identification format is either IM or IS plus DEEPnn or SHALLnn, meaning MKIIIb or Smart CTD, Eg IMDEEP01.

This indicates that MKIIIb Deep CTD No.1 has been chosen.

The cursor will move to the next field required, which is 'Use CAL File name:'. <return> to display the available calibration files.

The calibration files are of the form IMDEEP01.Cnn.
The '.C00' file extension should be chosen.
Up and Down, <return> to select.

<F2> to save and exit the form.
Up and down keys, <return> to select the 'Listing Set-up' option.

<tab>, up and down to 'Screen'.
<space-bar> to toggle screen select. A tick will appear when the screen option is selected.

<tab>, <space-bar> to select printer output if this is required, a tick will appear if this option is selected.

Up and down keys to select 'Listing Parameter 1.'.
<return>, displays the list options.
Up and down cursor, <return> to select parameter.

Note. Any parameter marked '*' is a derived variable.
The cursor will move to the next parameter after a selection.

<tab> to select the 'Printer Listing Parameters'
This part of the set-up form shows 10 printer listing levels, but need only be set up if the 'Printer Listing' option is chosen.

<tab> to select the first 'Level #1.'

If no listing is required for say the first 10 Decibars, enter 10 in both the 'Pressure Bound' and 'Listing Interval' fields.
To list every scan set the Listing Interval to (0).
It is possible that when the system is run, the printer may not be able to keep up with the full data rate, therefore some scans may not be printed.

Enter the 'Upper Pressure Bound' required for that level, <return>.
The cursor will then move to the 'Listing Interval in Decibars'.
Enter the required interval, <return>.
The cursor will move to the next 'Level #'.
Repeat the previous two steps for each level.
It is not necessary to fill in all of the levels.

<F2> to save and exit the form.

Left and right cursor keys to select the 'Acquisition' option from the menu-bar.
Up and down, <return> to select the 'Deploy Instrument' option.
Follow the instructions at the bottom of the Monitor display to run the Acquisition program.
The screen data listing will show if the CTD is functioning correctly.
When satisfied that all is well the listing can be terminated by <CTRL>+<F10> together.

You will be asked to enter the 'Latitude'.
At this stage just press <return>.
Do the same with 'Longitude'.

You will then be asked if you require an up-cast.
<n>, <return> to this.

Depending upon how long you have been acquiring data, you may be informed that 'This was a short cast, do you want to increment the cast number. Y/N'.
To this answer <n>, <return>

<esc> to return to the menu-bar.

3.4 Testing the MKV CTD and software.

The MKV CTD Acquisition software is identical to the MKIIIb.

The CTD deck should be set to AUTOSTART MODE 22.

To run the software :-
Type CD\MKV.
Type MKVACQ or MKVACQ/M as required.

The instrument identification is IU221021 and the calibration file IU221021.C00.
The procedure for power-up of the MKV CTD is different from that of the MKIIIb CTD.
The CTD power supply current limit should be set at 1 Amp and the voltage control set anti-clockwise to zero output.

Slowly turn up the voltage,the current will rise to about 200 mA as the dummy load inside of the CTD turns on. Continue increasing the voltage.

The current will decrease slightly and then increase to about 500 mA, then drop to 370 mA as the CTD turns on. The load current should be increased to 520mA if the Rosette Firing system in circuit.

Increase the voltage to give 50 VDC measured at the CTD. The voltage required will obviously vary according to the length of sea-cable in use. If the CTD system does not function, refer to the CTD trouble shooting guide, section 5..

Both the SIG and SENSE/IDLE Led's on the deck unit will be on continuously. After a delay of 20 seconds the CTD should start transmitting data. The FSK tone will be heard on the Audio output and the SENSE/IDLE Led will flash.

If the CTD has been turned off for a number of days, then the data transmission may not start up. This is due to a capacitor start-up arrangement within the instrument.

Leave the CTD in this mode for 10 minutes, then reduce the voltage to zero and restart.
The data transmission should now start.

The procedure for operating the Acquisition software is exactly the same as for the MKIIIb already described.

4. SETTING UP THE MKIIIB/MKV CTD SYSTEM FOR A VERTICAL CAST.

At this stage the instrument package should have been tested, together with the Acquisition software. Assuming everything is functioning correctly then the system can be set up for a cast. If any problems have occurred then refer to the CTD trouble shooting guide for help.

Start by loading and cocking the Rosette Multisampler.

4.1 Loading and cocking the Rosette Multisampler.

The 10 Litre Niskin bottles are quickly and easily mounted on the Rosette frame.
First securely tie a length of cod-line to one of the strengthening members between the top and bottom Rosette plates. This should be of sufficient length to pass between each Quick-release shaft and bottle with enough left to tie off.

Locate the lower bottle support onto the appropriate pin on the bottom Rosette plate. Push the Quick-release shaft down. This is located at the top bottle support behind the top cap. The bottle can then be pushed into place and the Quick-release engaged in the Rosette top plate. Pass the cod-line between the Quick-release shaft and the bottle. Do this as each bottle is mounted. When the required number of bottles are in place, tie off the cod-line to one of the uprights between the top and bottom Rosette plates.

During a cast it is possible in heavy weather for the surging that takes place, to operate the Quick-release shaft.

NOTE: If the bottles are not tied to the Rosette in some manner then they will surely be lost.

IMPORTANT.

Make sure that the central slotted shaft or knurled knob protruding from the top plate of the multisampler, is aligned correctly before cocking the water bottles. The slotted shaft has a sloping shoulder machined on it, which should face the 12th or 24th bottle position depending upon which multisampler is in use. The knurled knob has an indication line on its top face for correct alignment. The slotted shaft can be rotated with the tool provided, or a large bladed, short screwdriver can be used with care.

Cock the water bottles and thermometer frames.

To do this, disconnect the clip securing the top and bottom endcaps. Push the top cap towards the centre of the Rosette and hold in this position. Insert the loop at the end of the lanyard into the opening between the nylon ball and the outer wall of the opening. Insert the cocking tool at the rear of the opening and with a slight downward pressure pull the release pin back towards the lanyard loop. A faint click will be heard when the release pin is locked.

If the pin locks and the lanyard has not been properly engaged, then insert the cocking tool and pull the release pin up and towards you, this will release the pin.

Cock all of the bottles in this way. It is then a simple matter to pull open the bottom cap and clip the bottom cap lanyard to the extension loop from the top lanyard.

The thermometer frames should be turned clockwise and the small nylon ball fitted to the end of the frame lanyard located in the slotted recess situated in the top cap. If you find that this recess is not at the front of the cap then unclip the top and bottom lanyards and rotate the top cap to the proper position. Reconnect the lanyards.

Check that the air vent cocks at the top of the bottles are closed, but do not tighten to breaking point.

Pull the taps at the bottom of the bottles fully out until they click into place.

Check that all lanyards are in place and cannot foul anything.

Now is a good time to switch on the Digital Reversing Thermometers.

Take the magnet provided and stroke it against the hatched area marked on the thermometer. The display will turn on and the 'Hold' mode will have been selected.

The second application of the magnet will select the 'Continuous' mode and the third and last the required 'Sample' mode. Occasionally, a thermometer will appear to switch straight through to the 'Sample' mode at the second application of the magnet, this is perfectly in order.

4.2 Setting up the Acquisition software.

Refer to the Eg&G Oceansoft, Software Acquisition manual for a full description of the system. However the following instructions will provide a practical approach to running the software.
The previous description of the CTD software only gave details for testing the instruments and no apology is given for repeating the instructions here in full.

If the CTD software is not already running,

Type CD\ <return>,

If a graphical display is required,

Type CD\CTD,CD\CTDCON2 or CD\MKV <return>, depending upon CTD and use.

Type CTDACQ <return> or SEASOAR <return> if in the C:\CTD directory, or CTDCON2 <return>, MKVACQ <return> if in the C:\CTDCON2 or C:\MKV directories respectively.

The CTDCON2 version of the software can of course, be used for all CTD work excluding the MKV CTD.

If the data is to be listed to the screen add /M to the acquisition command.

Eg,CTDACQ/M <return>.

Remember when listing data, the display will roll if the /M option is not added. This seems to be a feature of the PS2 and may not happen if some other type of PC is used.

Left and right arrowed cursor keys to make the
appropriate selection from the menu-bar.

Select the 'Utilities Menu'.

Up and down cursor,<return> to select the 'Reset Cruise #' option and enter up to two digits,<return> for the cruise number.

Up and down cursor,<return> to select 'Reset Station #' option and enter up to three digits,<return> for the cast number.

This will normally only be carried out at the start of the cruise, although there may be times when the station number will need resetting, such as when testing the system after set-up.

Left and right cursor to select the 'Settings' option.

Up and down cursor,<return> to select 'Cast Set-Up'.

Enter the ship name,<return> up to 20 alphanumeric characters.

Enter the operators name,<return> up to 15 alphanumeric characters.

Enter the cast direction by 'toggling' the <space> bar between U or D. D or down is usually set at this stage to allow for the proper sequence of events throughout the cast. Under special circumstances when a problem has occurred this may be altered to U or up.

The Station ID is made up of the first 2 characters of the vessel name, the first 2 digits of the cruise number, a D or U for the cast direction and 3 digits for the station number.
E.g DA51D005 refers to the down cast of station 5, cruise 51 on the Darwin.

Enter the 'Start Lat' in degrees, minutes and seconds (decimal fractions of a second required).
Remember that Latitude is negative for the southern hemisphere.

Up and down to select 'Start Long' and enter in degrees,minutes and seconds.
The longitude is negative west of 0 degrees.

Up and down,<return> to select the 'Instrument Ser. #' field.
Up and down cursor,<return> to select instrument.
The Identification numbers are in the form IMDEEP01 etc.
The IM signifies a MKIIIb CTD,IU a MKV CTD and the DEEP01 or DEEP02, which of the two deep MKIIIb CTDs are in use.
There is only one MKV instrument at the moment so use IU221021.
<return> to select the 'CAL File Name' field.
Up and down cursor,<return> to select the 'Cal File Name' for the selected instrument.
These will have a .Cnn form. Normally choose the .C00 extension.

Up and down cursor to the 'Sounding Depth' and enter depth as measured by the PES system etc.

<F2> to exit and save the form .

Select 'Listing Set-up', <return>.
Use the <space> bar to toggle either the list to 'Screen' or list to 'Printer' option.

In any case the list to screen option will take precedence over a graphical selection.

Enter the 'Listing Title'.

Up to 28 alphanumeric characters, however only the first 14 will be displayed on the screen.

'Printer Listing Parameters'.
There are 10 levels which allow the 'Upper Pressure Bound' for each level and the 'Listing Interval' to be selected.
To print every scan for a level select a 'Listing Interval' of zero.
If no listing is required e.g for the first 10 decibars, then set the 'Upper Pressure Bound' to 10 and the 'Listing Interval' to 10.
There is a limit to the printing rate available so some scans may be skipped if to small an interval is chosen.

'Screen Listing Parameters'.
Seven fields are provided in which any of the standard or calculated parameters can be selected.
Calculated parameters are prefixed by a '*'.
Remember that some parameters are only available on the MKV instrument, Eg. Fast Temperature, Pressure Temperature etc.

Choose as appropriate for the cast.

Change the 'Pressure Max' as appropriate.
Select and change other parameters as required.

Try to choose sensible parameter ranges that divide easily, Eg, Temp 18 to -2 deg or 9 to -1 deg etc, Ie divisible by 10.

<F2> to save and exit the form.

Left and right cursor to select the 'Acquisition' mode.

Just before the lowering, whilst the CTD package is still on the deck;

Up and down ,<return> to select 'Deploy Instrument'.

Obey the instructions at the bottom of the graph display.

4.3 Deploying the CTD package and making a cast.

Check that the Digital reversing Thermometers are turned on.

Inspect the package generally for any obvious problems that might occur, such as connecting leads that may not have been secured etc.

Remove the CTD sensor and Oxygen cell covers.

Remove the securing bolts holding the package in its baseplate.

Have at least two, preferably three people to steady the package as it is deployed. When all are ready, then gently take up the slack on the winch cable whilst keeping it under tension. This is essential to prevent loose turns occurring on the winch which could slip and cause injury to personnel or damage to the equipment. There is sufficient room on RRS Charles Darwin to lift the package over the ship's side without the need to remove the rails. Whether or not this method is used is really a matter of personal preference, but in heavy weather it is safer to have the rails in place. The articulated 'A' frame on the Charles Darwin allows good control without a long pendulum causing the package to swing.

Deploy the CTD package and lower to 5 metres from the surface. For the first few casts and also if there is a long period between casts (several days), then allow about 5 minutes for the CTD oxygen sensor to 'soak' before proceeding any further.

Lower the CTD package at 0.5 metres sec^{-1} for the first 100 metres. The lowering rate can be increased to 1 metre sec^{-1}.

At the bottom of the cast, <CTRL>+<F10> to end the down cast.

Enter 'Lat' and 'Long'.(Lat -ve for south,Long -ve for west)

You will be asked 'Do you require an up-cast, Y/N'.

Type <y> and obey instructions as before.

IMPORTANT.

Before firing a water bottle allow at least 30 seconds for the data input buffers to clear. Failure to do so results in the PS2 'hanging up'.

On the way up use <CTRL>+<F3> to fire a water bottle.

Observe the yellow Led on the Rosette Firing Module. This will be flashing. When <CTRL>+<F3> is pressed this will stop flashing and either, the red misfire or the odd, even green Leds will light. Do not try to fire another bottle until the confirmation Leds go out and the yellow Led flashes. At the surface use <CTRL>+ <F10> to end the cast.

Enter 'Lat' and 'Long'.

<F2> to save the 'Graph Screen'.
<F5> to back-up data to tape streamer if required, but only if you are running CTDCON2.
<Esc> to return to the start-up menu.

If after loading the cast information etc,
you get a message **Out of memory at address xxxx:xxxx** etc,

then press <CTRL>+<ALT>+<DELETE> to reboot the machine.

After the machine has rebooted, at the DOS prompt,

Type CD\CTD,CD\CTDCON2 or CD\MKV <return>

Type CTDACQ, CTDCON2 or MKVACQ <return>

Repeat pre-cast forms as required.

The above procedure should also be used if the machine hangs
up for any reason.

Once the cast has been completed, and the package safely inboard, replace the sensor and oxygen cell covers. Secure the package to the baseplate with its bolts. Fill the CTD sensor housing with fresh water. Read the thermometers before the water samples are taken.

At the end of, or after a number of casts have been completed the data needs to be backed up to the PS2 tape streamer if not already done.

4.4 Backing up Data files.

If you are running CTDCON2 then select the Back-up option (function key F5) when prompted. Before using this option, you will need to edit the SSCON2.BAT file in the PS2TAPE directory.
Type CD\PS2TAPE <return>

Either use the DOS utility EDLIN or the EDIT facility in XtreePro, to edit batch file SSCON2.BAT, or copy this file to C:\WIN386 and edit it using the WRITE facility. If using WRITE, then remember to copy the edited versions back to the PS2TAPE directory.

The SSCON2.BAT file is as follows:

```
C:
CD \PS2TAPE
PS2TAPE BACK-UP /n DARWIN51 /a /r /q /s C:\*.*
CD\CTDCON2\DATA
DEL *.EDT
DEL *.HDR
DEL *.PL1
DEL *.PL2
CD\CTDCON2
EXIT
```

The third line needs to be edited to update D'ARWIN51 to the appropriate ship\cruise number. This need only be done at the beginning of each cruise.

When the tape back-up option (function key F5) is selected the appropriate batch file is run, depending on which directory you are operating in. Only files that are new or have been changed will be copied to tape.

The .EDT copy of the raw data , header (.HDR) and screen save (.PL1, .PL2) files are then deleted from drive C:. This frees some of the hard disc space for further use.

Whilst this is not so important when making vertical casts, space does become a problem with long SeaSoar runs. It may then become necessary to delete the .RAW data files as well.

If you are running the Acquisition software and are in the C:\CTD directory, then use the left and right cursor, <return> to 'Exit' from the menu-bar.

Type the following commands:-

C: <return>
CD\PS2TAPE <return>
PS2TAPE <return>

Use the cursor keys,<return> to select option 1 BACK-UP., option 2. Select files and back-up.

Follow the instructions given by the software to select the C:\CTD\DATA directory.

Select the files to be backed up, these will be the .RAW, .EDT, .BTL and .HDR extensions. Follow the instructions to back-up these files. After this has been completed, the original files can be deleted if it is absolutely essential to retrieve space. If you want to process the files later, then archive them to floppy disc at this stage if required. Approximately 50 Mbytes of disk storage are available, so there is no need to rush into deleting files.

5 CTD TROUBLE SHOOTING AND SENSOR REPLACEMENT GUIDE.

Common Faults.

5.1 Supply voltage correct but no load current.

First check that the deck unit and instrument packages are correctly connected up as shown in Figs 1-4.

By following the CTD connection trouble shooting flowchart Fig 5. , you should be able to identify and repair the fault. In the majority of cases, if the supply voltage is correct but there is no CTD load current, then one of the cables or connectors/joints is faulty.

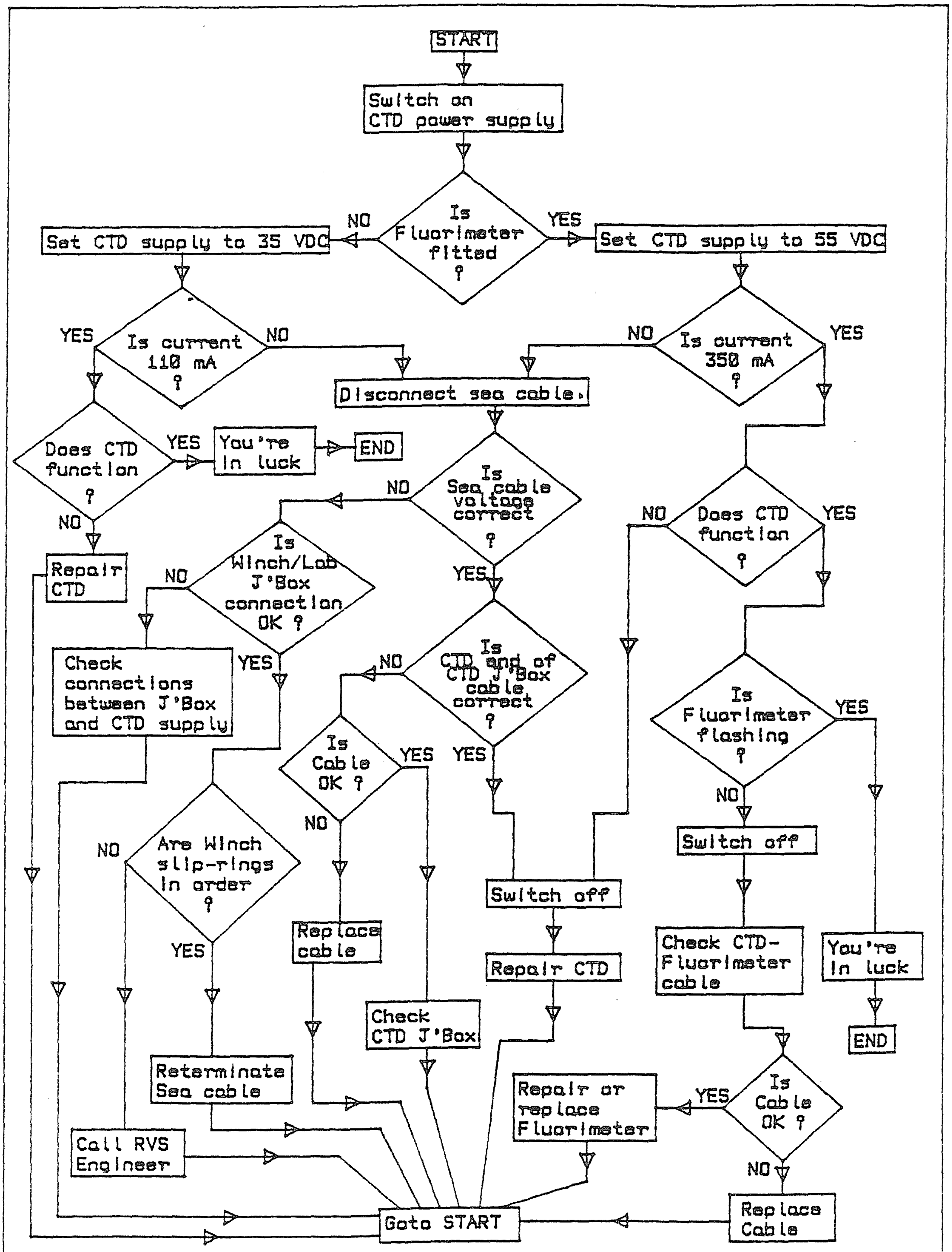

FIG.	5.	CTD CONNECTION TROUBLE SHOOTING FLOWCHART.	DRAWN	J.SMITHERS
INSTITUTE OF OCEANOGRAPHIC SCIENCES DEACON LABORATORY.			DATE	09-01-91

Start by disconnecting the sea-cable at the CTD end, and measure the open circuit voltage. This will be approximately as specified in the CTD Deck compliance voltage table ,but may vary depending upon the actual length of sea-cable in use.

If the sea-cable voltage is present and correct, then obviously the CTD underwater unit must be at fault. If not follow the flowchart and check each junction and connector in turn, until the fault is identified. All of the possible connections can be dealt with by the CTD/SeaSoar engineer with the exception of the shipborne CTD Winch slip-rings. These should be inspected and repaired if found faulty, by an RVS engineer.

Faults which require access to the CTD electronics rack.

Removing the CTD electronics from its pressure case.

To check and repair a fault requires the CTD underwater unit to be opened up. Before doing so the CTD should be thoroughly rinsed with fresh water and dried to prevent contamination of the internal electronics.

If the instrument has been used for deep casts and is still cold, then let it warm up for several hours if possible. Failure to do so may lead to excessive condensation forming on the boards, in warm laboratory conditions.

To open up the deep CTD, loosen the top endcap (Ie connector end) securing clamp nut and remove the clamp. With the sensor end of the CTD on the floor taking care not to damage the Oxygen sensor, the endcap must be pulled straight out without tilting it, otherwise it may jam in the tube. If this does happen, then gently tap the endcap with a hide mallet to reposition it, then try again. If the internal volume of air inside the CTD pressure case is still cold, it will be at less than atmospheric pressure, and will require a strong pull to release the endcap.

Disconnect the pairs of mating connectors found below the top endcap. These are colour coded to enable correct reconnection. Lay a clean layer of paper towelling on the floor. Turn the CTD over and stand it on end. Loosen and remove the second endcap clamp. Gently remove the sensor endcap and attached electronics. Stands are provided for working on the electronics. The CTD pressure case should be returned to its box.

The same general procedures apply to the shallow CTD underwater units, except that there are no clamps. The endcaps are secured by stainless steel screws through the pressure case.

Remove all of these and as before start with the connector endcap. A tool is provided to screw into the centre of the endcap to ease its removal. The endcaps of both shallow CTDs are connected to their electronics by a single multiway connector which should be unplugged. The sensor endcap and electronics can now be removed. After removal of the electronic assembly, reconnect the endcap. A test lead is provided to connect the CTD deck unit sea-cable connector to the CTD power/signal I/O 2 pin Brantner socket.

5.2 CTD supply voltage and current correct, but there is no FSK signal.

The Neil Brown CTDs have generally been found to be very reliable, with failures usually being confined to the external sensors. The most common internal fault to occur, is the failure of the FSK drive transistor Q2, on the TTY/FSK board during power up.

Remove the TTY/FSK board, plug in an extender card and replace the board. Switch on the CTD power supply and set the load correct to 110mA. Use an oscilloscope with reference to the CTD manual to check the FSK drive transistor Q2 for an output. If this is not present then check for a drive signal at the base of Q2 to determine whether or not it is at fault. In most cases you will find that Q2 has failed. If this is not the case then you will have to test the circuit in more detail to diagnose the problem.

5.3 CTD appears to function but one or more of the sensor outputs are incorrect.

There are a large number of possibilities here, but localising the faulty area is important for speedy identification and repair.

Firstly, decide whether the fault is in the digital or analogue section of the electronics. To do this, connect an oscilloscope probe to TP6 on the AC Comparator board and trigger from pin 31 of the Memory and Multiplexer board. Set the vertical sensitivity to 0.2 volts/division and the timebase to 5 msec/division.

If the analogue circuit is functioning correctly, then you should see three separate 10 msec envelopes of 10 KHZ signals, approximately 100 mV peak to peak rapidly reducing to 20 mV or so. Each

sensor and its wiring generate out of phase or quadrature signals. These are balanced out by an Automatic Quadrature Balance bridge circuit on the AC Comparator board. Each envelope is associated with P,T and C respectively, and shows the quadrature signal being balanced out. If the CTD sensors are in air, then a large quadrature signal will be seen during the conductivity or second 10 msec period, this is quite normal. However, if either P and/or T show large quadrature signals then a fault is most likely in the sensor head or in the analogue circuits.
If the quadrature signals are correct but false readings are obtained, then the digital circuit may be at fault.

5.3.1 Analogue faults.

The majority of these are usually sensor failures or faults in the sensor head assembly. The commonest are, ingress of sea water through the 'O' ring seal at the base of the conductivity cell, failure of the cell or platinum resistance thermometer.

During SeaSoar operations, there have been a number of occasions when the platinum resistance thermometer has failed completely due to corrosion. This can occur if any of the endcap plugs, blanked or otherwise, become leaky. This causes an electric current flow between the leaky plug and parts of the CTD unit, usually with rapid failure of the thermometer. An earthing strap fitted between the CTD sensor bulkhead and the SeaSoar frame seems to have overcome this type of failure.

Another fairly common fault that can occur, is failure of the conductivity cell. This can happen purely with age or use. The cell electrodes are of a deposited platinum construction. This platinisation will eventually fail, and initially shows up by the conductivity cell output becoming 'noisy'. There may also be a jump in the calibration and a large amount of hysteresis between the up and down casts. This will obviously require replacement of the cell.

Whether the problem is sea water ingress,thermometer or conductivity cell failure, the sensor head assembly will have to be dismantled. However, before proceeding with this, first determine whether the interface board or sensor is at fault. Unfortunately we do not have a spare set of underwater unit boards, so it may be necessary to open up one of the other CTDs to acquire one. This may seem a drastic solution, but the conductivity cell is both fragile and expensive, so do not dismantle the sensor head until you are sure you have to.

Substituting the P,T or C boards with known working ones should enable you to decide where the fault lies. If a faulty board is found, the commonest reason is for either the CD4011 sensor select IC to have failed, or more likely the FETs that switch the interface output signal to the D/A Converter board. If one of these switching transistors fails, then all or part of that interface output can be permanently connected to the D/A Converter.

This will show as a erroneous output from the faulty interface, and will also affect the outputs of the other two. Other faults on these boards are uncommon.

5.3.2 Dismantling the sensor head.

The sensor heads on all of the CTDs apart from the MKV are identical. As yet we have not used the MKV CTD, and have only a preliminary manual for it, so no instructions are given here. Before attempting to dismantle a sensor head, rinse it with fresh water and thoroughly wipe dry, being particularly careful around the conductivity cell. Lay out some clean dry paper towelling to place the parts on, making sure that they cannot roll off the bench. Use a small container to keep screws etc in.

Remove the two screws securing the sensor guard and wipe dry any areas that are still wet. The conductivity cell is the first sensor to remove. This is held in place by a rectangular stainless steel block, nylon insert, stainless steel clamp and two screws. The nylon insert is not present on all of the sensor heads. The screws must be removed with care as it all too easy to let the screwdriver slip and break the cell. There are two sensor holes in the clamp, insert and block, one for the conductivity cell and the other for a Fast Response Thermistor which is now no longer in use. The locating hole for the thermistor is blanked off with a small stainless steel cylinder and 'O' ring seal. After removing the two securing screws, gently raise the conductivity cell and clamp. This will allow you to turn the cell so that the clamp can be removed. Unplug the cell and lay aside safely for possible reuse. If the fault is the cell itself, then it can be replaced without dismantling the head any further.

5.3.2.1 Replacing a Conductivity Cell.

Clean all of the stainless steel parts. Take the new 'O' ring seal and lightly smear it with silicone grease or vaseline. Place the seal over the conductivity cell connecting lead.

Push the connecting lead through the block, insert and clamp. Locate the seal in its seat on the underside of the block. Plug the connector into the cell. The dimensions between the four connecting pins are different in the two axes, so it should be not be possible to connect the cell 90 degrees out of position. It does not matter however, which of the two ways in one axis, the cell is connected. Push the cell gently into the block, making sure that the seal seats around the base of the cell.

To reposition the insert and clamp, the cell needs to inserted in the block, 90 degrees from its final position. Replace the insert and clamp and pass the two screws through the fixing holes to hold the parts in position and do them up finger tight. Rotate the cell into its correct position and gently tighten each of the screws a small amount at a time. The screws need to be reasonably tight but not to the point of breaking the cell. The dimensions of the block allow sufficient 'crush' on the seal without normally causing damage, but do be careful. Replace the sensor guard.

The conductivity cell interface board will have to be readjusted. Setting up the interface to give the correct conductivity readings is not a particularly easy task to perform at sea and get good results. Use a text editor to check the conductivity cell ratio listed in the appropriate .Cnn calibration file. If this is not 1.0, then copy this file under a different extension not already used Eg, .C03 etc, and set the ratio to 1.0. Use this new file for calibration purposes.

Immerse the sensor head in a container of sea water of known salinity, ensuring that the ends of the conductivity cell tube are no closer than 3/4 inch to the sides of the container. Make sure that there are no air bubbles trapped in the cell. If the sea water is warmed slightly before use and then allowed to cool during the calibration procedure, air will go into solution rather than coming out. Connect an oscilloscope probe to TP6 on the AC Comparator board and trigger from pin 31 on the Memory and Multiplexer. Set the vertical sensitivity to 0.2 volts/division and the timebase to 5msecs/division. Adjust the quadrature potentiometer, P1, on the conductivity interface board to null the signal during the third 10 msec period. Siphon off the sea water and replace with a fresh, warm standard solution. The CTD acquisition software should be run in the listing mode. The conductivity sensitivity potentiometer, P2, should then be adjusted to give a correct salinity reading. For a full laboratory calibration, refer to the CTD manual.

5.3.2.2 Replacing the Platinum Resistance Thermometer.

Before attempting to replace the thermometer, is safer to remove the conductivity cell as explained previously.

There are four Cheesehead or Allen screws at the base of the sensor head holding it to the sensor arm. Remove these and gently part the head from the arm. The thermometer is directly soldered in circuit to avoid the connector contact resistance. As the change in resistance of the thermometer is quite small for a large temperature variation, any contact resistance, particularly one that varied, would cause severe errors in the thermometer response. There is a small reference Vishay resistor precisely 10 times the value of the thermometer resistance, glued to the underside of the sensor head. This will have to be changed for the new matching one. One red and one white thermometer lead are soldered directly to the transformer P.C card plate located in the sensor arm bulkhead.

Unsolder these and the reference resistor leads, remove the thermometer and prise off the resistor and reglue the new one. Take the new thermometer and shorten one pair of red and white leads to about 1/4 inch. Strip the insulation back and twist these together.Solder the joint and insulate with heat shrink sleeving. Remove the 'O' ring seal from the end of the sensor arm. Clean all 'O' ring grooves and sealing faces of the sensor head assembly. Replace the sensor arm seal with a new one, first making sure that it is clean and lightly smeared with silicone grease or vaseline. Do the same with the new thermometer 'O' ring seal. Carefully fit the seal over the thermometer thread and screw this into the sensor head. The white lead of the remaining pair must be cut to allow a connection to the resistor. Solder this lead together with the part that has been cut off, to one side of the resistor. Insulate with heat shrink sleeving. You will have to lay the sensor head and sensor arm close together on the bench to finish the remaining wiring. The long white lead can now be passed through the sensor arm and soldered to the bulkhead transformer P.C card, Pin 6 and the long red one to Pin 5.

The thermometer and resistor form two arms of a bridge circuit and a pair of transformer windings of ratio 10 to 1, the other two.

The remaining lead from the resistor should be soldered to Pin 8 on the P.C card.The gauge and length of this lead has been chosen to have a resistance 10 times that of the full length red lead. This ensures that temperature changes affecting the lead resistances do not unbalance the bridge. The sensor head can now be refitted to the sensor arm, making sure that the seal between the two parts are free from foreign materials , especially human hairs. The instrument will need to be recalibrated and adjustments made to the temperature interface.

Only very limited facilities will be found onboard ship, therefore one can only attempt a rather crude calibration.

Probably the only reasonably stable water bath sources available, will be an ice bath, and one at ambient temperature.

The first part of the calibration procedure is to null the quadrature signals from the sensors. This should be done with the sensors immersed in a well stirred water bath at 15 deg $\pm$ 1 degree C. Holding the water at this temperature may well prove difficult, but it should be possible to rig up some form of insulated container to do the job.

Connect an oscilloscope probe to pin 6 on the AC Comparator board and trigger it from pin 31 on the Memory and Multiplexer board. Set the timebase to 5 msecs/division and the vertical sensitivity to 0.2 volts/division.

The signal during the second 10 msec of the trace should be nulled with the quadrature adjustment potentiometer, P1, on the Temperature board. A more complicated procedure explained in the CTD manual, under section, Tests and Calibration should be followed if this is a laboratory calibration, however the thermometer replacement being discussed, assumes that this is a repair at sea.

Having set the temperature quadrature, the zero and sensitivity can now be set. A bath of ice/water mix should be used to first set the zero. Probably the best reference thermometer available to you, will be one of the Digital Reversing Thermometers used for CTD casts.

Adjust the zero potentiometer, P2, once the bath is stable. Ideally a second bath just below 20 deg will be needed.

The digital reversing thermometer readout is only accurate to 0.01 deg at or above 20 deg. Transfer the sensors and reference thermometer to this bath, allow to stabilise, then adjust the sensitivity potentiometer, P3. You will need to check the zero and sensitivity several times, so the need for two baths becomes obvious.

The CTDs are normally recalibrated after each cruise, but this is particularly important if any of the sensors have been replaced.

5.3.2.3 Replacing the Dissolved Oxygen sensor.

Due to their construction, the life of these sensors is limited, especially when used with SeaSoar. With normal regular use on deep casts the sensitivity will degrade as the sensor electrolyte becomes exhausted. If the Teflon membrane is allowed to dry out, or becomes contaminated with oil, this will result in premature failure. Contamination of the membrane is particularly evident when used with SeaSoar. This is partly due to oil that may leak from the SeaSoar hydraulics and partly from oil and waste that leaks from the ship. It also easy for sea water to enter the Silicone oil pressure balanced space.

Removing the sensor.

To remove the sensor assembly from the CTD, first unscrew the three nuts on the CTD sensor bulkhead. remove the bulkhead end cover.

Dry any areas that may still be wet.

Undo the inline connector between the sensor receptacle and P.C card.

The sensor receptacle can now be unscrewed, but care must be taken to ensure that the loose connector does not foul or damage any other wiring.

Remove the bleed screw on the side of the sensor receptacle.

If the sensor is not being replaced with a new one, then take care not to allow any of the silicone oil to contaminate the membrane.

Gently tighten a suitable hose clip around the sensor to give something to grip onto.

There will be some 'sticktion' between the sensor and receptacle and it may be quite difficult to unscrew initially.

It is imperative that the bleed screw be removed, as failure to do so will result in the membrane bursting, due to a reduction in pressure behind the sensor as it is unscrewed.

Unscrew the Perspex outer from the Marsh and Marine base, this will also allow removal of the 'O' ring seal on the centre pillar of the receptacle.

Thoroughly clean all parts, once again making sure that oil does not come into contact with the membrane.

Replacing the sensor.

Fully screw the Perspex outer onto the receptacle and then back off half a turn.

This is to allow a slight movement of the outer relative to the inner. The central pillars of the receptacles are not always concentric with the outers, causing the 'O' seal to fit tightly between part of the inner and outer, but leaving a gap elsewhere. The screw thread on the base of the outer is sufficiently loose if not fully home, to allow enough movement to centralise the parts.

Push the 'O' seal down over the centre receptacle using the tool provided. the seal is positioned to allow water contact with the receptacle central pillar in the area where the thermistor is moulded into the black epoxy resin.

Cover the bleed hole with your thumb and hold the receptacle vertically. Fill the receptacle with MS200 Silicone fluid, sufficient to cover the sensor screw thread in the central pillar. Gently push the sensor into position but do not try to screw it in at this stage.

The receptacle should now be held horizontally with the bleed hole uppermost.
Screw the Perspex outer down but do not overtighten, as it is quite easy to damage the threads. The use of a small hose clip fitted to the sensor will ease fitting. Screw the sensor fully home, allowing excess oil to flow from the bleed hole. The whole assembly should now be left for a few hours with the bleed hole uppermost and open, to allow trapped air to disperse.

Finally top up the oil if necessary and fit the bleed screw. Ensure that the sponge in the sensor cover is damp before replacing. Refitting of the receptacle to the CTD bulkhead is the reverse procedure to removal. It is wise to include some Silica Gel container within the CTD sensor bulkhead. Make sure all 'O' ring seals are cleaned and smear with silicone grease or vaseline.

Some of the receptacles have been manufactured at IOS and are different to the commercial ones. In these sensors, there is no moulded epoxy central pillar. The pins of a Marsh and Marine connector are cut down to 1/8 inch and a thermistor soldered to one pair. Flying leads then connect the remaining pins to a screwed base, into which the sensor fits.

The sensor and its connector are merely pushed into the Perspex outer and rely on the sea water pressure to hold them in place.

In these sensors, the 'O' seal between water and oil may be pushed right down to the base of the Marsh and Marine.

Refilling with oil, or replacement of the sensor follows the same general rules with either type of receptacle.

5.3.3 Digital faults.

Faults in the digital circuit can be various and no particular one crops up more than another. It is still possible however, to localise the likely area in which the fault lies.

Some of the circuits Eg. D/A Converter, Adaptive Sampler etc are common to P,T and C. If the fault affects all of the sensor outputs, then the problem must lie in a circuit which is common to all, conversely if only one sensor is affected then a circuit which is unique to that sensor is likely to be at fault. An example of this type of fault might be where the digital outputs of P,T and C are stored in the Memory and Multiplexer board, Eg. a memory chip or part of the circuit serving that chip may be faulty.

It is not possible to list every fault that might occur, but you can see that with some thought, the problem area can be quickly narrowed down to a few possibilities.

Replacement of the CTD electronics into its pressure case is the reverse of removal, but once again clean, inspect and regrease all 'O' ring seals or replace with new ones, being particularly careful not to introduce human hairs.

The CTD deck units and Rosette Firing modules are new and have only been used on two cruises so far, both without failures.

It is therefore not possible to catalogue any faults as yet,but each unit is backed up with a spare. Some possible problems that might occur with these units, Eg. corruption of the ROM based software in the CTD deck unit, could not be repaired at sea.

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