INSTITUTE OF HYDROLOGY

FIELD USE OF MICRODATA LOGGERS

by

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ABSTRACT

A practical guide on the use of Microdata loggers in the field, with emphasis on the essential role of the operator in maintaning consistent performance.

REPORT NO 64

July 1979

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1. INTRODUCTION

The advent of the Microdata logger made possible the collection of hydrometric data on a scale previously unknown. But despite this exciting potential there has been a depressingly low rate of success in actually collecting good data. The field operator was given a box of electronic tricks, the contents of which he had no knowledge of and the working of which he was unable to observe or correct. This was in direct contrast with established mechanical instrumentation using clockwork chart recorders. Superficially, the professional competence of the field operator was superfluous.

However, the early experiences of automatic logging was not the utopia anticipated by instrument designers. The problem of making devices work in outdoor environments, as opposed to the benign conditions found in the laboratory, has required the same application of field craft as had the earlier generations of instruments. This report attempts to deal with the more obvious topics associated with the Microdata loggers in which the field operator plays a crucial role. Approximately twenty loggers have been in use simultaneously during the last five years at the Institute's experimental site at Plynlimon, Central Wales. This degree of involvement is probably in excess of that experienced by most users but means that a considerable range of problems have been identified, solutions to which are given in the following pages.

The nature of the logger makes it virtually impossible for the field operator to check its operation whilst in the field and while, hopefully, the logger is collecting data. Thus much of the maintenance must be done in the laboratory prior to putting the logger out on site. The components of the logger are protected from the elements by a sealed metal box. To open this box in the field puts the components at risk. Although the problems of wet, damp and dust penetration may be reduced in sheltered conditions, repeated openings increases the risk, prejudicing the investment in the purchase and operating costs and hazarding the committment to this method of data collection.

It follows therefore, that if data logging techniques are used then sufficient back-up facilities must also be provided and the correct scale of equipment deployed. The simplicity of earlier instrumentation powered by springs and recording on charts meant that eyes and ears were the diagnostic tools. The complexity of electronic loggers requires test boxes so that while earlier instrumentation mainly required the field operator to be observant, loggers require observation plus check routines.

The Plynlimon data collection is based on five-minute intervals between recordings. Allied with existing tape and battery capacity this requires a two weekly routine which gives a margin of spare capacity to cope with emergencies. At the end of each fortnight the logger, complete with tape and battery, is withdrawn still as a sealed unit and a replacement connected to the sensor. The logger is opened and checked in the laboratory.

Every instrument package therefore requires a pair of loggers. Inevitably logger faults will require correction and if this cannot be accomplished within the turn-round period, a compromise must be made as follows:

(i) Open the logger in the field and replace tape and battery. This sacrifices the laboratory checks and exposes the interior of the logger.

(ii) Recalling the logger for servicing and sacrifice data.

The third solution is to carry a float of loggers to cope with this type of situation. This is clearly an expensive alternative but if continuous records are required, expenditure cannot be avoided. It is the responsibility of scientific management to define what is genuinely required and budget accordingly.

This report is intended as a practical guide to field workers for the successful use of Microdata loggers as a data collection technique and above all to avoid putting a defective logger into the field. It assumes a logical organisation of laboratory cupboards, adequate bench space, a Microdata test box, a digital volt meter, battery charger, and field record cards. It cannot be overemphasised that the best way of learning the maintenance and operation procedures is a short course of practical instruction from an experienced person who is sympathetic to the field operator's needs.

2. THE MICRODATA LOGGER

The Microdata logger can be conveniently thought of as five main units:-

- Logger circuitry
- The clock
- The tape deck
- The magnetic tape
- The battery

Logger circuitry

Before opening the logger inspect the connecting plugs to check that the pins are not bent. If a pin is bent, it can normally be persuaded back into position by carefully levering with a screw driver. The pins get dirty and should be cleaned with a typewriter cleaning brush and switch cleaning solvent. The outside of the plugs should also be cleaned to avoid build-up of dirt. This should be standard maintenance.
The logger can now opened by snapping back the side toggles. Due to pressure changes between sealing and opening, the lid may not part with the base. Careful levering will split the two units but the battery-connecting lead will tie the lid and base; this should be disconnected and the two halves of the logger laid on the bench (see Figures 1-5).

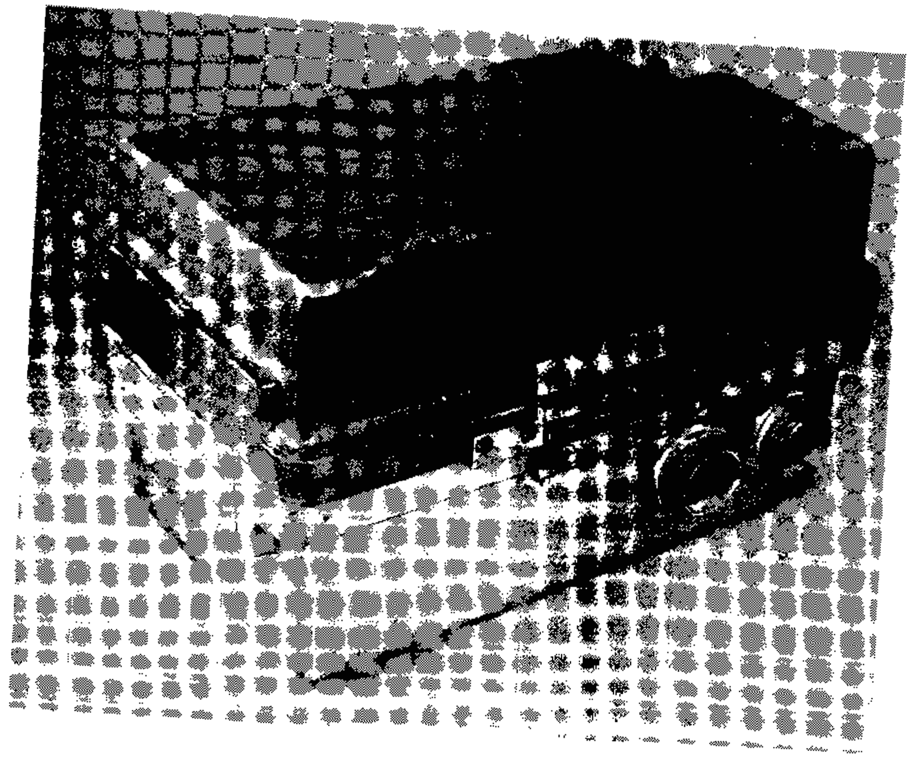

FIGURE 1   THE MICRODATA LOGGER

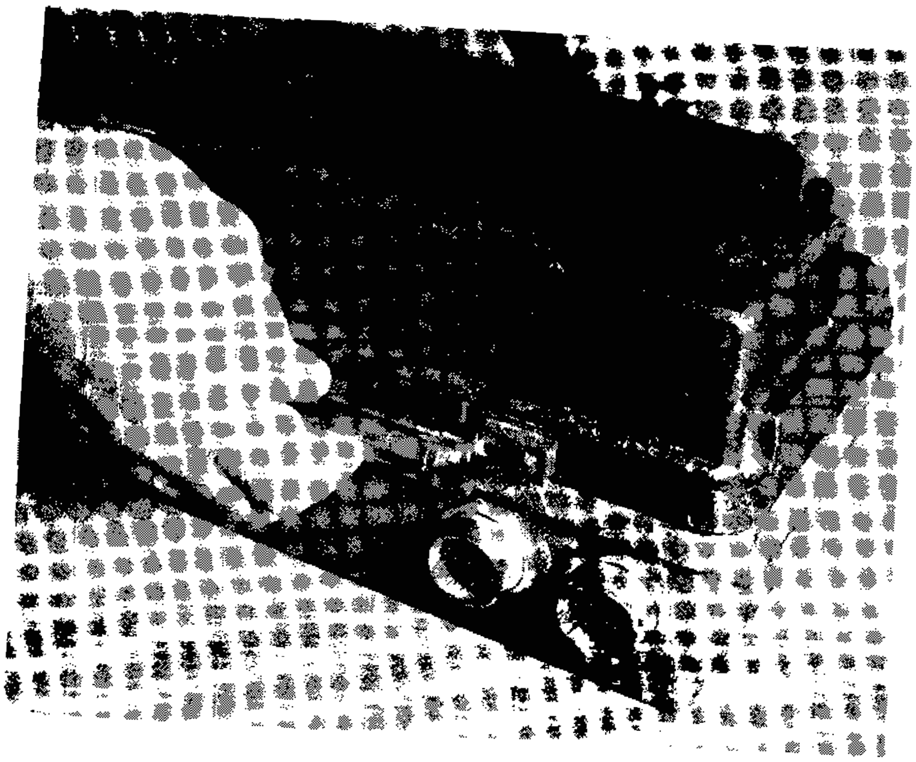

FIGURE 2   OPENING THE LOGGER

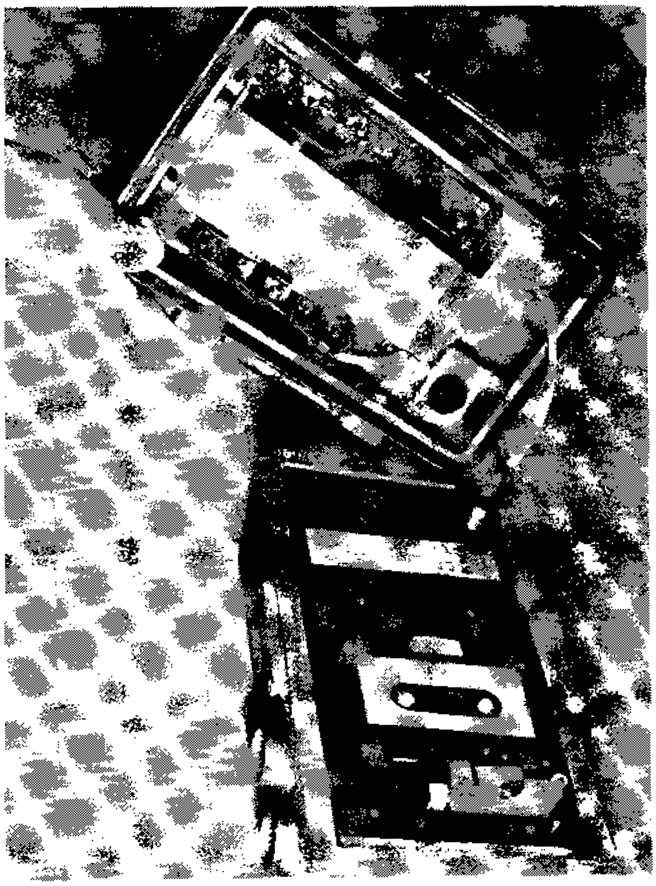

FIGURE 3

LOGGER WITH BATTERY CONNECTED

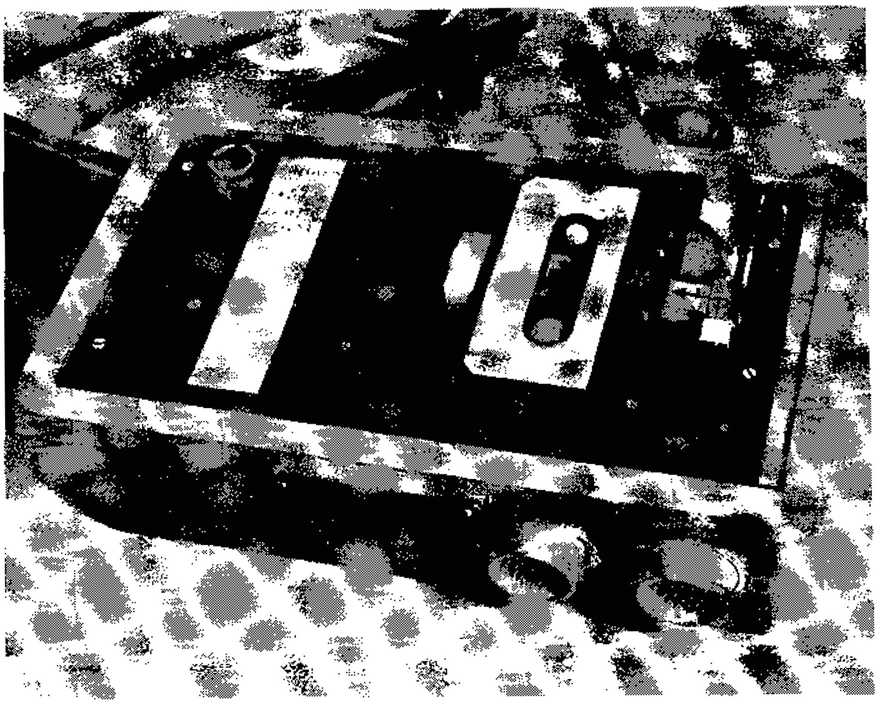

FIGURE 4 TAPE DECK WITH RECORDING HEAD PUSHED HOME

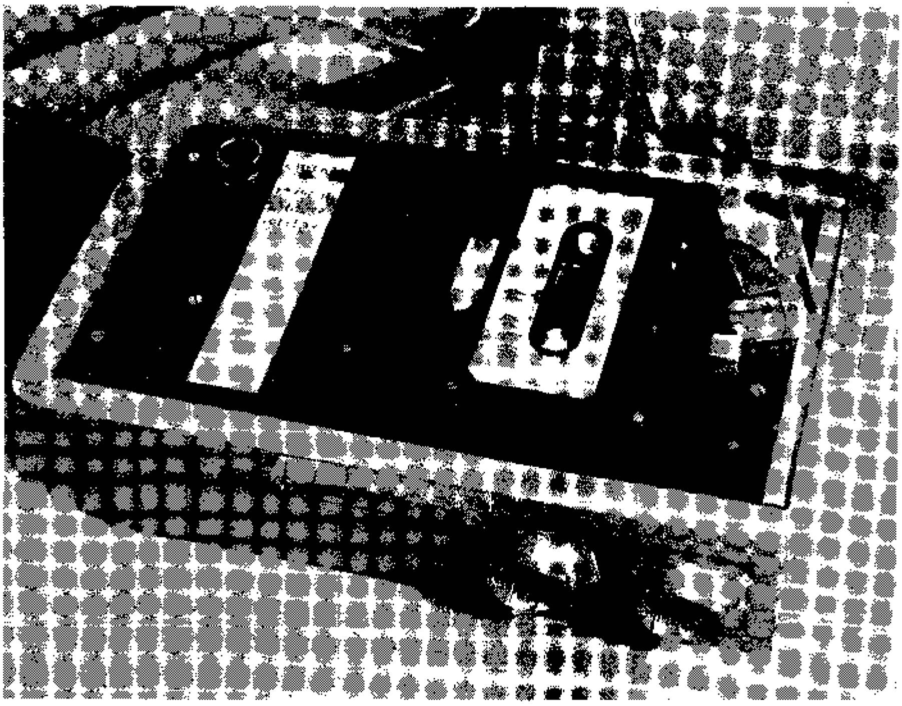

FIGURE 5 TAPE DECK WITH RECORDING HEAD OPEN

Look at the two halves to check:

a) The battery - any loose leads,etc?

b) The tape deck - Recording head pushed home?

Tape cassette in correct position?

Tape wound on?

Tape fouled round pinch wheel?

The battery should be tested with a voltmeter with a 5 ohm resistance in in the circuit, and the answer, plus relevant comments on visual checks made above, recorded on the field operation card. If the battery shows approximately six volts it can be put on charge or stored as required. For further details concerning batteries see page 13. The screws holding the tape deck closed should be removed (for location see Figure 6) and the tape deck tilted back on its hinge. Check for condensation. If water is present the logger should be left open in a warm room to dry out. Next, have a quick look over the circuitry and then a good blow to remove dust and small particles.

The logger should now be checked using the Microdata test box and preferably a digital volt meter. The test box instruction manual*gives comprehensive information plus circuit diagrams but it is probable that this will be of little help to most field operators. The detailed steps for field office checks are given at in Appendix III the end of this report together with illustrations to help locate the various trimming potentiometers.

* Model M200LT Data Logger Test/Calibration unit (Code ref D2/TM-1.76)

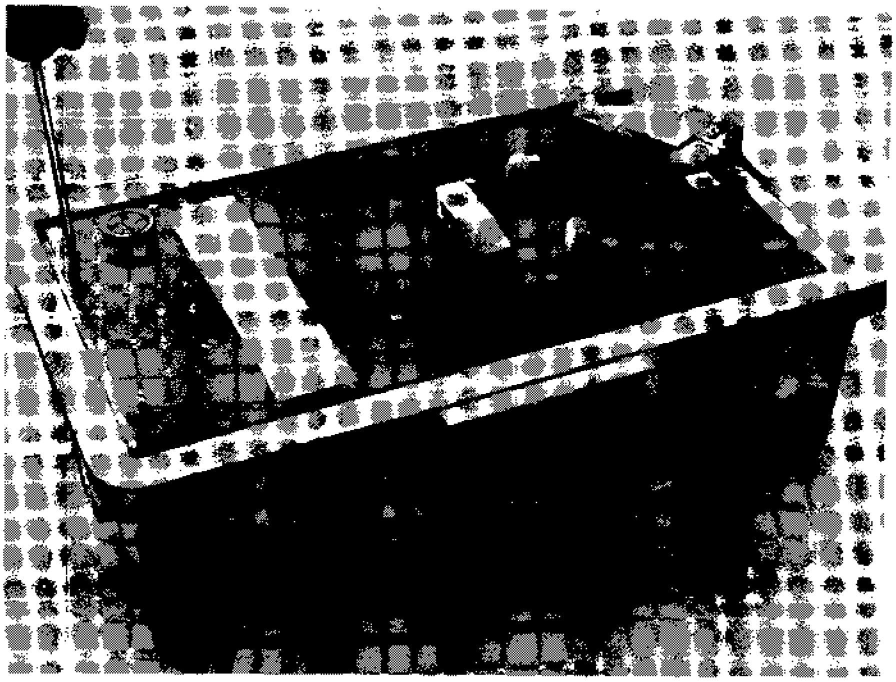

FIGURE 6 REMOVING TAPE DECK HOLDING SCREWS, OLD TYPE LOGGER

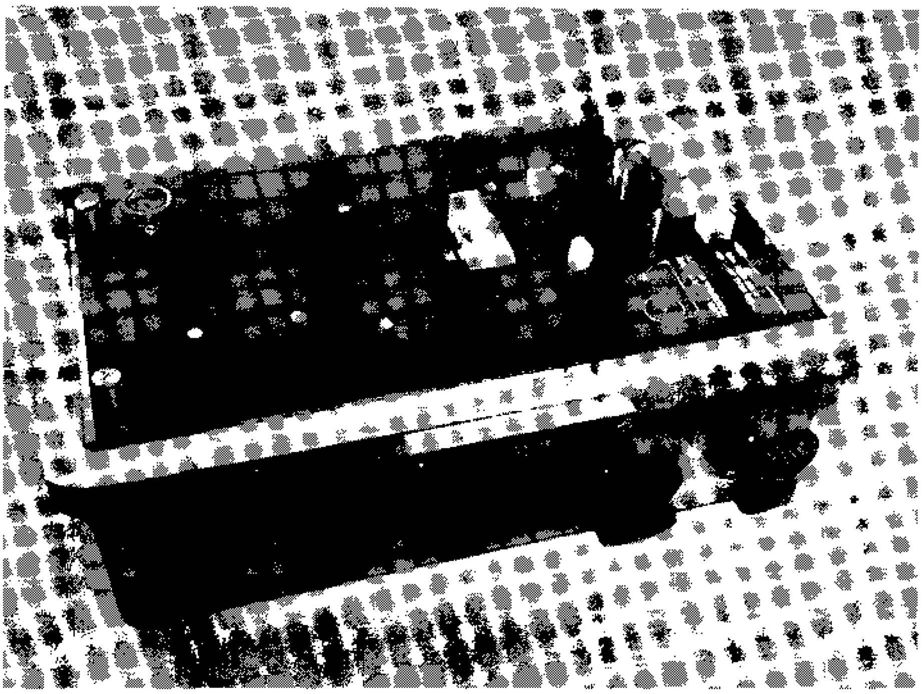

FIGURE 7 NEW TYPE LOGGER, IDENTIFICATION BY TAPE DECK THUMBS SCREWS

Note that the successful operation of the logger depends on the correct adjustment of the potentiometers. These are delicate components, especially the single-turn type, although the circuitry and logger box are robust. It is important therefore to realise that the loggers should be handled with care at all times and protected from sharp knocks.

The circuit boards are stacked and often the 4v and A/D output potentiometers are offset beneath the access holes. This means that adjustments are made with the screwdriver at an angle and ultimately the soft plastic gets chewed, making setting impossible and necessitating replacement.

The clock

The internal clock of the loggers does not record absolute time. The clock will 'run' for the pre-set interval and at the end of this interval, data from the various sensors is integrated and written on the magnetic tape. The clock will then start 'counting' the next timed period. The clock starts as soon as the battery in the logger lid is connected to the socket on the tape deck (see Figure 3) but no data is recorded until the recording leads from the weather station are connected to the external plugs of the logger (see Figure 1).

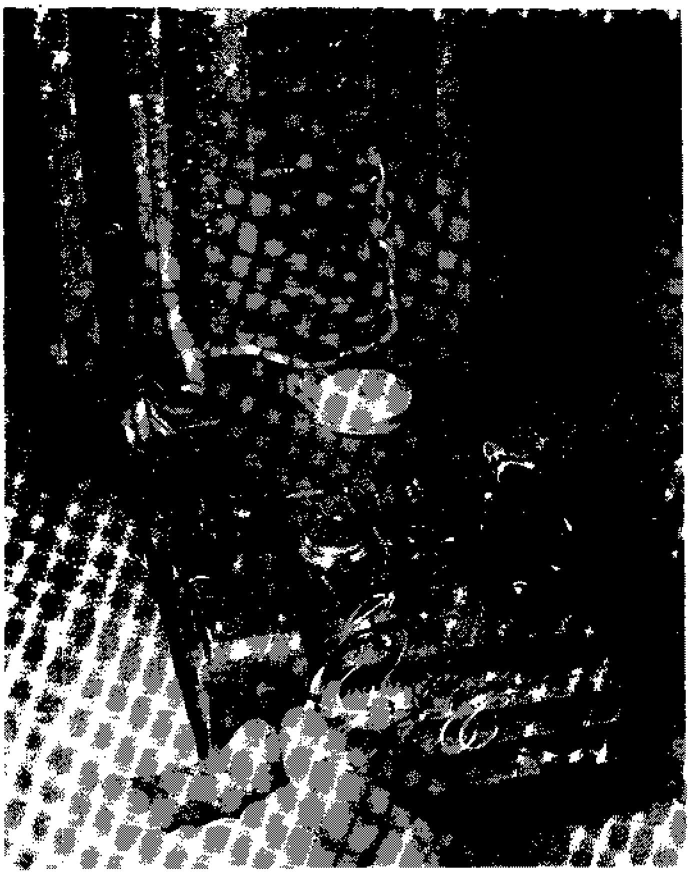

FIGURE 8

SETTING THE INTERNAL LOGGER CLOCK

The clock can be tested on the test box but faults cannot be repaired by the field operator. In the absence of a test box and to avoid putting an unserviceable logger into the field, the following simple check can be made:

(1) Connect a charged battery to the tape deck socket (Figure 3).
(2) Set the clock to 5 secs (Figure 8).
(3) Connect a dummy socket, in which pins R and S are shorted, to the inner connector on the outside of the logger (Figure 9).

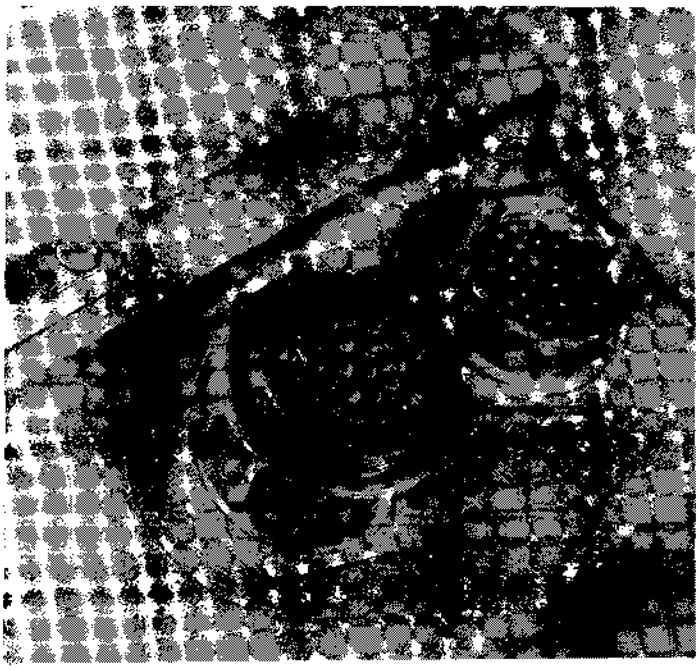

FIGURE 9

DUMMY SOCKET TO SIMULATE CLOCK TRIGGER

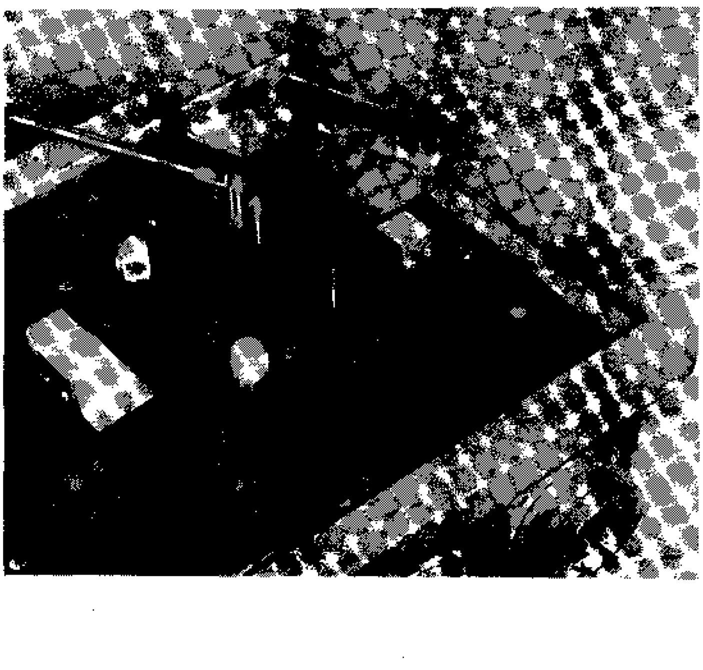

FIGURE 10

CAPSTAN POST

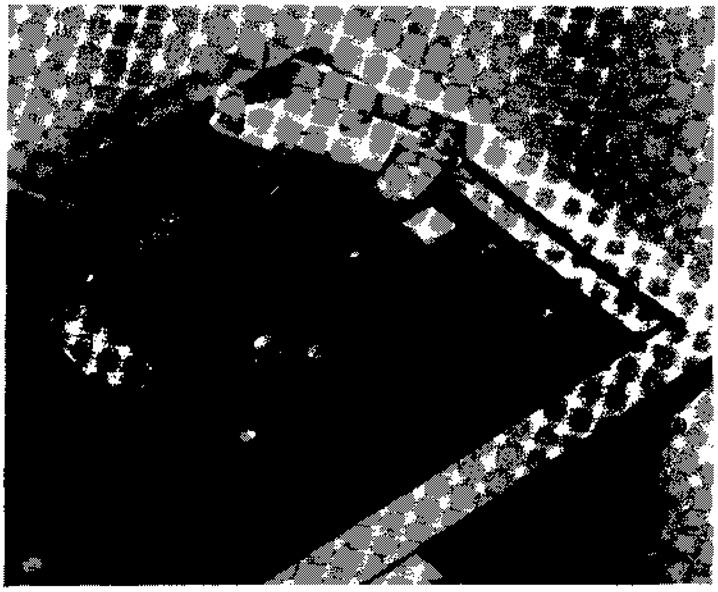

FIGURE 11

TAKE UP SPOOL

(4) The capstan post (Figure 10) and take-up spool (Figure 11) will now rotate every 5 secs.

N.B. do not forget to reset the clock to '5' minutes after the test.

The tape deck

When the logger is connected to the test box it can be set to 'run' continuously. (The setting on the test box to do this is detailed in Test IV in Appendix III). In this setting the capstan post (Figure 10) and take-up spool (Figure 11) should revolve continuously.

Beneath the tape deck is a small motor. Two drive bands from the motor rotate a large nylon wheel set on the capstan post shaft. A single drive band links the capstan shaft to the take-up spool shaft (Figure 12). A quick look will be sufficient to inspect the condition of the drive bands, and that both capstan post and take-up spool are revolving.

It is unlikely that there will be a fault with the capstan post but the take-up spool is sometimes troublesome. It can be checked in the following procedure:

(1) The take-up spool is spring loaded. It can be depressed with finger pressure and should return immediately. Any reluctance to depress or return should be investigated. Do not use oil as this will attract dust and ultimately make matters worse; use an evaporating switch cleaner.

(2) Whilst the logger is on 'run' and the take-up spool is revolving, hold the nylon head between finger and thumb

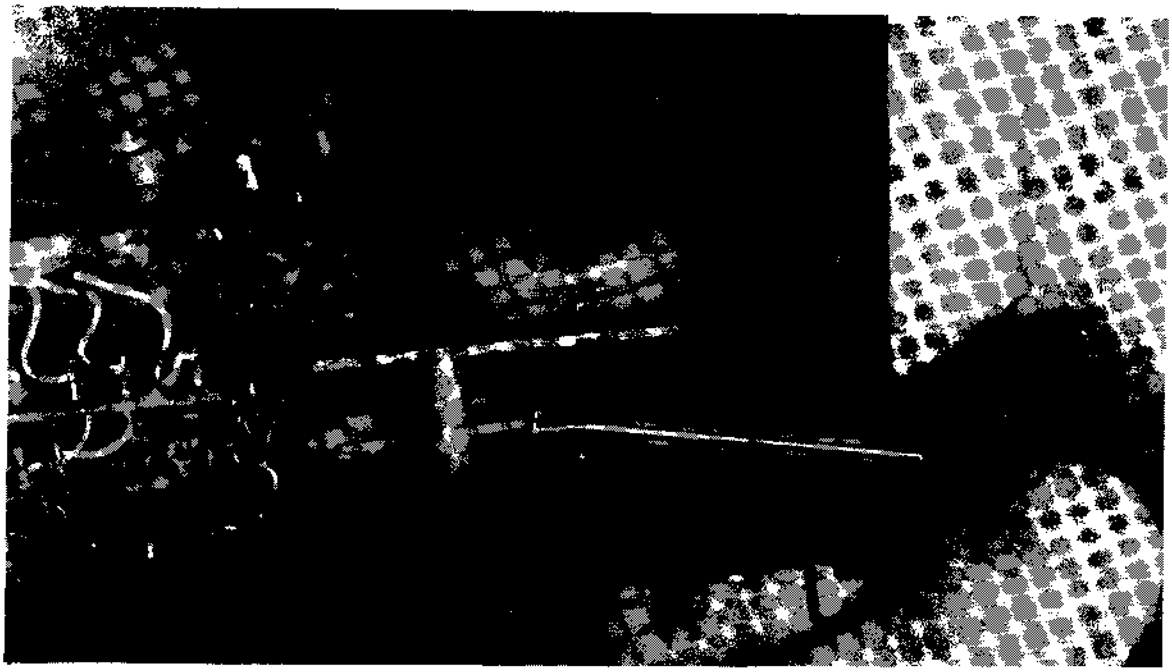

FIGURE 12   DRIVE BAND TO TAKE-UP SPOOL

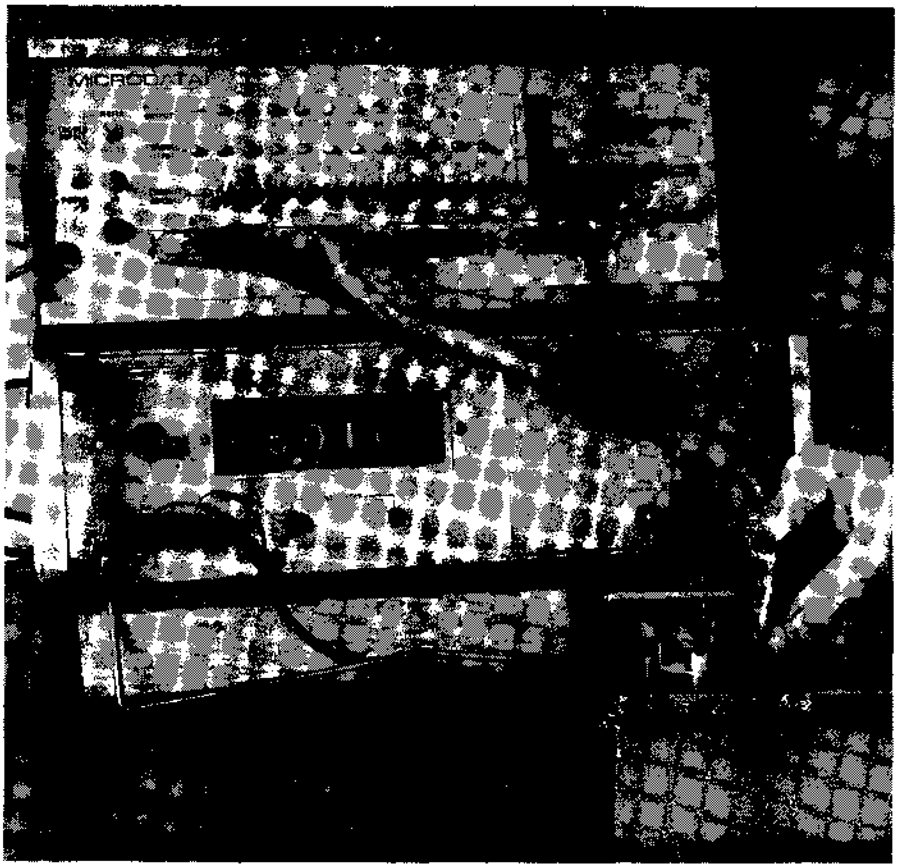

FIGURE 13   TESTING THE TORQUE ON THE TAKE-UP SPOOL

(Figure 13). It will be quite easy to grip it so that it stops revolving. By varying the grip the operator will eventually be able to judge whether it is 'weak' or 'strong' even though it is impossible to be more specific here.

The task of the take-up spool is to wind in the tape after it has passed between the capstan post and pinch wheel. The take-up spool does not have to drag the tape from the feed spool past the recording head. Thus the torque required is relatively small but if inadequate the tape will sometimes cling to the rubber pinch wheel and cause fouling (see later section on magnetic tapes).

If the operator decides that the rotation of the take-up spool is 'weak', the following action can be taken:

(i) Look to see if the nylon head is loose on its shaft. This can be improved with a little adhesive such as Evostick.

(ii) If the head is secure inspect the drive band carefully; it may be on the point of failure.

(iii) If these explanations are inapplicable the clutch may be ineffectual. The clutch is simply a felt washer between two nylon faces.

Normally the field operator should not attempt to dismantle the clutch but if the logger cannot be passed to a competent technician the following first aid action is possible:

Remove the four retaining screws holding down the motor bed plate (Figure 14) and carry it to one side (it will be held by

FIGURE 14

REMOVING THE MOTOR BED PLATE

fine wire connections so that movement is restricted). The spring and free nylon wheel can now be lifted from the take-up spool (Figure 15). The free nylon face can be roughened with a spike or coarse emery cloth.

FIGURE 15

DISMANTLING THE TAKE-UP SPOOL CLUTCH

This procedure is usually adequate to restore clutch efficiency but the need for care is emphasised.

Tape deck hygiene

The cassette tapes shed a small amount of oxide in normal use. This collects on the recording head, the pinch wheel, and on the capstan post.

All three should be cleaned by using genklene or a commercial solvent designed for the purpose. Cotton buds (from any chemists) dipped in the cleaner are very handy to use. The pinch wheel gets very dirty and needs careful cleaning but it must be dusted with french chalk (or baby powder) to avoid any stickiness from the cleanser. Excess chalk should be blown or brushed away.

Magnetic tapes

Very little maintenance can be given to magnetic tapes. If the tape becomes fouled in any way it should be destroyed after translation.

Fouling can occur in a number of ways resulting in the tape being wrapped round the pinch wheel or jammed in the start position. Operators often rectify the tangle and rewind the tape into the cassette. Translation does not always reveal the damage and unless the operator notes on the cassette that it should be destroyed after translation, the tape may go back into service and the next set of results is prejudiced.

Field operators should be quite ruthless in destroying suspect tapes and should always mark damaged tape cassettes with instructions for destruction after translation. A further safeguard is to use an exclusive set of tapes so that their own standards cannot be compromised by others.

Tapes can be used without erasing as the logger overwrites previous data. But as translation problems may arise when a short set of new data is overwritten on a long set of earlier data, it is better to use a magnetic eraser to clean the entire tape after use.

Batteries

The logger is powered by a battery in the lid (Figure 3). This battery may be three sealed lead acid cells or a nickel cadmium unit. On a five minute clock setting a fully charged battery will last approximately three weeks. (This is comparable to the capacity of one side of a C60 tape). Batteries are subject to chemical deterioration in the long term and self discharge in the short term. A slight excess in load by a sensor or adverse temperature conditions in the field all conspire against consistent battery performance.

For these reasons it is advisable to change batteries every 14 davs if a five-minute clock setting is used (which means changing complete loggers for reasons given at the start of this report). The lead acid batteries should be charged using a constant voltage charger (7 volts with maximum output 1 amp) for approximately six hours. The nickel cadmium batteries should be charged using a constant current charger (500 ma for 14-16 hours). The battery state should be checked immediately before and after use and recorded on the field operation card.

The battery check should be made using a voltmeter with a 5 ohm resistance across the batter terminals (Figure 16).

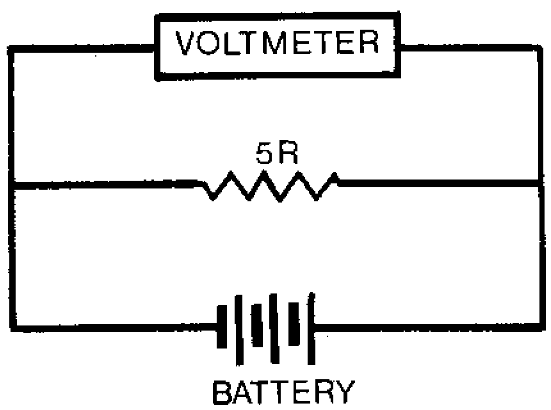

FIGURE 16

BATTERY TESTING DIAGRAM

Eventually the batteries will fail. The operator should be quite ruthless in their rejection, as with suspect tapes. The cost of new batteries and tapes is quite disproportionate to the capital sum invested in the loggers and the value of good, continuous runs of data.

If a user is involved with considerable numbers of batteries the replacement costs will be significant. Under these circumstances, it is economic to test the batteries using a recording voltmeter. This test requires the battery to be charged normally and then, after 24 hours, connected to a recording voltmeter with a 5 ohm resistance across the terminals. This effectively discharges the battery. A servicable battery will show a slow but steady discharge for approximately 3 hours and then a very rapid decline. A deteriorating battery can be detected as it will discharge in a much shorter period and can therefore be discarded.

3. ROUTINE AND BOOK KEEPING

It follows from the problem associated with eventual deterioration of battery condition that some form of book keeping and general organisation is imperative. If a number of stations are used simultaneously, involving double the number of loggers, then it is desirable that record keeping is meticulous. Often the first indication of faults (except for obvious problems such as fouled tapes) is a lack of, or incorrect, data. Sometimes this is not apparent for several weeks, due to tape translation delays. By this time the original logger tape/battery combination will have been dispersed among other stations and the only way of positively identifying which unit is at fault is a re-occurrence of trouble with components. For example, lack of data because the tape did not move on may appear initially to be due to a faulty clutch in the tape deck but finally found to be caused by a battery unable to hold its charge, a problem possibly made worse by low temperatures.

Thus a logical approach to the use and maintenance of loggers and their ancilliary units (tapes and batteries) is required. The methodical organisation of storage, dispatch, receipt, checking and return to storage in the laboratory is essential. The use of shrouds over the plugs on the side of the logger as protection against chance contacts with wet fingers, oilskins or other equipment on site is representative of the concern for detail which the field operator can give to underwrite the technology behind the logger.

APPENDIX I

A CHECK LIST OF OPERATIONS TO BE DONE IN THE LABORATORY ON RECEIPT OF A LOGGER WHICH HAS BEEN USED IN THE FIELD

---

1. Receipt from field with completed field sheet. Check logger connecting plugs are undamaged: clean with brush and solvent.

2. Open logger and inspect for obvious problems.

   a. condensation?

   b. logger/batt/tape ref. check with field sheet?

   c. recording head pressed home correctly?

3. Remove battery and check charge. If approximately 6 v (± 0.25 v) - OK; if low (4 v) check individual cells and note battery no./logger no./site combination for future fault chasing.

4. Put battery on to charger. Check charge and return to storage shelf of trickle charge. N.B. Batteries will require recharge if stored for more than a week.

5. Check logger:

   a. check that clock works.

   b. check head and capstan post for oxide deposition; clean off with Genklene. Check pinch wheel, clean and dust.

   c. connect to test box.

   d. check 4 v and 5 v supply and adjust as quickly as possible while logger circuitry is cold.

   e. check drive bands to tape deck OK.

   f. check torque on take-up spool.

   g. check inside of logger for general cleanliness and clock setting.

   h. check logger steps 240-zero.

   i. check A/D output and channel output displays.

   j. note date of check and return to store.

APPENDIX II

SETTING UP A LOGGER FOR USE

1. Check that battery voltage is in excess of 6.0 v with Avometer with 5 ohm resistance across battery terminals and note battery number, charge and date.

2. Select tape, clean with magnetic eraser, note tape reference number and side.

3. Wind on tape past leader, tension tape in cassette and position on deck with full spool on same side as exterior logger connectors.

4. Check that tape is on correct side of capstan post, so that it will be pinched by pinch wheel against capstan post.

5. Take up slack in tape by moving spigots on take-up spool head until feed spool rotates.

6. Press recording head home into guide slots.

7. Connect battery. This will start the clock but tape will only move past recording head in time increments selected when input leads from interface/sensor connected. Good practice is to connect the battery exactly on '5' minutes. The input leads should then be connected between 5 minute readings. This is not essential but establishes a routine leading to minimum loss of data between scans.

8. Close battery lid to logger and secure.

9. Cover connector plugs with shrouds before removing logger from laboratory.

APPENDIX III

THE USE OF THE MICRODATA TEST BOX WITH A DIGITAL VOLTMETER AS A MEANS OF CHECKING THE LOGGER

Microdata publish a comprehensive manual for users of the test box*. This technical manual contains all the information that a technician might require but has shortcomings as far as the average field worker is concerned. The instruction that the 4 v reference check should be to ± 2 mV and that required adjustments should be to VR1 on the Logger Analogue/Digital Converter card fails to explain what, and where, VR1 is physically located and how it can be adjusted. In practice the adjustment is simple. The point was made earlier that there is no substitute for practical instruction but the photographs given in this report should help.

Wherever possible this appendix has used the wording contained in the Microdata manual to avoid confusion.

The following paragraphs explain how physical measurements are converted via the logger to computer print-out. Hopefully, this will place the logger checks in context and make their significance better understood.

The sensors on the weather station feed signals to the interface. These are converted into voltages which are printed in blocks of data on magnetic tape. The tape is removed from the logger and is then translated by a computer to give printed lists. In the field, the logger battery provides current for both interface and logger. A 4 volt supply is divided into 240 logger steps, each of 0.017 v. *200 of these steps are assigned to the range of any particular parameter. Thus the minimum value would be zero steps and maximum value 200; the range between is divided proportionally. When the tape is translated the computer requires a scan reference marker to recognize firstly the start of every data block on the tape and secondly to check the performance of the logger. The use of 240 logger steps serves both purposes, for it is sufficiently different from 200 to avoid ambiguity with sensor data while a value different from 240 will indicate 'drifting' by the logger components. If the difference is within acceptable limits the computer calculates a correction and applies this to the rest of the data in the scan.

It is obviously vital that the power supply of 4 v should be adjusted accurately. This is done by adjusting a potentiometer and, ideally, by monitoring the result on a digital volt meter. A setting of ± 0.002 v is delicate but feasible and this is well within one logger step of 0.017 v. A single logger step is approaching the limits of accuracy for any sensor used on a weather station.

As an illustration, the temperature sensor on the weather station operates in the range -15°C to +35°C. Thus 50°C are divided into 200 logger steps and 1 step equates to 0.25°C.

* Model M200LT Data Logger Test/Calibration unit (code ref DL/TM-1.76).

Test box procedure

This procedure assumes that all testing will be done in the laboratory using mains supply. It can be used as a self contained unit in the field but reference should be made to the technical manual (D2/TM - 1.76) for information if this is done. The tests do not require a battery to be connected to the logger.

Initial setting-up for normal test and calibration sequence

Connect open logger and test box (no logger battery required).

TEST I Power supply check using test box with digital volt meter

Test box switch	Position
INT/EXT	INT.
EXT/4VR-Zero	Zero (Down)
ITO	ON (Down)
RUN/HOLD	RUN (up)
STEP	NORMAL (Unoperated, spring loaded)
CYCLE	ON (Down)
CALL	NORMAL (Unoperated, spring loaded)
CHANNEL INHIBIT (2-12)	ON (Down)
LOGGER SUPPLY	TESTER (Up)
POWER	ON (Down)

Connect digital volt meter by plugging into Ov. 5V sockets of Test Volts on test box.

Within 2 seconds after switching POWER ON the logger should be called.
A) The tape deck should now operate. The 5v display should be adjusted using the appropriate potentiometer (for location see Figure 17).
B) Move digital volt meter leads to 12v and 4vR. The 4v display should be adjusted using the appropriate potentiometer (for location see Figure 17).

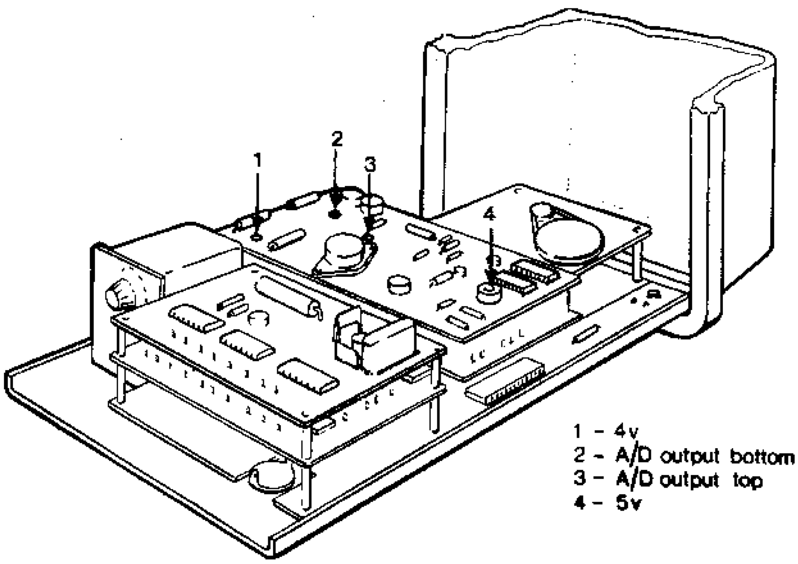

FIGURE 17

LOCATION OF TRIMMING POTENTIOMETERS - OLD TYPE LOGGER

This potentiometer is on the middle circuit board and access to the trimming screw is through a small hole in the top board. Sometimes the potentiometer is offset beneath the access hole and difficulty can be experienced in finding the screw head. Repeated adjustment usually 'chews' the soft plastic. The access hole can be enlarged (with very great care) but if the damage has already been done the logger will have to be returned to a qualified technician and the potentiometer replaced.

It is worth noting that the potentiometers come in varied forms. Some are small cylinders with screw heads in the top. Others are cubes with the adjusting screw in the top. In the new type logger the A/D output top and 4 volt potentiometers are rectangular in shape with metal adjusting screws. Some are single-turn, others multi-turn. However, despite individual differences they are all located in the same relative position and identification with the aid of Figures 17 and 18 should present no problem.

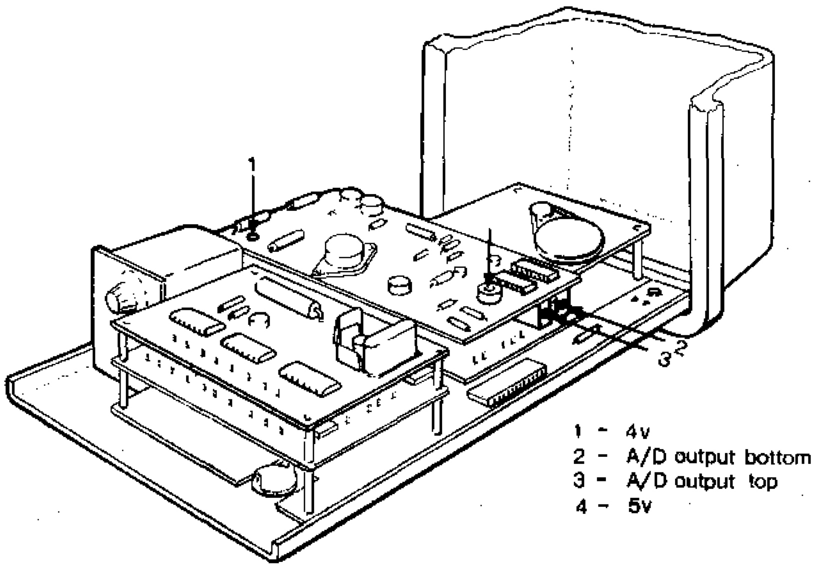

FIGURE 18

LOCATION OF TRIMMING POTENTIOMETERS - NEW TYPE LOGGER

New type loggers

These can be distinguished by the use of thumb screws (Figure 7) to hold down the tape deck. The old type uses counter sunk screws (Figure 6). The positions of the voltage trimming potentiometers can be located from Figure 18.

Note

The voltage adjustments should be done as quickly as possible after switching on the power to correspond with the field situation when the logger is 'cold'. Once adjusted do not return for further adjustment.

TEST II Analog/digital converters - setting logger steps

A) Setting 240 scan marker

Switches as in Test I. The A/D output lights 16, 32, 64, 128 should display (ie a total of 240). If adjustment is required, locate the A/D output top potentiometer (Figure 17, old type logger, Figure 18 new type). On the old type logger this potentiometer is on the middle circuit board and access is through a small hole in the top board.

B) Setting the zero logger steps

Switches as in Test 1 except the Ext 4VR should be put down to zero. All A/D output bottom potentiometers (for location see Figure 17 old type logger Figure 18 new type). On the old type logger this potentiometer is on the middle circuit board and access to the trimming screw is through a small hole in the top board. The correct setting is when all A/D output lights are just extinguished. Movement of the trimming screw will establish this position quite definitely.

TEST III Channel inputs

A) Set all the test box switches to the initial positions given for Test I. CHANNEL OUTPUT light 1 will remain on throughout Test III.

B) Set each of the CHANNEL INHIBIT switches OFF (Up) for Channels 2-9 in turn, noting that each relevant CHANNEL OUTPUT light and the corresponding A/D OUTPUT (binary count) lights are illuminated in turn. When the inhibit switch for 10, 11 and 12 are operated in this way the A/D OUTPUT lights 1, 2 and 4 illuminate.

If A/D OUTPUT lights show, other than the correct ones, this can be corrected using the A/D output top potentiometer (for location see Figures 17 and 18).

If such an adjustment is required return to the start of Test III and proceed from this point. It is worth noting that there are alternative ways of doing this test but an adjustment can only be made when the RUN/HOLD switch is in the RUN position and the channel in question has the inhibit switch OFF.

TEST IV

With all the CHANNEL INHIBIT switches off (up) and RUN/HOLD switch on RUN (up) the two banks of display lights should flash in pairs. At the same time the capstan post and take-up spool should rotate continuously. This gives an opportunity for a lengthy inspection of the mechanical action of the tape deck and drive bands from the motor.

Interface and sensor testing

The test box has the capability of battery powered operation. In this form it can be taken into the field and connected to the interface. By selecting individual channels the output from a particular sensor can be interrogated through the interface, and the binary control logger steps equivalent to the sensor output will be displayed on the A/D output lights. Coupled with a check e.g. a reference thermometer, and calibration it is therefore possible to test the performance of a sensor and the interface.

The facility is mentioned in this report for completion. It is not recommended that it should be undertaken by the field operator except when extreme circumstances dictate.

It is very strongly emphasised, however, that routine checks of this type together with periodic recalibration of the sensors, should be undertaken, ideally every six months.

APPENDIX IV

FIELD OPERATION CARD

This appendix describes the field operations card (Figure 19) used by the Institute of Hydrology. This card accompanies the tape when it is sent for translation and on the reverse side (not described) has sections for comment arising at the tape translation stage. The information is an essential diagnostic tool for identifying faults which may be in logger, battery, tape or sensor and are only traceable when used in different combinations if the correct information has been recorded on an operations card. The explanations give the field maintenance instructions for the sensors.

Field Op. Card heading		Entry	Explanation
Equipment type		AWS	Automatic Weather Station
Catchment		Severn	Research catchment
Site		Tanllwyth	Definition of a particular site in the Severn catchment
Station No:		1	Used when more than one instrument is located at the same site
Logger No:		1251	Maker's serial number (NOT HRU number)
Cassette No:		PLYN 69	Tape reference number
Sensor Nos:	Net	6223	Serial number of net radiometer
	Solar	700763	Serial number of solar radiometer; these are required to define individual calibrations used in data translation
Date fitted if new			A note to alter the calibration of radiation sensors stored in computer translation programmes.
Interface No:		1274	Maker's serial number (NOT HRU number)
Battery No:		LA99	Battery reference number
Cassette side:		1	Data is recorded on one side of tape only.
Battery volts:		6.5	Voltage before use. Must exceed 6.0V measured with Avometer with 5 ohm resistance across battery terminals
Water level:			For use when logger used with a water level sensor; if used, quote water level when logger disconnected.

Connected at GMT	0953	The GMT time when logger was connected to interface. Should be between five minutes, eg 0953 or 1427. Connect batter to logger in laboratory exactly at five minutes, eg 0950 or 1420. This practice avoids translation confusion.
On:	14/1/79	Date of connection.
Disconnect at GMT	1122	Time of disconnection of logger from interface.
On:	28/1/79	Date of disconnection

(THE LOGGER CLOCK DOES NOT USE ABSOLUTE TIME, IT ONLY 'COUNTS' INCREMENTS OF TIME. THE PRECISE DEFINITION OF START AND FINISH TIMES AND DATES OF THE TRANSLATED DATA ARE THEREFORE COMPLETELY DEPENDENT ON THESE ENTRIES)

Tape used:	38	Read from scale on cassette. This is a coarse check on final print-out from computer.
Battery volts:	6.0	Voltage after use. Measure with avometer with 5 ohm resistance across battery terminals.
Change wick?	No	Wick should be changed if dirty.
Change net gel?	No	Indicator is unreliable. Approximately every six weeks remove sensor from station cross arm. Remove sealing bung and inspect silica gel crystals. Replace if pink.
Adjust net level?	No O.K.	Bubble must be central. Adjust by moving station cross arm, or rotate sensor root in cross arm. Do not force sensor stalk.
Top up wet bulb?	Yes	Use distilled water only. Top up at every logger change.
Solar domes dry?	Yes	Inspect with mirror from ground. If condensation present note, but check that outer glass dome is secure. If loose report. If condensation under inner dome inspect black face for any white spots of corrosion. If found report.
Check raingauge level?	Yes	Check with spirit level across rim of raingauge

Net domes dry?	Yes	Inspect and report condensation; if present inspect top and bottom polythene domes for damage. If domes collapsed remove sensor from station cross arm and blow down tube. Do not attempt to restore collapsed dome with finger pressure. If domes punctured remove sensor and cover plug to keep dry.
Change solar gel?	No	Inspect approximately every six weeks by withdrawing chrome cylinder under sensor. The cylinder is held in position by knurled ring. If silica gel is pink, change. If condensation found under domes change silica gel at once.
Vane free?	Yes	Observe and test for stickiness; listen for squeaks in bearings.
Cups free?	Yes	Observe and test for stickiness; listen for squeaks in bearings.
NOTES		Any additional information, eg grass removed from raingauge funnel. If tape found fouled in any way, put sticky lable on cassette with instructions to destroy after translation.

FIGURE 19 FIELD OPERATION CARD

EQUIPMENT TYPE: AWS

sensor	no.	date fitted if new
net:	6223	
solar:	700763	

CATCHMENT: SEVERN

SITE: TANLLWYTH

Station no: 1 | Interface no: 1274

Logger no: 1251 | Battery no: LA99 | Battery volts: 6.5

Cassette no: PLYN 69 | Cassette side: 1 | Water level:

CONNECTED AT: 0953	GMT	ON: 14	1 1979
DISCONNECTED AT: 1122	GMT	ON: 28	1 1979

Tape used: 38 | Battery volts: 6.0 | Water level:

Change wick? No | Top up wet bulb? YES | Net domes dry? YES

Change net gel? No | Solar domes dry? YES | Change solar gel? NO

Adjust net level? No, OK. | Check rain level? YES | Vane free? YES Cups free? YES

NOTES: Grass removed from raingauge funnel

J.D.C.S.

APPENDIX V

FIELD MAINTENANCE FOR USERS WITH ONE LOGGER ONLY

This appendix deals with the situation in which the user has only a single logger and two batteries. Although it is inevitable that the situation will arise requiring the logger to be withdrawn for maintenance, and therefore loss of data, there is much that can be done to secure data retrieval using a single logger. It follows that the maintenance must be done on site, and is done during routine visits for tape and battery changes. It assumes that the operator takes to the site a charged battery (see page 13).

Logger protection from the weather

The logger and interface are in sealed metal boxes. This protection is lost when the methal boxes are opened and their contents put at risk. Ideally, therefore, the logger and interface should be kept in a hut giving free access regardless of weather.

The more usual alternative is to keep the interface and logger in a weather-proof box. If possible, service visits should be in good weather periods only. Routines make this an unlikely possibility and the weatherproof box should therefore be designed in size and layout to give ample space for the maintenance suggested below. Driving snow or dripping oil skins can make this a difficult task.

Recommended sequence of maintenance:

1 Open logger

2 Make visual inspection of battery and tape deck (see page 5)

3 Observe a scan by watching partial rotation of tape spools

4 Immediately the scan is complete change batteries; this should be done within 5-10 secs. Record GMT time on old field operations card under 'Disconnected at'

5 After connecting new battery, open recording head and lift off old tape

6 Clean recording head, capstan post and pinch wheel with solvent and cotton buds (see page 9). Dust pinch wheel with french chalk and blow away excess. This cleaning is not normally required at every tape change and the amount of dirt on thecotton buds will soon indicate the required frequency

7 Hold feed spool lightly and wind tape onto take-up spool for approx 150 mm beyond leader. This takes up slack tape and gets beyond start of tape which sometimes is superficially damaged

8 Check that the support pad is centrally behind the tape in the cassette

9 Position the new cassette on the deck with the full spool on the right, viewed from the battery socket

10 Check that the tape is between the capstan post and the pinch wheel

11 Rotate the take-up spool anti-clockwise to check free tape movement. This can be done with a biro or pencil but it is worthwhile making a special tool from a tube if the work is done in a restricted space. This check also ensures the the cassette is flat on the tape deck

12 Push home the recording head in the guide slots, and record GMT time on new field operations card under 'Connected at'

The checks 5-12 must be completed in less than 5 minutes, ie between scans. If this is not possible it simply means that one data scan has been lost.

13 Observe the next scan by watching the partial rotation of the tape spools

14 Note details of the battery numbers, tape cassette and side on the new operations card

15 Shut logger

There is no further maintenance that can be carried out on the logger in the field. However, its performance can be checked provided the interface is of the new type embodying a three figure display of logger steps (see Appendix III).

To make these checks open the interface. The display, the channel selector switch and the call button are the items of interest. Every 5 minutes the logger scans the sensors and displays the logger steps of one sensor. The display lasts for a few seconds only. By selecting the channels progressively, the output of each sensor can be observed; all eight channels takes eight scans or 40 minutes. To speed this process the channels can be progressively called although every scan moves the tape forward. If the tape is in position this will give extra records and lose correspondence with start and stop times on the field operations card. Therefore, do not use the call button unless the tape has been removed from the tape deck.

The most significant channel will be the first, giving the scan marker. This should be 240 but may range from 235-245. A reading outside these limits requires remedial action in the laboratory as detailed in Appendix III.

If the scan marker is correct the individual sensors can be checked. Precise calibration is only possible in the laboratory using a standard reference but the list given below will give confidence in the data up to that time or warn that sensor replacement/maintenance is required.

Channel	Sensor	Correct display
1	Scan marker	240 ± 5
2	Solarimeter	Exclude all light, allow one minute for stabilisation and display should read 000 = zero radiation
3	Net radiometer	Exclude all light, allow one minute for stabilisation and display should read 040 = zero radiation
4	Wet bulb depression	See manufacturer's handbook
5	Air temperature	See manufacturer's handbook
6	Wind-run	Display any count 0-127. Each 32 rotations of anemometer increases display by 1 logger step
7	Wind direction	See manufacturer's handbook
8	Rain	Display any count 1-124 in multiples of 4 logger steps. Each bucket tip increases the display by 4.