3.2.3 MAINTENANCE

Dependent on local situations and the types of instruments employed a local operator may or may not be required. In general with instruments using a recording chart fixed to a drum it will be necessary to replace this on a weekly basis and an operator then becomes necessary. When instruments are employed which record on punched tape or magnetic tape or where no local records are produced e.g. when the remote monitoring station is set up, then only routine maintenance visits at monthly or greater intervals become necessary. In the case of a remote station requiring a local operator his duties fall into two categories, maintenance and observation.

(i) Maintenance by Operator

The operator's duties are mainly concerned with maintaining the correct running of the instruments according to the maker's recommended maintenance schedules. For this work to be effective the operator must be provided with tools, lubricants and spares which are likely to be required. The following is a typical list of spares for a float operated gauge:-

pens
float and counterweight wires and wire connectors
float
clock

Maintenance is simple but nevertheless important. The mechanism must be kept adequately lubricated particularly bearings and slides. Wires must be regularly examined for deterioration and replaced at the first sign of fraying. Clocks should be regularly checked on a daily basis and the errors noted. Mechanical clocks can be adjusted to correct constant errors but must be replaced or repaired if the error is random. Clocks should be cleaned periodically and reset, this operation being best left to a qualified clock repairer.

The operator is also required to ensure the building is kept in good condition and to arrange for repair in case of storm or other damage. A routine for cleaning the stilling well inlet must be instituted, the period between cleaning operations being dependent on local conditions of growth and silt deposition. Periodic inspection of the VTS is required to check the condition of its mountings and cleaning of the face.

Check levelling at least each year between the group of local bench marks and the contact point and VTS is necessary.

(ii) Timing

Most analogue tide gauges employ mechanical clocks to rotate the recording drum or advance the strip chart. Some use electric clocks employing synchronous motors driven from the local mains electrical supply. All types of clock are susceptible to erratic operation.

Mechanical clocks can vary in speed with tension in the spring and with temperature. Electric synchronous clocks respond to the supply frequency which may change during the day particularly at peak load periods and then be corrected overnight at the power station. The result is that the clock may appear to be correct at the same time each day but vary about this time as the load changes. It is very difficult to adequately correct for clock variation but whenever this is noted it must be recorded, so that corrections can be made at the analysis stage. A good quality mechanical clock should be accurate to within 1 minute over a period of one week and this is normally adequate.

Timing errors can also be produced by a badly fitted chart- where the ends either overlap or leave a gap. In this circumstance the timing is correct only at one particular time every twenty four hours with an accumulating error over the remaining period.

Note: Uncorrected timing errors will result in the acceptance of incorrect height readings. This is particularly significant when tide levels are changing rapidly. Timing checks can only be made by use of an accurate watch or clock which has recently been set to a time signal.

(iii) Mechanical Clocks

These should be periodically cleaned and set by a reputable watch repairer and then tested before being put into use. The clock should also be wound at equal intervals e.g. weekly; be fully wound, but not overwound. The clock should be protected against the ingress of dust. Operation in a constant temperature is also beneficial. When fitting the clock the meshing of the gears must be carefully carried out to avoid backlash or binding.

(iv) Synchronous Clocks

There is no control over the frequency of the power supply. If large variations are common then an alternative type of clock should be sought.

Electro-mechanical clocks are likely to be more accurate than pure mechanical types. Crystal source clocks are even more accurate but few are available with sufficient torque to drive a recording drum or strip chart.

Where charts do not fit the drum correctly then either the drum is the wrong diameter or is damaged, or the chart is the wrong length. Whichever is found to be wrong must be replaced.

We have dealt with reducing errors as far as is possible by careful preparation and operation. However it is not possible to be certain that small errors are not creeping in from time to time unless the daily checks are carried out correctly and conscientiously. When longer periods occur between checks i.e. unmanned gauges, errors can go unnoticed. In the latter case it is useful to have an automatic system for checking datum and timing errors which equates to the daily check.

(v) Daily Checks

Before starting the daily checks it is essential to have an accurate watch or clock which has been synchronised to a standard time signal within the previous hours. The standard daily check sheet which is used on the British National Tide Gauge Network is shown in Table 3.1. The instructions for use of this check sheet are given on the reverse side of the sheet (Table 3.2).

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SUMMARY OF CHECKS ON AUTOMATIC TIDE GAUGE

(For instructions on completing this form—see back)

Week commencing ....

Place ....

Time kept (GMT or BST or Zone) ....

Date and time of starting record ....

Date and time of removing record ....

Date	Correct Time	Time on Chart	Height of tide on tide scale	Height of tide on Chart	Scend on tide scale	WIND		Remarks (including times of sudden changes in wind force or direction)	Initials of Checker
						Direction	Force		

....

Officer in charge of gauge

Table 3.1

INSTRUCTIONS FOR COMPLETING THIS FORM

1. Checks should be made daily, preferably at approximately the same time of day, unless weather conditions are unsuitable for making an accurate check.

2. If conditions are unsuitable, ie if it is impossible to estimate the height on the tide scale to the nearest 2 centimetres, the scend and wind forces and direction should still be entered on the form and 'conditions unsuitable' entered in the remarks column.

3. The correct time should be obtained from an independent watch or clock which should be checked daily by time signal.

4. The height on the tide scale and on the chart should be read to the nearest 2 centimetres, though in cases where the scale of the chart permits a greater precision, readings to the nearest centimetre may be given.

5. The checks should be carried out by making readings in the following order:

   i. Read the height on the tide scale and write it down.
   ii. Read the height of the pen on the chart and write it down.
   iii. Write down the correct time.
   iv. Read off the time indicated by the pen on the chart and write it down.
   v. Complete the remaining columns.

6. The scend is the vertical movement of the water on the scale apart from the rise and fall of the tide; the total range of movement should be entered in metres and tenths of a metre (eg 0.3 m).

7. The wind should be entered in the direction from which it is blowing to the nearest 45 degrees, eg North, South West, North East, etc.

8. The strength of the wind should be entered in miles per hour where this can be read from an anemometer. Where no anemometer is available it should be given in general terms, eg Calm, light, moderate, strong, gale, hurricane.

9. The remarks column should contain, apart from remarks on the weather, anything of interest or importance relating to the tide gauge, eg reasons for breakdowns, times of resetting the pen after repairing breakdowns or to correct errors etc.

10. The check sheet should be fastened to the tide gauge chart and sent in monthly to the authority concerned.

Table 3.2

In some instances it may not be possible to read the VTS at the same time as the recorder unless two people are present. If only one person is present then the recommended procedure is first to check that the recorder is set to the correct time then read the VTS at a precisely known time and take the height reading on the recorder for this same time using the timing graticule. With recorders which only give a digital readout another procedure must be adopted:-

e.g.	Read gauge	at 10.15	= 6.230	metres
	Read VTS	at 10.20	= 6.25	metres
	Read gauge again	at 10.25	= 6.272	metres
	Enter VTS reading on check sheet			
	Gauge reading is	$\frac{6,230 + 6,272}{2}$	= 6.251	which is then entered on check sheet.

When there is an appreciable scend on the VTS the reading will become less accurate and a judgement of the accuracy of this reading should be shown on the check sheet e.g. 6.2 metres $\pm$0.1 metres.

The information logged on the daily check sheets should be a true record of observations in no way modified to give neater looking results, since the information so recorded can be useful in the detection of timing and datum errors and stilling well performance.

In the case of dual installations i.e. where there are two tide gauges at the same site a cross check between readings of the two instruments can also be useful in detecting a system malfunction.

(vi) Weekly Checks

At weekly intervals when changing charts the following additional checks are carried out:

chart change requiring glue.

check and possibly change or refill pen.

wind clock.

align the new chart to the correct time. This must be checked again after a few minutes to allow any backlash effects to be noticed and corrected.

write the start time and date on the new chart.

A check between the VTS and the chart record should show the same agreement as the previous chart. If this is not so the reason should be found, it is not sufficient to reset the pen.

If a manual probe is kept at the site this can be used each week to check that the gauge datum is being maintained.

Where other types of gauges are used the procedures will obviously differ from the one given, but should in general be as indicated in the maker's manual.

(vii) Identification of Faults

Faults may occur from time to time though with good preventive maintenance these should be rare. Whenever a malfunction occurs it is necessary to identify the cause of the fault so that corrective action can be taken. Some faults which occur may not be noticed unless the observational procedures are strictly adhered to. The Van de Casteele test will identify most gauge faults. Simultaneous recording of water levels inside and outside the stilling well will identify stilling well faults. Non linear timing faults can be seen from examination of the daily check sheets. In general the more accurately noted are the observations then the greater the possibility of quickly identifying faults. The actual observations should be noted on the check sheet and not modified figures in an attempt to show good agreement; e.g. in the presence of large waves it will not be possible to obtain an accurate reading from the VTS, so this fact should be stated on the check sheet.

A diary should be kept a the tide gauge station in which entries are made at the time of each visit by whosoever visits stating reason for visit and work done and any other items worth noting. A summary of essential checks for tide gauge operators can be found in Appendix 1.

3.3 OTHER TYPES OF TIDE GAUGES

Although float operated analogue recording tide gauges are predominant many other types are in common use and a few of these will be described. Appendix 2 contains the names of suppliers of tide gauge equipment known to the authors.

(i) Float Operated Gauges with Punched Tape Recorders

The principal of operation of these instruments is similar to that already described for the analogue float gauge, the difference being in the way tidal information is recorded. These instruments do not give a continuous record of the tidal level but record spot heights at predetermined intervals of time, normally every fifteen minutes. These instruments contain a coding unit driven from the float mechanism. The coding unit is designed to transfer a height reading onto a recording tape at each recording period. The height is punched out in a binary code form as shown in the examples in Figure 3.10.

Reading these records by hand is particularly laborious and an automatic reader is necessary to translate the information on the tape into a more usable form.

(ii) Pneumatic Gauges

The descriptions which follow are limited to gauges which operate on pneumatic bubbler systems. Figure 3.11 shows the basic essentials of a bubbler system. Air is passed at a metered rate along a small bore tube to a pressure point fixed under water well below the lowest expected tidal level. The pressure point normally takes the form of a short vertical cylinder with a closed top face and open at the bottom. A small hole is drilled about half way down its length and metered air is entered through a connection on the top surface. As air from the tube enters the pressure point it becomes compressed and pushes the water down inside the chamber until the level of the bleed hole is reached when the air bubbles out through the hole and back to the surface. Provided that the air flow rate is low and the air