RECOMMENDED

OPERATING PROCEDURES

FOR

TIDE GAUGES

ON THE

NATIONAL NETWORK

National Mapping Council Special Publication No. 9
Permanent Committee on Tides and Mean Sea Level

NMP 84/001.6

PREFACE

In 1979 the National Mapping Council of Australia established the Permanent Committee on Tides and Mean Sea Level.

The committee consists of representatives from the Flinders Institute for Atmospheric and Marine Sciences and the Association of Australian Port and Marine Authorities, together with persons nominated by the Director of National Mapping and the Hydrographer, Royal Australian Navy. Provision is made to coopt members of the National Mapping Council as necessary.

The aims of the Permanent Committee are:

- to establish a data base of digitised tidal observations;
- to establish a catalogue of available tide gauge recordings which are still in a non-digitised form;
- to establish a data base of tidal harmonic constants;
- to consider the most appropriate media and formats for the storage and exchange of the above data;
- to investigate the quality of the existing tide gauges and their records;
- to obtain tidal records from all Council members and other cooperating authorities;
- to recommend other relevant activities which may be in the national interest.

Essentially a national data base of tidal observations is to be established, extending that already compiled at Flinders University, and a network of primary tide gauge sites selected which the committee believes is representative of the tidal phenomena of Australia and could be reasonably maintained to acceptable standards of data quality.

The Permanent Committee is endeavouring to coordinate a network of calibrated gauges in Australia. A network gauge would need to be calibrated at least annually, in accordance with the "Tide Gauge Survey Instructions" prepared by the Permanent Committee. Data from a network gauge would need to be freely accessible to the Permanent Committee for assessment, analysis and archiving in the national data base.

A network gauge should be of such a type and so located as to be able to be checked at least weekly or of such a type as to require minimal operator intervention. Obviously logistics play an important role in such a network and in this context there may be a requirement to install new or improved gauges.

Tidal data from other gauges will be included in the national data base and where the Permanent Committee is satisfied that the above conditions and quality controls are met those gauges could be included in the national network.

Where a tide gauge has been accepted on the national network certain benefits accrue as follows:

- local operations may be assisted by the service of periodic calibrations and survey checks, arranged by the Permanent Committee;

- once the data is in the data base, an archiving service is available to the operator. Also the quality control provisions enable a number of standard processing procedures to be available as required.

Any enquiries requesting advice on instrumentation, installation or tide gauge maintenance or the operation of the national network may be directed to the address below:

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PROPOSED NATIONAL NETWORK SITES

NMP 84/001.6.3

ACKNOWLEDGEMENT

The Permanent Committee on Tides and Mean Sea Level gratefully acknowledges the kind permission of the UK Committee on Tide Gauges to use their publications:

- 'Tide Gauges - Requirements'
- 'Tide Gauges - Operation and Maintenance' and
- 'Operating Instructions for Tide Gauges on the National Network'

as starting points in the drafting of this booklet.

INTRODUCTION

Many tide records show unexplained jumps in datum, bad overlaps on charts, time errors, and other discrepancies which have no connection with the tidal movement which the gauge is required to monitor.

The fact that a gauge is in error is not necessarily a reflection on the attention of the operator. No gauge is perfect or trouble-free and errors are to be expected from time to time. Our main concern is that the user of the records should be able to see at once whether any correction to the records is necessary.

Perhaps the main requirement to enable the tide gauge records to be correctly processed is the availability of independent checks. From these checks the performance of the gauge can be assessed and any necessary corrections made before putting the records into the national data base. It is therefore most essential that accurate and true comparisons be made between the gauge time and a standard clock and also between the recorded height and the height as read from the tide staff.

In order to ensure that records can be handled by computer methods, it has been decided to issue operating procedures which have, as their primary aim, the removal of all discontinuities from a tide gauge record. When a new chart or tape is fitted to the instrument, attempts should be made to ensure that this is recording correctly, but thereafter, throughout the life of the record no adjustment should be made to the instrument unless it is absolutely vital for your work. It is particularly important that the height setting of the gauge is not altered

unless this can be done by an accurate method. The aim is that there should be minimal interference with the mechanism. However, it is necessary to observe discrepancies in time and height and note them on appropriate check sheets. Continuous records so achieved can be much more accurately interpreted than records containing discontinuities with no adequate explanation.

Ideally a new gauge would be calibrated as soon as possible after being put into service at a network site. Thereafter it should be calibrated at least annually as stated in the preface of this booklet.

OPERATING PROCEDURES FOR TIDE GAUGES ON THE NATIONAL NETWORK

1. Purpose of Booklet

1.1 This booklet is designed to assist all authorities responsible for the local operation and maintenance of tide gauges in order that the records should be as accurate as possible and of such a quality that they may be easily interpreted.

2. Uses of Tide Gauges

2.1 In addition to local needs such as use in connection with shipping movements, harbour works, etc. tide gauge records are required for the following purposes:

- in the preparation of tide tables, for which they are the only reliable source. Tidal predictions are based upon the identification of the response of the sea to several components of astronomical and fluid motions. Often as many as 100 or more of these are required to provide adequate predictions, and many of them are of small size so placing a premium on accurate tide gauge operation. Although for on-site practical purposes, accuracies of half a metre in level seem adequate, it is important to note that predictions depend upon observed levels with an accuracy of 1 cm or better and time accuracies of 2 minutes or better;

- in surveying and mapping the legal definition of the coastline depends on a knowledge of tidal levels, whilst nautical charting requires reduction of soundings to a common datum to remove the effect of tides;

- to estimate storm surge and flooding risks both in the long and short term in order that harbour works and coastal protection can be properly designed. For this, knowledge of the frequency of abnormal levels and the incidence of storm surges and other randomly occurring phenomena is essential;

- to calculate mean sea level as it changes with the passage of time so that estimates can be made of the long-term movements of sea level with respect to the land. Here, in particular, the requirement is for long and continuous observational records extending over at least 20 years;

- for scientific research leading to the understanding and improved accuracy of all of the above.

3. Importance of Accuracy

3.1 In the past some records have been inadequate and badly documented and in some cases have proved useless. The accuracy of the records is of paramount importance. The trend in shipping circles to build larger vessels with the consequent increase in draught means that it is even more essential to know the depth of water in a channel at a given time and this can only be achieved by making the predictions as accurate as possible.

3.2 It will be understood therefore that in order to achieve this the basic data, i.e. the tide gauge records, should be as accurate as possible.

3.3 The tide gauge instrument has many imperfections and may not record an accurate level at all times. In particular it is affected by local conditions of

salinity variation, of wave action and of nearby currents. Also in the absence of electronic timepieces, clock errors are inevitable and it is important to have a record of all errors which occur. These should be recorded on a check sheet, see appendices B and C.

3.4 It is desirable that checks are made frequently and if possible on a daily basis. In order that the recorder graphs may be correctly interpreted it is essential that the record is continuous so that no adjustment of height or time error should be made during the life of a single record. Each chart should be set as correctly as possible and the instrument should then be allowed to record without further interference, until it is time to replace the chart. Errors occurring meanwhile should be carefully noted on the check sheets.

3.5 Check sheets which show constant agreement with the tide staff and an independent timepiece would be highly suspect. Analogue gauges are particularly susceptible to errors and these should be noted.

4. Height Errors

4.1 Height errors may arise as follows:

(a) the chart may not be correctly fitted;
(b) the pen may not indicate the correct height on the chart;
(c) the water level in the stilling well may not represent accurately enough the level of the water outside, in particular the inlet may be partially blocked;
(d) there may be excessive friction in the mechanism;

(e) there may be friction between the float and the stilling well;
(f) the chart may be distorted. This can be caused through changes in humidity;
(g) the tide staff may be difficult to read accurately;
(h) the graduations on the chart may be inaccurately printed.

4.2 Of these (a) and (b) should be checked after putting on a new chart; (c) and perhaps (d) and (e) can only be ascertained by a special test or by long periods of observations. Chart distortion (f) may be due to the paper charts being stored in a damp environment. Charts must be kept dry until required for use. Nevertheless a well kept chart may still cause trouble if the tide gauge hut is allowed to become humid. Any special problems should be noted on the check sheets. Difficulty in reading the tide staff (g) may be due to fouling with marine growth. Even with a clean tide staff accurate reading is not possible in the presence of appreciable wave action.

4.3 In order to achieve an accuracy of 1 cm, or better, in height a scale of not less than 1:10 is desirable on an analogue chart. This means that 1 cm of water level change is represented by 1 mm on the chart. The smallest graduation on the chart should represent a change of water level of 1, 2 or 5 cm.

5. Time Errors

5.1 Time errors may arise as follows:

- the pen may not be set to the correct time on the chart;
- the clock driving the instrument may be unreliable;

- the chart transport may be distorted or misaligned;
- a drum chart may have an overlap or gap on the join;
- allowance for daylight saving (summer) time may not have been made;
- the graduations on the chart may be inaccurately printed.

5.2 Any of these discrepancies should be noted on the check sheet but no adjustment made except when fitting a new chart.

5.3 The required time accuracy cannot be met if the time scale is too compressed. It is recognised that there are certain problems in the Australian environment:

- over some sections of the coastline the tidal sequence will result in the graph coinciding daily on a drum chart with a 24 hour rotation. The tendency then would be to use a drum rotating every 7 days or a strip chart to achieve adequate separation. The former gives rise to a compressed time scale;

- because of the remote nature of many tide gauge sites frequent maintenance visits are not possible. In these cases the tendency is for the chart transport to be set at a slow rate, again resulting in a compressed time scale. Nevertheless a tide gauge on the National Network should be able to meet the accuracies specified and for an analogue chart the time scale should be not less than 1 cm per hour, but 2 cm or more per hour is preferred.

5.4 There is a need to match the time and height scales so that the gradients of the recorded tidal curves are not too steep. Gradients greater than 70^{o} from the horizontal should be avoided.

6. Operating Procedures

6.1 Analogue Recorders

6.1.1 For an analogue recorder the following checks should be carried out as frequently as practicable and before and after changing the chart:

(a) carefully read the tide staff, allowing for wave motion, and note the time using a reliable independent timepiece. Enter the height and time in the appropriate columns of the check sheet;

(b) now read the tidal height and the time as shown on the recorder graph and also the correct time and enter these in the appropriate columns of the check sheet;

(c) with minimal interference to the mechanism, mark the chart to show the position of the recorder pen at the time of the check.

IMPORTANT: (a), (b) and (c) should be performed within a short a time interval as is possible.

(d) now complete the line of the check sheet as appropriate.

For drum charts do not attempt to adjust the gauge for any discrepancy, except when changing the chart, but ensure that these discrepancies are noted fully on the

check sheets. For strip charts which may run for several months it is advisable to adjust for any observed discrepancy in time or height at intervals of approximately one week.

6.1.2 When changing charts:

(a) note on the old chart the date and actual time the pen was lifted clear prior to removal of the chart. Note this also on the check sheet in the space provided at the top;

(b) attach all check sheets pertaining to this record to the old chart;

(c) fully wind the recorder clock;

(d) refill or replace the pen as required;

(e) enter on the new recorder graph the date and tide station name;

(f) fit the new recorder graph ensuring the chart graduations are parallel with the guides;

(g) set the pen to the correct time graduation using the reliable independent timepiece. The final movement of the chart drive when setting the time must be against the motion of the drive in order to take out the backlash;

(h) at least 5 minutes after setting the pen on the recorder graph (to allow for all the backlash to have been taken out) compare the time shown on the graph with that shown by the reliable independent timepiece, and if necessary reset the graph until the pen is reading the correct time;

(i) as a final check, compare the time and height readings on the old graph with those on the new graph to ensure that there is no gross error (e.g. an error of 1 hour or 10 cms);

(j) enter on a new check sheet in the space provided at the top, the date and time when the new recorder graph was fitted;

(k) now that everything is correctly lined up, repeat the usual checks (as described above) entering the data on the first line of the new check sheet.

NOTE:

(i) it is essential that any differences between the height shown by the tide staff and that shown by the recorder graph be noted. Such differences do in fact occur for various reasons, and it is by seeing these that defects in the gauge can be detected and remedied. For this reason the tide staff should always be read first, before knowing the level shown by the recorder;

(ii) never refer to any clock dial which may be incorporated in the tide gauge when checking the time. Time checks must be made from an independent watch or clock which has been checked by a time signal within the hour. It is essential for the time zone being recorded to be indicated on the check sheet. It is advisable that daylight saving (summer) time is used when appropriate.

(iii) always ignore the height scale provided in some instruments. It is the pen height on the chart which matters.

6.2 Digital Recorders

6.2.1 A digital recorder is a recorder where the tidal record is not represented graphically by a pen drawn curve, but instead is recorded as a numerical list of tidal observations, which may be printed, or a sequence of holes punched in a paper or plastic tape, or a signal recorded on a magnetic tape, at a set time interval. These gauges are designed to be automatic, and apart from routine changing of tapes and batteries, require little attention to the recorder.

6.2.2 The main advantages of digital gauges are as follows:

- the accuracy of each recorded height is generally better than the equivalent from an analogue gauge;
- require less attention and may continue to record automatically with accuracy over an extended period with minimal operator intervention, making them suitable for installation at remote sites;
- the elimination of problems such as chart fitting, inking and paper distortion;
- improved performance in the maintenance of a stable height datum and time base;
- the elimination of the laborious process of extracting digital data from graphical records;
- simplifies transmission of accurate water levels to remote displays.

6.2.3 Digital gauges have some disadvantages, such as:

- recent water levels are not always displayed directly;

- an instrument malfunction or operator error may not be obvious for a considerable period of time and may result in a major loss of data;

- unless the gauge records time as well as height great reliance is placed upon the operator's notes of starting and end times. If the number of recorded observations does not agree with the elapsed time of gauge operation the whole record becomes useless;

- where rapid water level oscillations (seiches) occur, with a period of oscillation of perhaps 10 to 30 minutes, care should be taken in choosing the sampling time interval of the gauge short enough to avoid the introduction of a spurious signal (aliasing) - see Appendix A. Some digital gauges record the water level signal averaged over some minutes which helps in this regard.

6.2.4 The recommendation of this committee is that the National Network would be best served by the use of digital rather than analogue gauges.

6.2.5 The following general points should be noted:

(a) Digital gauges normally sample at some interval of an hour (e.g. 5, 10, 15 minutes). It is recommended that this interval does not exceed 15 minutes and that the gauge be set so that a sample is recorded on the hour. For example, for a sampling interval of 15 minutes,

recordings should take place on the hour and 15, 30 and 45 minutes past.

(b) Although many instruments are capable of operation for extended periods it is recommended that the record be removed for processing at monthly intervals. It is clearly of advantage if the instrument can be serviced within the sampling period so that continuity of the record is not broken.

(c) It is essential that, in order to obtain correct results when these records are being processed, the correct dates and starting and finishing times of each record are known, as well as the sample number (if available) at the beginning and end of the record. If this information is not provided, there is no means of finding out whether or not there have been any breaks in the recording process.

6.2.6 It is recommended that the following routine be adopted at each visit:

(a) Wait until the next recording sample. At this time read the tidal height if displayed on the gauge and note the time using a reliable independent time piece. Enter the height and time in the appropriate columns of the check sheet.

(b) Now carefully read the tide staff, allowing for wave motion, and note the time. Enter the height and time in the appropriate columns of the check sheet.

IMPORTANT: (a) and (b) should be performed within as short a time interval as possible.

(c) Now complete the line of the check sheet as appropriate.

(d) Where a sample number is indicated this should be entered on the check sheet and a check made that the number of samples made since the last check is correct.

(e) In the case of punched tape ensure that the last few records have been punched cleanly, remove punched remnants of tape from the instrument and ensure that the punch mechanism is clean.

(f) Check the state of the battery, where appropriate, by reference to its installation date.

Do not attempt to adjust the gauge for any discrepancy, except when removing the record, but ensure that these discrepancies are noted fully on the check sheets.

6.2.7 When removing records:

(a) After completing the above checks remove the record from the gauge. When only the recorded portion of a tape is to be removed, allow about 0.5 metre of blank tape after the last recording before cutting (this blank tape is needed for spooling in the decoding device).

(b) A suitable label should be fixed to the record indicating the name of the station, the date, the time, and number of last recording, if available. These facts should also be entered on the check sheet.

(c) All check sheets pertaining to this record should be stored with it.

(d) Fully wind the recorder clock and/or replace batteries, if required.

(e) Reset clock to correct time using the reliable independent time piece.

(f) Ensure that sufficient unused tape or other medium remains to last until the next record change.

(g) Ensure that the expected battery life is sufficient to operate the recorder until the next visit.

(h) Where applicable the end of the remaining tape in the spool, or new tape, should then be carefully threaded through the mechanism onto the take up spool, again allowing about 0.5 metre of blank tape. Where a punch counter exists this should be reset to zero. Care must be taken to ensure that the tape is seated properly on or through the guides and rollers. Careless positioning could render the tape illegible. In the case of magnetic tapes failure will occur if the operator does not ensure that a fresh or de-Gaussed tape is used and that it is fitted in accordance with the instrument manufacturer's recommendation. This will ensure that the oxide coating is in contact with the writing head.

(i) Enter on a new check sheet, in the space provided at the top, the date and time when the new tape or other medium was fitted.

(j) At the time of the first recording repeat the time and height checks as above, entering the data on the first line of the new check sheet.

IMPORTANT: It is essential that the check sheets must always remain with the relevant record.

7. Sensors

7.1 Stilling Wells

7.1.1 Stilling wells act as a filter of surface waves and their efficiency depends on the ratio of the diameter of the inlet to the diameter of the stilling well, normally 1:10. Some evidence of wave action is nevertheless desirable on the record in order to ensure that the tidal oscillations are recorded faithfully.

7.1.2 Consequently the stilling well and inlet must remain clear of silt, marine growth and corrosion so as to maintain the design performance. Cleaning programs must be scheduled regularly, perhaps as often as 2-monthly intervals.

7.1.3 The operation of the stilling well depends on the balance of pressures inside and outside the inlet, consequently it is affected by pressure variations in its vicinity. Such variations can arise from wave action outside the well and by pressure disturbance due to stream flow around the well. Both processes produce lower levels inside the well than in the open water. The tide gauge operator should advise the data user if either condition exists.

7.2 Pressure Sensors

7.2.1 Various types of pressure-operated tide gauge systems are in use. They may be classified into open or closed gas systems and electronic systems.

7.2.2 Open gas or "bubbler" systems employ the escape of small bubbles of air or other gas from a pressure line. The pressure of gas in the line varies with the water head and is measured by one of a number of different methods.

7.2.3 Closed gas systems employ a diaphragm or a bladder to detect the changes in water pressure, which are transmitted through a capillary tube to the recorder where they are measured by one of a number of different methods.

7.2.4 In the gas system the sensor is often a mechanical device such as a Bourdon tube or an aneroid capsule but it may also be a crystal transducer or strain gauge.

7.2.5 In the electronic system the changes in pressure are detected by a sensor immersed in the water and converted directly to an electrical signal. In these systems the sensor may be a crystal transducer, strain gauge or other transducer.

7.2.6 In order to maintain the design performance of these systems the operator should guard against the following:

- marine fouling or siltation of bubble escape, pressure inlet or diaphragm;

- escape of gas from a closed system;

- loss of gas pressure in the bubbler system, whether due to leakage or to failure of gas supply;

- damage to pressure line or electrical cable.

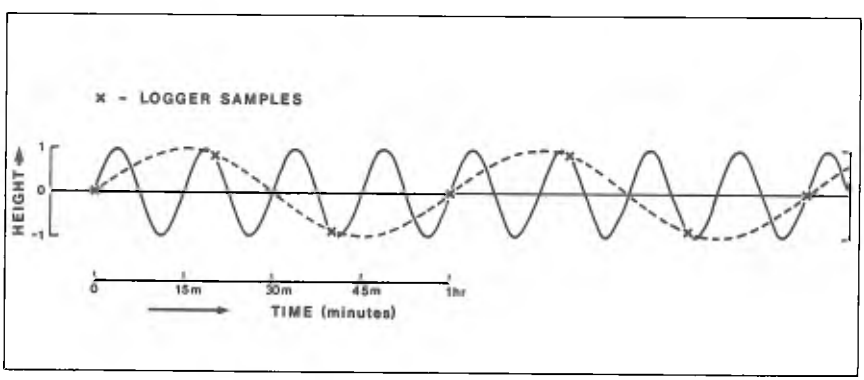
7.2.7 Gas systems require damping of the effects of surface wave action. This is usually effected by a constrictor unit in the pressure line. Electronic systems achieve the same effect by averaging or filtering of the electrical signals.

ALIASING

Aliasing is a problem which can occur when the sampling period of a logger is not matched to the variable which is to be recorded.

Sea level records contain oscillations of many tidal and resonant frequencies. Suppose one oscillation contained in the record, say a harbour seiche, has a frequency of 4 cycles per hour (15 minute period). Suppose also the logger is set to sample at intervals of 20 minutes. The diagram illustrates the systematic error which would result and here it will be seen that the logger will not recognise the seiche but instead will contribute an entirely spurious longer-period oscillation of one cycle per hour.

A general rule would be to attempt to ensure that the sampling interval is less than half the period of any oscillation which might be present in the records. With this in mind, a recommended procedure would be to install a temporary analogue recorder and to examine the content of the record before deciding upon the sampling interval of the digital recorder.



CHECK SHEET – ANALOGUE RECORDER

Station Name: _____

Gauge Operated by: _____
(Organisation)

Date and Time of Starting Record: __ / __ /19 __ : __ am pm*

Date and Time of Removing Record: __ / __ /19 __ : __ am pm*

Gauge Zero: _____ metres above* below* tide staff zero

(*Delete as required)

Time Kept (tick appropriate box)

Eastern Standard ☐ Eastern Summer ☐

Central Standard ☐ Central Summer ☐

Western Standard ☐ Western Summer ☐

Universal Time (formerly GMT) ☐

Other ☐ (please specify _____)

Date	Correct Time of Tide Staff Reading			Correct Time of Graph Reading			Time on Graph			Water Level on Tide Staff	Height of Tide on Graph	Remarks	Operator's Name
	Hours	Mins	am* pm	Hours	Mins	am* pm	Hours	Mins	am* pm	Metres/Feet*	Metres/Feet*		

CHECK SHEET – DIGITAL RECORDER

Station Name: _____

Gauge Operated by: _____
(Organisation)

Date and Time of Starting Record: __ / __ /19 __ : __ am pm*

Date and Time of Removing Record: __ / __ /19 __ : __ am pm*

Gauge Zero: _____ metres above* below* tide staff zero

(*Delete as required)

Time Kept (tick appropriate box)

Eastern Standard ☐ Eastern Summer ☐

Central Standard ☐ Central Summer ☐

Western Standard ☐ Western Summer ☐

Universal Time (formerly GMT) ☐

Other ☐ (please specify _____)

Sample Interval _____ minutes

Date	Actual Time of Sample			Correct Time of Tide Staff Reading			Height of Tide on Gauge	Water Level on Tide Staff	Sample Number	Remarks	Operator's Name
	Hours	Mins	am* pm	Hours	Mins	am* pm	Metres/Feet*	Metres/Feet*			

DOCUMENTATION, BENCH MARKING AND LEVELLING REQUIREMENTS FOR TIDE GAUGE INSTALLATIONS

1. Irrespective of the expected duration of operation of a tide gauge the following work should be carried out at each tide gauge:

- Complete "Tide Gauge Details" sheets for each tide gauge;
- Search for existing bench marks and, where necessary, install additional or supplementary marks to bring the number of stable marks in the vicinity of each gauge to at least three;
- Determine the difference in height between each of the tide gauge bench marks and the zero of the tide staff and/or recorder at each installation;
- If not already connected, and where reasonably possible, connect the tide gauge bench marks to a level traverse of the National Levelling Survey;
- Prepare a plan of each tide gauge installation;
- Send a copy of all documentation to the PCTMSL as soon as possible after installation.

2. Tide Gauge Details sheets

2.1 Complete the 4 pages of "Tide Gauge Details" in as much detail as possible.

2.2 These sheets serve as a permanent record of the tide gauge installation and it is important that as much information as possible be obtained and that the information is accurate.

2.3 With reference to environmental effects (Question 28) describe in detail any feature which may limit exposure of the gauge to open water (e.g. shallows, narrows, etc.).

3. Bench Marking

3.1 Inspect existing permanent bench marks in the vicinity of each tide gauge and if they are inadequate in number and/or quality establish new permanent marks so that at least three marks of good quality and stability are available at each gauge.

3.2 New marks should be about 100 metres apart and away from any anticipated construction activity or other possible cause of disturbance.

3.3 Marks established as tide gauge bench marks should preferably be constructed of brass rod set at least 150 mm into solid rock, concrete foundations or other suitable structures, the top of the rod protruding not more than 5 mm and indicated by a brass numbering plate. If no suitable rock or structure is available bench marks are to be established in accordance with Schedule 4 "Recommended Marking Practices" of NMC Special Publication 1 "Standard Specifications and Recommended Practices for Horizontal and Vertical Control Surveys".

3.4 The identification number allocated to each new bench mark is to be legibly stamped on the brass numbering plate.

3.5 Each new bench mark is to be fully described in the field level book and a Permanent Bench Mark record is to be prepared for each new mark.

3.6 Bench marks established during the level connections from tide gauge bench marks to National Levelling Survey traverses shall be constructed in accordance with the above Schedule.

3.7 Supply a copy of all Permanent Bench Mark Records to the State Survey Authority.

4. Levelling to the zero of Tide Staffs

4.1 The differences in height between all tide gauge bench marks and the zero of the tide staff is to be determined to third order levelling standards at each gauge.

4.2 All levelling is to be carried out in accordance with Schedule 3 "Recommended Survey Practices" of Special Publication 1 (see paragraph 3.3).

4.3 A diagram showing the differences in height between the tide gauge zero and the tide gauge bench marks is to be prepared for each gauge, and included with the Tide Gauge Details sheets.

5. Connection to the National Levelling Survey

5.1 If the tide gauge bench marks have not already been connected to a traverse of the National Levelling Survey such a connection shall be carried out to third order standards in accordance with Schedule 3 (see paragraph 4.2).

5.2 All levelling is to be checked and a summary completed on the forms provided before leaving the site of the survey.

5.3 The levelling summary should be submitted to the State Survey Authority for incorporation into the National Levelling Survey adjustment.

6. Plan of Tide Gauge installation

6.1 The position of the recorder, the tide staff, and all bench marks shall be shown on a large scale plan of the area.

6.2 A suitable map of the area can usually be obtained from local authorities. Where such plans or maps are unobtainable a sketch shall be prepared showing the recorder hut, the tide staff, the bench marks and other local features in their proper relative positions, and identify their location on aerial photography as described below.

6.3 The automatic recorder and all bench marks shall be identified on aerial photography by pricking their positions on the photos with a fine needle and by suitable annotation.

Where an identification is in doubt, an easily identifiable point nearby shall be identified. The photo annotation shall refer to this nearby point as the "Photo Reference Point" and shall indicate its bearing and distance from the recorder and the bench marks.

6.4 The plan of tide gauge installation should be included with the Tide Gauge Details sheets.

7. Permanent Committee on Tides and Mean Sea Level

7.1 Supply a copy of the Tide Gauge Details sheets, plan of installation, annotated aerial photograph (if applicable) and height connection diagram (see paragraph 4.3) to the PCTMSL as soon as possible after installation.

7.2 If any changes occur to the details provided or the gauge is removed, the PCTMSL should be informed immediately.

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GLOSSARY

Analogue Gauge

A tide gauge where the variation of water level is continuously recorded by a pen moving along a recorder graph.

Bench Mark

A permanent, stable object containing a marked point of known elevation with respect to a datum used as a reference level for water level observations or as a control point for levelling.

Chart Datum

Chart datum is the reference level, below which depths on a nautical chart are measured and from which water levels are measured and tidal predictions given by the authority responsible for publishing the chart and tide tables.

Digital Gauge

A tide gauge where the variation of water level is recorded, on magnetic tape, punched tape, or printer, in order to produce a numerical list of water level observations at a set time interval.

Inlet

The small hole or holes situated at or near the bottom of the stilling well through which the tidal water passes in and out.

GLOSSARY

Pressure Sensor

That part of a pressure-operated tide gauge which detects the variations in pressure.

Recorder

That part of a tide gauge that records the variation of water level.

The record may be a graph on specially printed paper, punched tape, magnetic tape, or a printed list.

Recorder Graph

The graph of water level against time plotted by a recorder.

Stilling Well

A tube with an inlet, designed to reduce the effect of short-period waves on the vertical motion of the water level within the well.

Tide

The periodic rising and falling of the surface level of water that is associated with the gravitational attraction of the moon and sun acting upon the rotating earth.

Tide Gauge

An apparatus for measuring the variations of water level due to tide, weather and other effects.

Tide Gauge Bench Mark

A bench mark near the tide gauge used for check levelling.

Repeated levellings from the tide gauge bench mark to other bench marks in the vicinity check the stability of the tide gauge installation.

Tide Staff

A vertical graduated pole or board from which the height of water level at any time may be read directly.

Transducer

A device that converts variations of one quantity into those of another.