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DELFT HYDRAULICS with
HALCROW, TAHAL, CES,
ORG & JPS

**VOLUME 4
HYDROMETRY**

**FIELD MANUAL - PART II
RIVER STAGE OBSERVATION**

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GENERAL

The Field Manual on Hydrometry, comprises the procedures to be carried out to ensure proper execution of design of the hydrometric network, and operation and maintenance of water level and streamflow gauging stations. The operational procedures are tuned to the task descriptions prepared for each Hydrological Information System (HIS) function. The task description for each HIS-function is presented in Volume 1 of the Field Manual.

It is essential, that the procedures, described in the Manual, are closely followed to create uniformity in the field operations, which is the first step to arrive at comparable hydrological data of high quality. Further, reference is made to the other volumes of the manual where hydro-meteorology, sediment transport measurements and water quality sampling and analysis is described. It is stressed that hydrometry cannot be seen in isolation; in the HIS integration of networks and of activities is a must.

This Volume of the Field Manual consists of 8 parts:

- Part I deals with the steps to be taken for network design and optimisation. Furthermore, site selection procedures are included, tuned to the suitability of a site for specific measurement procedures.
- Part II comprises operation of water level gauging stations equipped with staff gauges, autographic chart recorders or digital water level recorders.
- Part III comprises the preparatory activities and execution of float measurements, including selection of float type, reach preparation, observation practice and discharge computation
- Part IV comprises the preparatory activities and execution of current meter measurements by wading, and from cableways, bridges and boats. The procedure for discharge computation is included.
- Part V deals with the field application of the Acoustic Doppler Current Profiler (ADCP). It covers operating modes and site conditions, deployment, operating set-up and measurement runs as well as the data handling and recording.
- Part VI presents the required activities for the execution of the Slope-Area Method and the procedure to be applied to arrive at a discharge.
- Part VII comprises Field Inspections and Audits, with required check lists and standard forms.
- Part VIII, finally, deals with routine maintenance of gauging stations and calibration of equipment.

The procedures as listed out in this manual are in concurrence with the ISO standards as far as available for the various techniques and applicable to the conditions in peninsular India.

1 INTRODUCTION

The measurement of water level or stage at a gauging station is perhaps the most fundamental in hydrology. Field practice and frequency of observation should match with the data needs and the available instrumentation. The greatest frequency of observation is required when the level (and discharge) is changing rapidly in response to rainfall, especially during the monsoon season and on small catchments.

Manual observations by staff gauge will remain as the sole means of observation at some stations for many years. They will also continue to be used at all stations to check the operation of recording equipment at intervals, as a back-up in the event of instrument failure and in conjunction with discharge measurements for stage-discharge determination.

Part II comprises the operation of:

- Staff gauge stations (Chapter 2)
- Stations with autographic chart recorder (Chapter 3)
- Stations with digital water level recorders (Chapter 4)

2 STAFF GAUGES

The gauge observer will read the water level at an external staff gauge located directly in the river, and record to the nearest 1 mm where the water has little surface fluctuation. Where the water level is unstable due to wind action or turbulence, the observer will assess the mean level by noting the level fluctuation over a period of approximately 30 seconds and take the mean (average) of the normal range. An internal staff gauge situated in a stilling well will not normally be used as the primary water level measurement. Observation will be made by making the closest possible approach to the gauge consistent with safety. Where the staff gauge is likely to become too distant for accurate gauge readings during rising flood levels, a simple pair of binoculars may be provided.

The frequency of observation of staff gauges and the period over which the observational frequency is to be applied, will be specified for a given station and **observations will be recorded on a standard form**. Examples of the standard forms to be used for daily, twice, trice daily and hourly readings are presented in Annexures I & II.

During the monsoon months (normally between June and October) when the flow is high and variable, hourly staff gauge observations are made over the full 24 hour period where the staff gauge is the sole means of level measurement.

The forms may also be used to record the maximum and minimum water level during the day in addition to hourly levels, if such additional data is available. In rapidly changing flows, the maximum level may exceed the highest recorded hourly level, when it occurs between the hourly observations. Similarly, the minimum level may be lower than the lowest hourly level.

The gauge reader is required to maintain **good time keeping** and the hourly observation will not fall more than 5 minutes before or after the hourly observation time.

The observer will note on the form whether the gauge is the only gauge, the main gauge, or a supplementary gauge, or gauges, for assessing surface water slope. A separate form will be used for each supplementary gauge in use. It is important that each gauge is clearly identified on the form. For supplementary gauges the observer will note whether the gauge is upstream or downstream from the main gauge. Where supplementary gauges exist, the upstream gauge will be read first and the

downstream gauge as soon thereafter as is consistent with safety. Where the supplementary gauges are some distance apart

During periods of low flow or where the station is equipped with a reliable automatic or digital method of recording, the observer will take readings three times daily at 0800, 1300 and 1800 hours and record on the standard form covering a period of one month per form. Where an internal gauge exists in a stilling well it will be read once daily at 0800 and recorded.

When the gauge observer reads the gauge at other, non-standard times, he must ensure that he records the actual time of reading.

When the gauge observer is unable to visit the station for sickness or other reason he will in no instance attempt to estimate or interpolate the missing value(s) but will leave the space blank or note “M” and record in “Remarks” the reason for the missing record.

The observer will ensure that there is a direct connection between the flowing water surface and the gauge. After flood siltation he will, if necessary, remove sandbars or dig a trench from the gauge to free water. A shovel will be provided for this purpose. The channel to the gauges may require renewal on a daily basis.

The observer will note in “Remarks” all those occurrences which may influence the level as observed at the gauges and especially those which may affect the level-discharge relationship. The time/date and location of occurrences will be noted. The following occurrences in particular will be noted:

- damage or destruction of gauges due to flood or other cause
- scouring and lowering of the river bed level either at the gauges or at the control site
- construction of bunds downstream to raise water level for abstraction or diversion
- extraction of sand or gravel from the river channel
- blockage or partial blockage of the channel by floating or other debris in flood
- significant weed growth in the channel or on the weir and its subsequent removal.

The observer will record the level at which flow ceases and the pool of water at the gauges becomes static.

Where the river level falls below the level of the lowest gauge but flow continues, for example due to scouring of the bed at the station, the observer will attempt to continue the observations. In such occasions, the observer will measure downward from the datum of the gauges and record it as a negative stage i.e. he will measure the distance from the zero on the gauge to the water surface. For example if the distance from the gauge zero to the water surface is 0.15 m, then the gauge reading should be recorded as -0.15 m. As soon as possible, the engineer in charge will re-survey the station and reinstall the gauges with a new datum, ensuring that survey details and the change in datum are fully documented in the Station Record.

3 AUTOGRAPHIC CHART RECORDERS

To ensure efficient and continuous operation of the autographic chart recorder, it is necessary that the observer checks daily the condition of the recorder and installation and compares levels shown on the recorder with those on the reference staff gauge. This regular check is required to minimise malfunctioning for a period of time.

The following general routine is to be applied on a daily basis:

1. Read the outside reference gauge, cleaning if necessary.
2. Read the inside reference gauge if one is installed
3. Read the indicated level on the chart and compare with the above i.e. steps 1 & 2. If the readings do not agree, find the cause and remedy it.
4. Check that the clock is running and read the time indicated by the pen on the chart.
5. Enter all readings of water level, recorder time and clock/watch time on the chart. For this purpose the operator is provided with a reliable watch.
6. Mark the chart with a short vertical line by raising the float wire.
7. Remove the stylus (pen) from the chart.
8. Remove the chart drum from the recorder.
9. Remove the chart from the drum by cutting cleanly with a sharp blade. Do not cut at the joint, as it is essential to be able to examine the join to determine any error.
10. Place the new chart tightly on the drum, making sure that it fits properly on the rim and that it matches on the joining edges.
11. Rewind the clock.
12. Check the stylus (pen) assembly to ensure that it is working properly and recharge with ink if necessary.
13. Replace the chart drum on the recorder.
14. Check the float and counterweight assembly and clean the float if necessary.
15. Clean and oil the recorder mechanism according to the manufacturer's instructions.
16. Rotate the drum anticlockwise to eliminate backlash.
17. Reset the stylus on the chart at the correct time and level.
18. Enter the readings of water level and time on the check form or on the new chart.
19. Before leaving the station check that the instrument is working properly.
20. Lock the lid or door of the recorder housing.

4 DIGITAL WATER LEVEL RECORDERS

Digital water level recorders (DWLR's) take a variety of forms but have in common the ability to measure and register the water level at a specified interval in digital storage on a data logger. The sensor may take the form of a float-operated shaft encoder or a pressure transducer. Data loggers for water level measurement also take several forms, those with separate removable memory, those with integral memory for which a standard portable PC computer is used to set-up and download data, and those with integral memory but with proprietary retrieval device.

The methods of setting up and checking DWLR's depend upon the type of logger and sensor and on software specific to a logger type. Visual checking of the performance of the DWLR is possible if an on-site display is incorporated into the logger. Routine data retrieval and checking involves following steps:

1. Read the reference staff gauge.
2. Plug in the computer or data retrieval device to the data logger and check the current level.
3. Check that the logger clock is within acceptable time accuracy.
4. Enter all current readings of water level, logger time and clock time in the Station Record Book and compare with previous performance record.
5. Download the logger data, either the full stored contents or the data since last download, as required.
6. Check exchangeable battery power sources and replace if below the recommended voltage, paying due attention to the time period, which will elapse before the next service visit.
7. If logger level and reference level disagree, depending on the level of disagreement, four categories of associated action may be applied
 - Do not adjust
 - Adjust logger to reference level
 - Investigate potential faults including stilling well blockage if one is installed. Remedy if possible and adjust logger.
 - If no problem is identified and disagreement persists, remove logger and/or sensor and replace.
8. If logger and clock time disagree, depending on the level of disagreement, three categories of associated action may be applied
 - Do not adjust
 - Adjust logger to clock time
 - Remove logger and replace
9. Restart logger if necessary (most modern loggers do not need to be restarted)

Annexure – I

Standard form for 1, 2 and 3 daily gauge readings for one month

Annexure – II

Standard form for hourly gauge readings for one month