Government of India & Government of The Netherlands

Technical Assistance
HYDROLOGY PROJECT

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

VOLUME 4
HYDROMETRY

FIELD MANUAL - PART III

FLOAT MEASUREMENTS

Table of Contents

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

General principles of site selection and measurement techniques are described in Volume 4, Design Manual, Hydrometry, respectively in Chapters 4 and 6.

The methodology of rigorous float measurement is described in ISO 748 but there are practical limitations to its full application. Three principal problems are:

1. Floats cannot be tailored to different dimensions to measure mean velocity in the vertical, where depths differ between gaugings and across the section. For operational purposes only surface or near-surface floats are practical and there is therefore uncertainty in the coefficient which must be used to convert surface velocities to mean velocity in the vertical.
2. Floats can rarely be positioned precisely in the cross section and hence there is a difficulty in assigning a width and panel area to the measured velocity.
3. Application of the methods described in ISO 748 requires laborious plotting of cross section and velocity distribution curves, and the graphical assessment of segment areas for each gauging. The effort required is greater than for a typical current meter gauging and may not be practical in the field.

The procedures described below have therefore been adapted to Indian conditions, recognising the inherent uncertainties in the method and attempting to match the simplicity of field measurement with ease of computation.

Float gauging will only be carried out when it is not possible to make measurements by current meter. This may be at stations where current metering facilities exist but conditions for their use have become unsuitable or dangerous. The float method will most often be applied to flood gauging. Float gauging may also be carried out at stations where current metering facilities have not yet been installed or as part of a preliminary survey for station design.

This part III of the Field Manual includes:

1. Selection of float type
2. Reach preparation
3. Observation practice
4. Discharge computation

2 FLOAT TYPE

Surface or near-surface floats should generally only be used. These will normally be wooden cylindrical rods 0.4m in length and 4 cm in diameter. They will be weighted so that they float nearly vertically with one third of the length protruding above the water surface. This is to minimise the effects of wind. The rods will be brightly painted for easy identification in turbid or turbulent water. A shorter length rod of 0.25 m may be prepared for shallow flows of less than say, 1.5 metres.

3 REACH PREPARATION

For all stations at which regular float measurements are made, or where occasional flood measurement by float is anticipated, the reach will be chosen, cross sections surveyed and data prepared in advance.

The upstream and downstream cross sections will be sufficiently far apart for accurate assessment of float traverse time (3 to 5 times the width or a minimum of 20 seconds travel time). Where the reach is

located downstream from a bridge, the upstream section will be sufficiently far from the bridge to avoid the effects of turbulence.

The cross sections at the upstream and downstream ends of the reach will be clearly marked such that the time when the float crosses the line can be clearly identified. There will be markers on both banks.

The upstream and downstream cross sections will be surveyed and tied to the zero of the staff gauges. The upstream channel cross section will be divided into a number of segments at which the floats will be placed (or attempt to be placed) at equal spacing across the channel. An odd number is convenient as it allows one float to be placed at 50% of the width. Use of more than 7 segments is usually impractical unless the floats are placed from a bridge.

If the reach is uniform and flow parallel with the banks, the downstream section will be similarly divided by the same proportional spacing. If there are cross currents or divergence, trials will be carried out to establish the average 'destination' in the downstream cross section of the floats placed at the specified intervals upstream, and these destinations used to subdivide the downstream reach into segments.

From these cross sections, segment areas will be determined for incremental staff gauge levels and the mean of the upstream and downstream segment areas will be calculated. This will be prepared for the number of segments selected for the station using a standard form (Figure 1). For convenience, the form will be completed for upstream and downstream sections separately and a third (working) form prepared from the mean of the areas for given segment and gauge height. A new tabulation will be prepared following re-survey, with a minimum of once per year before the monsoon season.

The pre-selection of segment locations may cause problems where the channel width increases significantly with gauge height, but this is less likely at high flows where most of the observations will be made.

4 OBSERVATIONAL PRACTICE

1. An observer will be stationed at upstream and downstream ends of the reach and will be visible to each other. The downstream observer will act as timekeeper and will be equipped with a digital stop watch.
2. The upstream observer will release (or throw) the floats far enough upstream from the first cross section for them to obtain a constant velocity before reaching the first cross section. Ten metres will usually be adequate. The upstream observer will signal the downstream observer when the float crosses the start line. Badly placed floats will be repeated.
3. Floats will be released sequentially, timed (to the nearest 0.1 sec), and recorded in the standard form illustrated in Figure 2.
4. Floats which snag on banks or debris are ignored and the float run repeated.

Note that the selection of equal float-placing distances across the channel will result in unequal segment widths as the floats nearest the bank will incorporate a greater width to the water's edge. Thus for 5 segments the floats will be placed at 17% (one sixth), 33% (one third), 50% (middle), 67% (two thirds) and 83% (five sixths) of the distance across the channel. For 7 segments the floats will be placed at 12.5% (one eighth), 25% (one quarter), 37.5% (three eighths), 50% (middle), 62.5% (five eighths), 75% (three quarters), and 87.5% (seven eighths) of the distance.

5 COMPUTATION

1. Discharge will be completed at the station immediately after completion of the measurement.
2. Surface velocity is calculated for each segment as reach length divided by travel time and entered in Column 3 of the form (Figure 2).
3. Mean vertical/segment velocity is determined as 0.85 x Surface velocity, unless there is evidence from current meter measurements of a different surface float coefficient.
4. Segment area for the given gauge height is read from Figure 1. Interpolation in the form to the nearest centimetre is justified at low flows but unnecessary at high flows.
5. Segment discharge is calculated as the multiple of segment area and velocity.
6. Total discharge and area are calculated as the sum of segment discharges and areas.
7. Mean velocity is computed as Total discharge divided by Total area.

……STATE SURFACE WATER SECTOR

DISCHARGE MEASUREMENT BY FLOATS

Cross sectional areas for given gauge heights

Basin ..... River ..... Site..... Code No .....

Staff Gauge Level	Sgt. Area 1	Sgt. Area 2	Sgt. Area 3	Sgt. Area 4	Sgt. Area 5	Sgt Area 6	Sgt. Area 7	Sgt. Area 8	Sgt. Area 9	Sgt. Area 10	Sgt. Area 11	Total Area
0.00												
0.10												
0.20												
0.30												
0.40												
0.50												
0.60												
0.70												
0.80												
0.90												
1.00												
1.10												
1.20												
1.30												
1.40												
1.50												
1.60												
1.70												
1.80												
1.90												
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3.00												
3.10												
3.20												
3.30												
3.40												
3.50												
3.60												
3.70												
3.80												
3.90												
4.00												

Figure 1: Segment and cross sectional areas for given gauge height.

……STATE SURFACE WATER SECTOR

DISCHARGE MEASUREMENT BY FLOATS

Cross sectional areas for given gauge heights (contd.)

Basin ..... River ..... Site..... Code No .....

Staff Gauge Level	Sgt. Area 1	Sgt. Area 2	Sgt. Area 3	Sgt. Area 4	Sgt. Area 5	Sgt Area 6	Sgt. Area 7	Sgt. Area 8	Sgt. Area 9	Sgt. Area 10	Sgt. Area 11	Total Area
4.10												
4.20												
4.30												
4.40												
4.50												
4.60												
4.70												
4.80												
4.90												
5.00												
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7.80												
7.90												
8.00												

Figure 1 (contd.): Segment and cross sectional areas for given gauge height

……STATE SURFACE WATER SECTOR
FLOAT DISCHARGE MEASUREMENT NOTES

Basin ..... River ..... Site..... Code No ..... Date .....

Observation made by ....

Weather Conditions .....

Condition of Water ....Fairly clear / Ordinarily Silty / Intensely Silty

Wind .. Slight / Moderate / Strong / Very Strong Direction ...Upstream / Downstream / Cross

Changes in Control - Describe (Scouring, deposition, bunding, debris, weed etc.) .....

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Character of River bed

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Segment No	Travel Time (secs)	Sfc. Velocity (m/sec)	Vert/Segment Vel. (m/sec)	Segment Area)m^2)	Discharge (m^3/sec)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
Total					

Distance between sections ..... Surface : Mean Vertical velocity .....

Gauge readings At Start..... At Finish..... Zero R L (GTS)..... m

Gauging Results

Area ..... Mean Velocity ..... Mean Gauge height. ..... Discharge .....

Gauging No. .....

Figure 2: Float discharge measurement notes - summary form