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Technical Assistance
HYDROLOGY PROJECT

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

VOLUME 4
HYDROMETRY

FIELD MANUAL - PART VIII

MAINTENANCE AND CALIBRATION

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 hydrometeorology, 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

1.1 GENERAL

Regular maintenance of stage and streamflow measuring stations, equipment and instruments is essential if the continued collection of good quality hydrometric data is to be assured. In most circumstances a poor measurement site which is well maintained is better than a good measurement site which is badly maintained. Also, hydrological instruments need regular checking and calibration.

Many maintenance and calibration routines and requirements are site and instrument specific. However, an attempt has been made in the following sections to provide some general guidelines which are applicable to most stations.

The maintenance and calibration procedures should be linked closely to the Field Inspections described in Part VII of the Field Manual on Hydrometry.

1.2 SPARE PARTS AND EQUIPMENT

It is very important to maintain an adequate stock of back-up equipment and spare parts at each Divisional office. The number of spare instruments and parts to keep in stock will be a function of the number and type of site, the type of equipment and the proximity of the supplier's stocks. The following Table 1 is included as a guide:

Item	Number of spare instruments	Spares	Remarks
Gauge plates	Min. of 10 no. x 1 m gauge plates for every 5 sites	Supply of spare fixing bolts	
AWLRs	One spare AWLR for every 7 sites	Adequate stock of charts (min. 6 months supply), pens, ink, cable, float tape / wire, floats, counterweights, clocks, batteries	The number of spares to be kept in stock should depend on operating experience and the ability of the supplier to react to orders at short notice
DWLRs*	One spare for every 20 sites with the same measuring range and cable requirements	It would be possible to keep a few spare loggers for surface logging systems but it is probably better to place responsibility with supplier DRS and several sets of interface cables for connection of DRS to DWLR as well as PC.	If a large number of installations is intended (>10) it is suggested that an annual maintenance contract is agreed with the supplier
Current meters	One spare standard current meter for every 5 sites	Connecting cables and suspension and signal cable	
Revolution counters	Preferably one spare unit for every site, but no less than	Batteries	
ADCP	Nil	Set of cables	Specialist equipment - should be maintained and repaired by supplier

Table 1: Suggested spare requirements

***** - **Note:** There are several types of DWLR design. In some models the logger is installed in the sensor casing i.e. it is submerged, conversely in other systems the logger is installed separately at the surface. Also, there are several different ways of downloading data. Based on operating experience with good equipment it is very rare for more than 1 in 20 instruments to malfunction within their design-life. It is generally recommended that whenever possible, particularly, when a large number of units is purchased that an annual maintenance contract is entered into with the supplier.

The responsibility for supplying and installing spare parts and replacements thus rests with the supplier. The ability of a supplier to offer a competitive, efficient support service is an essential consideration when evaluating tenders for the supply of DWLR's (see Design Manual, Chapter 7).

2 STAGE MEASUREMENT EQUIPMENT AND INSTALLATIONS - ROUTINE MAINTENANCE

2.1 STAFF GAUGES AND BENCH MARKS

Despite their simplicity, even staff gauges require regular care and maintenance. Table 2 below gives an indication of the regular inspections and tasks which should be carried out:

No.	Task	Frequency and remarks
1.	Inspect for damage	Daily or on each visit
2.	Clean gauge plates	As required but no less than monthly
3.	Remove debris and silt from gauge	Daily or on each visit if required
4.	Check levels of each gauge plate relative to each other and Temporary Bench Mark	During monsoon - monthly (max.) and after each flood event, Lean season - once prior to next monsoon season
5.	Check TBM levels relative to each other (if two installed)	Same as task 4 above
6.	Check level of TBMs relative to GTS	Annually, provided nearest GTS bench mark is within 5 km, else once every 3 - 5 years, but sooner if TBM's are damaged
7.	Take appropriate action to remedy any deficiency and repair damage	On each visit, take action Immediately

Table 2: Maintenance of staff gauges & bench marks

2.2 AWLRs

Even though AWLRs (chart/autographic water level recorders) have been used for many years experience has shown that in many States there are problems in keeping these operational. This seems to be due to a combination of factors including lack of fast moving spare parts such as charts, ink and pen nibs, inadequately trained and motivated field staff and lack of in-depth instrumentation knowledge.

Table 3 below provides an indication of the type of inspection and maintenance that is required at an AWLR site. This includes the maintenance of stilling wells, which are required by necessity at AWLR sites. Similar procedures are also required where digital shaft encoder float systems are installed.

Comparison of Inside and Outside Water Levels. The external staff gauge is considered as the reference gauge and the AWLR is normally set and checked against this gauge. However, it is good practice to use an inside gauge in the stilling well such as an internal staff gauge or measuring down from a known reference mark to the water surface using an electric tape gauge. Obviously, the electric tape is to be of excellent accuracy, i.e. at least four times better than that of the AWLR. The accuracy of the tape is to be verified against a precise reference. If there is a significant difference between the external and internal water levels this is either due to siltation of the stilling well and intake pipe or differences between the outside and inside gauges caused by the design of the stilling well and the hydraulic conditions prevailing at the time. If the stilling well is well designed significant differences should not occur between the two readings unless there is a siltation problem. If the difference is greater than 20 mm consideration should be given to de-silting the well. If the difference is due to hydraulic reasons it is important that a relationship between external and inside water levels is established. If the differences persist the stage-discharge relationship is developed on the basis of

the external gauge heights observed when discharge is measured. The relation is then adjusted to correspond with internal water level readings observed at the time of discharge measurement. This is because it is the digitised chart values, which will be entered onto the database for the estimation of corresponding discharge values.

No.	Task	Frequency and remarks
1.	Routine chart changing and maintenance tasks	Once a day/week depending on type of recorder. The procedure for chart changing and for checking AWLR's is contained in Part II of this Field Manual
2.	Routine instrument maintenance tasks e.g. oiling	In accordance with the manufacturer's instruction manual
3.	Check inside well level and compare with external water level	Daily or on every visit. If the difference is greater than 20 mm under steady flow consideration should be given to de-silting well and intake pipes
4.	De-silting of stilling well and intake pipe*	Prior to every monsoon season, then as and when required (see point 3 above).
5.	Check weatherproofness and security of recorder housing	Daily or on each visit - if maintenance required either undertake or initiate immediately

Table 3: Maintenance of AWLR's and Stilling Wells

* - **Note:** There must be adequate provision for stilling well maintenance. As a guide, with accessories for 5 stations in rivers with very heavy silt loads. On other rivers 10 stations per pump should be adequate.

2.3 DWLRs

Once they are installed, DWLR's should require very little maintenance other than ensuring that the DWLR reading agrees with the external reference gauge. The responsibility for any major repairs and maintenance should be the responsibility of the supplier, provided that this is clearly spelled out in a Maintenance Contract.

Table 4 below provides an indication of the type of inspection and maintenance that is required at a DWLR site.

No.	Task	Frequency and remarks
1.	Routine downloading of data	No greater than monthly, preferably more frequently
2.	Check instrument reading with external reference reading	At the same frequency as downloading, both readings should be recorded but no adjustments should be made. If significant differences of (say > 20 mm) occur Executive Engineer to be notified
3.	Check logger clock	On each downloading visit. If a difference of > 2 mins occurs Executive Engineer should be informed, no adjustments
4.	Battery check	On each downloading visit, replace batteries if required
5.	Remove silt from around sensor head	As and when required - design of installation should try to minimise any detrimental silt effects
6.	Check weatherproofness and security of recorder housing	On each visit - if maintenance required either undertake or initiate immediately

Table 4 : Maintenance requirements for DWLR's

The float-counterweight DWLR well should be maintained much like the well of the AWLR as stipulated under AWLRs.

*** - Note:** When a DWLR is installed it will be fixed in the required position and normally set to the zero of the staff gauge using the off-set facility. Over a period of time the DWLR reading might start to drift away from the staff gauge reading. This drift could be caused by several factors including a stretching out of the DWLR cable when it is freely suspended and not clamped in one position, or due to a gradual ageing process. No attempt should be made by the observer or field hydrologist to re-adjust the DWLR to the reference gauge value. The corresponding readings should be noted and the necessary shifts can be applied to the recorded stage data at the data processing stage if required. If significant, sudden differences (say > 20 mm) occur the matter should be referred to the supplier.

3 FLOW MEASUREMENT EQUIPMENT AND INSTALLATIONS - ROUTINE MAINTENANCE

3.1 CURRENT METERS AND SUPPORTING EQUIPMENT

3.1.1 CURRENT METERS

The regular maintenance procedures to be adopted will depend on the type of current meter. Therefore, the maintenance procedures should be based on the manufacturer's manual and/or instructions. However, the following guidelines which have been mainly based on Herschy (1995) have been included as a general guide.

1. Before and after each discharge measurement examine the meter cups or vanes, pivot, bearing and shaft for damage, wear or faulty alignment.
2. Clean and oil meters daily when in use (unless they are water lubricated).
3. Undertake a spin test before each day of use (unless they are water lubricated), see Chapter 6 of Design Manual for procedure. A significant decrease in the duration of spin is indicative of worn bearings, other parts or a bent shaft
4. Clean the meter immediately after each measurement if the meter is being used in sediment-laden water. For cup-type meters the surfaces to be cleaned and oiled are the pivot bearing, pentagear teeth and shaft, cylindrical shaft bearing and thrust bearing at the cap.
5. For cup meters keep the pivot and pivot bearing separate when the meter is not in use by means of the raising nut or lever provided. Replace worn parts or fractured pivots.
6. Limit on-site repairs to minor damage only. This is particularly pertinent to impeller meters where small changes in shape can affect the rating. In cup-type meters minor dents in the cups can be straightened to restore the original shape, but in case of doubt replace the rotor wit a new one*.
7. Damaged plastic impellers should be replaced with a new one*.
8. Dispatch to workshop for repair or reconditioning, badly sprung yokes, bent yoke stems, misaligned bearings, tailpieces and impellers*.
9. If a cable suspension is being used, check that the conductor cable is adjusted as necessary to prevent interference with meter balance and rotor spin. Check the meter's balance on the hanger bar and the alignment of the rotor when the meter is on the hanger bar.
10. Meter should be re-calibrated on a regular basis and after major overhaul, damage or replacement of key parts (see Chapter 4 below).

*** - NOTE:** If significant parts are replaced or damage occurs and repairs are undertaken in most circumstances the meter should be re-calibrated prior to being put back into operation. If this is not possible the meter should be re-calibrated as soon as possible and comparisons made between the original and new rating to ensure that there are no significant differences over the calibrated measuring range.

3.1.2 PULSE COUNTERS AND TIMERS

These should be checked before each day of use. Recommended procedures are contained in Chapter 6 of Design Manual.

3.1.3 BRIDGE OUTFITS

Bridge outfits should be checked before each day of use for any signs of detrimental wear. Regular checks should be made to ensure that depth measuring devices e.g. depth counters are reading correctly. These should be checked by comparing a 10 m length of suspension cable against a reliable steel tape.

If the current meter to counter connecting cable is embodied in the suspension cable checks should be undertaken before each day of use to ensure that the pulses are being recorded correctly.

The stability of the gantry should be checked periodically to ensure that it is still structurally sound and not a potential hazard to the operatives.

3.1.4 CABLEWAYS

The following general procedures should be adopted:

1. All maintenance should be in accordance with the supplier's instructions and maintenance schedules. An operations and maintenance manual should be provided with the cableway on delivery.
2. The cable shall be regularly inspected and lubricated.
3. Anchorages shall be regularly inspected and remedial measures should be taken as soon as they are required.
4. The sag shall be checked at regular intervals, particularly when large changes in temperature occur and adjustments made accordingly.
5. The depth and horizontal distance counters, where installed shall be checked against known reference distances on a regular basis.
6. For manned cableways, where the safety of the operators is of paramount importance, the structural integrity of the structure should be inspected on a regular basis by a qualified, approved, structural engineer.

3.2 ADCP

There are diagnostic checks that can be run on the ADCP using its supporting software. The software checks that all the ADCP's internal systems are responding. It is recommended that these checks are performed prior to departure for a field trip at the beginning of each field day to save any wasted time and journeys. It is essential to check the power supply (batteries) and the interfacing cables. Details of the diagnostic tests and other operational procedures will be contained in the supplier's operating manual.

In particular the reference sensors (temperature for speed-of-sound, tilt and compass for ADCP attitude) need regular checking. The temperature sensors can be checked against a laboratory style thermometer while putting the ADCP in water at different temperatures while continuously stirring and mixing the water. Allow several minutes for the ADCP to settle after changing the temperature, e.g. after adding ice or hot water.

The tilt sensors can be checked by tilting the ADCP body over known angles. First the body has to be placed on a horizontal plane. Use a spirit level to verify if the plane is horizontal indeed by checking

along the x and y direction. For axes, which are perpendicular to each other, the spirit level should show nil tilt. The tilt readings as obtained from the ADCP should be close to 0 then.

The compass can be checked and calibrated under guidance of the calibration software, which is part of the delivery. The compass calibration should be repeated daily while the ADCP is installed on the boat in its rigging. Part of the calibration procedure is the sailing of a circle under guidance of the calibration software. The circle should be sailed smoothly without sudden changes of speed or direction.

4 CALIBRATION

4.1 STAGE MEASUREMENT DEVICES

4.1.1 STAFF GAUGES

Spot checks should be undertaken on gauge plates (say every 1 in 5) prior to installation against a reliable standard e.g. a steel tape. If gauge plates are removed and the graduations re-painted then the new graduations should also be checked using a steel tape or similar.

4.1.2 DWLRs

DWLRs of the pressure sensor type should be calibrated prior to delivery at an accredited calibration facility.

It has been pointed out in Chapter 6 of the Design Manual that over a sufficiently long period of time, any of the performance characteristics of a pressure sensor device may alter, due to the simple ageing process altering the physical state of its component parts - quite aside from the effects of general operational stress or of chemical processes (oxidation as a result of moisture ingress, for example, or corrosion through the ingress of gaseous chemicals). The existence of the ageing process should be recognised through **periodic calibration checks** of all operational parameters detailed in the basic device specification - at intervals of time no longer than (say) three years, with less wide-ranging tests applied (in the field if necessary) at no greater than annual intervals.

The following is recommended:

1. Once every 12 months a check should be made on the performance of the sensor. If the sensor is installed in a vertical tube this is straight forward since it can be raised by a known distance in the tube and see if this rise is accurately reflected in the reading. Where this is not possible the transducer could be removed and tested in a drum, stand pipe or something similar where either the position of the transducer or the water level can be readily changed. It is recommended that this type of checking and testing is only undertaken during the lean season unless a particular instrument is giving suspect data.
2. Ideally DWLR's of the pressure sensor type should be returned to the manufacturer every three years for full re-calibration. In reality this may not be logistically possible, particularly if a large number of units is involved. Therefore, field calibration would be required. In any organisation that uses pressure sensors as an everyday hydrometric tool on which reliance is to be placed, a high quality, portable field calibration unit (**Pressure Tester**) is likely to be an essential support device. This device, in turn, should be subject to rigorous quality assurance procedures that allow its performance to be traced back confidently to an accepted standard. Ultimately the organisation might build-up its own in-house capability to undertake this field calibration. This would require a calibration device like the Pressure Tester and staff with proper instrumentation expertise. However, in the first instance this might be better undertaken by the supplier as part of the annual maintenance contract or by contracting the work to a third party who specialises in instrument

calibration. Also then someone, of the own organisation or acting in behalf of it, should be capable to assess the performance and methods of the third party.

4.2 ADCPs

The ADCPs measuring principle is related to the measurement if time / frequency. To make this possible the ADCP contains a crystal based frequency reference. Such crystals have a very high stability, and as a result the velocity accuracy of the ADCP is not likely to change appreciably over time. The performance of the ADCP may change over time though, e.g. due to failure of the transducers and analogue circuitry and power supply. Also drift and / or failure of the compass and the sensors for temperature and tilt sensors will affect the measuring results. It is recommended to verify the performance of the compass and auxiliary sensors before and after each deployment.

The performance of the sound intensity indicator is difficult check accurately. Some indications may be derived from experience. Calibration of the velocity measurement in a rating tank is possible but only under specific conditions. First of all, there should be a sufficient amount of scatterers (sound reflecting particles) well distributed over the entire cross section of the tank. Because the water in the tank is virtually stagnant, only few particles will stay in suspension, most will settle at the bottom or at the surface. Further, the size of the tank, in particular the width and the depth should be sufficient to allow the beams to properly spread, reaching the bottom without touching the walls would be best. Obviously the minimum depth should allow at least one full cell to be measured, taking the draft, blanking distance and blind zone at the bottom into account. Proper bottom tracking might be difficult due to poor retro reflection (in the direction of the ADCP's acoustic transducers) of the bottom, in particular when the bottom is smooth and clean. Due to reverberation of acoustic energy in the tank, the measuring signals can be overwhelmed effectively "blinding" the ADCP. Taking all those limitations in account, it is still worthwhile to experiment with ADCP measurements in large (rating) tanks.

4.3 CURRENT METERS

4.3.1 INTRODUCTION

The calibration of current meters has been introduced to in Chapter 6 of the Design Manual.

The normal way to calibrate a current meter is to tow it through still water and observe the time of travel and the number of revolutions as the meter travels a given distance. The number of revolutions per second and corresponding velocity are then computed. When these two quantities are plotted against each other, a series of equations of a straight line will be used to fit the points. A rating table is prepared substituting values of revs per second to obtain corresponding velocity values.

4.3.2 RATING TANK

Rating tanks are usually of the order of about 100 m long, 2 m wide and 2 m deep. A carriage runs on rails above the water surface to which current meters are fixed either by means of rods or suspension cables. The carriage is run at different speeds along the top of the tank and the time it takes to cover a fixed distance at a relatively constant target speed is recorded. The revolutions made by the current meter while travelling over the same distance are also recorded. The speed of the carriage and the corresponding revolutions per second can then be estimated and the corresponding points plotted on a graph. In modern rating tanks the horizontal distance travelled is usually measured electronically using photoelectric cells or similar. The revolution counter and time measuring device are synchronised with the distance-measuring device. Some tanks have the facility to fix the number of pulses and record the distance travelled and the time to make the pre-set number of revolutions. This has the advantage that the observation will always stop exactly on a full revolution and not partially through one which could introduce some slight inaccuracies at lower velocities.

An Indian rating tank is illustrated in Figure 1 and a close up of the towing carriage is illustrated in Figure 2.

Figure 1:
Example of a rating tank

Figure.2:
Close up of towing tank carriage

4.3.3 SOME POINTERS FOR SATISFACTORY CALIBRATION

1. The counting of pulses and the measurement of distance and time have to be carried out to a very high level of accuracy.
2. The carriage should run smoothly over the full range of speeds and at a constant speed so that oscillatory motion is avoided.
3. Calibration runs are taken over the full range of velocities for which the meter is designed or is intended to be used.
4. The meters should be suspended in the same manner, as they will be fixed in the field i.e. from a rod or suspension cable of the same diameter and material.
5. When the current meter is rod mounted at higher velocities greater vibration can occur than under field conditions when the rod base is placed on the bed of the river.
6. When a current meter is being calibrated on cable suspension it is important that measurements are not commenced during any run until the oscillations of the meter particularly at low speeds have been damped out.

7. A run should not commence until the water in the tank is effectively completely still. This might mean waiting up to 15 minutes or more after a high velocity run. Herschy (1995) notes that the residual movement is probably the largest source of error in the calibration method. Visual indication of movement can be detected by observing the surface of the water or by means of a small sub-surface float having a slight buoyancy and tethered at the depth of the meter by a fine thread tied to a small sinker resting on the bottom of the tank.
8. In order to ascertain the **minimum response** speed of the current meter. i.e. the minimum speed of the rotor of the current meter which attains continuous and uniform angular motion, the carriage is set at a low speed which is gradually increased until the rotor is seen to start to turn. It is possible that the meter might not complete one revolution at this low speed due to friction and/or magnetic drag of the contact system or it may have a pronounced hesitation. The speed of the carriage is increased until the rotor is just turning regularly. Knowing the least speed at which the meter turns regularly and the approximate intervals between pulses, the pulse timers and counters are set, and the calibration measurements are made at the lowest speed.
9. The axis of the meter should be parallel to the water and to the long dimension of the tank.
10. When the speed of the carriage is close to $\sqrt{gd}$ where g is the acceleration due to gravity and d is the depth of the water in the tank, the Epper effect can occur. When the carriage has this speed the disturbance caused by the immersed current meter and its suspension equipment moves along the tank with the meter and reduces the rate of revolution of the rotor. The size of the Epper effect is such that it may be little more than the uncertainty of a single calibration point.

4.3.4 INDIVIDUAL AND GROUP RATINGS

Some current meters are calibrated individually while others are not. When using a group rating it is assumed that if identical meters are used which have been manufactured to a very high standard using the same machines and tools, then they should all have, within acceptable tolerances, the same calibration. The group rating should be produced from the individual ratings of at least 10 meters from the same production batch, the sample containing new current meters, well maintained used meters, or ratings from both.

Some reputable manufacturers of current meters have demonstrated that the use of a group rating can be justified. However, strict control of the manufacturers tolerances is an essential requirement for a successful group rating. Even though these are laid down in international and other standards the user must take care when using current meters with a group rating. When purchasing a make that is previously unfamiliar to the user it might be worthwhile having some independent check calibrations made on several group rated meters to check their validity.

Generally, it is to be preferred if each meter is calibrated separately and comes when new, with a **traceable calibration certificate**. The meter should have been calibrated in a tank, which meets Indian or other acceptable standards.

4.3.5 FREQUENCY OF CALIBRATION

Over a period of time the current meter rating may change as a result of accidents such as damage to impeller shafts and cups or wear and tear, particularly during harsh Monsoon conditions. These changes might be quite small at higher velocities but may change significantly at low velocities. It is strongly recommended that current meters are calibrated and serviced regularly. The CWC recommendation for the re-calibration of current meters is **the minimum of 300 hours or 90 working days of use**. This a commendable standard and one that should be adopted if possible.

At the very worst, current meters should be re-calibrated **at least once a year** between each Monsoon season i.e. after a season of heavy use but prior to the next season of heavy use, **or after 300 hours of use, which ever occurs first**.

ANNEX I
MAINTENANCE NORMS

1. GENERAL

Maintenance norms for Gauge Discharge (GD) stations:

There are different types of GD Stations for measurement of water levels and velocity. The commonly considered types under the Hydrology Project are:

1. GD Stations (Wading) or wading at low flows and is for part-time
2. GD Stations (Bridge or Cableways) at higher flows
3. GD Stations (Boat outfit) at higher flows
4. GD Stations having sediment laboratory

The maintenance costs for the above types of GD Stations comprise the following components:

1. Maintenance cost of civil works
2. Maintenance cost of equipment
3. Cost of consumables
4. Payments to staff
5. Miscellaneous expenditure

Note: Norms for various types of sites have been worked out further. Following these norms, staff costs are assuming quite a substantial amount. If same staff can be deployed for doing a set of tasks or on roving basis, the costs have to be adjusted in budgets.

2. MAINTENANCE NORMS FOR GD STATIONS

Maintenance costs for GD stations are required for civil works, maintenance of equipment, consumable items, payments to staff and miscellaneous expenditure.

2.1 GD STATIONS (WADING TYPE)

The annual maintenance costs for a GD station (Wading Type) are estimated at approximately Rs. 17,500/- and are detailed below.

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
Part A: Maintenance of Civil Works					
1	Jungle clearance	200 m^2	1	m^2	200
2	Repairing/replacing broken and/or fallen gauge plates	Job/ Year	1,000	Job/ Year	1,000
3	Painting	Job/ Year	300	Job/ Year	300
4	Surveys to check BMs, taking cross-sections, longitudinal sections etc.	Job/ Year	3,500	Job/ Year	1,500
			Total for Civil Works maintenance		**3,000**

Part B: Maintenance of Equipment					
5.	Re-rating of current meters	Job/ Year	3,500	Job/ Year	3,500
				Total for maintenance of Equipment	**3,500**

Part C: Cost of Consumable Items					
6	Register for data entry	2	50	No	100
7	Stationery (paper, graph sheets, pencil, etc.)	Job/ Year	300	Job/ Year	300
				Total for cost of Consumable Items	**400**

Part D: Payments to Staff					
8	Khalashi/ Gauge Reader 3 nos. working per day @ 2 days per week over 5 months (4 weeks/ month)	3	80	-	9,600
				Total charges of Staff	**9,600**

Part E : Miscellaneous Expenditure					
9	Rain suit, umbrella, torch, gum boot	Job/ Year	1,000	Job/ Year	1,000
Total of Miscellaneous Expenditure					**1,000**
				Grand Total (Part A+B+C+D+E)	**17,500**

N.B.:

The HP Monitoring Network covers Peninsular India. Thus to provide uniform costs may not be appropriate. Costs are recommended amounts, and may be adjusted.

The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

2.2 MAINTENANCE NORMS FOR GD STATION (BRIDGE OR CABLEWAY SITE + DWLR/ AWLR)

PART – A

Maintenance of Civil Works

Staff gauges and AWLRs housed in steel pipes do the water level measurement. The structural steel pipes attached to the bridge structure need maintenance and periodic painting.

The measurement of discharge is done by wading when there are low flows, and for heavier flows, the measurement of discharge is carried out from a bridge by a bridge outfit arrangement (velocity measurement).

a) Painting to steel structure

   i) The painting of the bridge outfit and the steel pipe housing AWLRs should be done with synthetic enamel paint once in two years.

   ii) The pipe housing AWLRs and cabin should be maintained and painted with synthetic enamel paint above H.F.L. Below H.F.L., it should be painted by bituminous paint once in two years.

b) Overhauling and oiling & greasing of winch and suspension cable in bridge outfit or double drum winches

In case the bridge outfit is used, it needs to be pulled to the bridge every day. Its winch, suspending cable, locking arrangement to set the current meter have all to be greased and maintained.

c) Maintenance of cableways where these are used in place of bridge

The cable towers, the track cable, the endless horizontal and the suspending vertical cable are the main components. There are winches, electrical cables and housing cabins. All these have to be maintained. Moving parts have to be greased. Weather exposed parts are to be painted to avoid rusting and jamming. The grease and oil quantity is required as mentioned below:

- Grease: 4 times x 15 kg each time = 60 kg/year
- Oil: 4 times x 4 lit each time = 16 lit/year

d) Tensioning/stretching of main rope and 8 mm endless cable

- The main rope of the winch and cradle arrangement should be tensioned once in two years alongwith 8 mm endless cables. Check all pulleys and turn buckles. These movements should be free, 'U' bulldog bolts should be greased at the time of tensioning.

e) Building Maintenance

i) The painting of store /residential building housing the bridge outfit, current meters, fish weights, should be done once in three years.

ii) The repairing of window, doors, water supply, sanitation and electrification should be done once in three years.

PART – B

Maintenance of equipment

a) Current meter with counter

The current meter rating should be done every year. It should be cleaned after every observation. The spin test should be taken every day. The counter should be checked before going to work.

b) Repairs to current meter & counter

The current meter should be repaired and calibrated every year. The electric cable should not disturb the movement of the current meter. The counter settings should work properly.

c) Repairs to stop watch

The stopwatch should be checked with a calibrated stopwatch at least twice in a month. A stand by stopwatch is essential on every site.

d) Repairs to DWLR/AWLR equipment

Working of DWLR/AWLR should be routinely checked by comparing the staff gauge levels with concurrent values from DWLR/AWLR. For AWLR, the ball bearing, pointer of pen, ink, clock wire and batteries for electric clock should be checked and in the case of DWLR, life of batteries, continuous recording of data should be checked.

PART – C

Cost of consumable items

a) Battery or dry battery cell (1.5 volts) for current meter should be used for 15 days or as necessary at the time of working season.

b) Connecting cable from current meter to counter should be changed twice a year. The connecting cable should be of I.S. Standard.

c) The strip charts of AWLR should be used as per requirement of instrument/site.

d) AWLR instrument-recording pointer should be kept in proper working condition, if necessary should be replaced immediately.

e) Printer - specific ink should be used.

f) Good quality clean plastic cans should be used for collection of water samples from river-gauging sites. Generally 16 nos. plastic cans are required for every WQ site. Out of then, 20% i.e., 4 nos. becomes unserviceable every year requiring replacement by new good quality plastic cans.

g) The winch and the cableway arrangement, cradle or bridge outfit should be sheltered properly. The GI sheets or tarpaulin should be replaced once in two years.

h) Stationery

i) 200 page hard bound register – 10 nos./station
ii) 200 pages note books – 2 nos./station
iii) Drawing sheets – 6 sheets/station
iv) L-section/Cross-section – 3 sheets/station
v) Plain paper, rubber and pencils should be required for every station

PART – D

Payments to staff

a) At every river gauging site, one observer is required for checking the operations of all instruments for level and discharge measurements. Currentmeter rating chart is checked. Battery and battery box should be kept in ready condition. He should see and keep all the structures, equipment in good working condition for discharge measurements. He should keep daily discharge data posted in books.

b) At every river gauging site two gauge Khalasies (SI) are required for operating of the current meter suspension into the river and in velocity measurements at various sections. They should help the observer in discharge measuring work.

c) Every river-gauging site requires 2 labourers for operating, helping and for carrying out observations. (They should collect and transport the WQ samples by plastic cans from site.) In every gauging station, two labourers are required at each river-gauging site for a period of 5 months.

PART – E

Miscellaneous Expenditure

Every river gauging station requires following items for maintaining and operating the site.

a) The raincoat per person once in two years
b) The gum-boot per person once in two years
c) One torch per person once in two years

Maintenance Norm

GD Station (Bridge or cableway + DWLR/AWLR)

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (in Rs.)
	Part A: Maintenance of Civil Works				
1.	Providing and carrying out repairs	Job/year	500	Job/year	500
2.	Painting to steel structures				
	a) Painting of winches and cable spools by synthetic enamel paint after every two years 200 x 28/2	100 m^2	28	m^2	2,800
	b) Painting AWLR/DWLR housing after 2 years 140 x 25/2	70 m^2	30	m^2	2,100
3.	Overhauling, oiling and greasing of bridge outfit/ winches	Job/year	500	Job/year	
4.	Building maintenance	Job/year	2,500	Job/year	2,500
	Total for Civil Work maintenance				**8,400**
	Part B: Maintenance of Equipment				
5.	Rating of current meter and counter	1	3,500	No.	3,500
6.	Repairs to current meter and counter	Job/year	1,000	Job/year	1,000
7.	Repairs to stop watch	Job/year	500	Job/year	500
8.	Maintenance cost of DWLR/AWLR	Job/year	2,000	Job/year	2,000
	Total for Equipment maintenance				**7,000**
	Part C: Cost of Consumable items (Stationery)				
9.	Battery or dry cells	10	40	No.	400
10.	Connecting cable	20 m	10	M	200
11.	AWLR graphs/ink or DWLR/battery cells	Job/year	1,000	Job/year	1,000
12.	Plastic Sample cans	16	50	No.	800
13.	GI sheets or Tarpaulin	1	500	No.	500
14.	Stationery (paper/charts/ sheets/pencil etc.)	Job/year	1,000	Job/year	1,000
	Total for Consumable Items				**3,900**
	Part D: Charges of Staff	1 x 12 months			
15.	Observer/ Gauge reader		5,500	Month	66,000
16.	Gauge Khalashi / helper	2 x 12	2,000	Month	48,000
17.	TA provision	Job/year	5,000	Job/year	5,000
18.	Seasonal labour (2 x 150 days)	300 days	60	Days	18,000
	Total Charges of Staff				**1,37,000**
	Part E: Miscellaneous Charges				
19.	Rain Suit/Umbrella	2 No.	300	No.	600
20.	Gum Boot	2 No.	250	No.	500
21.	Torch	2 No.	100	No.	200
22.	Kerosene	1 can	100	Can	100
23.	Nylon rope	100 m	5	m	500
24.	Battery cells	30	10	No.	300
	Total for Miscellaneous Charges				**2,200**
	Grand Total				**1,58,500**

N.B.:

a) The HIS Network covers Peninsular India. Thus to provide uniforms costs may not be appropriate. Costs are recommended amounts, and may be adjusted.

b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

2.3 MAINTENANCE NORMS FOR GD STATION (BOAT OUTFIT + DWLR/ AWLR)

PART – A

Maintenance of Civil Works

Staff gauges and AWLR/DWLR should be appropriately housed to do the level measurement. The structural arrangements for stilling and the lead pipes to the structure need maintenance and periodic painting.

The measurement of discharge is done by wading when there are low flows; and for heavier flows; the measurement of discharge is carried out by a boat outfit arrangement (velocity measurement). Markers on the banks and the compass on the boat to do the positioning of the boat for velocity measurements.

a) Maintenance of stilling arrangements
   i) The repair and painting of the structure on the bank of the river shall be done once in two years.
   ii) AWLR/DWLR shall be painted by synthetic enamel paint above HFL and by bituminous point below HFL, once in two years.
   iii) The FRP boats need no painting, but may require occasional repair.

b) Building maintenance
   i) The site store shall be painted once in a year.
   ii) Repair to windows, doors, water, supply/sanitation/electrical installation shall be done once in three years.

PART – B

Maintenance of equipment

a) Current meter with counter - The current meter rating shall be checked every year. It shall be cleaned after every observation. The spin test shall be taken every day. The counter-setting shall be checked before going to work.

b) Repairs to current meter & counter - The electric cable shall not disturb the movement of the current meter. The counter shall work properly.

c) Repairs to stop watch - The stopwatch shall be checked with a calibrated stop watch at least twice in a month. Stand by stopwatch is essential at every site.

d) Repairs to DWLR/AWLR instrument - The AWLR shall be overhauled every year. Ball bearing, pointer of pen, ink, clocks, wire and batteries for every clock shall be checked. The DWLR setting shall be cleaned after each setting.

e) The OB engine shall be cleaned and maintained every year before and after the monsoon period. The electrical connections, oil seal and oil tanker shall be cleaned and maintained properly.

PART – C

Cost of consumable items

a) Battery or dry cell (1.5 volts) for current meter shall be used for 15 days or as per necessity.

b) Connecting cable from current meter to counter shall be changed twice in a year. The connecting cable used shall be of I.S. Standard.

c) The specific chart of AWLR shall be used as per requirement of instrument / site condition.

d) AWLR chart pointer shall be kept in proper working condition. If spoilt, shall be replaced immediately.

e) The ink used shall be printer-specific per manufacturers list.

f) Good quality plastic cans shall be used for collection of WQ samples from every river gauging site. Generally 16 nos. plastic can be required for every rivergauging site out of then 20%, i.e., 4 nos., is become unserviceable after every year. These shall be replaced by new good quality plastic cans.

g) The boat and OB engine shall be sheltered by good GI shed /quality tarpaulin cover. These shall be replaced once in every two years. The OB engine shall be kept inside the site store building.

h) Stationery

i) 200 pages hard bound register – 10 nos./station
ii) 200 pages note books – 2 nos./station
iii) Drawing sheets – 6 sheets/station
iv) L-section/Cross-section – 3 sheets/station
v) Plain paper sheets, rubber and pencils shall be required for every station

PART – D

Payments to staff

At every river gauging site with boat, one observer/gauge reader is required for checking the operations of boat/engine, AWLR/ DWLR. He shall prepare a report and submit it to the sectional engineer, and check that rating chart is received in time. Battery and battery box shall be kept in ready condition. He shall keep all the structures, equipment in good working condition for discharge measurements. He also shall keep daily discharge data in the discharge measurement register.

At every river-gauging site with boat three helpers for operation of boat and current meter measurements are needed bends one engine driver. They shall help the observer in discharge measuring work.

At every river-gauging site with boat, two labourers are required for operating, helping and for carrying out observations. They shall collect and transport the water samples by plastic cans from site. These labourers shall be employed during monsoon period only (5 months: July - Nov.).

PART – E

Miscellaneous expenditure

At every river gauging station, the following items are required for proper measurement of discharges operating the site.

a) The raincoat to each person once in two years
b) The gum-boot to each person once in two years
c) One torch to each person once in two years

Maintenance Norm

GD Station (Boar and OB Engine + DWLR/AWLR)

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Maintenance of Civil Works				
1.	Providing and carrying out repairs	Job/year	500	Job/year	500
2.	Repair to stilling structures				
	a) Repair cleaning lead pipes and restting after every two years	100 m^2	28	m^2	2,800
	b) Painting AWLR/DWLR housing after 2 year 140 x 25/2	70 m^2	30	m^2	2,100
3.	Overhauling, oiling and greasing to boat outfit/ winches	Job/year	500	Job/year	500
4.	Building maintenance	Job/year	2,500	Job/year	2,500
	Total for Civil Work maintenance				**8,400**
	Part B: Maintenance of Equipment				
5.	Rating of current meter and counter	1	3,500	No.	3,500
6.	Repairs to current meter and counter	Job/year	1,000	Job/year	1,000
7.	Repairs to stop watch	Job/year	500	Job/year	500
8.	Maintenance cost of DWLR/AWLR	Job/year	2,000	Job/year	2,000
9.	Running cost of OB Engine, P O L's	Job/year	L S		200
	Part C: Cost of Consumable Items (Stationery)				
9.	Battery or dry cells	10	40	No.	400
10.	Connecting cable	20 m	10	m	200
11.	AWLR charts/ink or DWLR/battery cells	Job/year	1,000	Job/year	1,000
12.	Plastic Sample cans	16	50	No.	800
13.	GI sheets or Tarpaulin	1	500	No.	500
14.	Stationery (Paper/charts/ sheets/pencil etc.)	Job/year	1,000	Job/year	1,000
	Total for Consumable Items				**3,900**
	Part D: Charges of Staff				
15.	Observer/ Gauge reader	1 x 12 months	5,500	Month	66,000
16.	Gauge Khalashi / helper (includes one OBE driver)	3 x 12	2,000	Month	72,000
17.	TA provision	Job/year	5,000	Job/year	5000
18.	Seasonal labour (2 x 150 days)	300 days	60	Days	18,000
	Total Charges of Staff				**1,61,000**

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part E: Miscellaneous Charges				
19.	Rain coat/Umbrella	2 No.	300	No.	600
20.	Gum Boot	2 No.	250	No.	500
21.	Torch	2 No.	100	No.	200
22.	Kerosene	1 can	100	Can	100
23.	Nylon rope	100 m	5	m	500
24.	Battery cells	30	10	No.	300
	Total for Miscellaneous Charges				**2,200**
	Grand Total				**1,80,500**

N.B:

a) The HP Monitoring Network covers Peninsular India. Thus to provide uniform costs may not be appropriate. Costs are recommended amounts, and may be adjusted.

b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.