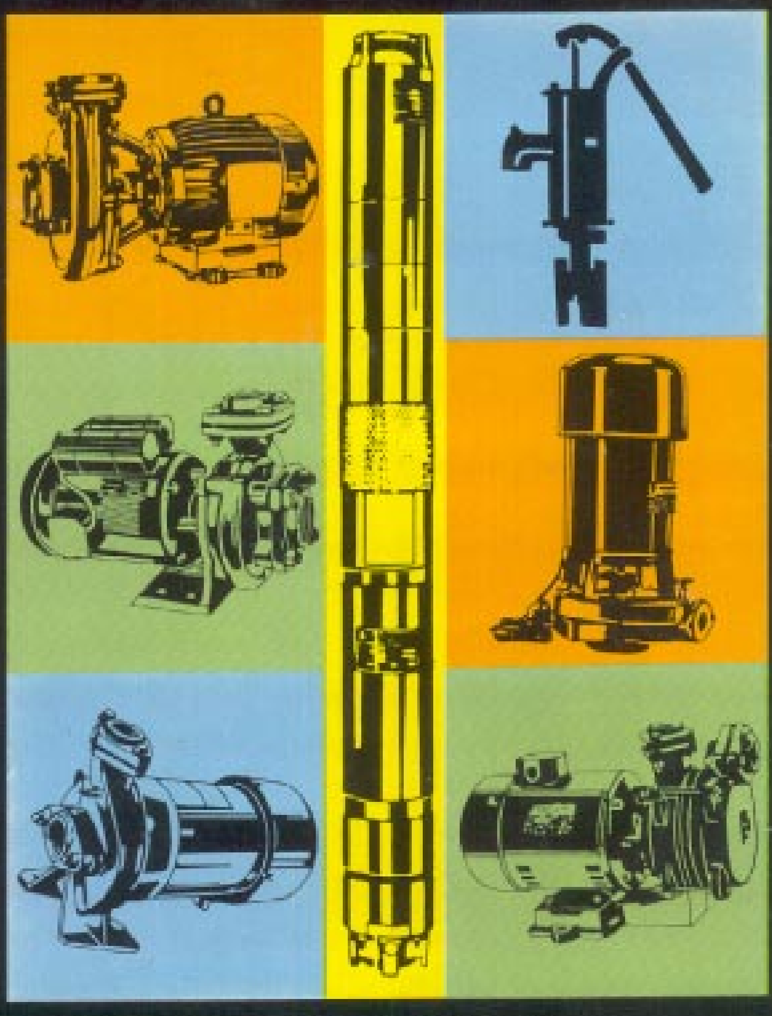
Handbook on Pumps for Drinking Water Supply



BUREAU OF INDIAN STANDARDS

HANDBOOK ON PUMPS FOR DRINKING WATER SUPPLY

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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FOREWORD

Water and sanitation services are one of the essential components for the well-being of mankind. Towards the achievement of this basic necessity, the Bureau of Standards bring out the Standards and Code of Practices for various materials and equipment used in the rural drinking water supply.

2. Pumps are required for most of the situations encountered in the water supply delivery and thus represent an important, essential and major investment in the water supply project. Utmost care should, therefore, be bestowed in selecting the appropriate pump for cost-effectiveness of the project keeping in view essential requirements such as durability, life, cost, installation, testing, ease of maintenance and the like.

3. At the request of the Rajiv Gandhi National Drinking Water Mission, the Bureau of Indian Standards has brought out a Handbook on pumps for drinking water supply by pooling together all the relevant standards and specifications published by them.

4. I am confident that this Handbook on pumps would provide information and guidance that could be beneficially utilised by the field engineers while designing water supply projects.

(B.N.Yugandhar)

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PREFACE

The Bureau has been associated with the Rajiv Gandhi National Drinking Water Mission and has lent its full support in this project.

The Bureau's contribution focusses on quality in the material/products used, construction/installation, operation and maintenance of the works. To meet the above objectives, BIS prepares National Standards by pooling the experience of relevant experts in order to ensure uniformity, save time and resources at least in repetitive items. It also conducts training programmes on

i) Statistical quality control to the BIS licensed manufacturers, and

ii) Sampling and testing of products/materials to organized purchasers.

It conducts periodically awareness programmes for water supply engineers throughout the country for effective interaction to get feed back.

Further BIS provides third party certification for products, which helps the users in choosing products conforming to standards thereby avoiding further inspection and testing.

A strong need has been felt during the interactions for concise handbooks on some subjects on the basis of Indian Standards and providing additional material to cover the subject fully.

This Handbook on Pumps for Drinking Water Supply is based on materials collected and collated from more than 125 Indian Standards: a list of the relevant main standards is given in the annex to the Handbook. Considerabale assistance has been drawn from various publications on the subject of water supply and the same are also given in the annex.

This is third in the series of handbooks other two being on the subject of Tubewells/Borewells and Pipes and Pipe Fittings.

Use of this Handbook and the referred standards besides the relevant marked products would go a long way in enhancing the quality of pump installations for water supply. The resulting feed back to BIS would ensure improvement of the related standards and the handbook.

N.S. CHOUDHARY

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INTRODUCTION

Pumps are required for most of the situations encountered in water supply to deliver water from the source to the destination. Pumps used for this purpose can be broadly classified into two major types, i) power driven pumps (electric motor driven or diesel engine driven) and ii) handpumps.

This handbook has been prepared with a view to provide adequate guidelines for the proper selection, installation, maintenance and testing of pumps, besides specifying the requirements of pumps, used in rural drinking water supply, both power driven and hand operated. This handbook is meant basically for users of pumps, specially public health engineers involved in drinking water supply for rural communities. Incidentally this can be of use to the manufactures also. However, the respective standards should be referred to for details, wherever necessary.

This handbook has been divided into five chapters, namely :

- Guidelines for Selection of Pumps
- Guidelines for Installation of Pumps
- Guidelines for Maintenance of Pumps
- Testing on Pumps
- Specifications on Pumps

The contents of this handbook are mainly based on Indian Standards available. Wherever a gap existed, information has been taken from other relevant sources. A list of Indian Standards cross referred in this handbook and a list of Indian Standards and other major sources used in the preparation of this handbook are given as Annex A and Annex B respectively.

It will be noticed that some of the Indian Standards used in the preparation of this handbook relate to pumps used for agricultural purpose/industrial application. However, care has been taken that the information added is relevant to pumps used for drinking water supply.

CHAPTER 1

GUIDELINES FOR SELECTION OF PUMPS

1 GENERAL

Proper selection of a pump for pumping water from the source of water to the desired destination is of prime importance in any water supply system. This is true for both, a small pumping unit and also a large water supply system. This chapter deals with the subject of selection of pumps for drinking water supply. Part I deals with pumps where the drive for the pump is received from a prime mover - an electric motor or an IC Engine, usually a diesel engine. Part II deals with handpumps.

PART I

PUMPS DRIVEN BY A PRIME MOVER

2 FACTORS TO BE CONSIDERED IN THE SELECTION OF PUMPS

The following are the major factors which should be considered while selecting a pump for drinking water supply:

a) Water quantity requirement

b) Water source from where the water is to be supplied, and

c) Operating conditions under which pump is required to work.

2.1 Water Quantity Requirement

This depends on a) The population to which the water supply system is to cater, and b) Provision made per capita.

2.1.1 The estimates of per capita water requirement for villages identified as problem villages under Rajiv Gandhi National Drinking Water Mission, of Government of India are as follows:

a) Water requirement shall be 40 litre per capita per day for villages in areas other than desert areas and where there is no need to provide water for cattle.

b) Water requirement shall be 70 litre per capita per day for desert areas where water is also required for cattle.

2.1.2 For other situations, water requirements may be assessed as per IS 1172:1993 which is 200 litre per capita per day for water supply for residences out of which 45 litre per capita per day may be taken for flushing requirements. This value of 200 litre per capita per day may be reduced to 135 litre per capita per day for homes of lower income group (LIG) and economically weaker sections of society (EWS) depending on prevailing condition.

2.2 Water Source

The major sources of drinking water are :

a) Rivers and Streams,

b) Canals,

c) Wells, and

d) Ponds/Tanks.

The source of water from which the water is to be supplied shall be identified.

2.3 Operating Conditions

The main operating conditions which primarily affect pump selection are as given below.

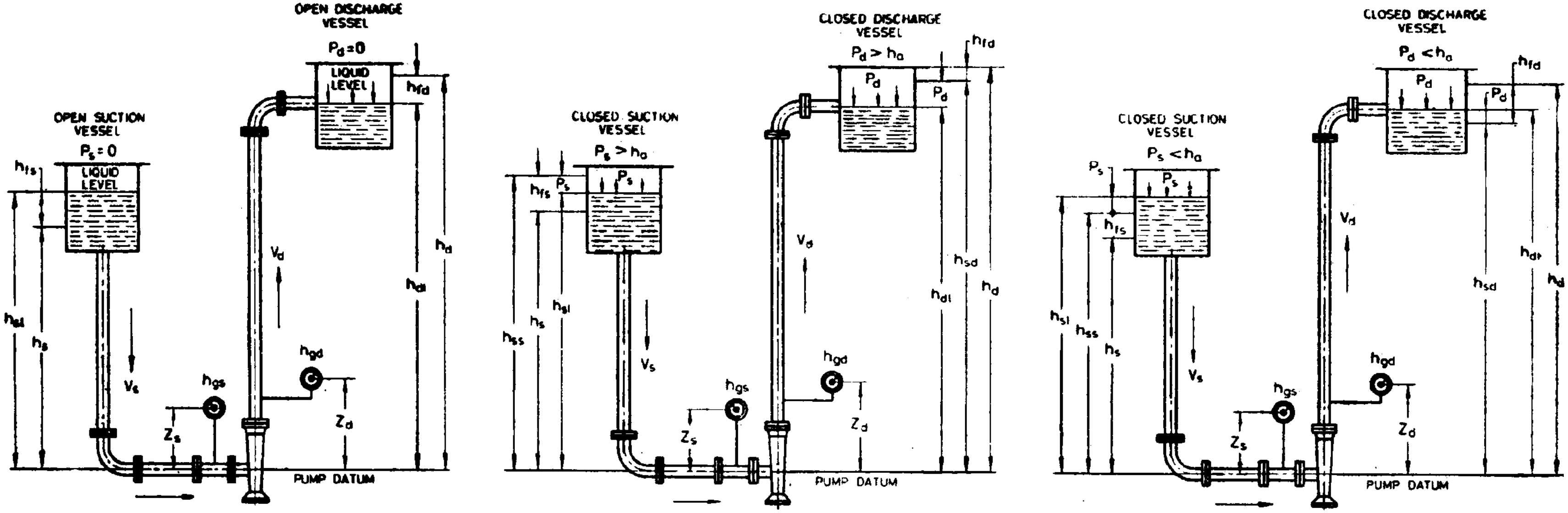
2.3.1 *Pump Discharge*

This will depend on the quantity of water required as determined in **2.1** and the type of duty to which the pump is to be subjected, such as, a) whether the pump is supplying water to an overhead reservoir, or b) whether it is to be used for direct supply. It will also depend on the duration for which the pump has to operate and peak water requirements, etc. In case of pumping of water from a well, pump discharge shall also depend on the yield of the well.

2.3.2 *Total Head (H)*

This is the measure of the energy increase per unit mass of water imparted to it by the pump and is, therefore, the algebraic difference of the total delivery head and the total suction head (*see* Fig. 1).

$$H = h_d - h_s$$
$$= (h_{sd} + h_{fd}) - (\pm h_{ss} - h_{fs})$$
$$= \left(h_{gd} + Z_d + \frac{V^2_d}{2g}\right) - \left(\pm h_{gs} + Z_s - \frac{V^2_s}{2g}\right)$$



$h_{ss} = h_{sl}$

$h_s = h_{ss} - h_{fs}$

$= h_{gs} + Z_s + \frac{V_s^2}{2g}$

$h_{sd} = h_{dl}$

$h_d = h_{sd} + h_{fd}$

$= h_{gd} + Z_d + \frac{V_d^2}{2g}$

OPEN SUCTION VESSEL WITH OPEN DISCHARGE VESSEL

$h_{ss} = h_{sl} + P_s$

$h_s = h_{ss} - h_{fs}$

$= h_{gs} + Z_s + \frac{V_s^2}{2g}$

$h_{sd} = h_{dl} + P_d$

$h_d = h_{sd} + h_{fd}$

$= h_{gd} + Z_d + \frac{V_d^2}{2g}$

CLOSED SUCTION VESSEL WITH CLOSED DISCHARGE VESSEL HAVING $P_s > h_a$

$h_{ss} = h_{sl} - P_s$

$h_s = h_{ss} - h_{fs}$

$= h_{gs} + Z_s + \frac{V_s^2}{2g}$

$h_{sd} = h_{dl} - P_d$

$h_d = h_{sd} + h_{fd}$

$= h_{gd} + Z_d + \frac{V_d^2}{2g}$

CLOSED SUCTION VESSEL WITH CLOSED DISCHARGE VESSEL HAVING $P_s < h_a$

FIG. 1 TERMINOLOGY IN HEAD MEASUREMENT FOR PUMPS

Where

H = total head in metres,

h_d = total delivery head in metres,

h_s = total suction head in metres (+),

= total suction lift in metres (-),

h_v = velocity head in metres,

V = average velocity in pipe, at the cross section of measurement in m/s,

V_s = average velocity in the suction pipe at the cross section of measurement in m/s,

g = acceleration due to gravity in m/s^2,

h_{s1} = difference in elevation between the pump datum and the liquid level in the suction vessel when the pump is running, in metres.

If the liquid level in the suction vessel is above the pump datum, h_{s1} is to be taken as positive, and if the liquid in the suction vessel is below the datum, h_{s1} is to be taken as negative,

P_s = pressure head in closed suction vessel in metres,

h_{ss} = static suction head in metres (+),

= static suction lift in metres (−),

h_{fs} = friction and entrance losses in suction pipe line in metres,

h_{gs} = reading of a gauge on the suction side in metres,

If the value of h_{gs} is above atmospheric pressure head, plus (+) sign applies,

If the value of h_{gs} is below atmospheric pressure head, minus (-) sign applies,

Z_s = vertical distance between the liquid level in the gauge on suction side and the pump datum in metres,

If the liquid level in the gauge is above the pump datum, plus (+) sign applies,

If the liquid level in the gauge is below the pump datum, minus (-) sign applies.

V_d = average velocity in delivery pipe at the cross section of measurement in m/s,

h_{d1} = difference in elevation between the pump datum and the highest point of delivery in metres,

P_d = pressure head in closed discharge vessel in metres,

h_{sd} = static delivery head in metres,

h_{fd} = friction and exit losses in the delivery pipe line in metres,

h_{gd} = reading of a pressure gauge on delivery side in metres,

Z_d = vertical distance between the liquid level in pressure gauge on delivery side and the pump datum in metres,

If the liquid level in the gauge is above the pump datum, plus (+) sign applies.

If the liquid level in the gauge is below the pump datum, minus (-) sign applies.

h_a = atmospheric pressure head in metres, absolute,

h_{sa} = total suction head in metres, absolute, and

h_{vpa} = vapour pressure head of pumped liquid at pumping temperature at the suction nozzle in metres, absolute.

2.3.2.1 To make the understanding of the term, total head, clear, various components of total head are explained below (for the abbreviations, *see* **2.3.2**):

(a) *Total delivery Head (h_d)*

This is the sum total of the static delivery head and the friction and exit losses in the delivery pipe line.

The total delivery head as measured on the test bed is the reading of the pressure gauge at the discharge of the pump corrected to pump datum plus the velocity head at the point of measurement.

$$h_d = h_{sd} + h_{fd}$$
$$= h_{gd} + Z_d + \frac{V^2_d}{2g}$$

(b) *Total Suction Head (h_s)* — Suction head exists when the total suction head is above atmospheric pressure head. This is equal to the static suction head minus the friction and entrance losses in suction pipe line. Total suction head as determined on test bed is the reading of a suction gauge at the suction nozzle of the pump corrected to pump datum plus velocity head at the point of measurement.

$$h_s = \pm h_{ss} — h_{fs}$$
$$= \pm h_{gs} \pm Z_s \pm \frac{V^2_s}{2g}$$

If the value of h_s is negative, that is, the total suction head is below atmospheric pressure head, then total suction lift exists. In case where water is being drawn from a well, draw down of well will also be taken into account.

(c) *Static Delivery Head* (h_{sd})— When the pump discharges into an open vessel, the static delivery head is the difference in elevation between the pump datum and the highest point of delivery.

When the pump discharges into a closed vessel, the pressure acting on the liquid level in the vessel, if above the atmospheric pressure, is to be added to h_d and if it is below the atmospheric pressure, it is to be deducted from h_d in order to arrive at the static delivery head. Thus,

$$h_{sd} = h_{d1} \pm P_a$$

(d) *Static Suction Head* (h_{ss}) — When the liquid level in an open vessel is above the pump datum, static suction head is the difference in elevation between the pump datum and the liquid level in the suction vessel.

When the pump draws liquid from a closed suction vessel, the pressure acting on the liquid level in the vessel, if above the atmospheric pressure, is to be added to h_s and if it is below the atmospheric pressure, it is to be deducted from h_s in order to arrive at the static suction head.

$$h_{ss} = \pm h_{s1} \pm P_s$$

(e) *Velocity Head* (h_v) — This is the kinetic energy per unit mass of liquid handled at a given section and is expressed by the formula :

$$h_v = \frac{V^2}{2g}$$

(f) *Friction Head* — It consists of head loss due to friction in foot valve, reflex valve, entire length of suction pipe, suction bend (if any), delivery valve, entire length of delivery pipe, along with losses in any other fitting in suction or delivery line.

NOTES

1. Head loss due to friction due to resistance to flow in any pipe may be calculated using the formula

$$h_f = \frac{f L V^2}{2gD}$$

Where

h_f = loss in head due to friction, in m of water ;

f = friction factor ;

L = length of pipe, in m ;

D = average internal dia of pipe, in m ;

V = average velocity, in m/s; and

g = acceleration due to gravity in m/s^2.

IS 2951 (Part 1) : 1965 gives formulae for friction factor (f) for different flow condition which are as follows:

i) Laminar Flow —

friction factor, $f = \frac{64}{Re}$

Where

Re = Reynold's number (Reynold's No. is a dimensionless number expressing the ratio of inertial forces, to viscous forces).

ii) Turbulent flow with Reynold's Number between 3000 and 100000 —

for smooth pipes $f = \frac{0.316}{Re^{1/4}}$

for rough pipes $\frac{1}{\sqrt{f}} = 2.0 \log_{10} \frac{1}{2\varepsilon} + 1.74$

Where

ε = relative roughness. (Ratio of absolute roughness to the internal dia expressed in same unit)

IS 2951 (Part1):1965 also gives Universal Pipe Friction Diagram, a reference to which may be made for complete solution of flow through pipes (*see* Fig 2 for Universal Pipe Friction Diagram).

2. Head loss due to friction in pipes may also be found out in accordance with Tables 1 and 2.

3. Head loss in valves or fitting shall be calculated from the formula

$$h_f = \frac{k V^2}{2g}$$

Where

k = resistance co-efficient for valve/fitting

V = average velocity in pipe corresponding to diameter, in m/s., and

g = acceleration due to gravity, in m/s^2

Values of resistance co-efficient for valves and fittings carrying turbulent flow are given in Table 3. Values of resistance co-efficient for valves used in suction lines of agricultural pumping systems are given in Table 4. In Valves and fittings carrying laminar flow the head loss may be assumed to be negligibly small. Flanged valves and fittings should have lower resistance coefficient than screwed valves and fittings. The lower limits in Table 3 should be used with valves and fittings particularly with sizes above 100 mm nominal dia. For further details on the subject, IS 2951 (Part 2):1965 may be referred to.

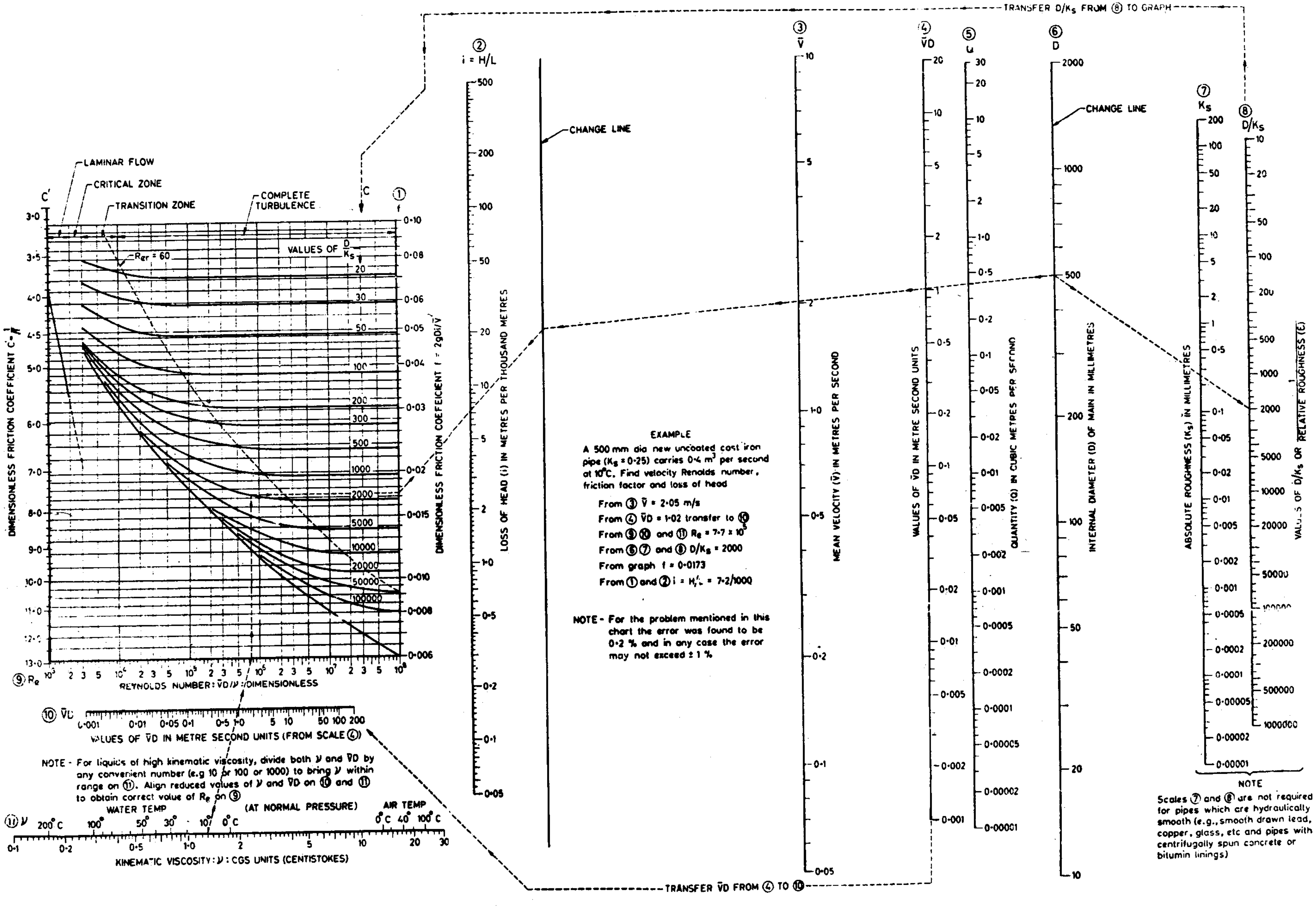


FIG. 2 UNIVERSAL PIPE FRICTION DIAGRAM

TABLE 1 FRICTION LOSS IN METRES FOR 10 METERS LONG NEW STEEL GALVANIZED PIPE (C=140)

(*Clause* 2.3.2.1 (f), NOTE 2)

Volume Rate of Flow, l/s \ Nominal Pipe Dia in mm	25	32	40	50	65	80	100	125	150
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0.50	0.364								
1.00	1.315	0.341							
1.25	1.988	0.516	0.246						
1.60	3.140	0.814	0.388						
2.00		1.231	0.587						
2.50		1.861	0.888	0.282					
3.2		2.940	1.402	0.446	0.126				
4.0			2.120	0.674	0.190				
5.0			3.205	1.019	0.288				
8.0				2.433	0.687	0.313			
10.0				3.678	1.038	0.474	0.131		
12.5					1.570	0.716	0.198		
16					2.479	1.131	0.312	0.111	
20					3.747	1.710	0.472	0.167	
25						2.585	0.713	0.253	0.106
32						4.083	1.127	0.400	0.167
40							1.704	0.605	0.252
50							2.576	0.914	0.381
60								1.281	0.534
80								2.182	0.910
100								3.299	1.376
125									2.081

TABLE 2 FRICTION LOSS IN TEN METRES LONG NEW UPVC PIPES (C=150)

(*Clause* 3.2.1 (f), Note 2)

Volume Rate of Flow l/s \ Nominal Pipe Dia in mm	40	50	63	75	90	110	125	140	160
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0.50	0.074								
1.00	0.268								
1.25	0.405	0.134							
1.60	0.640	0.211							
2.00	0.967	0.319							
2.50	1.462	0.483	0.158						
3.2	2.309	0.762	0.250	0.106					
4.0	3.491	1.153	0.377	0.160					
5.0		1.742	0.571	0.242					
8.0		4.161	1.363	0.577	0.237				
10.0			2.060	0.873	0.358	0.133			
12.5			3.114	1.319	0.542	0.201			
16			4.919	2.084	0.856	0.317	0.172		
20				3.151	1.293	0.479	0.260		
25					1.955	0.725	0.392	0.225	0.117
32					3.089	1.145	0.620	0.355	0.184
40						1.731	0.937	0.537	0.279
50						2.617	1.416	0.812	0.421
60						3.668	1.985	1.138	0.590
80							3.382	1.939	1.006
100								2.931	1.521
125									2.299

Table 3 Resistance Coefficient for Valves and Fittings

(*Clause* 2.3.2.1 (f), Note 3)

Sl.No	Description of Valves and Fittings	Co-efficient K[1)]
(1)	(2)	(3)
i)	Inlets or Reducers	
	1) Bell mouth	0.04 to 0.05
	2) Square edged	0.47 to 0.56
ii)	Elbows	
	1) Regular screwed 45° elbow	0.30 to 0.42
	2) Regular screwed 90° elbow	0.55 to 0.90
	3) Regular flanged 90° elbow	0.21 to 0.30
	4) Long radius flanged 45° elbow	0.18 to 0.20
	5) Long radius flanged 90° elbow	0.14 to 0.23
	6) Long radius screwed 90° elbow	0.22 to 0.60
iii)	Bends	
	1) Screwed return bend, close-pattern	0.75 to 2.2
	2) Flanged return bend composed of two 90° flanged elbows	
	a) Regular	0.38
	b) Long radius	0.25
iv)	Inward Projecting Pipe	0.62 to 1.0
v)	Valves	
	1) Globe valves	
	a) Composition disc globe valve	0.23 to 5.2
	b) Bevel seat globe valve	6.2 to 7.2
	c) Plug disc globe valve	7.2 to 10.3
	2) Gate valves	
	a) Wedge disc gate valve	0.05 to 0.15
	b) Double disc gate valve	0.08 to 0.13
	3) Check valves	
	a) Swing check valve	0.6 to 2.3
	b) Horizontal (left) check valve	8 to 12
	c) Ball check valve	65 to 70
	4) Angle valve	2.1 to 3.1
	5) Y or blow off valve	2.9
	6) Foot valve	0.8 *Max*
vi)	Standard Screwed Tee	
	1) Branch blanked off	0.4
	2) Line blanked off	
	a) Flow from line to branch	0.85 to 1.3
	b) Flow from branch to line	0.92 to 2.15
vii)	Long Radius Screwed Tee	
	1) Line blanked off	
	a) Flow from line to branch	0.37 to 0.80
	b) Flow from branch to line	0.50 to 0.52
viii)	Couplings and Unions	0.02 to 0.07
ix)	Reducing Bushing and Coupling Used as Reducer	0.05 to 2.0

[1)] K decreases with increasing wall thickness of pipe and rounding of edges.

NOTE — Used as increaser, loss is up to 40 percent more than that caused by a sudden enlargement.

Table 4 Resistance Co-efficient for Valves Used in Suction Lines of Agricultural Pumping Systems

(*Clause* 2.3.2.1 (*f*), Note 3)

Sl. No.	Description of Valve	Resistance Co-efficient
(1)	(2)	(3)
i)	Foot valve	0.8 *Max*
ii)	Reflux valve	0.5 *Max*
iii)	Bore valve with strainer	1.4 *Max*
iv)	Bore valve without strainer	1.2 *Max*

2.4 Besides above factors, other major factors which may affect pump selection are

a) Cost including initial cost, operational cost and maintenance cost of the pump,

b) Type of prime mover available,

c) Ease of installation and maintenance, and

d) Efficiency of pump, its applicability and space required by it.

3 SELECTION OF TYPE OF PUMP

3.0 The various types of pumps normally used for potable water supply are

(a) Horizontal centrifugal pumps

(b) Submersible pumps

(c) Vertical turbine pumps

(d) Jet centrifugal pump combination units

3.1 Selection of appropriate pump type should be made with due consideration to the advantages and limitations of different pump types. A comparative analysis of the advantages and limitations of the types of pumps, with respect to some of the main factors important from the view point of selection, is presented in Table 5 for general guidance.

Table 5 Selection Guide for Different Types of Pumps

(Clause 3.1)

Sl. No.	Selection Factor or Criterion		Horizontal Centrifugal Pumps	Submersible Pumps	Vertical Turbine Pumps	Jet Centrifugal Pump Combinations
(1)	(2)		(3)	(4)	(5)	(6)
i)	Suction capacity	Low (upto 3.5m)	Suitable	Not applicable as pump is submerged in water	Not applicable as pump is submerged in water	Used when suction lift limitation of lift of horizontal centrifugal pump is to be overcome
		Medium (up to 6 m)	Suitable	-do-	-do-	
		High (up to 8.5 m)	Not Suitable	-do-	-do-	
ii)	Head	Low range (up to 10 m)	Suitable for end suction pumps. Not suitable for multi-stage pumps	Suitable	Suitable	Suitable
		Medium (up to 40 m)	Suitable	Suitable	Suitable	Suitable
		High (above 40 m)	Not suitable for end suction pumps. Suitable for multistage pumps	Suitable	Suitable	Suitable (up to 70 m)
iii)	Discharge	Low (up to 30 l/s)	Suitable	Suitable	Suitable	Suitable
		Medium (up to 500 l/s)	Suitable	Suitable	Suitable	Not suitable
		High (above 500 l/s)	Not suitable	Suitable	Suitable	Not suitable
iv)	Application		i) Suitable for supply of water from shallow wells with suction lift up to 6 m ii) Suitable for pumping water from ground level or from overhead reservoir with positive suction head. iii) Suitable to be used as a booster pump.	Suitable for pumping water from shallow wells or deepwells.	Suitable for pumping water from shallow wells or deep wells	Suitable mainly for wells and generally used where suction lift limitation does not permit use of horizontal centrifugal pump.
v)	Efficiency		Normally better than submersible pumps.	Normally better than vertical turbine pumps due to reduction in moving parts and unobstructed delivery of water	Normally lower than submersible pumps	Considerably low (of the order of about 35%)

Table 5 *(Concluded)*

(Clause 3.1)

Sl. No. (1)	Selection Factor or Criterion (2)	Horizontal Centrifugal Pumps (3)	Submersible Pumps (4)	Vertical Turbine Pumps (5)	Jet Centrifugal Pump Combinations (6)
vi)	Pump Drive	May be electric motor or diesel engine	Only electric motor	May be electric motor or diesel engine	May be electric motor or diesel engine
vii)	Power Transmission	Pump and prime mover direct coupled/ close coupled in a monoblock/ pump may be belt driven	Motor and pump are direct coupled/ close coupled together	Pump and prime mover direct coupled/ coupled by a gear head/the pump may be belt driven	Pump and prime mover may be direct coupled/ close coupled in a mono-block /pump may be belt driven
viii)	Installation	Easy, may be used even as a portable pump	a) Simpler than vertical turbine pumps b) Can be used even in a very deep well where a long shaft is not practicable for vertical turbine pump	a) Require specia-lized labour for installation b) Can not be used in crooked wells (wells which are not straight)	a) Simpler than vertical turbine pumps b) Can be installed in a crooked well also
ix)	Maintenance	Simple, cost is low since used generally at ground levels	a) Requires pulling out of pump from the well for servic-ing and repair b) Simple to withdraw and replace c) Reliability of motor is a weak point.	a) Requires pulling out of pump to repair b) Costly to withdraw and replace. c) Reliability of pump is better than submersi -ble pump as the motor is outside the well.	Easy since the pump is installed on surface
x)	Pump house space required	Occupies space for pump house, in case of water being drawn from a well horizontal offset of pump from the well is possible although limited by suction limitation	No space required for pump house as there is no machinery above ground, a man-hole cover plate will suffice for maintenance purpose	Pump house has to be provided at the top of the well	Pump house has to be provided, however, it can have horizontal offset which may be higher than that in case of horizon-tal certifugal pump
xi)	Initial Cost	Normally low	Lower than vertical turbine pump but higher than horizontal centrigulal pump	Normally very high	Normally lower than submersible pumps

NOTE — The limits for operational characteristics as given above at Sl. No. i), ii) and iii) are for general guidance only. Specific designs may exceed the limits or may not satisfy the limits. Similarly the descriptions for other factors, for each pump type, are for general guidance and should be further assessed for different pump designs.

4 SPECIFIC SPEED CONSIDERATIONS IN PUMP SELECTION

4.0 Specific speed of the pump is defined as the speed in rev/minute of an imaginary pump, geometrically similar in all respects to the pump under consideration that is capable of raising 75 kg of water per second to a height of one metre.

$$n_q = 3.65\, n \frac{\sqrt{Q}}{H^{3/4}}$$

n_q = specific speed of pump, in rev/min,

n = speed of pump under consideration in rev/min,

Q = discharge, in m^3/s, of pump under consideration, and

H = head in m of pump under consideration.

4.1 The impeller form (and thus the class of pump among radial flow pump, mixed flow pump and axial flow pump) is largely dependent on the specific speed.

4.1.1 Pumps of radial flow, mixed flow and axial flow type usually have the specific speed ranges as given in Table 6.

4.2 The specific speed has been found to be an important criterion in determining the permissible maximum suction lift or minimum suction head to avoid cavitation for various conditions of capacity, head and speed. For a given head and capacity a pump of low specific speed will operate with a greater total suction lift than the one of higher specific speed.

4.2.1 Fig. 3 gives the total suction lift limit for double suction pumps of predominantly radial flow type having specific speed from 50 to 500 rev/min. Fig. 4 gives the same for single suction mixed flow pumps of specific speed from 200 to 800 rev/min. The pump may be selected with reasonable assurance of freedom from cavitation or the pumps should give the best efficiency point for a suction lift shown in these curves.

NOTES

1. For determining the total suction lift for a single suction radial flow pump, its specific speed should be multiplied by $\sqrt{2}$ and then the curves in Fig. 3 referred to.

2. For double suction radial flow pumps, the total discharge including both suction sides should be taken into consideration.

5 SELECTION OF PUMP SIZE BY MATCHING PUMP AND SYSTEM CHARACTERISTICS

In order to analyse a particular pumping system with the objective of selecting the right pump or pumps, use may be made of a system head curve.

A system head curve is a plot of total system head (variable head plus fixed head) for various flow rates.

A pumping system for drinking water supply, besides the pumping unit, consists of components such as piping, valves and fitting, etc. The resistance to flow through these components increases with increase in the rate of flow through the system and is therefore called variable system head. In addition head is required to cause water to be raised from suction level to the discharge level. This type of head is not affected by the flow rate and is, therefore, called static system head.

Table 6 Specific Speed Ranges for Different Flow Types

(*Clause* 4.1.1)

Flow Type	Impeller Type	Specific Speed
Radial flow	Single suction	Below 300
-do-	Double suction	Below 400
Mixed flow	Single suction	300-650
-do-	Double suction	400-850
Axial flow	Single inlet	Above 900

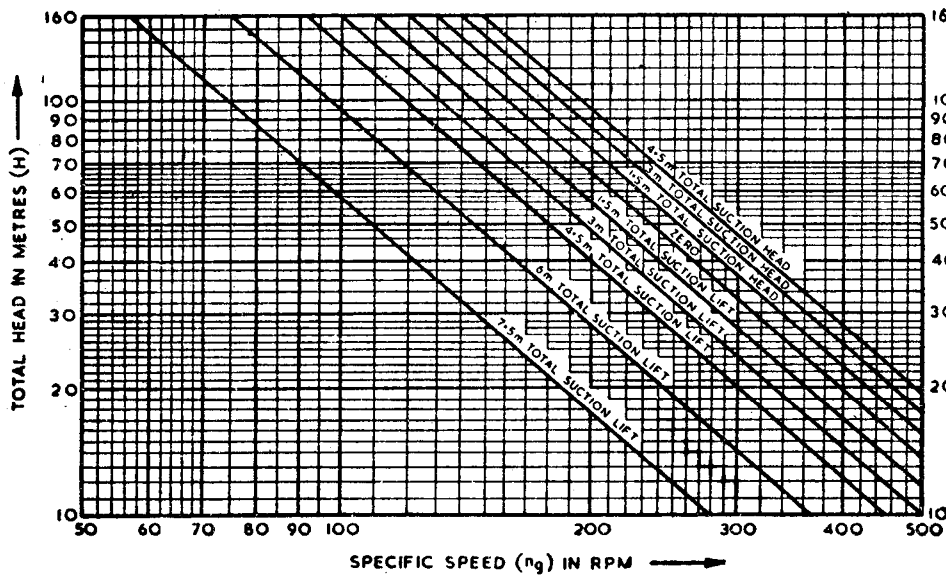


FIG.3 SUCTION LIMIT CURVES FOR SINGLE STAGE, SINGLE AND DOUBLE SUCTION PUMPS

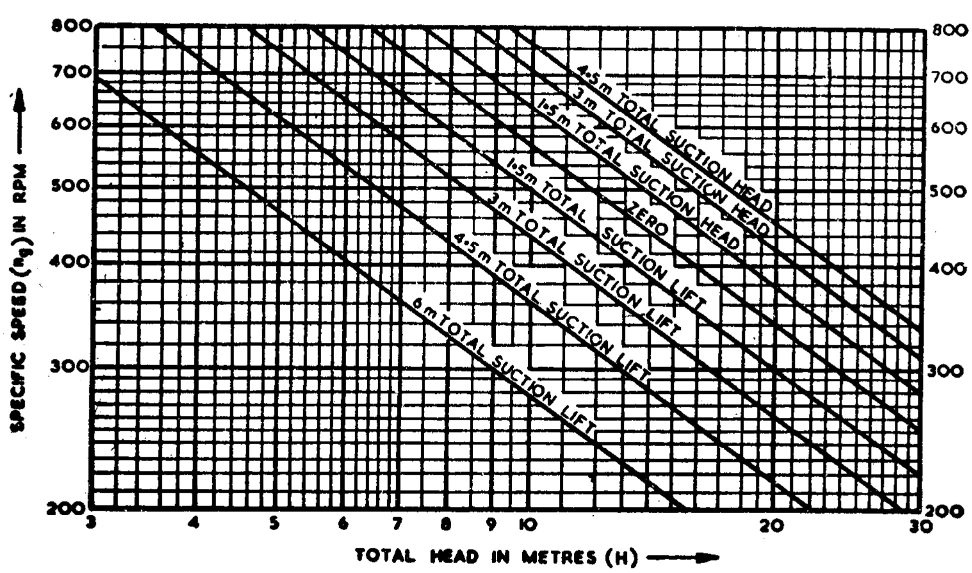


FIG.4 SUCTION LIMIT CURVES FOR SINGLE SUCTION MIXED FLOW PUMPS

Total system head is the sum of variable and static system heads and it naturally varies with the flow rate.

Figure 5 illustrates a typical system head curve plotted for a pumping system to lift water through a height Z.

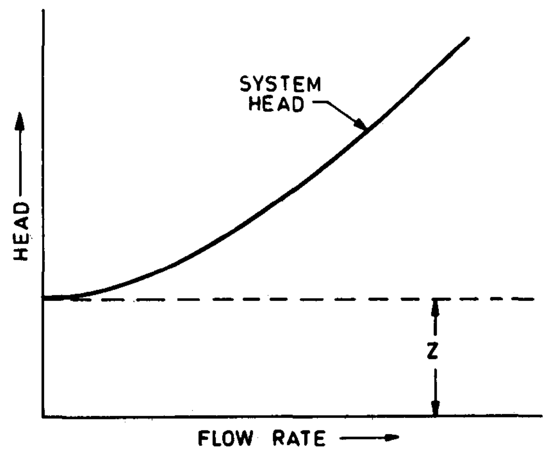


FIG. 5 TYPICAL SYSTEM HEAD CURVE

By superimposing the head-capacity curve of different centrifugal pumps on system head curve suitability of the pump for a particular situation may be analyzed. When a pump is being purchased/selected, it should be specified/ensured that pump head capacity curve intersects the system head curve at the desired flow rate. This intersection should be at pump's best efficiency or very close to it.

6 SUMMARY OF ESSENTIAL INFORMATION REQUIRED IN SELECTION OF A PUMP

6.1 When enquiring or ordering pumps, following informations are required to be furnished to the supplier:

a) Pump application:

1) Altitude at site;

2) Ambient temperature at site;

3) If pump is to work in parallel or in series with other pumps, detailed sketch of the installation with performance and details of other pumps;

4) Details on duration of operation of the pump such as number of working hours of operation per day, continuous/ intermittent operation, and if intermittent, how often is the pump started or stopped; and

5) Details of quality of water, that is, its turbidity, *p*H value, etc.

b) Number of pumps required :

c) Pump operating conditions :

1) Total capacity in litres per second;

2) Capacity of each pump required in litres per second;

3) Total head(including friction losses) in m; and

4) If the total head is not known, then the details of the following shall be provided along with a figure of the set up where pump is to be installed:

i) Static suction lift/positive suction head, in m;
ii) Static delivery head, in m;
iii) Pipe material, conditions: new/used;
iv) Suction pipe dia in mm, length in m; and
v) Delivery pipe dia, in mm and length, in m.

d) Pipe fittings — Number and size of pipe fittings such as foot valve, sluice valve, non-return valve, bend, tee and elbow etc. required for suction and delivery sides.

e) Prime mover details:

1) Prime mover required or not;

2) In case of electric motor drive:

i) Type of drive - Direct or indirect through pulley or gear, whether mounted on a common base plate or separately;
ii) Type of current - ac/dc, Phase-single/ three;
iii) Frequency, in Hz;
iv) Voltage;
v) Rating in kW;
vi) Type of enclosure - totally enclosed/ drip proof/flame proof etc;

3) If other source of power is used, give full details; and

4) Special features required, if any, with details.

f) Stuffing box/ seal arrangment required.

g) If any other pump is already in use, following information should be given :

1) Material of construction for
   i) Delivery casing,
   ii) Shaft,
   iii) Impeller,
   iv) Shaft sleeve, and
   v) Gland;
2) Arrangement of stuffing box seal;
3) Service life in months;
4) In case of trouble, which parts were affected;
5) Nature of trouble, for example, corrosion, erosion, galvanic action, stray current etc.;

h) In case where pump is to be installed for supply of water from a well, following informations on the well shall be given :

1) Installation of the pump in:
   i) Open well,
   ii) Tube well,
   iii) Open well with a sump, and
   iv) Others;
2) Minimum inside diameter of the well or casing in mm;
3) Total depth of well in m;
4) Total depth of casing pipe for tubewell in m ....;
5) Well developed to ..... l/s at ...m of drawdown; and
6) Type of installation, that is, vertical or horizontal.

7 SELECTION OF JET CENTRIFUGAL PUMP COMBINATION

IS 12699 : 1989 provides the guidelines for selection, installation, operation and maintenance of jet centrifugal pump combination. Relevant portions out of this standard, dealing with selection of this type of pump have been put in Annex C.

PART II

HANDPUMPS

8 GENERAL

Handpumps are mainly used where the water requirements are relatively low, intermittent and water is to be drawn from underground. These pumps, are manually operated without requiring a prime mover to drive, therefore, are specially relevant to rural surroundings. These pumps are simple to operate and maintain, with no operating cost and low maintenance cost.

9 HANDPUMP VARIETIES

9.1 Shallow Well Handpumps

These pumps are suitable for drawing water from a depth up to 8 m. Their requirements and characteristics are covered under IS 8035 : 1976. These pumps are available in three sizes — 65 mm, 75 mm and 90 mm nominal size (internal dia of pump body).

9.2 Deepwell Handpumps

These are used for drawing water from a depth of 20m or more up to normally 50 m. These pumps are used for bores fitted with casing pipes of nominal dia from 100 mm to 150 mm. These pumps are popularly known as India Mark-II Deepwell Hand Pumps and their requirements are covered in IS 9301 : 1990.

9.3 Deepwell Handpumps (VLOM)

Village level operation and maintanance (VLOM) deepwell handpumps are suitable for lifting water from borewells fitted with casing pipes of nominal dia from 125 mm to 150 mm and with static water level from 20 m to 40 m. These pumps are designed with an open top cylinder and their design is such that the repair of the pumps, can be done by local mechanics at village level. The basic difference of this pump with deep well handpump (India Mark-II) is that it has an open top cylinder which facilitates pulling out of plunger assembly and check valve assembly from the cylinder without pulling out the riser main/cylinder. This type of pumps are popularly known as India Mark-III deepwell handpumps. Their requirements are covered in IS 13056 : 1991.

9.4 Extra Deepwell Handpumps

These pumps are suitable for drawing water from a depth of 50 m to 90 m from borewells fitted with casing pipes of nominal diameters from 100 mm to 150 mm. The requirements are covered in IS 13287 : 1992.

9.5 Direct Action Handpumps

These pumps are designed for lifting water from a bore well with static water level not exceeding 12m. These pumps are more cost effective than deepwell handpumps and are safer from bacteriological contamination and can be used in places having corrosion problems. An Indian Standard over these Handpumps is under formulation.

CHAPTER 2

GUIDELINES FOR INSTALLATION OF PUMPS

1 GENERAL

Correct installation of the pump is one of the most important factors for successful operation of the pump. A pump which is correctly installed, requires less maintenance, has fewer shut-downs, longer operating life and lower maintenance cost.

This chapter deals with the aspect of proper installation of pumps. The chapter covers the installation of horizontal centrifugal pumps, submersible pump sets, jet certrifugal pump combinations, deepwell handpumps (India Mark II) and deepwell handpumps (VLOM). Guildelines given on installation of deepwell handpump (VLOM) are based on a UNICEF publication entitled 'India Mark-III (VLOM) Deepwell Handpump Installation and Maintenance Manual' due to non-availability of any Indian Standard on this subject. Installation of vertical turbine pumps, extra deepwell handpumps and shallow well handpumps have not been covered due to non-availability of any Indian Standard or adequate, available documanted information from other sources.

2 INSTALLATION OF HORIZONTAL CENTRIFUGAL PUMPS

The guidelines given below are relevant to horizontal centrifugal pumps used for drinking water supply and are based mainly on IS 9694 (Part 2) : 1980.

2.1 Shipment of Pumps

2.1.1 Controls should be exercised right from the stage of shipment of pumps to ensure its safe delivery without damage to parts. Following precautionary measures are suggested which should be taken for protecting all the internal parts of the pumps :

a) Bearing should be lubricated or protected by a film of oil,

b) Machined parts exposed to atmosphere should be protected against rusting; and

c) Openings of pipes, pipe flanges and nozzles should be protected suitably by flange covers or by screwed plugs etc.

Besides there may be some special conditions of delivery which should be mutually agreed to between the manufacturer and user

2.1.2 Usually the pump and prime mover which are meant to be stored on receipt without installation, are supplied in a situation suitable for it, in agreement with the user, in such a way that they retain their mechanical condition during and after storage time. The user will therefore, ensure that the precautionary measures specified by the manufacturer have been taken and are still effective. If it is not so, or in case of delayed use of unprotected pumps, precautionary measures should be taken to protect the equipment. Following are the suggested precautionary measures:

a) The pumpset should be kept in a dry place which is not subject to vibrations ;

b) The openings of the pipes and stuffing boxes should be effectively protected to prevent dust or any foreign particles getting into them; and

c) Bearings should be properly lubricated.

2.2 Installation — The following factors come into play in the installation of a pump

a) Location,

b) Foundation,

c) Grouting,

d) Alignment, and

e) Piping.

2.2.1 *Location* — Correct location of pump is important for operating as well as for maintenance purposes. As far as possible, the pump should be located close to the source of water when suction lift is present. This in turn, will minimize the suction lift and permit the use of short direct suction piping. The pump should be placed in an accessible place, so that one can easily inspect the glands, bearings, etc, during operation. Sufficient headroom should be made available where there is a need to employ cranes, etc. Pumps should be generally located in a dry place.

2.2.1.1 In order to avoid the formation of air pockets and the risk of unpriming resulting therefrom, the suction pipe shall have a slope constantly rising to the pump. If the diameter of this pipe is greater than the pump suction branch size, the connection has to be made by means of an eccentric pipe.

The pump should be installed in a well ventilated pump house with enough space round about the pumpset for easy approach for inspection and maintenance.

2.2.1.2 If the pumping water level in the pit or open well or dug cum bored well is more than six metres, the pump may be installed in the well on a special location created for such a pump so as to keep the suction lift at minimum possible level. If the seasonal variation in pumping water levels are excessive, that is, more than 6m, two or more platforms have to be created in the well so as to place the pump very near to the pumping water level.

2.2.2 *Foundation*

2.2.2.1 A rigid foundation into the ground is normally required for installing a pumpset, unless it is to be mounted on a rigid structured platform. It should be suitable to provide a permanent rigid support for the baseplate for taking the weight of the set, and should have enough mass to absorb any vibrations. The surface area of the foundation should be of sufficient dimensions so as to leave adequate space of sufficient width, around the pumpbase when installed on it, to allow for grouting the foundation bolts, etc. The depths of the foundation depends on the nature of the soil in which it is to be laid.

2.2.2.2 Continuous concreting should be done as far as possible for laying the entire block of foundation, leaving provisions for grouting and pockets for locating foundation bolts in proper position. It should be provided with double reinforcements, which should not be less than 50 kg/m^3 of concrete. The minimum diameter of the bars should be 12 mm and the maximum spacing should be 200 mm in order to take care of shrinkage in concrete [*see* also IS 2974 (Part 3): 1992 and IS 2974 (Part 4) : 1979].

2.2.2.3 The size and number of foundation bolts for each pumpset depend on its kW rating and type of prime mover used. For horizontal agricultural centrifugal pumpsets with prime movers of 1.5 kW to 11.0 kW, foundation bolt diameter normally varies from 12 to 20 mm and length from 150 to 450 mm.

2.2.2.4 Before placing the pumpset with its monoframe base (in case of monosets) or baseplate (in case of direct coupled sets) on the concrete foundation, it is recommended to chip off its upper surface for ensuring perfect adhesion of the grout. Moreover, water should be sprayed on the foundation before pouring the grout. The pumpset should be placed on the foundation with its foundation bolts in position, making it rest on shims and/or wedges placed at frequent intervals (close to foundation bolts position) between the baseplate and concrete block, to provide sufficient space for grouting.

2.2.2.5 When the pumpset is installed on a platform, constructed inside an open dug well for reducing pump suction lift or for some other reasons, it should be ensured that main supporting wooden beams or steel structures are of suitable size for the required span between their supports and rigid and strong enough to take the weight of the pumpset and two/three men, as also for absorbing vibrations, if any, likely to be caused by the running of the pumpset.

2.2.3 *Grouting*

Grouting prevents lateral movements of the pump base, and reduces vibration. Normally, grout is composed of one part ordinary Portland cement and two parts dry, well graded sand with water just to make the mixture placeable.

2.2.3.1 Before starting grouting work, the pumpset should be levelled properly, with the help of a spirit level, by adjusting the thickness of the shims and/or positions of the wedges, on which it is resting on the concrete foundation block. After satisfactory levelling, foundtation bolts should be tightened initially by hand. It is recommended that a frame work should be built around the pumpset base. Now the grout is poured until the entire space under the base is filled to the top of the under side. A stiff wire should be used through the grout holes to work the grout in and release air pockets. In order to prevent cracking due to rapid drying, the exposed surfaces of the grout should be covered by wet burlap. The frame work should be removed and exposed surfaces of the grout and foundations finished smooth only after ensuring that the grout is sufficiently set. After 72 hours or more, the hold down foundation bolts should be finally tightened.

2.2.4 *Alignment (For Coupled Pumpsets)*

2.2.4.1 Flexible type couplings are used normally for connecting the shafts of the pump and its prime mover and for transmission of power to the pump. The purpose of the flexible coupling is to compensate for temperature changes and to permit end movement of the shafts without interference with each other while transmitting power from the driver to the pump. A flexible coupling should not be used to compensate for misalignment of the pump and driving shaft. The following are the two forms of misalignment between the pump shaft and the driving shaft :

a) Angular misalignment — Shafts with axes concentric but not parallel, and

b) Parallel misalignment — Shafts with axes parallel but not concentric.

2.2.4.2 The couplings are to be mounted on the pump shaft and prime mover shaft. The pump and the prime mover should be mounted on the baseplate in such a way that the faces of the couplings are parallel to each other and are spaced far enough so that the coupling/ shaft ends cannot strike each other. The minimum dimension for the separation of the coupling used is usually specified by the manufacturer. This dimension may vary approximately from 3.0 to 6.0 mm. The tools for checking the alignment of flexible couplings are a straight edge or a set of feeler gauges. For accurate jobs dial gauge is also used.

2.2.4.3 A check for angular alignment is made by inserting the taper gauge or feelers at four points between the coupling faces and comparing the distance between the faces at four points spaced at 90 degree intervals around the coupling (*see* Fig.1). The unit will be in angular alignment when the measurements show that the coupling faces are the same distance apart at all points.

2.2.4.4 A check for parallel alignment is made by placing a straight edge across both coupling rims at the top, bottom and at both sides (*see* Fig 2). The unit will be in parallel alignment when the straight edge rests evenly on the coupling rim at all positions. Allowance may be necessary for coupling halves that are not of the same outside diameter. Care must be taken to have the straight edge parallel to the axes of the shafts.

2.2.4.5 Angular and parallel misalignment are corrected by means of shims under the motor mounting feet. After each change, it is necessary to recheck the alignment of the coupling halves. Adjustment in one direction may disturb adjustments already made in another direction. It should not be necessary to adjust the shims under the pump.

The permissible amount of misalignment will vary with the type of pump and driver. The manufacturer's recommendations should be obtained and followed.

2.2.4.6 Only after both the halves of the couplings are aligned by making their side faces exactly parallel to each other and their top circular faces in line with each other as mentioned above, the coupling bolts with their rubber bushes should be inserted in coupling bolt holes.

2.2.4.7 Care should be taken to ensure that faces of shaft ends do not project out of the half coupling faces, when the latter are fitted on to the pump and prime mover shaft extensions. Otherwise they may rub against each other and/or will not allow sufficient clearance for unhampered endwise movement of the shafts.

2.2.4.8 Even if the pump and its prime mover in a coupled set are properly aligned to each other at the manufacturer's works, the alignment gets invariably disturbed while handling during the transit of the set to the installation site. It is, therefore, always necessary to check up this alignment and make necessary adjustments for proper realignment, before the pumpset is placed on the foundation according to **2.2.2.4.** This realignment should be rechecked once again after grouting has set on the foundation.

2.2.5 *Piping*

2.2.5.1 The suction and discharge piping should be connected only after ensuring that the grout is sufficiently set.

2.2.5.2 In order to have least possible friction head losses it is recommended to employ suction pipe as direct and short as possible. If a long suction line is unavoidable, the pipe size should be suitably increased to reduce friction head losses. It is preferred that pump suction line is jointed with pump flange by an eccentric reducer, if needed. For reduced friction and more uniform flow large radius elbows should be preferred.

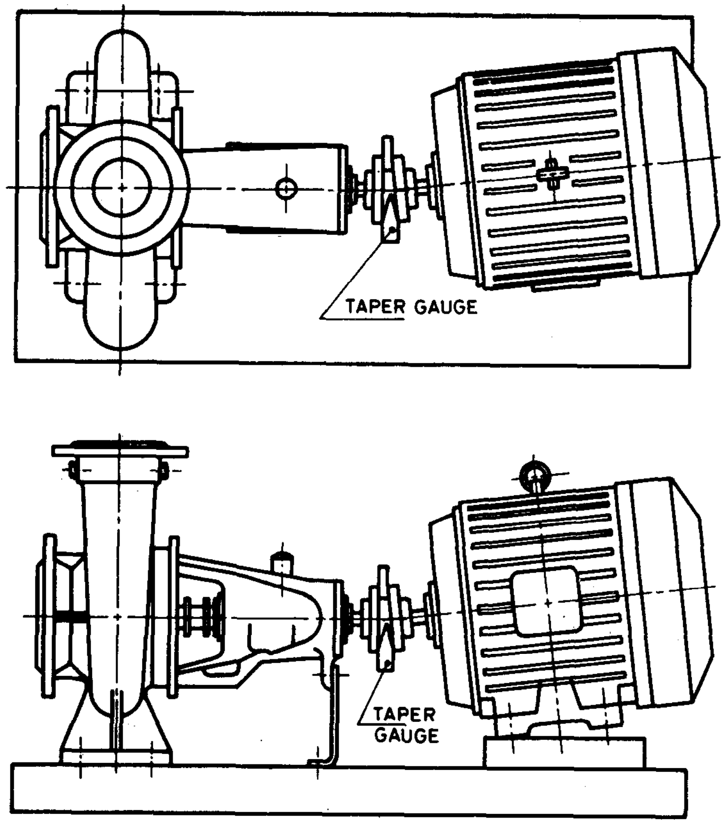


FIG. 1 CHECKING ANGULAR ALIGNMENT

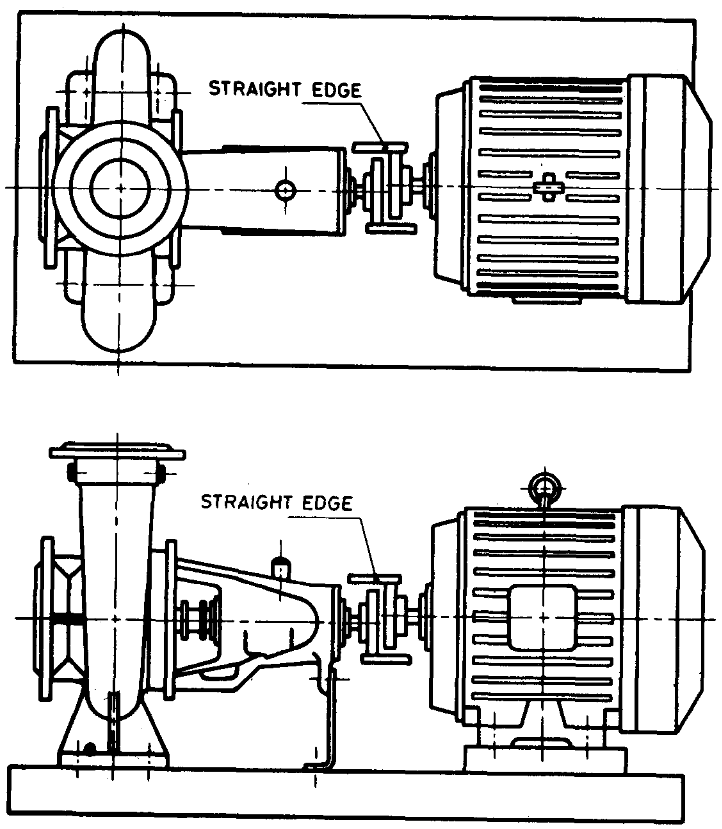


FIG. 2 CHECKING PARALLEL ALIGNMNET

2.2.5.3 The discharge line should be provided with a check valve after the pump and a gate valve should be placed next to the check valve. The gate valve is used when the pump is to be primed or shut down for inspection and repairs.

2.2.5.4 Piping should be such that it does not impose excessive forces and moments on the pump casing to which it is connected, since it might spring the pump or pull it out of position. Piping flanges should be brought squarely together before the bolts are tightened. The suction and discharge piping and all valves, strainer etc, should be supported and anchored near to but independent of the pump, so that no strain will be transmitted to the pump casing.

2.2.5.5 *Final installation*—After the piping is over, alignment should be thoroughly checked and corrective action taken, if necessary. Now the nuts are finally tightened.

2.2.5.6 The rotating parts such as couplings, fly wheel pulley, belts, etc, should be properly protected by guards.

3 INSTALLATION OF SUBMERSIBLE PUMPSETS

For proper installation of submersible pumpsets following guidelines have been provided in IS 8034 : 1989.

3.1 Since the motor and the pump are directly coupled, or close coupled, the manufacturer shall indicate the minimum size of the bore hole in which the submersible pumpset shall be erected and suspended freely.

3.2 The pump shall be installed generally in accordance with the manufacturer's recommendation. A typical sketch of submersible pumpset installation is given in Fig. 3.

3.3 For smooth and efficient working of the submersible pumpsets, the manufacturer shall declare the minimum submergence along with the performance parameters.

4 INSTALLATION OF JET CENTRIFUGAL PUMP COMBINATION

The guidelines on installation of Jet Centrifugal Pump Combination given below are based on IS 12699: 1989.

4.1 Types of Installation — There are two types of installation possible for jet centrifngal pump combinations:

(a) *Horizontal Installation* — In this type of Insutallation, centrifugal pump is mounted horizontally. The horizontal pipe-line length shall not be more than 1.5 to 2 m. In case lengths are to be increased, one size higher diameter of pipe shall be used to keep the frictional losses minimum.

(b) *Vertical Installation* — Whenever space availability is limited and where pump has to be installed above the well, vertical mounting of the centrifugal pump shall be preferred.

4.2 Installation of Centrifugal pump

All requirements laid down in clause **2** shall apply to centrifugal pump part (for simplicity the centrifugal pump has been taken as a motorized monoblock horizontal type centrifugal pump). The entire installation is given for pump with flanged ends. For screwed end, the procedure is same except that the pipes are screwed and jointed with union joint slip coupling. Further the pipe tapping to jet pump shall be provided in the centrifugal casing itself.

4.3 Plumbing of Well

Before erecting the jet inside the borewell, lower a guide of outer diameter 6 mm bigger than the outer pipe coupling jet diameter with a minimum length of 2 m into the borewell. It shall be noted that it goes into the borewell freely. At every 3 m interval, a knot shall be tied in the inserting rope to find out the water depth. A yield test conducted in the bore with test pump will also help to assess the maximum length of pipe to be lowered.

4.4 Installation of Twin Type Jet Centrifugal Pump Combination

4.4.1 *Inspection*

All components before erection, shall be inspected for possible damage in transit. No dirt or foreign particles entrapped inside shall be seen by blowing air through jet assembly combination. Pour water inside the jet assembly up to pressure pipe housing level and find out whether there is any leakage in the jet body or the foot valve. If there is any leakage in the foot-valve where it is threaded with the jet assembly, tighten them with suitable pipe compound and thread packing. Over tightening may result in breakage.

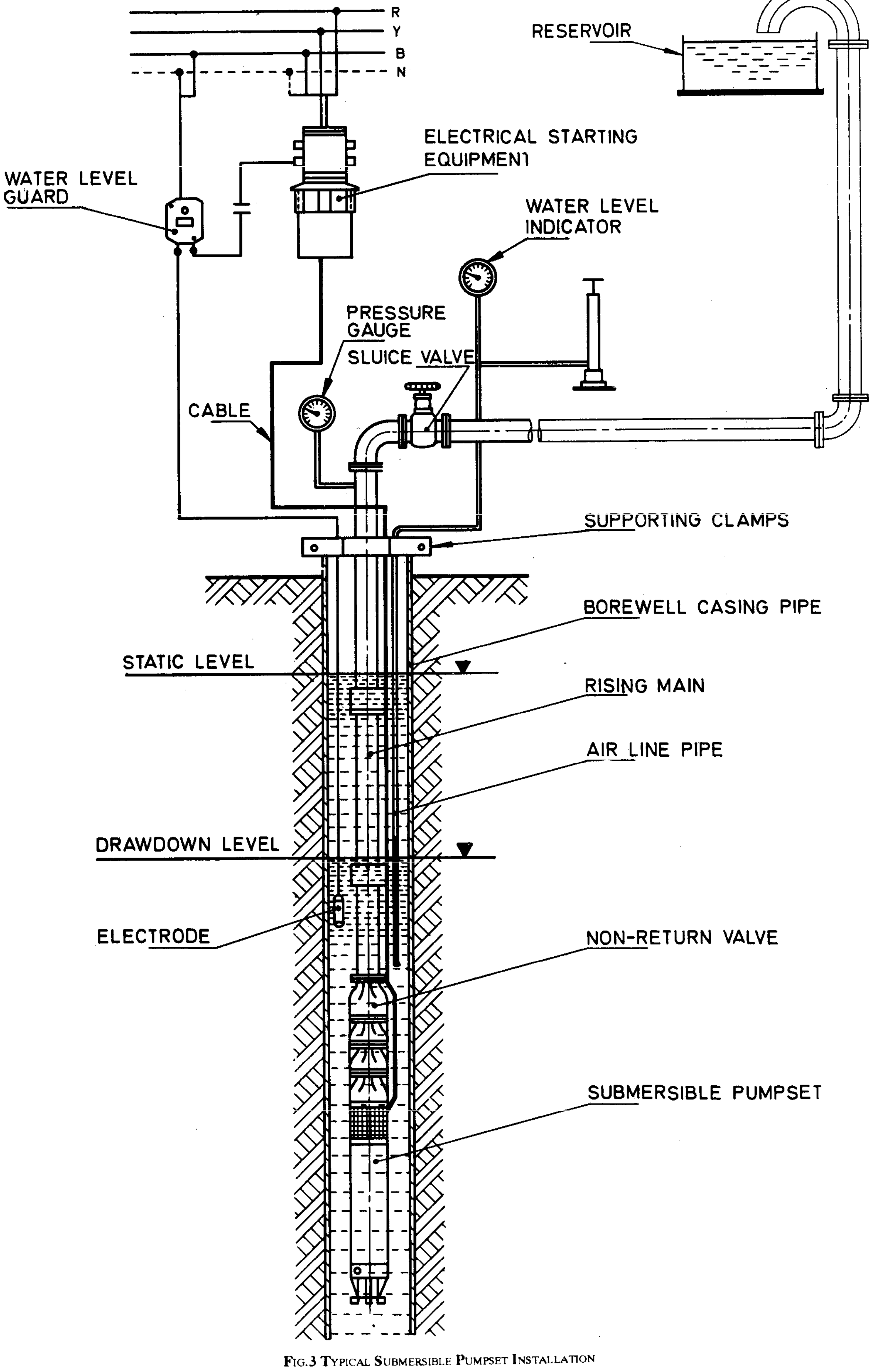


FIG.3 TYPICAL SUBMERSIBLE PUMPSET INSTALLATION

4.4.2 *Pipe Assembly*

Clean all pipes from foreign particles before tightening with jet pump. Tighten the delivery and pressure pipe, applying suitable pipe compound to the proper threads with the ejector body. While tightening the delivery pipe, care shall be taken to see that it does not on any account strike the protruding portion of the venturi tube. Do not over-tighten the pipe in the jet body and while tightening the pressure pipe, do not move away the two pipes too much as this may lead to breakage of jet assembly. After tightening each length, pour water and see that there is no leakage in the joints. A chain block of minimum two tonne capacity with tripod of 6 m length of 50 mm pipe can be used for deepwell erection. Each pipe shall be clamped with proper size clamp securely and while one clamp is used for lifting or lowering, the other must be loosened and positioned in the proper place and secured to fit the chain block for the subsequent operation. Tighten each end of pipe length by a binding wire to avoid damage to the jet assembly due to pipe chattering during subsequent pipe tightening. When the pipes have been fitted up to full length, fit two elbows with the delivery and pressure pipes with proper centre distance between the pipes and fit them to the delivery and pressure pipe tapping in the flange. The slip coupling in the pressure pipe line facilitates easy erection. Make a central cut in the horizontal length of the pressure pipe line, then insert the slip coupling in the pressure line such that the cut is in the centre of the slip coupling. Then tighten the slip coupling nuts to seal the pressure line from leakage. Tighten pump common flange with a rubber washer to the pump body. In vertical mounting, fit directly the delivery pipe to the common flange and assemble the slip coupling to the pressure pipe vertically.

4.4.3 *Assembly of Discharge Pipe to the Monopump*

Fit the discharge flange to the pump body using the rubber washer and wire gauge to avoid entry of foreign particles. To the discharge flange using a nipple, tighten a T-coupling. To the top of the T-coupling, tighten the priming unit. To the other side, tighten the pressure regulating valve. Connect the discharge line to the overhead tank on the other side of the pressure regulator valve. The arrow mark on the valve body shall point towards the direction of the flow of water in the discharge line. Tighten the delivery and pressure pipe lines in the horizontal portion by a twin clamp before starting. Give a proper support to the ejector pipe line so that it does not give any pressure on the pump body.

4.5 Installation of Packer Type Jet Centrifugal Pump Combination

4.5.1 The main components of packer type jet centrifugal pump combinations are:

a) Centrifugal monoblock pump/ coupled pump/ belt driven pump,

b) Jet Assembly Components

   i) Packer type jet assembly with foot valve, packer and strainer assembly,

   ii) Packer housing contained in a sealing pipe with stopper coupling,

   iii) Packer head/well adopter,

   iv) Flanges to connect pump and Packer head, and

   v) Clamp.

c) Delivery Assembly Components

   i) Pressure regulating valve,

   ii) Priming unit,

   iii) Pressure gauge,

   iv) Air releasing cock, and

   v) Delivery flanges.

4.5.2 Given below are the details of outer pipe assembly, assembly of inner (delivery) pipe to the jet assembly (including its location within the outer pipe), assembly of outer and delivery pipe to the monopump through packer head and flanges, and assembly of discharge pipe line to the monopump.

4.5.2.1 *Outer pipe assembly*

The packer housing which forms the bottom most part of the outer pipe is always supplied with a screwed in stopper coupling. Clean the packer housing and see that the stopper coupling contains within it, a shock-absorbing disc pasted to it. Then screw down the packer housing to the first length of outer pipe through a coupling firmly applying suitable pipe compounds. During the tightening operation, care must be taken to see that either the packer housing or the outer pipe does not collapse due to the excessive or improper tightening operation. Lower first length inside the bore gently without striking the walls of the bore. Connect through couplings up to the required length, successive bits of outer pipe to the first length. On the top of the last bit of the outer pipe, tighten the outer pipe flange and place above the bore well or open well, using a clamp on a bed, which may be bore casing pipe in borewell, or a platform of rails in open wells. For lowering the outer pipe within the bore well, a chain block mounted on a tripod post must be used. Each length of outer pipe must be checked for correct bore sizes and for bends, by passing through it a guide of the specified outer pipe bore size. Any burrs or welding lines inside the outer pipe protruding above the specified bore size shall be removed and then only the pipe shall be used for erection.

4.5.2.2 *Assembly of inner delivery pipe to the jet assembly and locating it within the outer pipe*

All the jet assemblies fitted with foot-valve, packer assembly and a strainer are to be tested for proper operation before leaving the works. The complete assembly of jet, foot-valve, packer assembly and strainer are to be supplied as a single unit. They contain two bucket washers at the bottom fitted to the packer assembly. Screw down the packer jet assembly to the first length of delivery pipe by using proper pipe compound so that there shall not be any leakage. During the operation, care shall be taken to see that the pipe is clean. During tightening operation, the bucket washer shall not be allowed to touch any surface which will lead to damage. Lower the delivery pipe with jet assembly into the outer pipe so that the rubber packer does not strike the wall of the outer pipe during lowering operation. A good suggestion is to use small lengths after cleaning them thoroughly. Care shall be taken to see that the joints are leakproof. During the tightening operation of successive bits of delivery pipe, the bottom portion of the pipe lowered inside the casing pipe shall not be allowed to turn. As soon as the bottom portion of the jet assembly has touched the stopper coupling, see that the delivery pipe protrudes above the outer pipe flange by 0.2 m. At the top, delivery pipe shall not be threaded. Do not allow the delivery pipe or jet assembly to strike the stopper coupling, suddenly. This may lead to damage of the complete unit itself. Use chain block with tripod to lower the delivery pipe.

4.5.2.3 *Assembly of outer and delivery pipe to the monopump through packer head and flanges*

The concentric flow areas between outer and inner (delivery) pipes are made twin flow areas by fitting a packer head above the outer pipe flange. Place its gasket above the outer pipe flange and then mount the packer head above it, passing it above the inner pipe outside diameter. In this condition, the inner pipe shall be protruding above the packer head top level by at least 40 to 50 mm. Cut the inner pipe using hacksaw to the top surface level of packer head. Clean out all the burrs around the inner pipe and insert the sealing ring rubber gland above the outside diameter of the inner pipe which will sit in its seating in the packer head. Place its gasket above the packer head, now it is ready for connecting with the monopump. Two sets of flanges one for the packer head and other for monopump shall be supplied. Connect these flange using two elbows and required length of pipes. A slip coupling may be used for ease of erection in the pressure line. Using the gasket, tighten this assembly to the packer head and monopump.

4.5.2.4 *Assembly of discharge pipeline to the monopump*

Fit the discharge flange to the pump body using the rubber washer and wire gauge to avoid entry of foreign particles. To the discharge flange using nipple, tighten a T-Coupling. To the top of the T-coupling, tighten the priming unit. To the outer side, tighten the pressure regulating valve so that the arrow on it points towards the flow of water in discharge pipeline. Connect the discharge line to the overhead tank, on the other side of the pressure regulator valve. In horizontal sets, tighten the suction and pressure pipelines in the horizontal portion by twin clamp before starting. Give a proper support to the erector pipeline so that they do not give any pressure on the pump body. Screw down the pressure gauge to its thread in the pump-casing/pressure regulator valve body.

4.6 Installation of Duplex Type Jet Pump

4.6.1 It shall be borne in mind that in duplex jet pump, both outer and delivery pipe are screwed to jet assembly together and then lowered in the well. The foot-valve of the duplex jet pump may be either external to the duplex assembly or internal within duplex assembly. The main components of a duplex type jet centrifugal pump combination are :

a) Centrifugal monopump/coupled/belt driven pump,

b) The jet pump assembly components :

   i) Duplex type jet pump assembly with foot-valve, strainer and duplex unit,

   ii) Outer pipe flange,

   iii) Duplex head/well adopter,

   iv) Flanges to connect pump and duplex unit, and

   v) Outer and inner pipe clamps.

c) Delivery pipe assembly components:

   i) Pressure regulating valve,

   ii) Priming unit,

   iii) Pressure gauge,

   iv) Air releasing cock, and

   v) Delivery flanges.

4.6.2 The installation of duplex type jet assembly with pipes and monopump is done in three phases:

a) Assembly of outer pipe and delivery pipe (inner pipe) to the duplex jet assembly,

b) Assembly of outer and inner pipe to the monopump through duplex head/well adopter through flanges, and

c) Assembly of discharge line.

4.6.3 *Assembly of Outer Pipe and Delivery Pipe to the Duplex Jet Assembly*

For ease of erection, the length of individual bits of pipes are generally kept less than three metres since both pipes are assembled together. Keep the length of the delivery pipe at least 3 m longer than outer pipe for easy tightening of the inner and outer pipe separately.

Check the duplex jet assembly for any damage in transit and blow air through the jet assembly to see that no foreign particles have clogged the venturi or nozzle. If the footvalve forms an internal part of the jet assembly, fit a small column of inner pipe and pour water to check water tightness of seating of the footvalve.

If the footvalve is external, it should be only fitted after the assembly of first length of inner and outer pipe to jet assembly before lowering. Tighten the jet assembly with first bit of inner pipe with proper sealing compound. Above the duplex nut seating, place the gasket and place the first bit of the outer pipe and tighten both through outer pipe coupling using proper sealing compound.

Using one clamp on the outer pipe and one on the inner pipe, lower the pipes within the bore. Pour water within these pipes and check for any leakage. If both the inner and the outer pipes are lowered to the required length, fix a clamp on the outer pipe and house it on the well casing. Tighten the outer pipe flange using proper sealing compound to the outer pipe. It shall be seen that in this position, the inner pipe shall be protruding above the outer pipe flange by a length of at least duplex head height plus 50 mm.

4.6.4 *Assembly of Outer and Delivery Pipe to Monopump through Duplex Head and Flanges*

The concentric flow areas between outer and inner (delivery) pipes are made twin flow areas by fitting a duplex head otherwise known as well adopter above the outer pipe flange. Place its gasket above the outer pipe flange and then mount the duplex head above it passing it above the inner pipe. In this condition, the inner pipe will be protruding above the duplex head top level by at least 40 to 50 mm. Cut the inner pipe using hacksaw to the top surface level of the duplex head. Clean out all the burrs around the inner pipe and insert the sealing ring rubber gland above the outside diameter of the inner pipe which will sit in its seating in this duplex head. Place its gasket above the duplex head. Now it is ready for connecting it with the monopump. Two sets of flanges, one for the duplex head and the other for the monopump shall be supplied. Connect these flanges using two elbows and the required length of pipes. A slip coupling shall be used for ease of erection in the pressure line. Using the gasket, tighten this assembly to the duplex head and to the monopump.

4.6.5 *Assembly of Discharge Pipeline to the Monopump*

Fit the discharge flange to the pump body using the rubber washer and wire gauge to avoid entry of foreign particles. To the delivery flange, using a nipple, tighten a T-coupling. To the top of the T-coupling, tighten the priming unit. To the other side, tighten the pressure regulating valve. Connect the delivery line to the overhead tank on the other side of the pressure regulating gate valve. Tighten the suction and pressure pipelines in the horizontal portion by a twin clamp before starting. Give proper support to the ejector pipeline so that it does not give any pressure on the pump body. Screw down the pressure gauge to its thread in the pump casing.

4.6.5.1 *Electrical connections*

Use proper capacity switch and starter with over load and under voltage protections. While giving connection, take care to avoid loose contacts. Do not use oversize fuse. Before starting, see that the motor runs in the correct direction as indicated by the arrow mark on the casing. In single phase jet pumps, test with a voltmeter to ensure that the line voltage does not go below 180 volts while starting the pump.

4.7 Shipment of Jet Centrifugal Pump Combination

4.7.1 For centrifugal pump part, the guidelines are same as mentioned under clause **2.1.**

4.7.2 For jet pump assembly following additional stipulations are made :

(a) All the important components, such as, venturi nozzle, foot valve, etc shall be clearly protected and covered from foreign particles entry.

(b) The venturi and foot valve stem portion shall be thoroughly protected from damage due to accidental throwing of packing.

(c) Pressure gauge supplied with the pump shall be thoroughly protected from damages to the dial and glass cover from shock.

5. INSTALLATION OF DEEPWELL HANDPUMP (INDIA MARK -II)

IS 11004 (Part I) : 1992 provides detailed guidelines for installation of deepwell handpumps conforming to IS 9301 : 1990 (India Mark-II handpumps). These guidelines are as given below.

5.1 Requirements for Installation

5.1.1 The location of the bore well is of prime importance and it shall be located away from source of faecal pollution. The area shall be easily approachable to users.

5.1.2 The location shall not result in an obstacle in free and smooth movement of traffic including the padestrians.

5.1.3 The location of the bore well shall be such that the spillage is easily drained off.

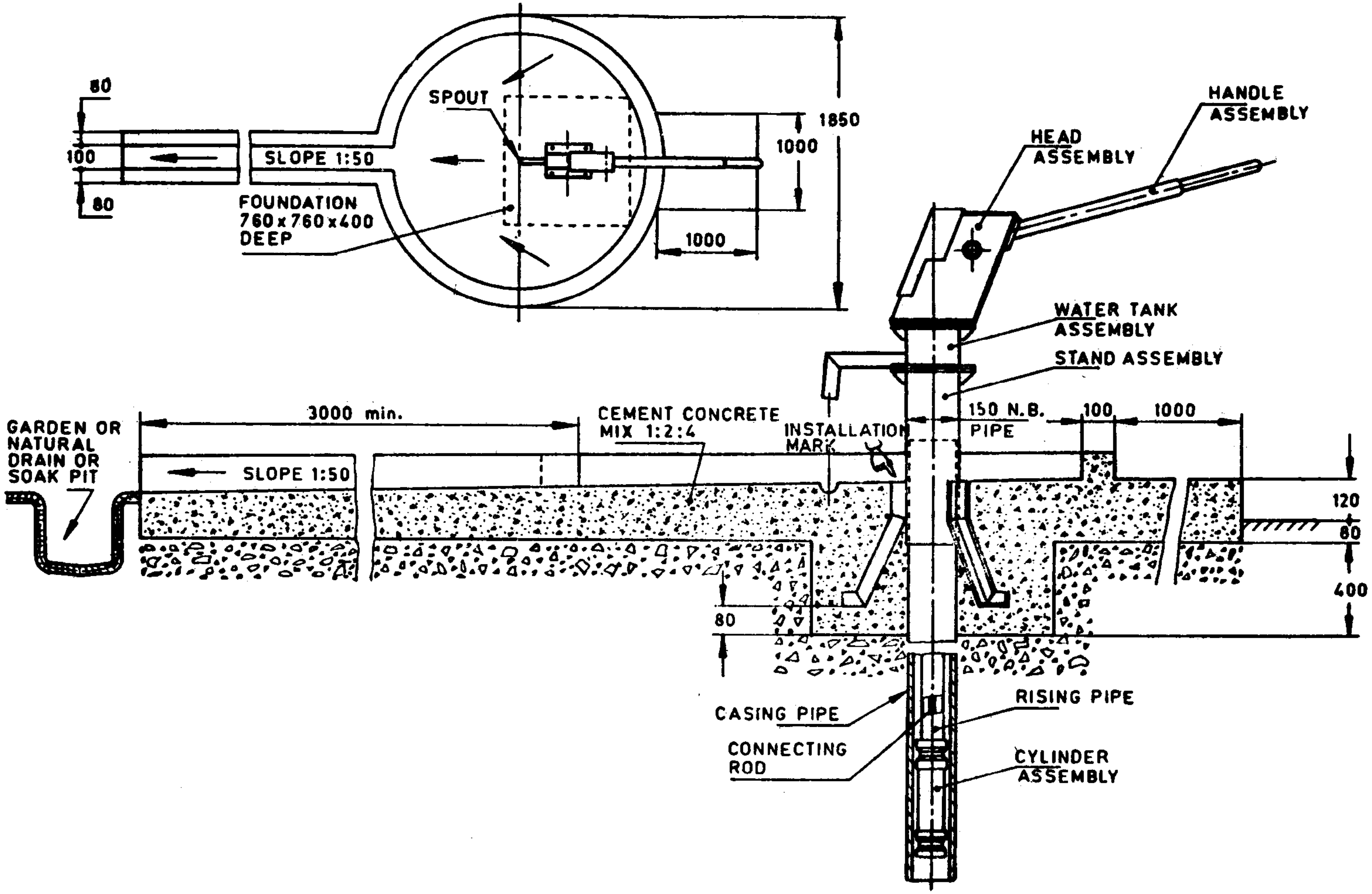
5.1.4 The bore well shall be of size 100 to 150 mm and the minimum recharge of the bore well shall not be less than 15 litres/minute.

5.1.5 In case the recharge of well is to be determined the same shall be done as per IS 2800 (Part 2) : 1979.

5.2 Installation

5.2.1 The platform and foundation shall be prepared as shown in Fig 4 and Fig 5 and soakpit shall be as shown in Fig 6.

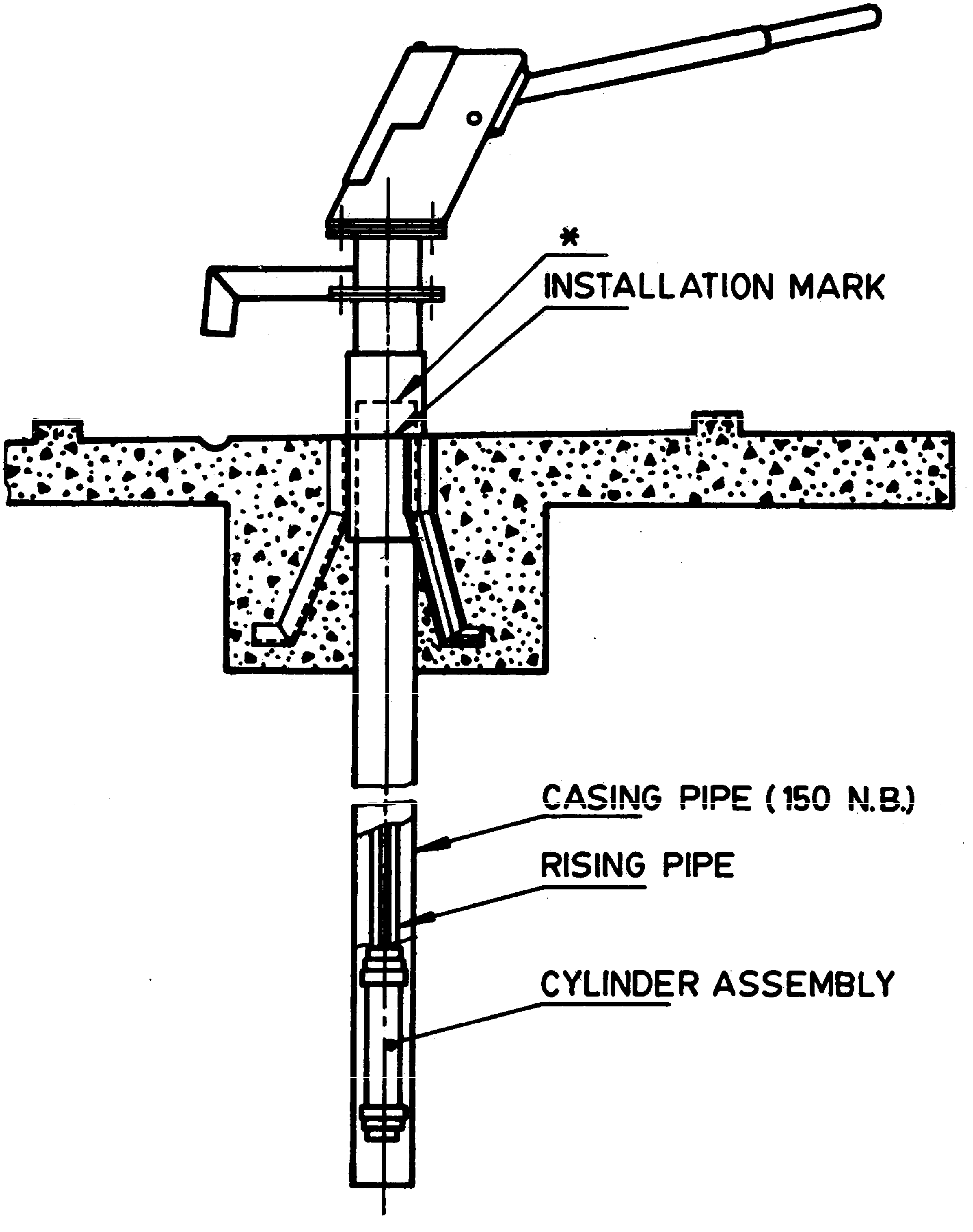
5.2.2 After the platfrom is ready that pump shall be installed according to steps 9 to 25.



NOTES:

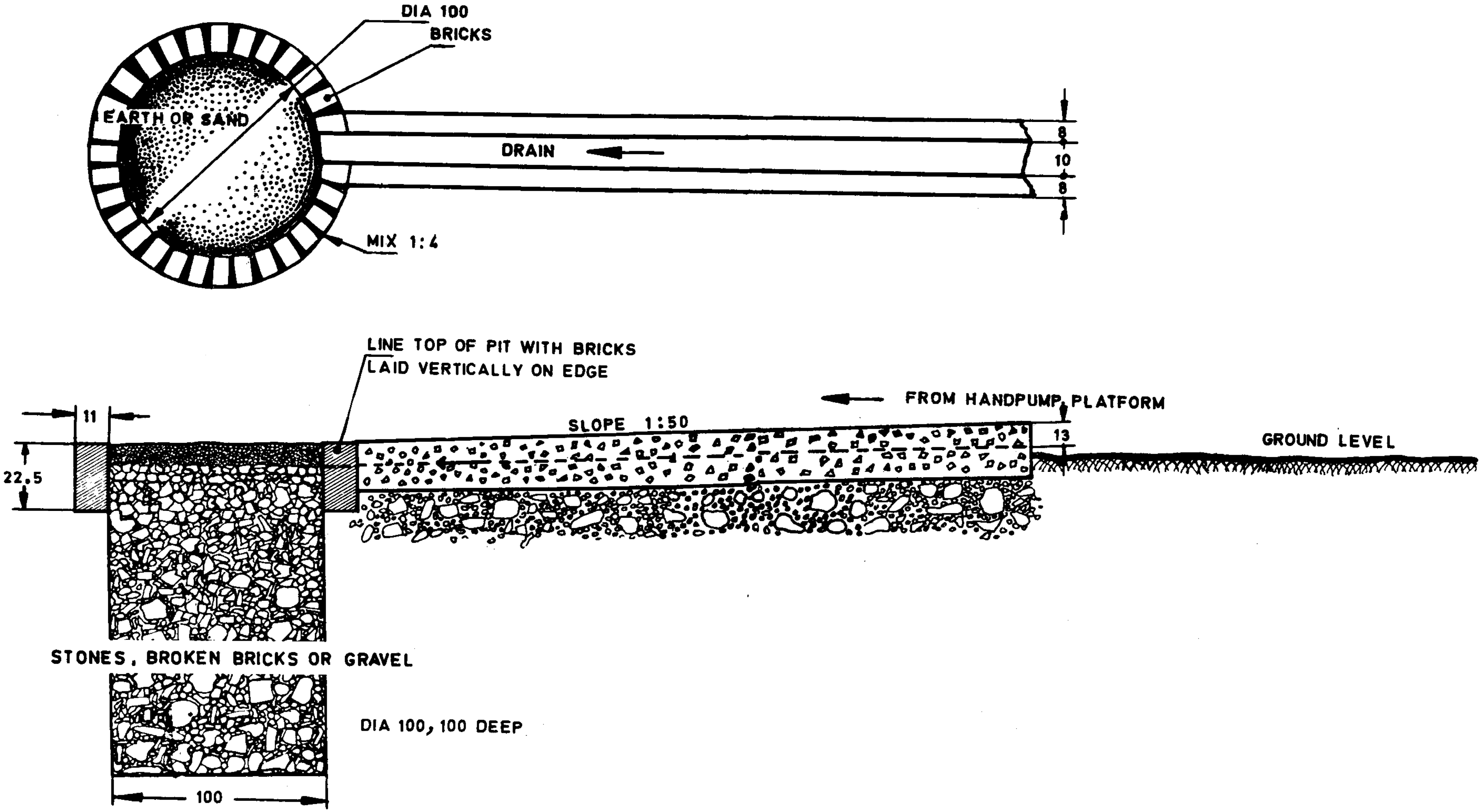
1. The free end of the casing pipe shall be minimum 300 mm above the installation mark.
2. Casing Pipe is not required when the bore pipe passes through rocks
3. Separate platform for wahing clothes/utensils and cattle truffs may be provided, if requir9ed

FIG. 4 TYPICAL SET-UP FOR DEEPWELL HANDPUMP



*For Casing Pipe of 150 mm N.B, use of Telescopic stand assembly as shown is recommended.

FIG. 5 TELESCOPIC STAND ASSEMBLY



Note-Design of Soak Pit is for guidance only. It may be circular, rectangular/square.
All dimensions in millimeters

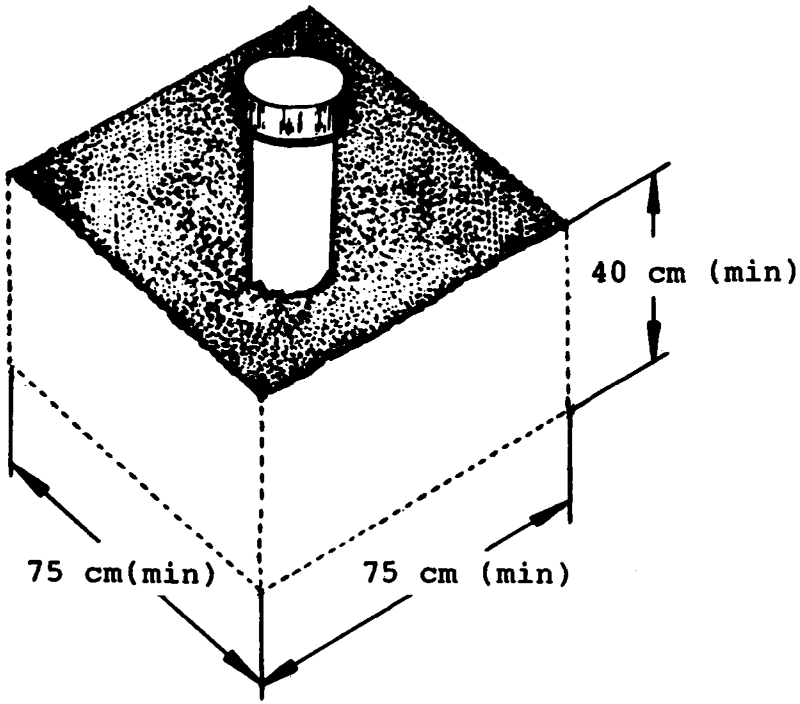
FIG. 6 SOAK PIT

STEP I DIGPIT FOR PUMP PEDESTAL

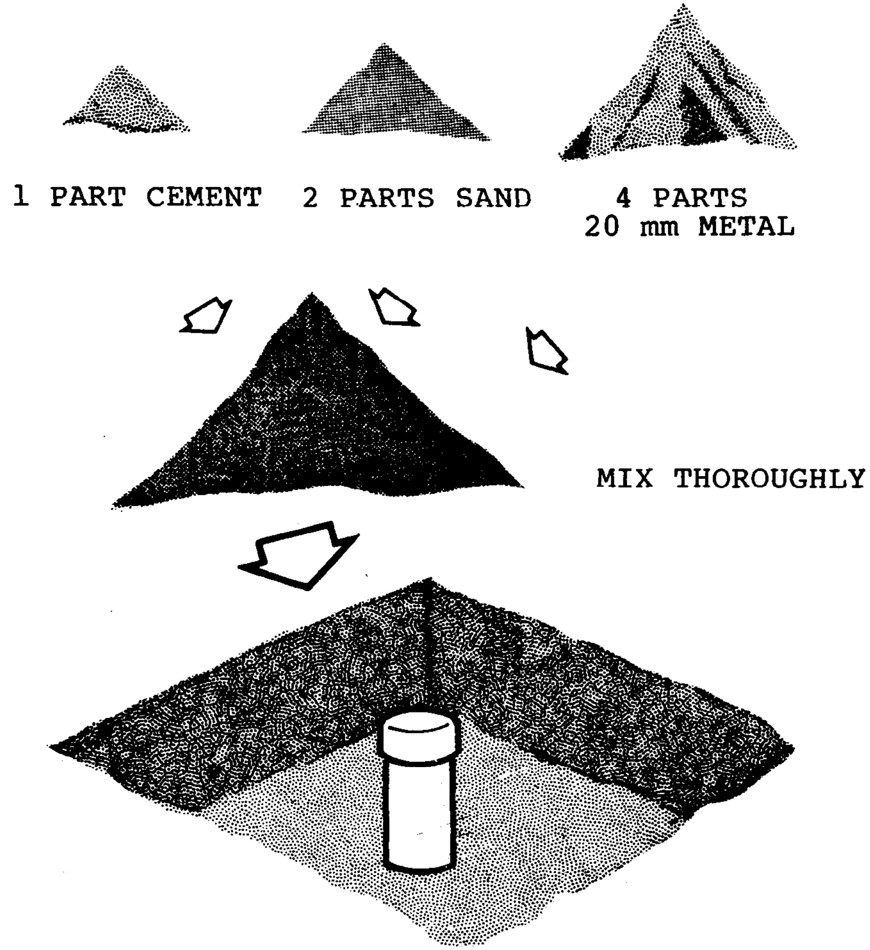
Remove casing pipe cover and measure depth and water level in tube well and ensure that it is free from obstructions.

Cover casing pipe.

Dig a square pit 75cm by 75cm around casing pipe and 40 cm deep.

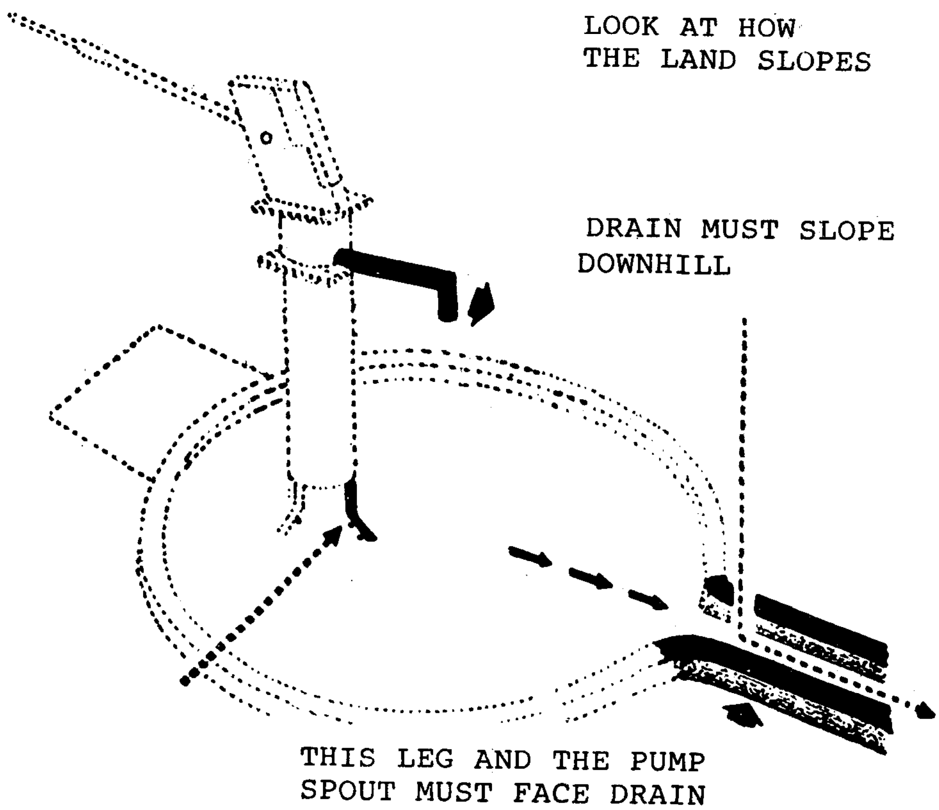


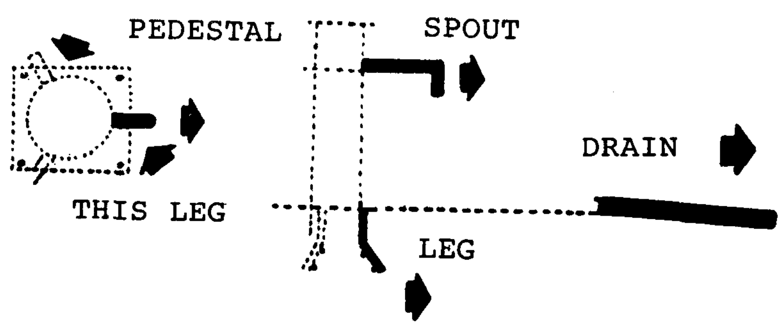
STEP 2 PREPARE CONCRETE MIX



POUR CEMENT CONCRETE
8 cm DEEP INTO PIT

STEP3 PLAN DRAIN DIRECTION

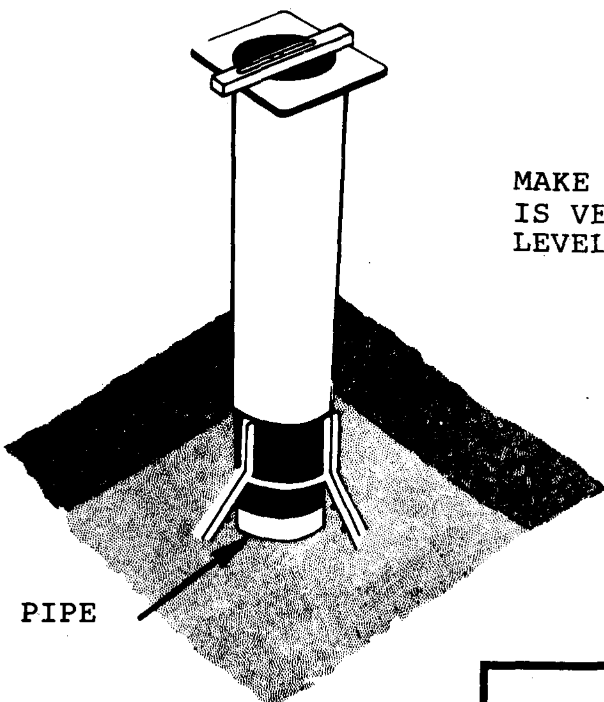




STEP 4 INSTALL PEDESTAL

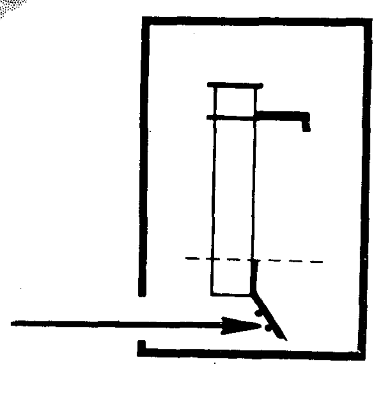
REMOVE COVER OF CASING PIPE

PLACE PEDESTAL
OVER CASING PIPE
SO THAT......



MAKE SURE THAT PEDESTAL IS VERTICAL. USE A SPIRIT LEVEL.

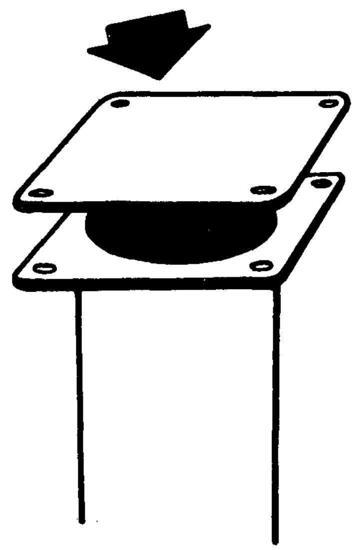
CASING PIPE



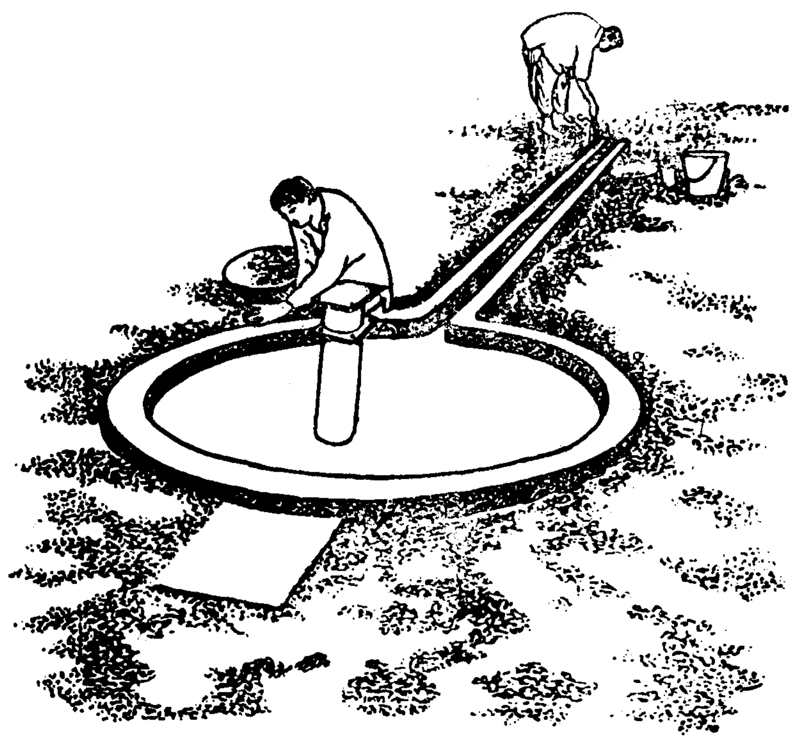
....WHEN YOU FIT WATER TANK, SPOUT WILL BE OVER THIS LEG

STEP 5 CONCRETE THE PEDESTAL

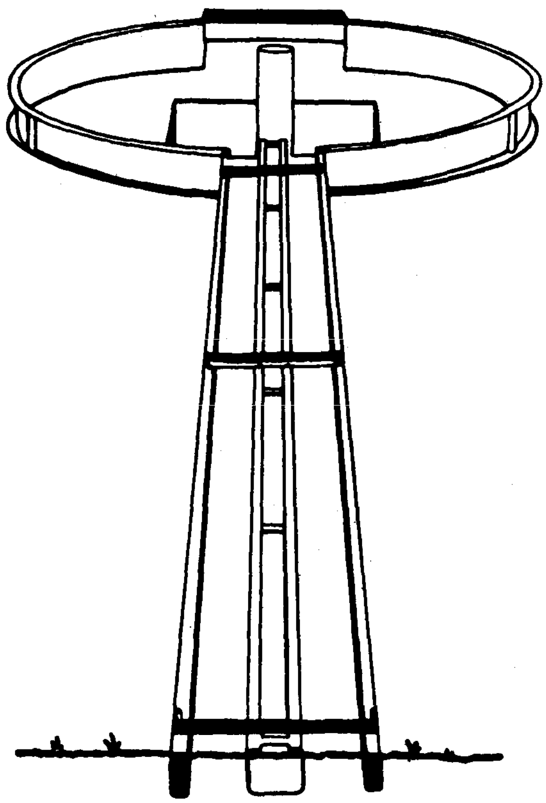
Fill pit with concrete and ram to get air bubbles out of concrete. Check that top flange is level. Use the spirit level in two directions. Construct platform to top of legs while concrete is still wet. Cover pedestal with cover plate so that children can not put stones in the well.



STEP 6 CONSTRUCT PLATFORM AND DRAIN

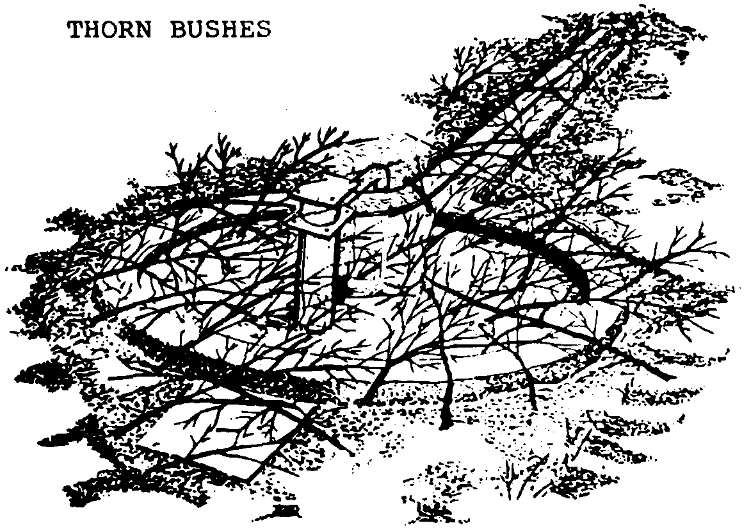


STEP 7 CONSTRUCTION' OF PLATFORM AND DRAIN WITH METAL SHUTTERING



STEP 8 PREVENT PLATFORM AND DRAIN FROM CRACKING

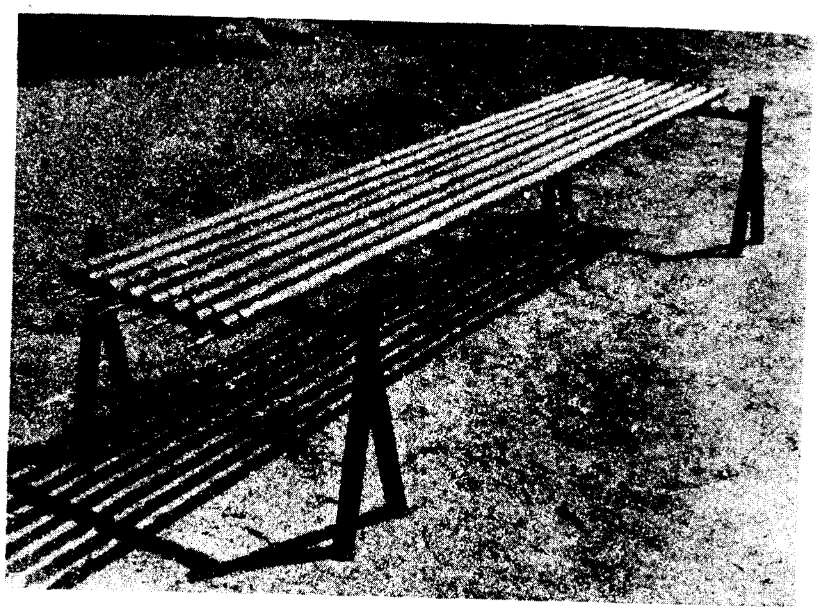
To cure concrete, block drain and fill platform with water for seven days. Ask villagers to keep way from installation



Important
ALLOW CONCRETE TO SET FOR 7 DAYS

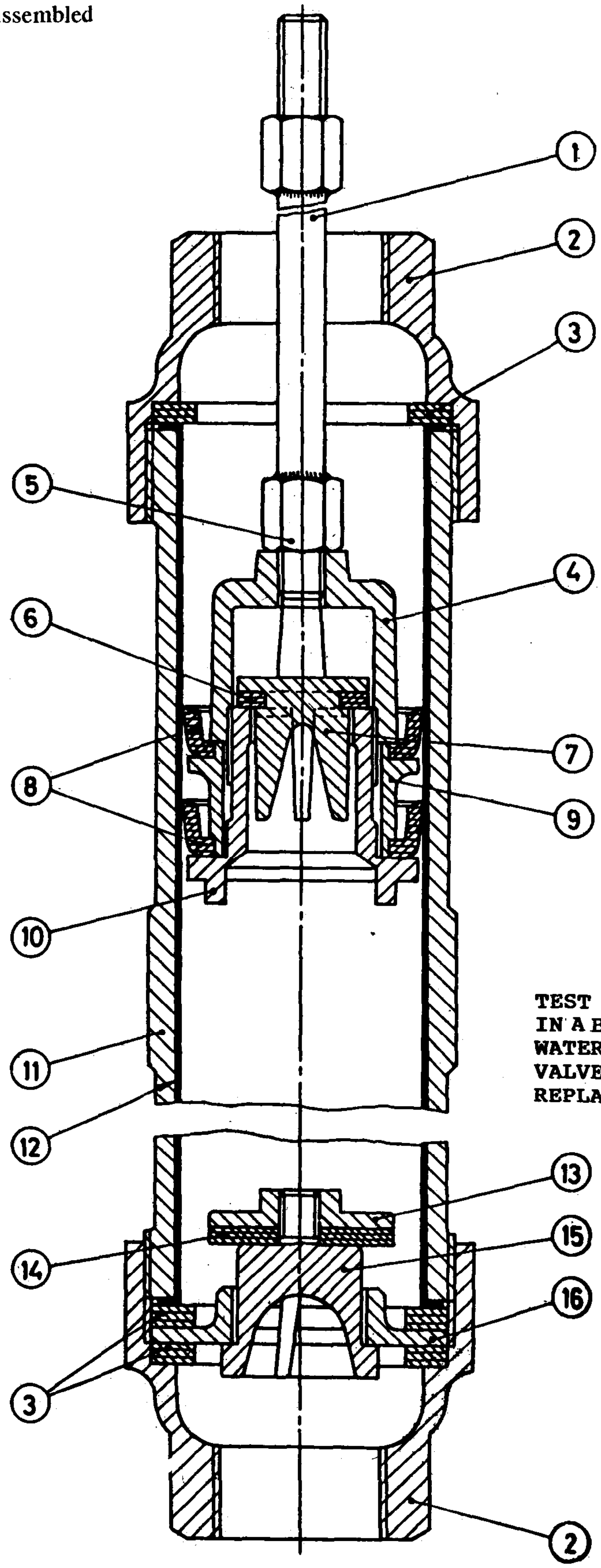
STEP 9 INSTALL PUMP SEVEN DAYS LATER

Layout pipes and connecting rods on pipe stand. Check that pipes and rods are threaded. Check that all threads are good and clean.



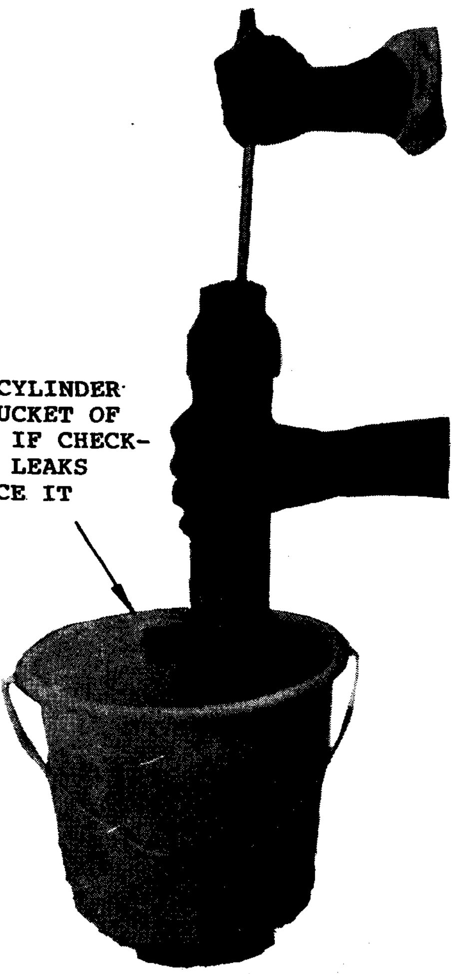
STEP 10 CHECK CYLINDER OPERATION

Open cylinder with the help of pipe wrenches and check that piston and check valves are tight and properly assembled



Part No.	No. Off	Description
16	1	Check valve seat
15	1	Check valve
14	1	Rubber seating (Lower valve)
13	1	Rubber seat retainer
12	1	Brass liner
11	1	Cylinder body
10	1	Follower
9	1	Spacer
8	2	Pump bucket
7	1	Upper valve
6	1	Rubber seating (Upper valve)
5	2	Hex coupler M12 × 1·75
4	1	Plunger yoke body
3	3	Sealing ring
2	2	Reducer cap
1	1	Plunger rod

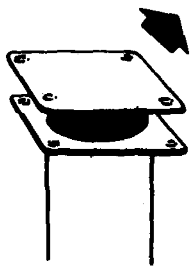
TEST CYLINDER IN A BUCKET OF WATER IF CHECK-VALVE LEAKS REPLACE IT



RE-ASEMBLE CYLINDER

STEP 11 FIT CYLINDER TO FIRST ROD AND PIPE

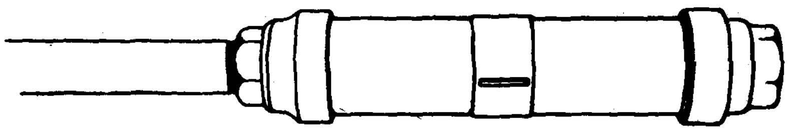
REMOVE COVER OF PEDESTAL AND
REMEASURE DEPTH AND WATER
LEVEL IN THE TUBEWELL



JOIN FIRST CONNECTING ROD TO PLUNGER ROD

WELDED HEX. COUPLER CYLINDER

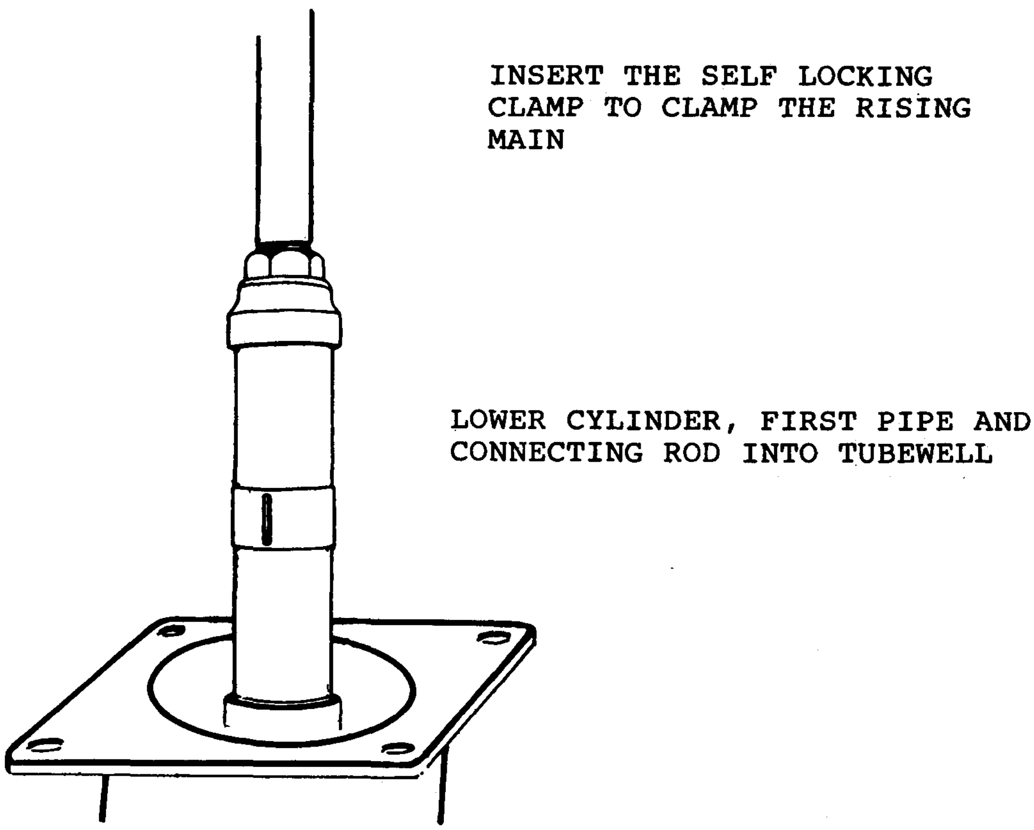
SCREW FIRST PIPE INTO CYLINDER
USE JOINTING COMPOUND
TIGHTEN FULLY



WIPE OFF EXCESS JOINTING COMPOUND

STEP 12 LOWER CYLINDER AND FIRST PIPE AND ROD

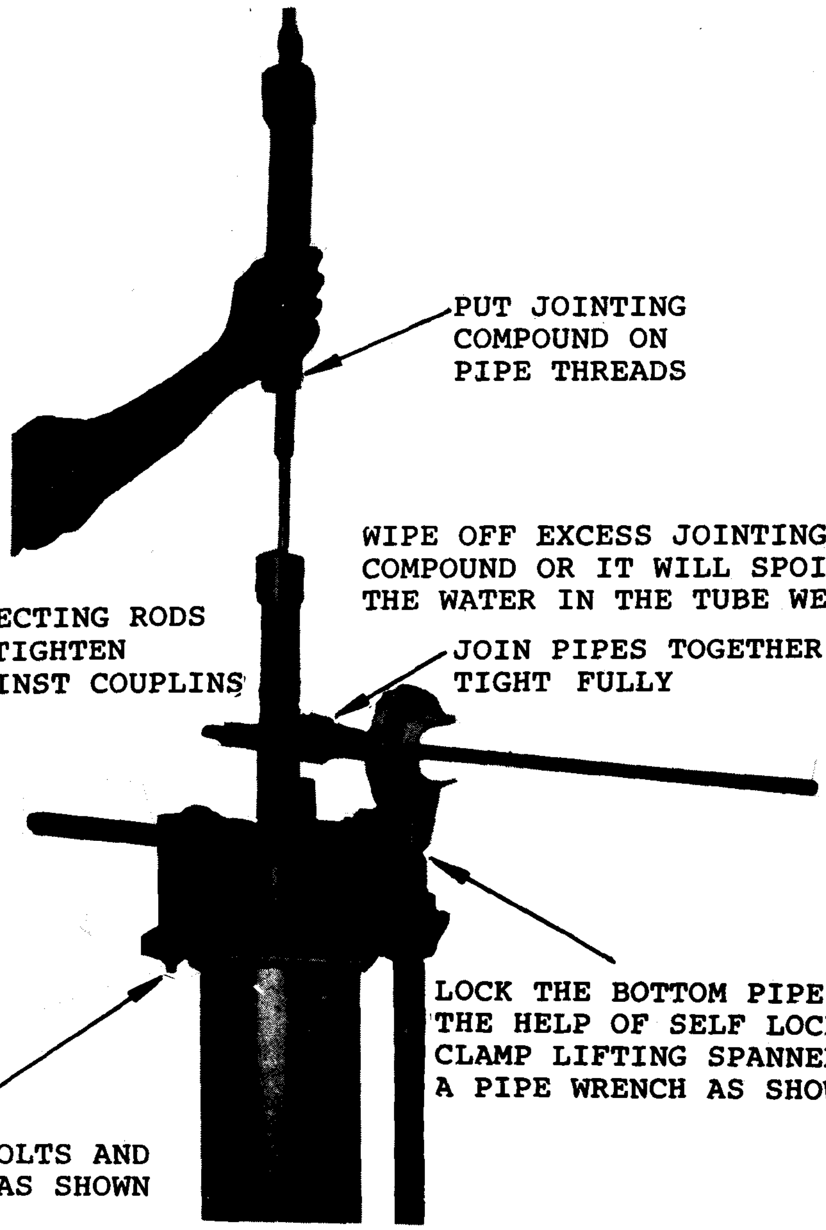
Cylinder should be installed at a minimum depth of between 24m and 36m for maximum efficiency. Cylinders installed at Greater depth will require more pumping effort. Never install a cylinder less than 6 m from the bottom of tubewell.



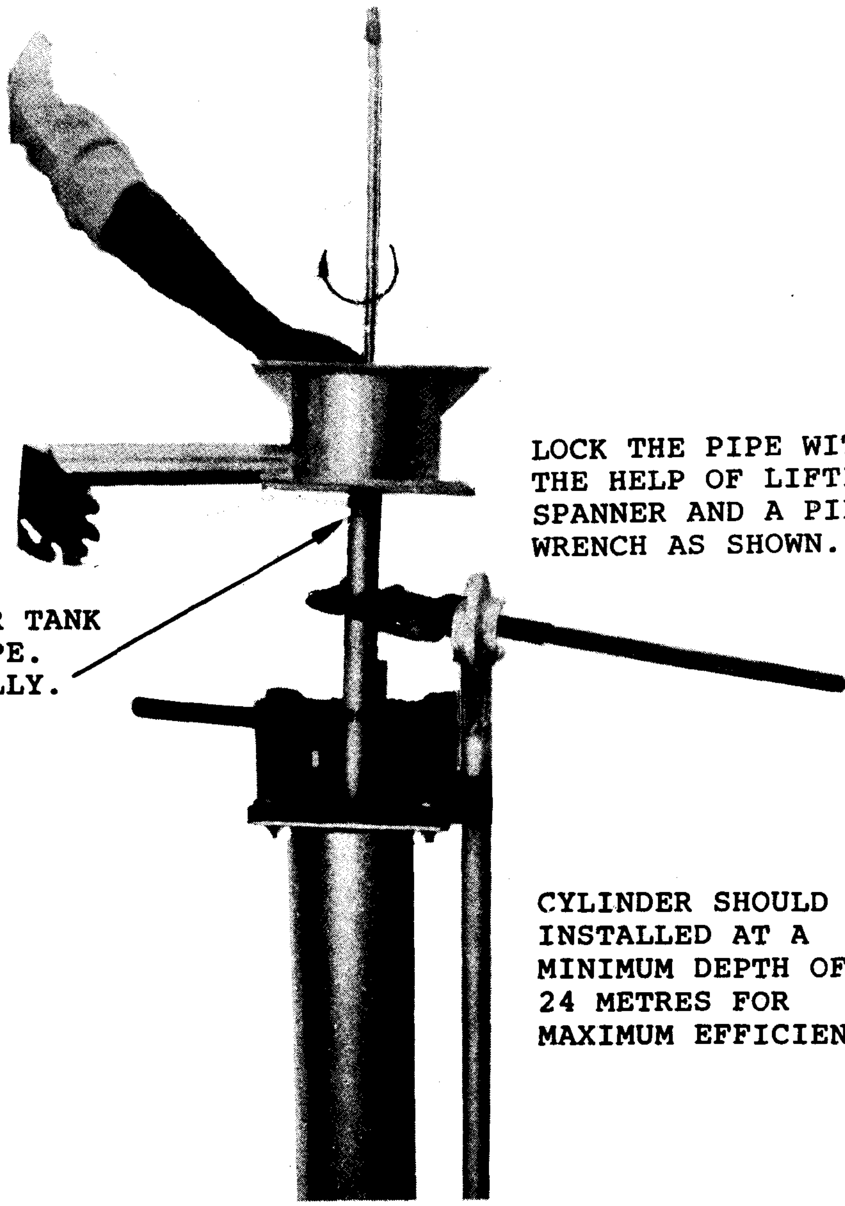
STEP 13 FIT SUCCESSIVE PIPES AND RODS

Wipe off excess jointing compound

Lower cylinder, pipe and connecting rod into tube well using pipe lifters and self locking clamp. Continue till last pipe.



STEP 14 FIT WATER TANK TO LAST PIPE



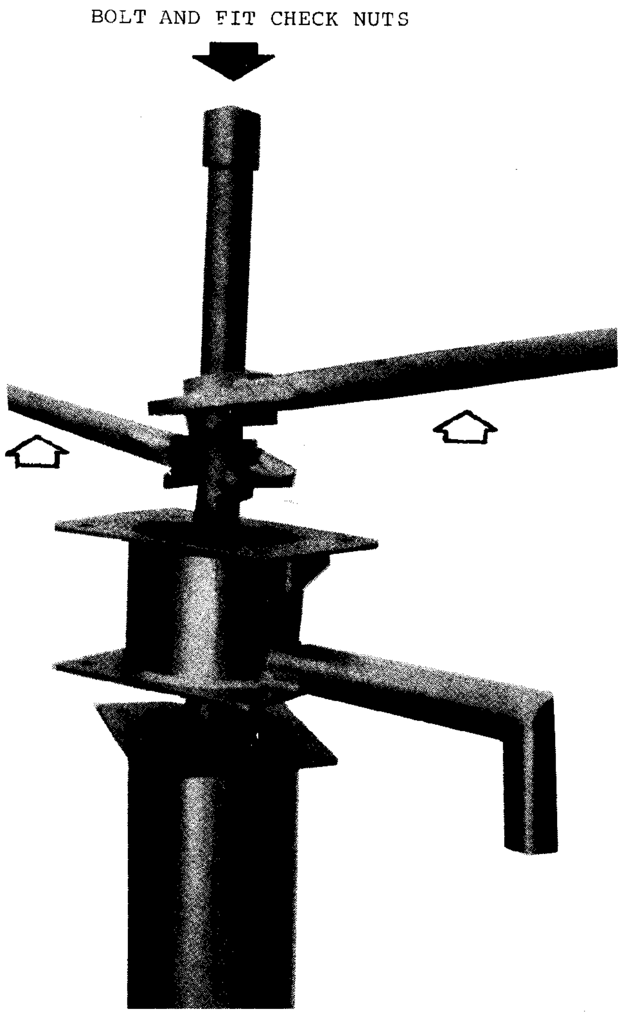
LOCK THE PIPE WITH THE HELP OF LIFTING SPANNER AND A PIPE WRENCH AS SHOWN.

SCREW WATER TANK TO LAST PIPE. TIGHTEN FULLY.

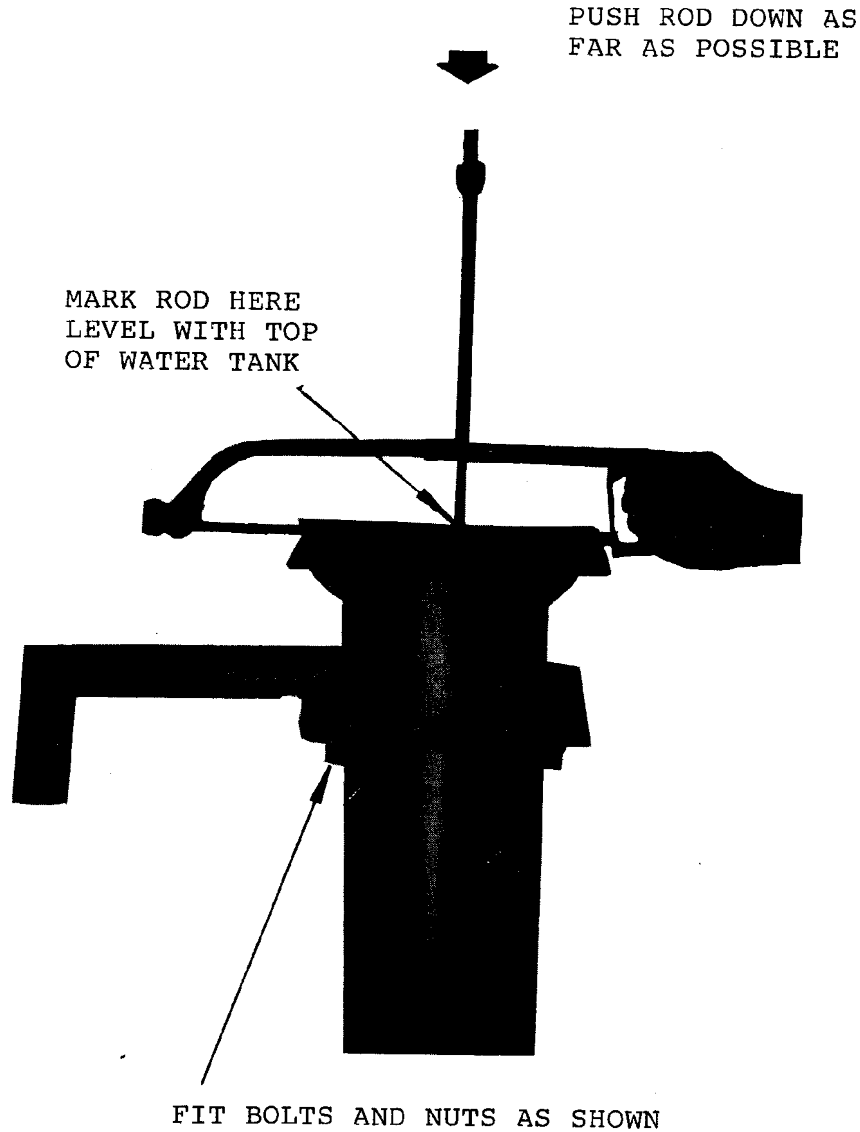
CYLINDER SHOULD BE INSTALLED AT A MINIMUM DEPTH OF 24 METRES FOR MAXIMUM EFFICIENCY

STEP 15 BOLT WATER TANK TO PEDESTAL

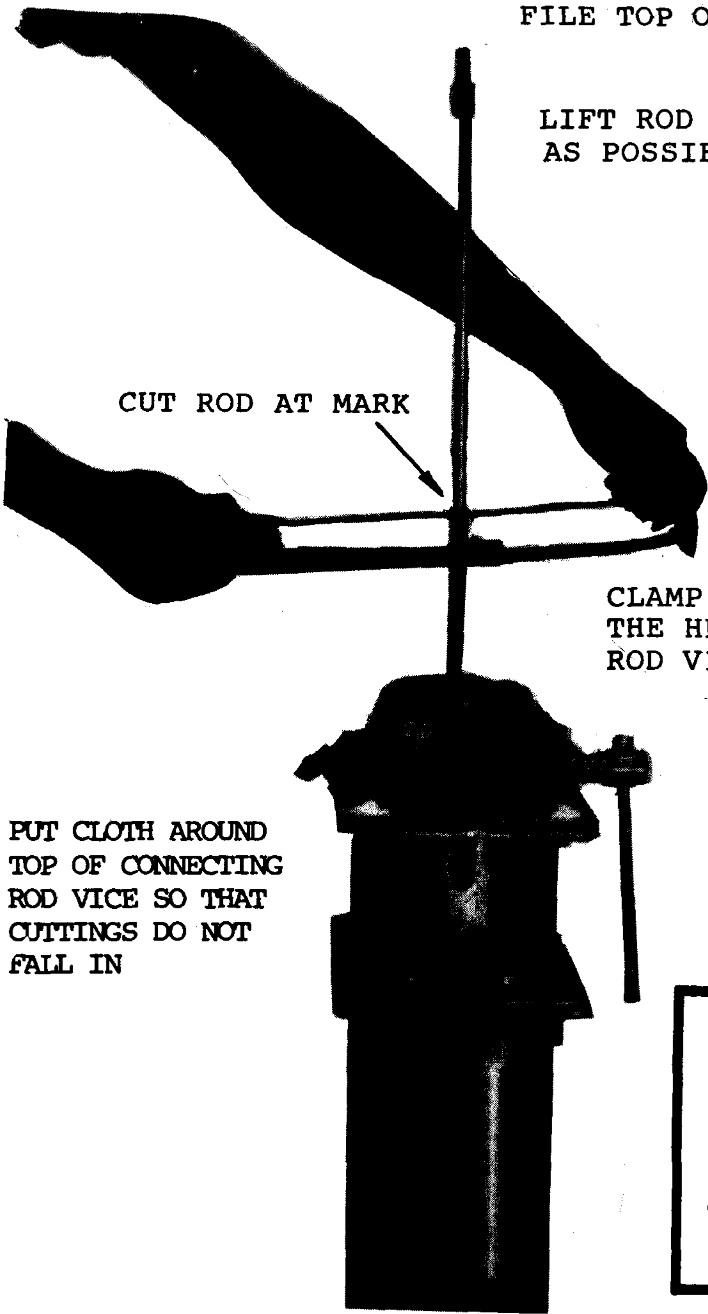
Carefully lower water tank on to pedestal with the water tank lifter and pipe lifters. Spout must face drain.

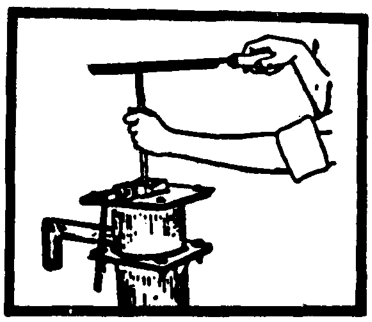


STEP 16 CHECK POSITION OF PISTON



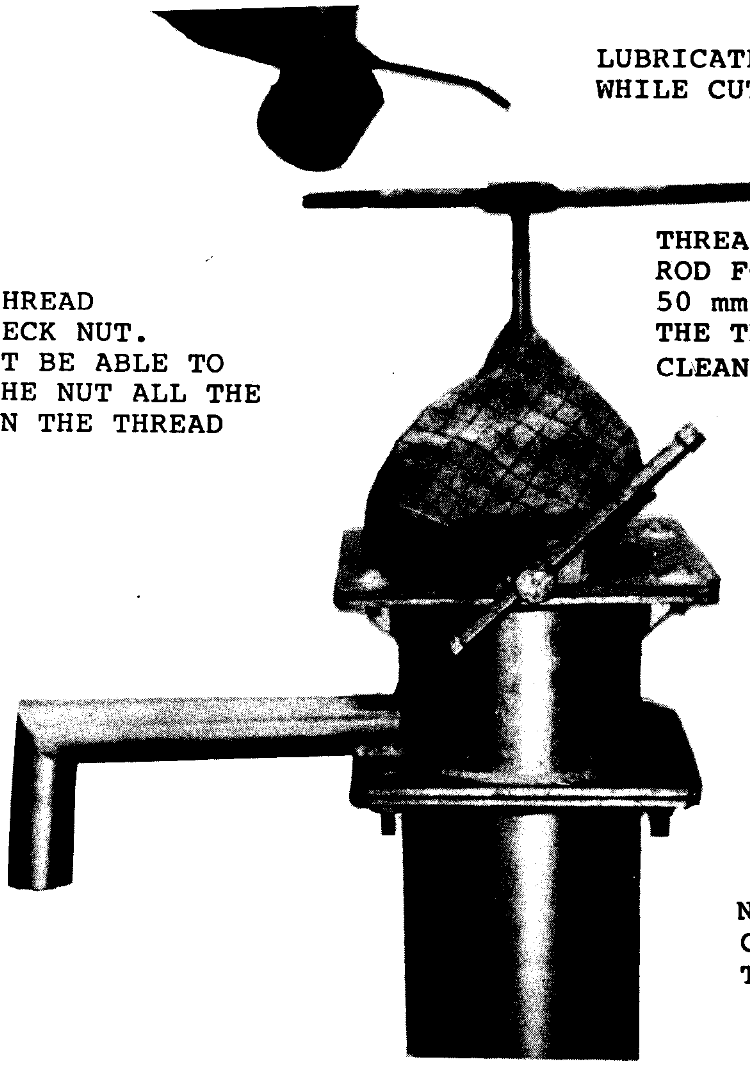
STEP 17 SET PISTON STROKE





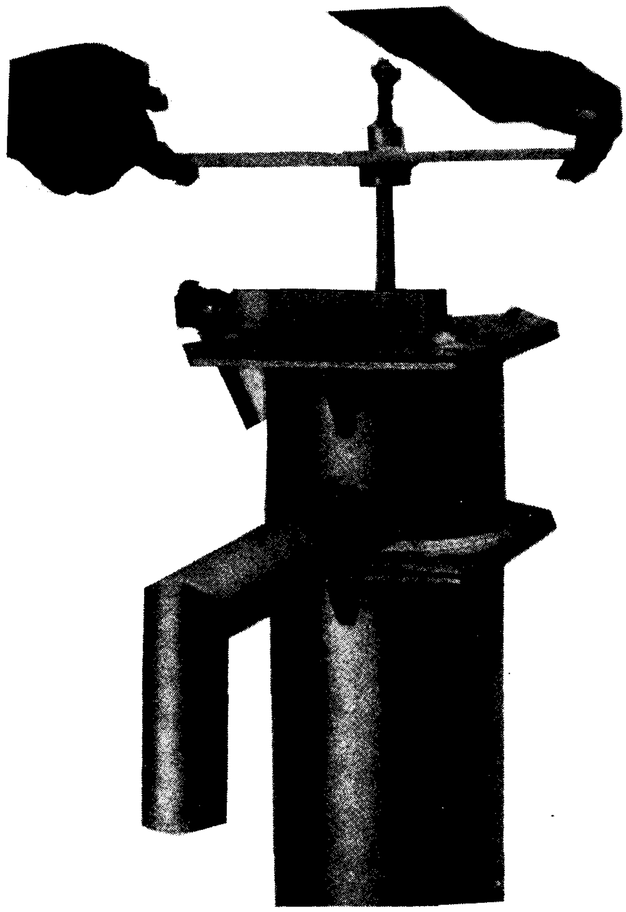
FILE TOP OF ROD SMOOTH

STEP 18 CUT ROD THREAD FOR CHAIN CONNECTION



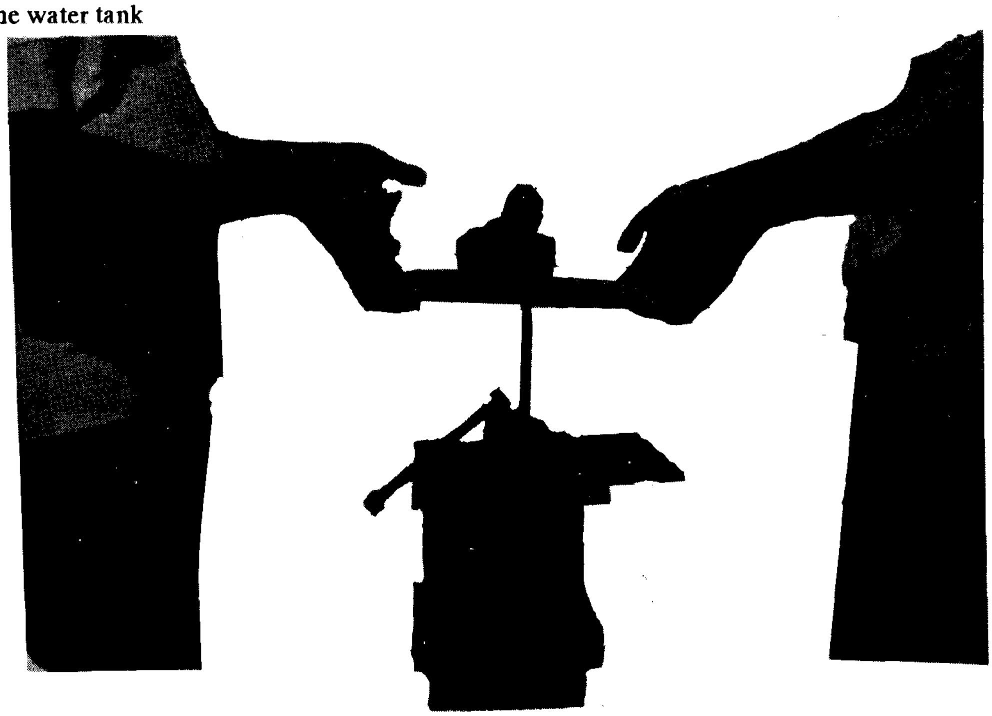
STEP 19 INSERT THIRD FLANGE AND FIX CHECK NUT AND CHAIN

Insert the third flange as shown, fix check nut and drain. Tighten using spanner. Insert chain coupler supporting tool.



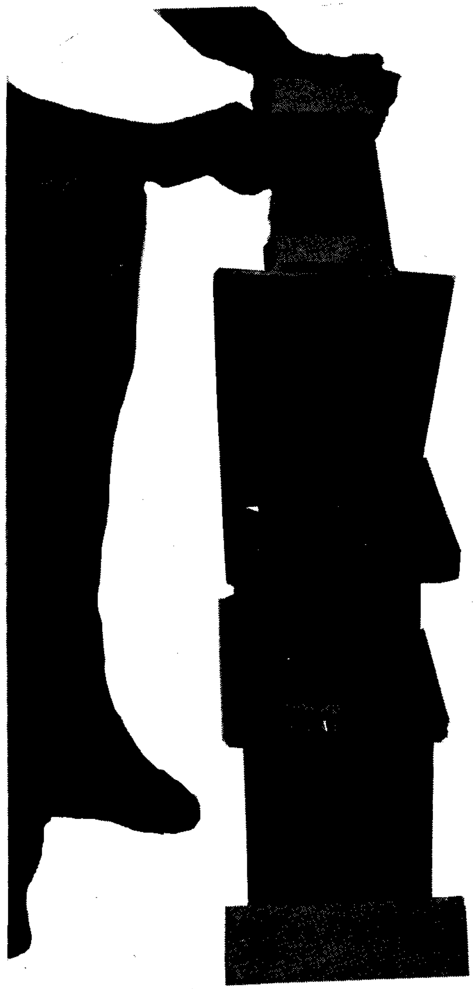
STEP 20 PLACE THIRD FLANGE ON THE WATER TANK

Lift third flange as shown gently by hand, unscrew the connecting rod vice and withdraw. Lower the third flange slowly till it sits on the water tank

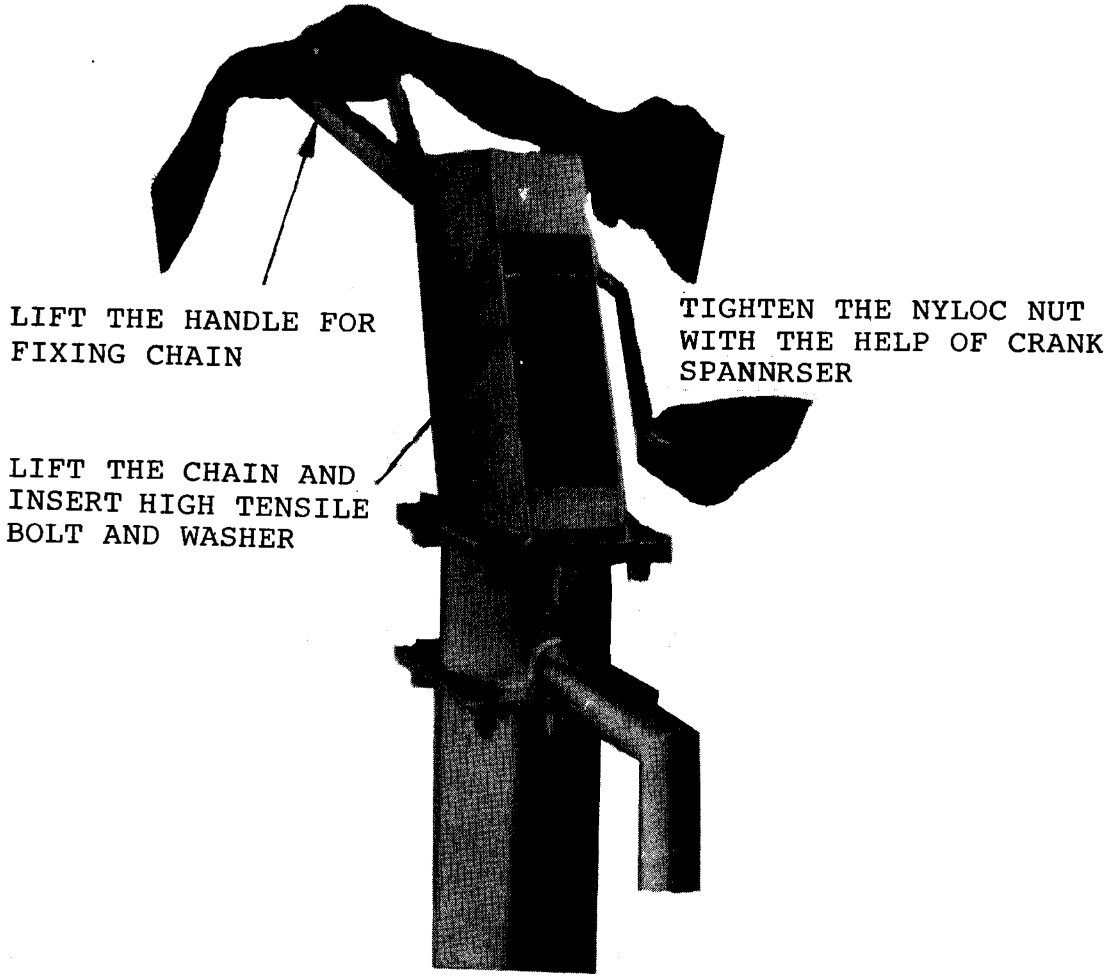


STEP 21 INSTALL HEAD ASSEMBLY

Remove inpection cover and place head assembly on third flange, passing the chain through the hole as shown.

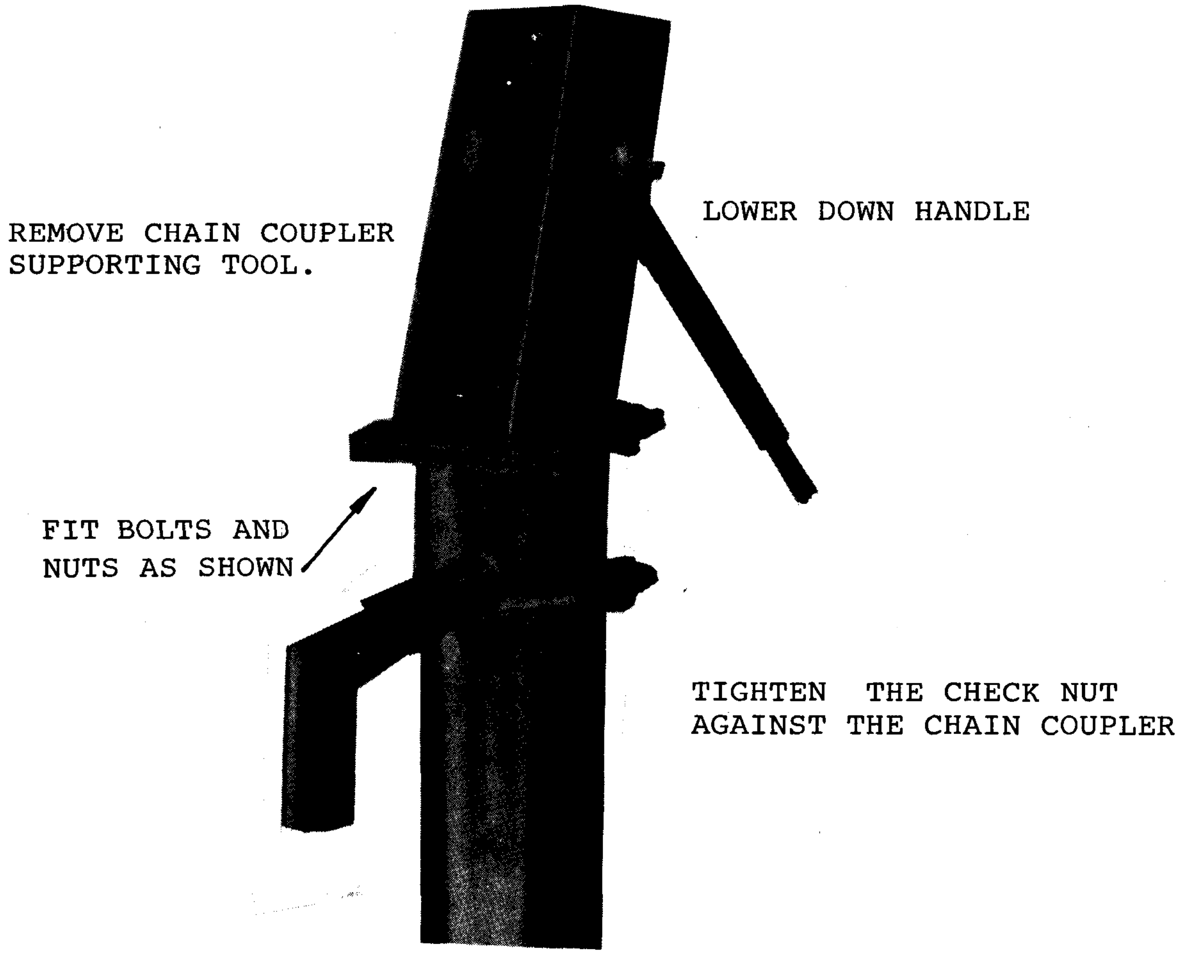


STEP 22 FIT CHAIN TO HANDLE



STEP 23 BOLT HEAD ASSEMBLY TO WATER TANK

Move handle up and down, check if connecting rod rubs against guide bush. If so, adjust third flange after loosening the bolts and Nuts. Grease the chain.



STEP 24 POST INSTALLATION CHECKS

Now make sure that:

When you pump, the handle touches the top and bottom stops. If it does not, then remove head and check the setting of the top connecting rod. Refer to Step 16.

Connecting rod moves up and down freely in guide bush. If it does not, then rod had been bent while threading.

You have the threaded chain coupling fully on the connecting rod, and tighened lock nuts fully.

You have tightened axle nut and lock nut fully and the axle is firmly retained.

You have tightened chain anchor bolt and nyloc nut fully.

You have greased the chain with graphite grease.

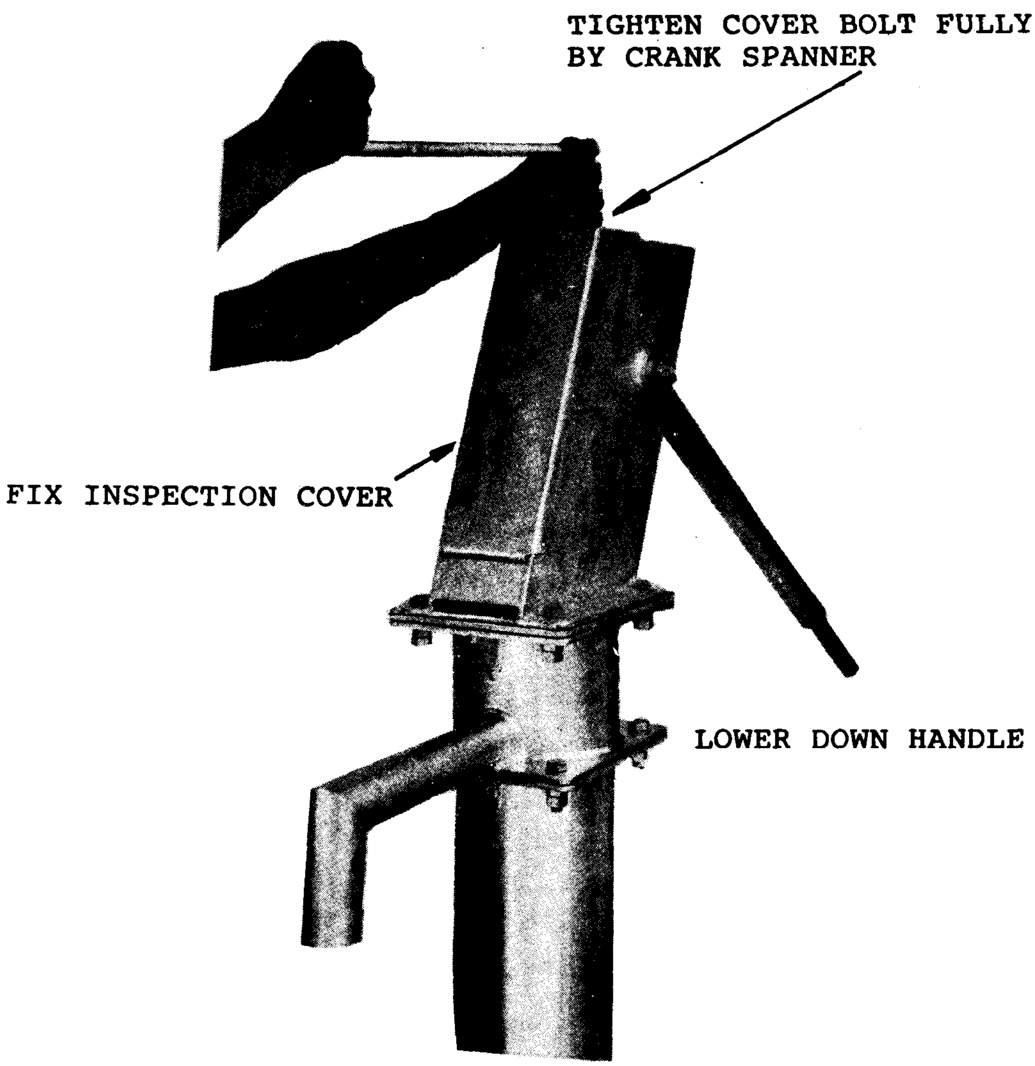
All the eight flange and lock nuts are tightened.

Nothing is left inside the head.

Now fit inspection cover.

Tighten cover bolt fully.

Make sure that all tools and unused parts are clean and loaded on the vehicle.



STEP 25 CHECK PUMP OPERATION

6 INSTALLATION OF DEEPWELL HANDPUMPS (VLOM)

For proper installation of deepwell handpump (VLOM), the guidelines as given below may be followed.

6.1 Requirements for Installation—The requirements for installation are same as given under **5.1** of this chapter.

6.2 Installation

6.2.1 The foundation and platform should be prepared as shown in Fig. 7 and soakpit should be as shown in Fig. 8.

6.2.2 Stepwise installation procedure shall be as given below:

Step 1 Dig Pit for Pedestal

a) Remove casing pipe cover, measure depth of water level in tubewell and ensure that it is free from obstruction.

b) Cover casing pipe.

c) Dig a square pit 76 cm by 76 cm around casing pipe, 40 cm deep.

Step 2 Chlorinate tubewell

Mix 300 g of bleeching powder in 15 litre of water in a bucket, stir well and pour into the tubewell for chlorination.

Step 3 Prepare Cement Concrete Mix

See step 2 of clause 5.

Step 4 Plan drain direction

See step 3 of clause 5.

Step 5 Install pedestal

See step 4 to clause 5.

Step 6 Concrete the pedestal

See step 5 of clause 5.

Step 7 Construct platform and drain

a) Lay the mild steel platform shuttering over levelled ground around the pump pedestal and prepare the ground for constructing the platform as per design.

b) Pour concrete partially.

c) Complete platform (by plastering and finishing).

Step 8 Prevent platform and drain from cracking

To cure concrete, block drain and fill water for seven days and leave undisturbed.

Step 9 Install riser pipes

a) Lay out riser pipes on stands after 7 days.

b) Check that pipes are threaded on both sides.

c) Check that all threads are good and clean.

d) One end of pipes should be socketed.

e) Test cylinder operation in a bucket of water.

f) If check valve leaks, screw down plunger, pull out check valve assembly and check all components. Insert assembly back into cylinder and test again to ensure that there is no leakage.

g) Screw down plunger again, pull out entire assembly from cylinder and keep in safe dust free place.

h) Remove the cover of stand assembly.

j) Screw drop pipe into cylinder bottom cap using jointing compound. Tighten carefully.

k) Wipe off excess jointing compound.

m) Lower drop pipe into the tubewell.

n) Insert self locking clamp through drop pipe and place it on top of stand assembly.

p) Tighten self locking clamp with four bolts and nuts on stand assembly top flange.

q) Join first pipe to the cylinder top cap using jointing compound. Tighten fully.

NOTES

1. Beyond 30 m of pipe, use of tripod and chain pulley block is recommended .
2. Never install a cylinder less than 6 m from the bottom of tubewell.

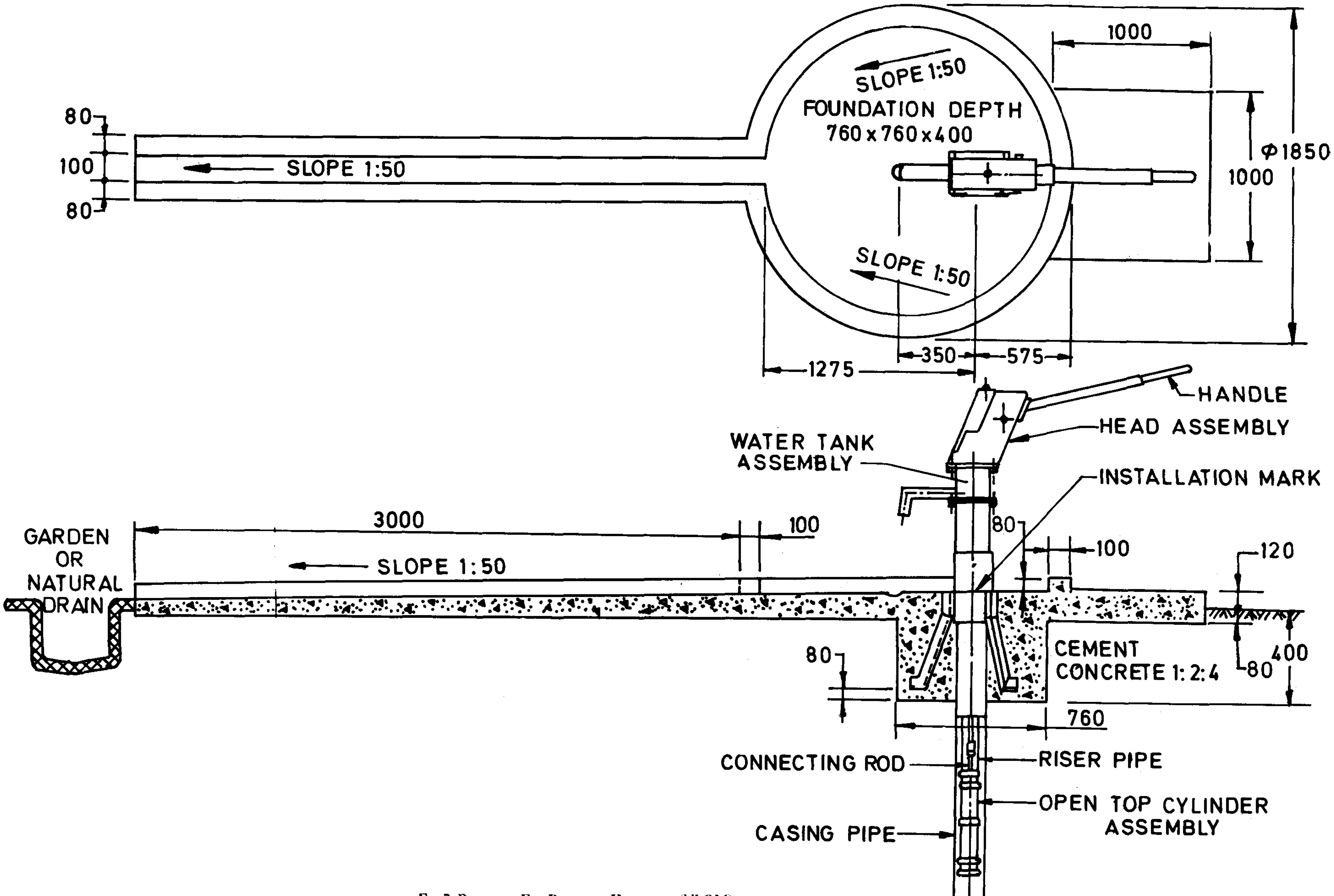


FIG 7. PLATFORM FOR DEEPWELL HANDPUMP (VLOM)

r) Lower first pipe screwed on to the cylinder top cap slowly. While lowering press handle of self locking clamp down.

s) Bring next pipe and screw with first one using jointing compound.

t) Insert pipe lifting spanner into the bush of self locking clamp and lock bottom pipe with wrench.

u) Tighten upper pipe using a wrench.

v) Lower down riser pipe with the help of pipe lifting spanner.

w) Press self locking clamp and open jaws only while lowering down riser pipe.

y) Repeating procedure from step 9 (s) to 9 (w) lower all the riser pipes into the well.

Step 10 Install water tank

a) Apply grease to water tank coupler thread

b) Locking the last riser pipe according to the procedure in step 9 (t), screw water tank with last riser pipe threads. Tighten fully.

c) Screw tank pipe lifter on to water tank coupler and hold it with pipe lifting spanners.

d) Remove the bolts and nuts holding self locking clamp and withdraw the self locking clamp.

c) Using pipe lifting spanners lower down water tank with riser pipes gently and place on it stand flange.

f) Fix with bolts and nuts the water tank with stand.

g) Unscrew and remove tank pipe lifter.

Step 11. Install check valve, plunger, connecting rods and pump head

a) Screw lower pick-up valve (check valve) assembly two threads with plunger assembly.

b) Clean connecting rod's threads and ensure all threads are in good condition by laying them on pipe stand.

c) Tighten the first connecting rod with plunger rod.

d) Lower plunger assembly screwed with check valve assembly into the riser pipes.

e) Lower the first connecting rod. Insert connecting rod vice to clamp this connecting rod and position it on water tank.

f) Tighten required number of connecting rods and lower them as before.

g) After lowering required number of connecting rods remove connecting rod vice.

h) Screw and tighten the rod lifter on the threads of top most connecting rod and turn it anticlock wise so that the check valve is unscrewed and left in the bottom cylinder cap.

j) Push the connecting rod assembly to bottommost position and put a mark on the top most rod in level with top of water tank.

k) Holding up the connecting rod lifter, lift the rod assembly and insert again the connecting rod vice to hold the top most connecting rod. Tighten connecting rod vice on connceting rod (Rod should be lifted sufficiently to facilitate its cutting at the position marked in step 11 (j) and then threading subsequently

m) Unscrew the connceting rod lifter.

n) Wrap cloth around the top of connecting rod vice so that metal cuttings do not fall inside the riser pipes.

p) Cut the connecting rod at the mark made earlier.

q) File the top as well as edges of connecting rod smoothly.

r) Thread top of connecting rod upto 45 mm length with rod die set for M 15 threads. Make sure the threads are clean and true.

s) Lubricate the rod with oil while cutting threads.

t) Remove the metal cuttings and cloth. Insert the middle flange into the connecting rod above connecting rod vice.

u) Fix the check nut on the connecting rod.

v) Allow middle flange to rest on top of connecting rod vice.

w) Screw chain coupler onto connecting rod threads by hand. Tighten check nut on the connecting rod with the chain coupling using double ended spanner.

y) Insert chain coupler supporting tool below the chain coupler. Lift the middle flange and loosen and remove connecting rod vice.

z) Slowly lower the middle flange onto the top of water tank and ensure that all four corners coincide.

aa) Holding head assembly above the water tank insert chain into head through 75 mm dia hole in the bottom flange. Lower head on top of middle flange ensuring that four corners coincide. Tighten head, middle flange and water tank with bolts and nuts.

bb) Lift the handle up. Fix free end of chain with handle. Tighten nyloc nut with crank spanners.

cc) Lower down the handle. Remove chain coupler supporting tool.

dd) Lift handle up. Apply graphite or multipurpose grease on chain.

Step 12 Post Installation checks

a) Make sure that when pumped handle touches top and bottom stops of bracket. If it does not, remove head and check setting of connecting rod stroke length.

b) Make sure that connecting rod moves up and down freely in guide bush. If it does not, the rod must have got bent while threading. Check the rod.

c) Make sure that chain coupler is fully threaded on the connecting rod and the lock nut is tightened.

d) Ensure that handle axle nut and lock nut are completely tightened and that handle axle is firmly retained.

e) Ensure that chain anchor bolt and nyuloc nut are fully tightened.

f) Ensure that all the eight flange bolts and nuts are tight and the lock nuts are also tightened.

g) Ensure that nothing is left inside the head.

Step 13 Fix inspection cover.

Tighten cover bolts fully by crank spaner.

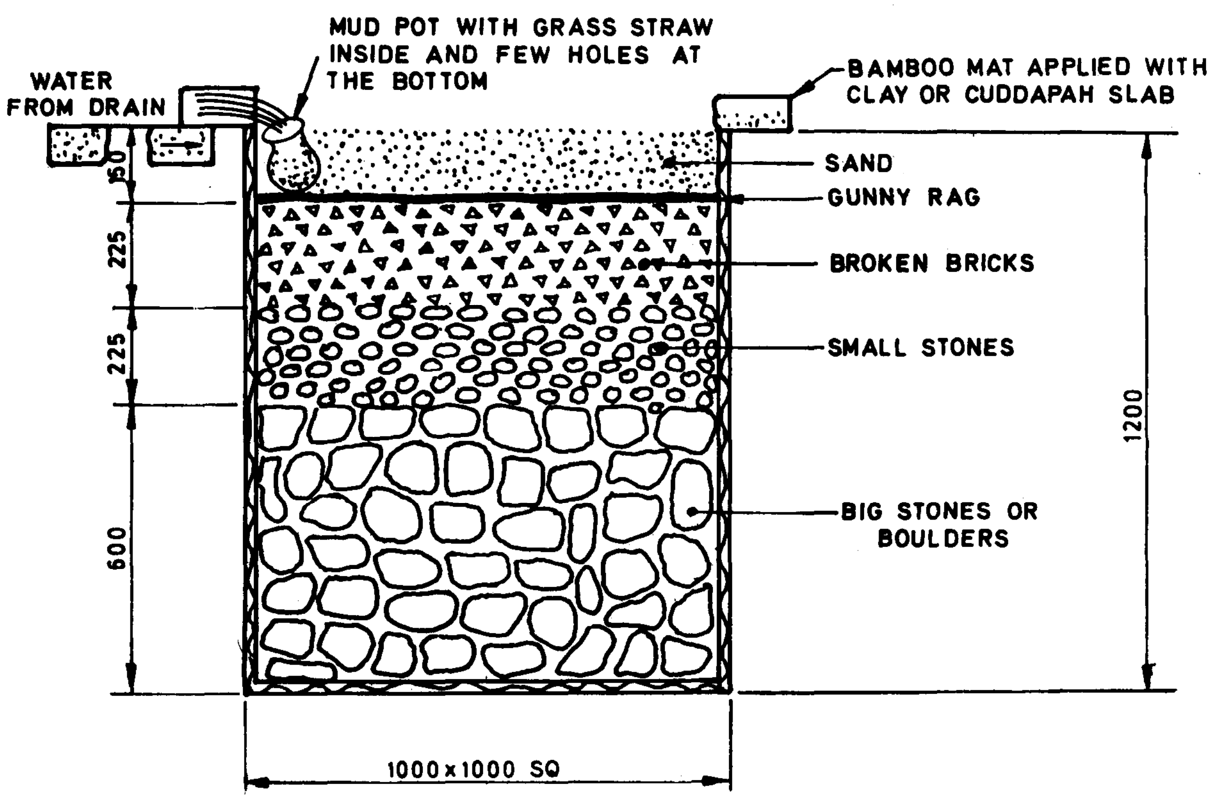


FIG. 8 DETAILS OF SOAK PIT FOR DEEPWELL HANDPUMP (VOLM)

CHAPTER 3

GUIDELINES FOR MAINTENANCE OF PUMPS

1 GENERAL

For smooth operation of any pumping system adequate attention needs to be given to maintenance of pumps. This chapter deals with the subject of maintenance of pumps. Part I of the chapter deals with the maintenance of pumps driven by a prime mover, that is, by an electric motor or an I.C. engine. Part II deals with maintenance of deepwell handpumps. It has not been possible to discuss some of the varieties of pumps in this chapter, namely, submersible pumps, shallow well handpumps and extra deepwell handpumps due to non-availability of Indian Standards or adequate, available, documented information from other sources on these topics.

As Indian Standards on maintenance of vertical turbine pump and deepwell handpump (VLOM) have not yet been formulated, the details on these given in this chapter are based on 'Manual on Water Supply and Treatment' Second Edition, brought out by Central Public Health and Environmental Engineering Organization, Ministry of Urban Development and 'India Mark-III (VLOM) Deepwell Handpump Installation and Maintenance Manual' brought out by UNICEF.

PART I

MAINTENANCE OF PUMPS DRIVEN BY A PRIME MOVER

2 For maintenance of pumps, like most other mechanical equipment, the common apporach is to have preventive maintenance on routine/periodic basis and overhaul/repair maintenance depeanding on the necessity. While the purpose of preventive maintance is take preventive actions necessary to minimize the wear and tear of the parts, thus minimizing the down time of pump, overhaul/repair maintenance is normally carried out when major problems such as defects or damage to parts are encountered.

3 ROUTINE/PREVENTIVE MAINTENANCE

3.1 Daily observation regarding general performance should be made and any irregularity in the operation of pump should be taken care of. This refers particularly to changes in sound of a running pump, stuffing box leakage, power consumption and abnormal temperature rise in the pump.

3.2 For periodic/preventive maintenance of pumps, generally preventive maintence schedules giving preventive maintenance steps to be taken at different intervals are prescribed, which should be strictly adhered to. The steps vary according to the type of pump.

3.3 A record of maintenance activities carried should be kept giving the descriptions of various maintenance operations at different period of time along with observations on pump performances/ operation.These records may be in the form of a maintenance card or log book and may be quite useful in diagnosing / anticipating pump troubles.

Besides these, other routine preventive maintenance carried out, any repair/overhaul work done with the details of repair carried out should be also recorded.

4. OVERHAUL/REPAIR MAINTENANCE

4.1 It is very difficult to make general rules about the frequency of complete overhaul as it depends on pump service, pump construction and material and economic evaluation of overhauling cost versus the cost of power losses resulting from increased clearance or due to other factors.

4.2 A pump need not be opened unless either factual or circumstantial evidence indicates that overhaul is necessary. Factual information implies that either pump performance has fallen off significantly or noise and over loading of impeller is in evidence. Circumstantial evidence refers to past experience with the pump in question.

4.3 Whenever overhauling of pump is carried out checks should be made for radial clearance between impeller and wearing ring, wear of the shaft or sleeve on which stuffing box is mounted, examination of all parts for corrosion, abrasion or pitting which can cause losses if on the fixed parts such as casing and unbalancing, if on moving parts such as impeller, alignment and checks on coupling, replacing of the packing or worn out parts of mechanical seal, checks of both radial and axial clearance of bearings.

5 SPARE AND REPAIR PARTS

Adequate stock of such items as gland packings, belts, lubricating oils, greases etc should be maintained. To avoid down time, a stock of frequently required spares should be maintained. A minimum number of spare parts which should be carrried in stock shall be determined to a large extent on the basis of severeity of service. In the absence of prior experience, the pump manufacturer should be consulted, on this subject.

6 PUMP TROUBLES, CAUSES AND REMEDIES

6.1 A diagnostic analysis alongwith the suggested remedies for horizontal centrifugal pump troubles is given in Table 1. These also apply to jet centrifugal pump combination.

TABLE 1 CAUSES AND REMEDIES FOR TROUBLES IN HORIZONTAL CENTRIFUGAL PUMPS

(*Clause* 6.1)

Sl. No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
i)	No water being delivered	Pump may not be primed	Ensure proper priming by any suitable method.
		Speed may be too low	Check whether the primemover is working satisfactorily or not. In case of electric motor it may be due to low voltage also. If primemover is not directly connected, it may be due to belt slip, etc. if employed.
		Discharge head too high	Check operating conditions. See that pipe friction and suction and discharge heads are as specified.
		Suction lift too high	Check it. Total suction lift should not exceed that recommended by the manufacturer.
		Impeller or piping may be choked	Inspect. Clear/repair/ replace the pipe, suction strainer, check valve and impeller.
		Impeller may be rotating in wrong direction	Check and correct the direction of rotation of impeller.
		Air leaks may exist in suction line or stuffing box	Plug inlet and put the line under pressure. A gauge in line will indicate leakage with a drop in pressure.
		Wearing rings may be worn	Check and replace, if required.

TABLE 1 *(Contd.)*

(*Clause* 6.1)

Sl. No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
		Impeller may be damaged	Repair or replace.
		Foot valve may be too small	Inspect and replace it by another valve conforming to IS 10805 : 1986.
		Casing gasket/stuffing box packing may be defective	Check. Replace worn out casing gasket packing.
		Foot valve or suction opening may not be properly submerged	Suction entrance should be placed atleast one metre below water level.
ii)	Pump works awhile and then loses priming	May be a leak in the suction line Water seal may be choked suction lift too high for operating point Air in the water Foot valve or suction opening may	Plug inlet and put line under pressure. A gauge in line will indicate leakage with a drop in pressure. Check for air leakage and repair the pipe line. Inspect line and position of seal cage in stuffing box. Check for obstruction in suction line and for low water level. Vent suction back to source of supply.
		not be properly submerged	Suction entrance shall be placed at least one metre below water level.
iii)	Pump consumes excessive power	Speed too high	Suitably reduce the speed of primemover or replace the exist ing pulley of the prime mover or counter shaft by another pulley of appropriate diameter.
		Head is lower than the rated value and the volume rate of flow of pump increases	Let pump manufacturer calculate impeller diameter required, and then machine impeller outside diameter.
		Mechanical defects such as a bent shaft	Check runout of the shaft. Total runout allowed depends upon pump design and speed; approximately 0.08 mm for high speed and 0.15 mm for low speed units. If bent more than allowed, replace it.
		Rotating elements may be binding	Check for too tight stuffing boxes, wearing ring fit and defective packing.
		Foreign matter in impeller	Provide means for removal of foreign matter.
		Misalignment	Re-align properly.
		Pump is inefficient	Replace the pump.
		Improper selection of pump	Select proper size of pump depending upon the requirement.
iv)	Bearings have short life	Misalignment Shaft excessively bent	Re-align properly. Replace.
		Rotor out of balance causing excessive vibration	Balance the rotor.

Table 1 *(Conclued)*

(Clause 6.1)

Sl. No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
		Excessive thrust caused by a mechanical failure inside the pump	Suitably repair it.
		Lack of lubrication	Ensure proper lubrication.
		Dirt in bearings	Clean and lubricate.
		Excessive grease or oil in antifriction bearing housing or lack of cooling causing excessive bearing temperature	Remove excessive grease or oil and improve cooling, if required.
		Excessive cooling of water cooled bearing housing resulting in condensation of moisture from the atmosphere in the bearing housing.	Decrease the flow rate of cooling water to prevent over cooling.
v)	Pump overheated and seizes	Pump not primed	Ensure proper priming.
		Rotating part rubbing on stationany part	Prevent it by suitable adjustment.
		Bearings worn out	Replace worn out bearings.
		Rotor out of balance causing vibration	Properly balance the rotor.
vi)	Pump is noisy	Air leaks in suction	Replace or tighten joints and fittings.
		Insufficient water supply in suction line	Ensure proper supply of water.
		Bent drive shaft	Replace.
		Misalignment or impeller not properly balanced	Re-align or balance the impeller properly.
		Vibrations due to non-rigidity of the foundation or nuts of foundation bolts loose	Tighten nuts and take corrective action.
vii)	Pump wears rapidly	Pump runs dry	Take every precaution to prevent dry running of the pump.
		Grit or dirt in water	Provide means to clear off dirt and grit from the water being handled
		Pipe load causing strain on pump casing	Provide proper support to pipe especially at suction and discharge ends.

6.2 A diagnostic analysis alongwith suggested remedies for vertical turbine pump troubles is given in Table 2.

TABLE 2 VERTICAL TURBINE PUMP TROUBLES—THEIR CAUSES AND REMEDIES

(*Clause* 6.2)

Sl.No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
i)	Pump does not start	Faulty wiring of motor	a) Check current characteristics with data on motor name plate.
			b) Check wiring with diagram and data on name plate.
			c) Be sure starter is properly connected and is correctly selected.
			d) Reset the starter overload relay if tripped.
			e) Check fuses or circuit breakers for open power line.
			f) If motor fails to operate independently of pump with all wiring correct, call a motor mechanic.
		Excessive bearing friction	g) Use oil of recommended grade for lubrication in case of oil lubricated pumps. Lubricate all bearings before operation.
			h) On oil-lubricated pumps, lack of proper tension on shaft enclosing tube may lead to mis-alignment of bearing. Be sure that tube tension is right.
			j) Be sure that shaft enclosing tube stablizers are properly located in column assembly.
			k) Rubber bearing in water lubricated units may seize if dry. Lubricate before drying.
			m) Bent shafts must be replaced.
			n) A crooked well (a well which is out of vertical alignment) causing misalignment must be straightened.
			p) Check for misalignment caused by crossed threads, or threads or dirty dowel fits on finished surfaces. Align head centre line with pump centre line. Improper anchoring of head can cause distortion and bending of pump shaft.
		Incorrect impeller adjustment	q) Set impeller high enough to allow for shaft stretch due to hydraulic thrust.
		Impellers locked	r) Sand locking is common. Sometimes raising or lowering impellers by the adjusting nut frees them. Backwashing with clear water may-help. Careful use of the right type of wrench on the shaft top may free the impellers. When these methods fail, pull the pump and dismantle the bowl assembly to free the impeller.
			s) Corrosion, graphitization or bacterial growth may lock the rotating element. This is especially true where the pump is idle for a long time [*see* Sl. No. i) Column 4r]

TABLE 2 *(Contd.)*

(Clause 6.2)

Sl.No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
		Packing too tight	t) Normally packing should be adjusted to allow a slight leakage for cooling and lubrication.
		Other causes such as pump is frozen, well has collapsed etc	u) Check for these and adopt necessary remedial measures.
ii)	Pump does not deliver water.	Pump not primed	a) Vertical turbine pump will not start against a suction lift. Be sure that the impeller is submerged.
			b) Vent well to atmospheric pressure so that pump may not operate under a vacuum at its suction.
		Incorrect rotation of driver	c) In three phase induction motor rotation can be changed by transposing any two of the power leads at motor's terminals or at the switch. Make sure that direction of of rotation is correct.
		Pumping head too high	d) Lowered pumping level (higher lift) or increased pressure on system beyond the pumps discharge can cause a total pumping head higher than what pump develops. Increased discharge pipe size or reduction in discharge pressure may be necessary. If this is not possible, install a pump that meets existing conditions.
			e) Be sure discharge valves are open and check valves are free.
		Overpumping well	f) Drawdown may lower the pumping level enough so that the pump is unable to suck water. This condition can cause serious harm to both pump and well. Throttle the discharge or use other means to reduce pump capacity and prevent overpumping.
		Pump speed too low, resulting in insufficient head	g) Be sure that frequency and voltage are correct for motor driven units.
			h) Be sure that the gear ratio and output speed of prime mover are correct for gear driven units.
			j) Check pulley size and prime mover speed on belt driven units.
			k) Be sure that impeller turns freely and mechanical troubles are not retarding speed.
		Suction clogged	m) Make sure that the strainer, suction pipe and impellers are not clogged. Back washing may clear.
			n) Well screens may be clogged and may require servicing.
		Mechanical failure	p) Check for broken shaft and replace if broken.

TABLE 2 *(Contd.)*

(Clause 6.2)

Sl.No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
			q) Make sure none of the impellers are loose.
			r) All column-pipe joints must be tight to eliminate leakage.
			s) Check bowl assembly and make sure that it is not broken.
iii)	Capacity too low	Head too high	a) See Sl. No. ii) Column 4 d) and e).
		Speed is too low	b) See Sl. No. ii) Column 4 g), h), j) and k).
		Poor suction conditions	c) Pit or sump must be properly designed so that liquid velocities and suction submergence are in accordance with the manufacturer's recommendations. Care must be taken against turbulance, eddying or vortexing at the pump suction. Baffling or other modifications may be required.
			d) Aerated or gaseous water has the effect of reducing capacity, check suction piping for air leaks.
			e) Properly vent the well.
			f) Check for obstruction in strainer, suction pipe and bowls.
			g) Check for partial clogging of water passages because of bacterial growth and other causes.
		Leakages	h) Tighten all pipe threads and flanges.
			j) Replace worn out gaskets and packings.
			k) Make sure that there are no cracks or holes in column pipe (casing pipe through which water flows upto surface), bowl assembly or discharge head.
		Mechanical failure	m) Worn impellers or wearing rings allow slippage which reduces capacity. If parts are badly worn, replacement may be necessary.
			n) Impellers may be loose on pump shaft. Check if taper key is tight in the key way for mounting the impeller on shaft. If not fit it tight in the key way.
iv)	Too much power consumption	Speed too high resulting in over capacity and higher head	a) See Sl. No. ii) Column 4 g), h) and j).
		Impellers rub because of incorrect adjustment	b) See Sl. No. i) Column 4q).

TABLE 2 *(Concluded)*

(*Clause* 6.2)

Sl.No.	Trouble	Cause	Remedies
(1)	(2)	(3)	(4)
		Lubrication incorrect	c) Check for proper quantity and viscosity of oil in oil lubricated pump.
			d) Be sure that prime mover bearings are lubricated according to manufacturer's instruction.
		Packing too tight	e) See Sl. No. i) Column 4 t).
		Mechanical trouble	f) See Sl. No. i) Column 4 m), n) and p).
v)	Pump Vibration	Misalignment	a) See Sl. No. i) column 4 g), h), j), k), m), n) and p).
		Bearing failure	b) Be sure that lubrication is correct.
			c) Check for excessive sand in water.
			d) Check and correct pump alignment, if required.
			e) Change the bearing which has failed.
		Poor suction conditions	f) Correct possible cavitation See Sl. No. iii) column 4 c).
		Imbalance	g) Check if the prime mover alone vibrates, if so get it corrected by a motor mechanic or an engine mechanic.
			h) Check for foreign material lodged in impeller or bowl passages. Such material might cause both static and hydraulic imbalance.
			j) Check rotating parts for excessive wear. Excessive wear can change the water passages and cause hydraulic imbalances. Wear also changes static balance.
vi)	Water in the shaft enclosing tube	Enclosing tube failure	a) Replace broken or leaking sections. b) Change broken or loose bearings. c) Be sure that all joints are tight.
		Failure in bowls	d) Make sure that discharge-case vent is not plugged.
			e) Check pump shaft for wear that would produce excessive bearing clearance,
			f) Be sure that bearing below vent is not worn or scored allowing excessive pressure on vent.

PART II

MAINTENANCE OF HANDPUMPS

7 DEEPWELL HANDPUMPS (INDIA MARK II)

7.1 For the maintenance of deepwell handpumps (India Mark II) detailed guidelines have been laid down in IS 11004 (Part 2) : 1991. This standard provides preventive maintenance schedule, for deepwell handpump (India Mark II) as per IS 9301 : 1990, describes the procedure for dismantling the pumps and gives a check list of pump troubles with their causes and remedies. This standard also lists the recommended spares for two year's normal maintenance of handpumps. The guidelines given below are based on this standard.

7.2 Preventive Maintenance Schedule

7.2.1 Tighten the handle axle nut and lock nut, if found loose.

7.2.2 Look for loose or missing flange bolts, nuts and washers, tighten if found loose and replace, if necessary.

7.2.3 Check handle for smooth and firm movement, if found heavy, look for possible reasons and rectify.

7.2.4 Open front inspection cover, and:

a) Clean inside using a wire brush;

b) Check the chain anchor belt for proper fitment, tighten, if necessary;

c) Ensure connecting rod threaded end and check nuts are tight;

d) Look for rusty patches, inside and outside; if found, clean with wire brush/sand paper and apply anticorrosive paint;

e) Apply fresh graphite grease over the chain after cleaning;

f) Check aligment of connecting rod in guide-bush; if movement is not free, look for possible reasons and rectify;

g) Grease the bearings, only if necessary, avoid excessive greasing; and

h) Refix front inspection cover and tighten cover bolts.

7.2.5 Check if hand pump stand assembly is firm in its foundation- if any cracks have developed in the platform, fill these up with cement mortar. If stand assembly is loose, arrange for fresh foundation.

7.2.6 Operate the handpump and check whether the discharge is normal - if not, repairs of below ground assembly may be necessary.

7.2.7 In case the pump is fully galvanised, only wash the external surface.

7.3 Procedure for Dismantling the Pump

7.3.1 Remove inspection cover from head assembly.

7.3.2 Insert chain coupling supporting tool.

7.3.3 Lift the handle to the top position and then disconnect handle from chain by removing the nyloc nut and anchor bolt.

7.3.4 Remove flange bolts from head assembly.

7.3.5 Take out head assembly with chain passing through the hole in the head flange.

7.3.6 Rotate the third flange 90 degree and lift it by hand and insert connecting rod vice.

7.3.7 Fit the connecting rod vice on to the water chamber top flange and tighten vice against connecting rod and allow the third flange to sit on the connecting rod vice.

7.3.8 Take out the support coupler. Unlock the lock nut and rotate the chain till it comes out. Then remove the lock nut and third flange.

7.3.9 Screw connecting rod lifter on to connecting rod end, lift connecting rods, loosen connecting rod vice and remove. Gently lower connecting rods. Remove connecting rod lifter.

7.3.10 Remove water tank bottom flange bolts.

7.3.11 Lift water tank by using tank pipe lifter and lifting spanners.

7.3.12 Lift water tank and fit self locking clamp on stand assembly flange to hold the riser main and remove water tank assembly.

7.3.13 Disassemble riser main and connecting rods. Remove connecting rod lengths, one at a time. Use one pipe wrench and one lifting spanner to lock the riser pipe.

7.3.14 When the last length of pipe is reached, remove self-locking clamp and pull out the last pipe and cylinder by hand.

7.3.15 Disconnect cylinder from the last pipe.

7.3.16 Check all the pipe threads; clean out the threads by using wire brush. Remove any dirt and rust from the pipes by using wire brush or sand paper. If any pipe is damaged, replace it. Ensure that all the pipe couplings are intact and fit properly.

7.3.17 Check all the connecting rod threads and couplings. Clean out threads with wire brush or sand paper. Re-thread connecting rods if required. Check each rod for straightness. If rods are bent, try to straighten them. If not possible, replace it. If any rod coupler is worn out too much or damaged, replace it.

7.3.18 Unscrew top and bottom reducer caps using pipe wrenches. Remove piston assembly and check valve. Inspect piston and check valve assembly and replace any worn out components. If necessary, replace cup washers, leather sealing ring, rubber seating, etc. Check for cracks which may have developed in the cylinder components. Replace parts, if necessary. Reassemble complete cylinder.

7.3.19 Clean out the cylinder components and the inner cylinder lining from sedimental materials and dirt by using wire brush and water.

7.4 Troubles Experienced and Remedies

A diagnostic analysis of pump troubles along with suggested remedies is given in Table 3.

Table 3 Causes and Remedies for Troubles in Deepwell Handpump (India Mark II)

(*Clause* 7.4)

Sl. No.	Trouble	Cause	Remedy
(1)	(2)	(3)	(4)
i)	Pump handle works easily but no flow of water	a) Damaged rising main	Replace the damaged pipe
		b) Water level gone down much below the cylinder assembly	Add more pipes and rods
		c) Worn out cylinder bucket washers	Overhaul the cylinder and replace the bucket washer
		d) Connecting rod joint disconnected	Pull out the pump and join the connecting rod wherever necessary
		e) Valve seats worn out	Replace valve seats
		f) Pump cylinder cracked	Replace cylinder assembly
ii)	Delayed flow or little flow	a) Leakage in cylinder bottom check valve or upper valve	Overhaul cylinder. Replace rubber seats.
		b) Leakage in pipe assembly	Replace rising main
iii)	Folding of chain during return stroke	a) Improper erection	Adjust the length of last connecting rod suitably
		b) Leather bucket washers getting jammed inside the cylinder	Overhaul the cylinder and replace leather buckets by nitrile bucket washer and modified spacer
iv)	Noise during operation	a) Stand assembly flange not levelled properly	Level the flange
		b) Bent connecting rod	Change the defective rod

Table 3 *(Concluded)*

(Clause 7.4)

Sl No.	Trouble	Cause	Remedy
(1)	(2)	(3)	(4)
		c) Haxagonal coupler welded off-set	Change the defective rod
v)	Shaky handle	a) Loose handle axle nut	Tighten handle axle nut
		b) Worn out ball bearings	Replace ball bearings
		c) Spacer damaged	Replace spacer
		d) Oversized bearing housing	Replace handle assembly
vi)	Pump handle very hard to operate	a) Rising main disconnected	Pull out the pump and join affected rising main

7.4.1 *Precautions for Handpump Users*

a) Use the handpump gently.

b) Operate the handle with long slow strokes.

7.4.2 *Precautions for Maintaining Handpumps*

a) Clean the platform regularly.

b) Keep the area around the platform dry and clean.

c) Make sure that no one throws rubbish near the pump.

d) Keep the drain clean.

e) Utilize the spilled water for a vegetable garden like nursery, etc. If this is not possible make soakpits minimum 3 m away from the pump.

f) Keep animals away from the pump and do make compost far from the pump.

7.4.3 *Chlorination*

Occasionally tubewells get polluted due to natural calamities such as floods, or if the handpump platform gets damaged or destroyed.

For chlorination

a) Put 300 gms of bleaching powder in a bucket of water.

b) Mix it thoroughly.

c) Remove the four bolts from the lower part of the handpump's water tank. Lift water tank and clamp riser pipe in the raised position.

d) Pour chlorine solution into open end of pedestal.

e) Lower water tank and bolt it back to pedestal. Tighten fully.

f) Pump. Stop pumping when the water smells strongly of chlorine.

g) The handpump must not be used for at least one hour. But it is better if the handpump is not used for 6 hours or more. So, ask the villagers not to use it until the next day.

h) The next day, pump until the taste of chlorine is just noticeable in the water.

j) Collect a sample of the water. Use a sterile bottle. Seal the bottle and label it.

k) Send the sample for bacteriological examination.

7.5 Recommended Spares for Two Year Normal Maintenance of Pumps

7.5.1 *Spares for Pump Head*

Item		*Quantity*
a)	Hexagonal bolt, M 12 × 1.75 × 40 mm long	8
b)	Hexagonal nut, M 12 × 1.75 mm	18
c)	High tensile bolt, M 10 ×1.5 ×40 mm long	1
d)	Nyloc nut, M 10 × 1.5 mm	2
e)	Axle	1
f)	Bearing	2
g)	Chain with coupling welded	1
h)	Cover bolt, M 12 × 1.75 × 20 mm long	2
j)	Special washer of axle	3

7.5.2 *Spares for Cylinder, Connecting Rod and Riser Pipe*

Item		*Quantity*
a)	Leather/Nitrile cup washers (Pump buckets)	4
b)	Leather sealing ring	6
c)	Rubber seating (small)	2
d)	Rubber seating (large)	2
e)	Upper valve assembly	1
f)	Check valve assembly	1
g)	Connecting rod 12 mm dia × 3 m long	2
h)	32 mm NB, GI Pipe 3 m long threaded at both ends and fixed with a coupling	2
j)	Seamless coupling socket, medium class, 32 mm	4

7.5.3 In addition to the consumable spare parts listed in **7.5.1** and **7.5.2** it is recommended that three percent complete pumps be kept for replacement of sub-assemblies, if required.

8 DEEPWELL HANDPUMP (VLOM)

8.1 The main feature of deepwell handpump (VLOM) is that this pump is provided with an open top cylinder which facilitates pulling out of plunger assembly and check valve assembly for maintenance work without pulling out the cylinder/riser main, with the result that the maintenance work is simplified to a large extent and majority of the maintenance work can be carried out by village level mechanics. These guidelines are based on a UNICEF publication entitled 'India Mark III (VLOM) Deepwell Handpump Installation & Maintenance'.

8.2 Preventive Maintenance by Village Mechanics

The village mechanics should carry out following checks for preventive maintenance on VLOM pump:

a) Check that the pump pedestal is firm on its base. If it is loose arrange for fresh foundation by reporting to the appropriate higher authority, before the pump and foundation are damaged.

b) Check that water discharge is satisfactory, that is, whether it is as usual, little or delayed.

c) Check that the handle is easy to operate.

d) Check that all the eight flange bolts and nuts are tight.

e) Check that handle axle nuts are tight.

f) Check that handle chain nyloc nut is tight.

g) Check that the chain is lubricated. If not, graphite or multipurpose grease should be applied.

h) Check that the inside of the pump is free from trash or dirt.

8.3 Curative Maintenance by Village Mechanics

Curative maintenance is carried out by a team of two village mechanics on the India Mark III (VLOM) handpump only when any trouble is noticed and the cure is within their scope. Wherever situation warrants, the village mechanics will be in a position to replace the following parts in the hand pump with the tools and parts available with them.

a) Rubber 'O' ring for the check valve seat in the cylinder,

b) Nitrile Rubber cup washers,

c) Check valve rubber seating,

d) Upper valve rubber seating,

e) Bolts,

f) Nuts,

g) Chain, anchor bolt, nut and washer,

h) Ball bearings, and

i) Pump axle.

The village mechanics will also be in a position to replace a connecting rod assembly with the tools provided and the spare assembly made available at the site.

For removal and refitting of pump head, connecting rods and cylinder assemblies, the village mechanics should follow the procedures given under **8.5**

8.4 Handpump Overhaul — Jobs to be handled by Village Machanic and Installation Maintenance Team are as given in Table 4.

Table 4 Handpump Overhaul

(*Clause* 8.4)

Sl. No.	Part/Work	Could be carried out by	
		Village Mechanic	Installation Maintenance Team
(1)	(2)	(3)	(4)
i)	Pump Body/Handle assembly		
	a. Clean pump head, water tank inside and outside and pedestal outer surface above ground with a clean cloth.	YES	YES
	b. Clean the chain, if necessary apply grease.	YES	YES
	c. Check and if found necessary replace handle ball bearings.	YES	YES
	d. Check all nuts and bolts including anchor bolt and nyloc nut, clean the threads	YES	YES
	e. If axle is found damaged, replace.	YES	YES
ii)	Cylinder Components		
	Pull out the plunger and check valve assemblies as per the procedure laid out under **8.5** and replace worn out components.	YES	YES
iii)	Connecting Rod		
	Pull out the connecting rods as per the procedure laid down and check for bent rods, damaged threads etc. and replace the rods wherever necessary.	YES	YES
iv)	Platfrom		
	a) If cracks are present in the platform, fill up the cracks with cement and plaster the exposed place.	NO	YES

Table 4 (Concluded)

(*Clause* 8.4)

Sl. No.	Part/Work	Could be carried out by Village Mechanic	Installation Maintenance Team
(1)	(2)	(3)	(4)
b)	If the hand pump pedastal is loose in the platform, dig a 76 × 76 × 52 cm square pit around the pedastal base (from top of platform) and fill the same with 1 : 2 : 4 : cement concerete mixture and allow it to cure for 7 days. Disconnect the chain from the handle and instruct villagers not to use the pump for 7 days. The curing/setting time can be reduced if quick setting cement-compound is used.	NO	YES
v)	Riser Pipes		
	Pull out the pipes as per procedure and check for cracks, bends, damaged or worn out threads and damaged or worn out couplers. Replace if necessary.	NO	YES
vi)	Cylinder Body and Caps		
	Pull out the riser pipes with cylinder body and caps as per procedure and check for cracks, damaged, or worn out threads. Replace if necessary.	NO	YES
vii)	Chlorination		
	Chlorinate the tubewell, after completion of handpump overhaul, as per the procedure.	YES	YES

8.5 Dismantling Procedure

Step wise procedure for dismantling of VLOM pumps is as follows :

(a) Loosen pump head cover bolts and remove inspection cover.

(b) Lower the handle. Insert chain coupler supporting tool below the chain.

(c) Lift the handle to top position. Loosen nyloc nut. Remove nyloc nut, washer and anchor bolt. Pull out chain from the handle.

(d) Remove bolts and nuts connecting head and water tank.

(e) Lift and remove head assembly leaving chain behind, through 75 mm dia hole in bottom flange.

(f) Lift connecting rod by lifting middle flange and insert connecting rod vice between middle flange and water tank top flange.

(g) Place rod vice gently on water tank top flange. Gently place middle flange on vice. Loosen and remove chain assembly from connecting rod. Remove chain coupler supporting tool.

(h) Remove check nut on conneting rod. Remove middle flange.

(j) Tighten rod lifter on upper most connecting rod. Holding the rod lifter firmly, slowly loosen vice and gently lower the connecting rods. Remove connecting rod vice.

(k) Rotate rod lifter in clockwise direction so that plunger assembly inside is screwed with check valve assembly.

(m) Remove rod lifter. Connect rod lifting adapter. Place head assemly and connect lifting adapter to the handle.

(n) Push handle down suddenly and wait till water column in rising main drains off.

(p) Lift handle upward slowly. Disconnect adapter.

(q) Remove head assembly. Screw rod lifter. Lift connecting rod. Insert connecting rod vice and tighten.

(r) Hold the rod. Slowly loosen vice and lift rod. Loosen and remove top connecting rod from the string. Tighten vice again on next connet-ing rod. Repeat this process till the last connecting rod with plunger and check valve is pulled out.

(s) Loosen and remove connecting rod vice. Remove plunger with check valve.

(t) Unscrew plunger from check valve.

(u) Dismantle all components from plunger and check valve and inspect. Replace worn out damaged components. Assemble plunger and check valve assemblies and erect the pump. After erection check whether pump is work-ing well in all respects.

8.6 Trouble Shooting - A diagnostic analysis of pump troubles which can be solved by village me-chanics of VLOM pumps is given in Table 5. Table 6 gives diagnostic analysis of troubles which can be solved by installation-maintenance team only.

Table 5 Causes and Remedies for Troubles in Deepwell Handpumps (VLOM)

(To be carried out by Village Mechanics)

(*Clause* 8.6)

Sl.No.	Trouble	Cause	Remedy
(1)	(2)	(3)	(4)
i)	Pump handle works easily but no flow of water.	Worn out cylinder rubber cup washers.	Replace rubber cup washers.
		Valve seats worn out.	Replace valve seats.
		Connecting rod joint disconnected.	Pull out connecting rods and join connecting rods wherever necessary.
ii)	Delayed flow or little flow of water.	Leakage in cylinder check valve or upper valve.	Pull out plunger and check valve assemblies replace rubber seats.
		Worn out 'O' ring.	Replace 'O' ring.
		Rubber cup washers worn out.	Replace rubber cup washers.
iii)	Folding of chain during return stroke.	Rubber cup washers got jammed inside the cylinder.	Replace rubber cup washers.
iv)	Noise during operation.	Bent connecting rod.	Change defective rod.
v)	Shaky Handle.	Loose handle axle nuts.	Tighten handle axle nuts.
		Worn out ball bearings.	Replace ball bearings.
		Spacer worn out or damaged.	Replace spacer.
		Worn out/damaged axle.	Replace axle.

Table 6 Causes and Remedies for Troubles in Deepwell Handpumps (VLOM)

(To be carried out by Installation-Maintenance Team)

(*Clause* 8.6)

Sl.No.	Trouble	Cause	Remedy
(1)	(2)	(3)	(4)
i)	Pump handle works easily but no flow of water.	a) Water level gone down below cylinder assembly.	Add more pipes and rods.
ii)	Delayed flow.	a) Damaged rising main.	Replace damaged pipe.
iii)	Noise during operation.	a) Shaky Foundation.	Check foundation and recast the same, if necessary.
iv)	Shaky handle.	a) Worn out ball bearings.	Replace ball bearings.
		b) Spacer worn out or damaged.	Replace spacer.
		c) Bearings loose in bearing housing.	Replace handle assembly.

8.7 Recommended Spares for Two Years Normal Maintenance of VLOM Pump

The following spares are recommended to be procured and stored for each VLOM India Mark III hand pump installed, for two years normal maintenance.

8.7.1 *Spares for Pump Head*

Item	*Qty.*
a) Hexagonal bolts M12 × 1.75 × 40 mm long	8 Nos.
b) Hexagonal nuts M12 × 1.75	18 Nos.
c) Washers M12	10 Nos.
d) High Tensile Bolt M10 × 1.5 × 40 mm long	1 No.
e) Nyloc Nut M10 × 1.5	2 Nos.
f) Handle axle (stainless steel)	1 No.
g) Washer (4 mm thick) for handle axle	1 No.
h) Bearing for handle axle	2 Nos.
j) Spacer	1 No.
k) Chain with coupling	1 No.
m) Bolt for front cover M 12 × 1.75 × 20 mm long	2 Nos.

8.7.2 *Spares for Cylinder*

a) Nitrile rubber cup washers	4 Nos.
b) Upper valve rubber seating	2 Nos.
c) Check valve rubber seating	2 Nos.
d Rubber 'O' rings	4 Nos.
e) Rubber sealing rings	4 Nos.

8.7.3 *Spares for Connecting Rods and Riser Pipes*

a) Hexagonal rod coupling M12x1.75x50 mm long	2 Nos.
b) Pipe sockets (65 mm N.B. Medium grade hot dip galvanised)	4 Nos.

8.7.4 In addition to the above spares listed in **8.7.1** and **8.7.2** it is recommended that 3 percent complete pumps be kept for replacement of sub-assemblies, if required.

CHAPTER 4

TESTING OF PUMPS

1 GENERAL

Testing of pumps is important for the purpose of assuring their performance. Prescribing standard test methods is, therefore, essential for ensuring uniformity in testing and analysis of test results.

This chapter deals with the subject of testing of pumps — both power driven and hand operated. The contents of this chapter are based on Indian Standards providing guidelines/requirements for testing of pumps.

2 ACCEPTANCE TESTING FOR CENTRIFUGAL, MIXED FLOW AND AXIAL FLOW PUMPS

2.1 The topic of acceptance testing of centrifugal, mixed flow and axial flow pumps has been covered in detail in IS 9137:1978 and IS 10981:1983.

These standards are two in a set of three standards dealing with the acceptance tests for these pumps, corresponding to classes B, and C. IS 10981 : 1983 deals with class B pumps and IS 9137 : 1978 deals with class C pumps. Class A (on which Indian standard is yet to be prepared) is the most accurate of the three classes. The use of class A and B is restricted to special cases where there is a need to have pump performance more precisely defined. Further class A and B require more accurate apparatus and methods which also increases the cost of such tests. The details given below in this clause are mainly based on IS 9137:1978 which deals with class C pumps which is in general, the most relevant standard for the pumps used for water supply. Important portions out of this standard have been discussed below, dealing with tests which are normally applicable, leaving out discussion on topics such as cavitation testing and tests for Net Positive Suction Head (NPSH), etc. However for exhaustive reference IS 9137:1978 may be referred to.

2.1.1 IS 9137:1978 lays down procedures for acceptance testing of pumps of all sizes. It defines the terms and quantities that are used and establishes the methods of testing and ways of measuring the quantities involved according to class C so as to ascertain the performance and to compare them with the manufacturer's guarantee.

2.1.2 Symbols as given in Table 1 have been used to explain various terms involved in this portion.

Table 1 Symbols

(*Clause* 2.1.2)

Quantity	Symbol	Dimensions[1)]	SI Units
Mass	m	M	kg
Length	l	L	m
Time	t	T	s
Temperature	θ	θ	°C
Area	A	L^2	m^2
Volume	V	L^3	m^3
Angular velocity	ω	T^{-1}	rad/s
Velocity	v	LT^{-1}	m/s
Acceleration of free fall	g	LT^{-2}	m/s^2
Speed of rotation	n	T^{-1}	s^{-1}
Density	ρ	ML^{-3}	kg/m^2
Pressure	p	$ML^{-1}T^{-2}$	N/m^2
Viscosity (dynamic viscosity)	μ	$ML^{-1}T^{-1}$	$N.s/m^2$
Kinematic viscosity	ν	L^2T^{-1}	m^2/s
Energy	E	ML^2T^{-2}	J
Power (general term)	P	ML^2T^{-3}	W
Reynolds number	Re	Pure number	-
Diameter	D	L	m
Mass rate of flow	q	MT^{-1}	kg/s
Volume rate of flow	Q	L^3T^{-1}	m^3/s
Distance to reference plane	z	L	m
Inlet total head	H_1	L	m
Outlet total head	H_2	L	m
Pump total head	H	L	m
Specific energy	ϒ	L^2T^{-2}	J/kg
Loss of head at inlet	H_{J1}	L	m
Loss of head at inlet	H_{J2}	L	m
Net positive suction head	(NPSH)	L	m
Atmospheric pressure (absolute)	P_b	$ML^{-1}T^{-2}$	N/m^2
Vapour pressure (absolute)	P_v	$ML^{-1}T^{-2}$	N/m^2
Pump power output	P_u	ML^2T^{-3}	W
Pump power input	P	ML^2T^{-3}	W
Motor power input	P_{gr}	ML^2T^{-3}	W
Pump efficiency	η	Pure number	-
Transmission efficiency	η_{int}	Pure number	-
Motor efficiency	η_{mot}	Pure number	-
Overall efficiency	η_{gr}	Pure number	-
Type number	K	Pure number	-
Friction factor	f	Pure number	-
Pipe roughness	k_s	L	m

[1)] M = Mass, L = length, T = Time, θ = Temperature.

2.2 Guarantees and Purpose of the Tests

2.2.1 *Guarantees*

2.2.1.1 *Subjects of guarantees* — It shall be agreed in the contract which values are guaranteed by the manufacturer and under what conditions.

One or more of the following quantities are usually guaranteed:

a) Outlet rate of flow of pump;

b) Total head of pump;

c) Power input or efficiency of pump or combined motor-pump unit (for example submersible pump or monoset pump; or separate pump and motor with overall efficiency guaranteed) ; and

d) Net positive suction head (NPSH)

Whichever of these quantities is guaranteed, it is necessary to specify the speed of rotation (or in some cases the electrical supply frequency and voltage for the motor- pump unit) and the chemical and physical properties of the liquid to be pumped (if other than clean, cold water).

For the purpose of IS 9137 : 1978 the guarantees refer only to the pump including the test arrangements as given in **2.3.4**. In particular, the guarantees do not apply to:

a) the test on the pipe and its fittings, such as valves, etc;

b) the general installation *in situ;*

if these parts do not belong to the test arrangements according to **2.3.4.**

The pump manufacturer is responsible neither for the determination of the pump guarantee point, nor for the arrangement of the pump, nor for the installation *in situ,* the sole exception being when he has undertaken these tasks as part of the order.

2.2.1.2 *Extent of guarantees* - The guarantee of the flow rate covers the flow rate at the agreed total head and speed of rotation, within the permissible tolerances above and below as given by **2.5.4.1**.

The guarantee of the head covers the pump total head (H) at the agreed flow rate and speed of rotation, within the permissible tolerances above and blow as given by **2.5.4.1**.

The guarantee of the efficiency covers the minimum value of efficiency at the guaranteed point Q-H within the permissible tolerances as given by **2.5.4.2**.

If the flow rate values and the efficiency stated are not guaranteed but are indicated on the basis of prior tests or are given in printed curves (for mass produced pumps),following shall be follwed for requirments on guarantees:

When, for mass-produced pumps, the manufacturer makes reference in his catalogue to IS 9137 : 1978 the curves published in his catalogue shall be such that any pump corresponding to the curves gives for any chosen operation point, after Class C tests, results not divergent from the values of the published curve by more than:

± 6 % for total head

± 8 % for rate of flow

± 8 % for power input

For a combined motor-pump unit (for example submersible pump or monobloc pump; or separate pump and motor with overall efficiency guaranteed) the guarantee covers efficiency of the entire unit.

2.2.1.3 *Implementation of guarantees*

(a) *Flow rate and total head values* - The guarantee for flow rate and total head is fulfilled if, at the agreed speed of rotation, the value of the equation given in **2.5.4.1** is greater than or equal to 1.

(b) *Efficiency* - The efficiency guarantee is fulfilled if, at the agreed speed of rotation, the conditions given in **2.5.4.2.** have been achieved or exceeded.

(c) *Net positive suction head (NPSH)* - When a test of (NPSH) is specified in the contract, the guarantees as defined in (a) and (b) above shall be achieved under those conditions of (NPSH) that are specified. This does not necessarily ensure absence of cavitation.

(d) *Motor speed of rotation* - If the driving motor is being supplied by the pump manufacturer, the speed of rotation named in **2.2.1.2** and **2.2.1.3** can be replaced by the frequency and the voltage.

2.2.2 *Purpose of the Test*

2.2.2.1 *Contractual object of the tests* — The tests are intended to ascertain the performance of the pump and to compare this with the manufacturer's guarantee. However, attention is drawn to the fact that the NPSH test increases the cost of the test substantially. It shall, therefore, be specified by the purchaser in the order/contract, if NPSH test is to be conducted.

Where a number of identical pumps are to be purchased and if NPSH test is specified in the contract, one pump shall be tested as type test, for other tests the method of sampling of pumps as per IS 10572:1983 shall be followed.

2.2.2.2 *Range of performance test* - The performance test of the pump shall be carried out to determine the performance of the pump with respect to the discharged rate of flow, total head, power absorbed, etc.

A check of the satisfactory running of the pump may be made from the point or view of cavitation, temperature of glands and bearings, axial thrust, and possibe air or water leakage, provided the hydraulic test is carried out at the specified speed of rotation.

NOTE — It is also possible to observe the amount of noise and vibration.

2.3 Organization of Tests

2.3.1 *Place of Testing*

Acceptance tests shall be carried out either at the manufacturer's works or alternatively at a place to be mutually agreed between the manufacturer and the purchaser.

2.3.2 *Test Programme*

Only the guaranteed operational data shall form the basis of the test: other data determined by measurement during the tests shall have merely an indicative (informative) function and it shall be so stated if they are included in the programme.

2.3.3 *Testing Apparatus*

When the measuring procedure is being decided on, the measuring and recording apparatus required shall be specified at the same time.

The chief of tests shall be responsible for checking the correct installation of these apparatuses and their perfect functioning.

All the measuring appartus shall be covered by reports showing by calibration or by comparison that it complies with the requirements of **2.3.9.** These reports shall be presented, if required.

2.3.4 *Test Arramgemets*

2.3.4.1 *Standard test arrangements* - Ideally, the flow through the inlet head measuring section should be such that:

a) the velocity is uniform, and axial, across the section; and

b) the static pressure across the section is uniform.

These are the conditions for the standard test arrangement, but they are impossible to achieve completely, and it is impracticable to check them for the class of test covered here.

However, significant maldistribution of a) and b) and swirl can be avoided by keeping bends and combinations of bends, and divergences and discontinuities of cross-sectional area, from the proximity of the measuring section. In general the importance of inlet flow conditions increases with the pump type number.

(The type number, a dimensionless quantity, is defined by the following formula :

$$K = \frac{2\,\pi\, nQ^{1/2}}{(gH)^{3/4}}$$

Here the type number, is based on the total head of a multistage pump and not on the head per stage and that it applies to the guaranteed flow rate, which is not in conformity with common practice where K is calculated for the flow rate corresponding to maximum efficiency.)

For type numbers greater than 1.5 it is more meaningful to reproduce site conditions than it is to use a standard test arrangement. For such non-standard conditions an agreement shall be reached in the contract.

2.3.4.1.1. *Inlet pressure tappings* — In general, the pressure tapping shall be placed in a section of equal diameter to and concentric with, the inlet branch of the pump. It should under normal conditions be located two diameters upstream from the pump inlet flange. Moreover it shall never be placed:

1) in a diverging section, or within four diame-

ters of straight pipe downstream from the divergence;

2) within the plane of a bend, either in the bend itself or within four diameters of straight pipe downstream from the bend. It may, however, be agreed to site a pressure tapping in this region at right angles to the plane of the bend; and

3) within four diameters of straight pipe following a sudden contraction, or other discontinuity of cross-sectional area.

When interpretation of readings in non-standard conditions is being negotiated, consideration shall be given to:

1) whether the value of inlet head itself is important (for example, for NPSH tests); and

2) the ratio of inlet velocity head to the pump total head.

If this ratio is very small (less than 0.5%) and the value of inlet head itself is not important, readings from a tapping in the pump inlet flange may be used in the inlet total head equation as given below (for ratio $\geq$ 0.5%: 2 *D* upstream)

$$H_1 = z_1 + \frac{p_1}{\rho g} + \frac{v_1^2}{2g}$$

(suffix 1 indicates suction side)

2.3.4.1.2 *Outlet pressure tappings* - Under normal conditions the outlet pressure tapping should be located two diameters downstream from the pump outlet flange.

For the pumps of type number equal to or less than 0.5, the outlet pressure tapping may be located directly at the pump outlet, provided it is at right angles to the plane of the volute or any other bend formed by the pump casing.

For the pumps of type number greater than 0.5, the straight parallel pipe shall be coaxial with the outlet pipe of the pump and have the same bore. The tapping shall be located in the pipe wall in a plane through the pipe axis at right angles to the plane of the volute or other bend formed by the pump casing.

2.3.4.2 *Pumps tested with fittings* - If specified in the contract, tests shall be carried out on a combination of a pump and

a) associated fittings at the final site installation; or

b) an exact reproduction there of; or

c) fittings introduced for testing purposes and taken as forming part of the pump itself (*see* for examples **2.3.4.3** & **2.3.4.4** etc).

Connections on the inlet and outlet sides of the whole combination shall be made in accordance with **2.3.4.1**.

Measurements shall then be taken in accordance with **2.3.8.2** & **2.3.8.3**.

2.3.4.3 *Pumping installation under submerged conditions* — Where a pump, or a combination of a pump and its fittings, is tested or installed in conditions where the pipe connection, on either inlet or outlet as described in **2.3.4** cannot be made owing to inaccessibility or submergence, measurements shall be taken in accordance with **2.4.2.2** (c) **2.4.2.3** (c).

2.3.4.4 *Borehole and deepwell pumps* — Borehole and deepwell pumps cannot usually be tested with their complete lengths of delivery main and, consequently, the loss of head in the portions omitted, and the power absorbed by any shafting therein, cannot be measured. Any thrust bearing would also be more lightly loaded during the test than it would be in the final installation [(*see* **2.4.2.4**(d))].

2.3.4.5 *Friction losses at inlet and outlet* — The guarantees under **2.2.1** refer to the pump inlet and outlet flanges, and the pressure measuring points are in general at a distance from these flanges (**2.3.4.1** to **2.3.4.4**). It may be necessary to add to the measured pump total head the head losses due to friction (H_{J1} and H_{J2}) between the measuring points and the pump flanges.

Such a correction should be applied only if

$$H_{J1} + H_{J2} \geq 0.000\,5\,H$$

If the pipe between the measuring points and the flanges is unobstructed, straight, and of constant circular cross section,

$$H_J = f\,\frac{l}{D}\,\frac{v^2}{2g}$$

The value of f should be derived from

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left[\frac{2.5}{Re\sqrt{f}} + \frac{k_s}{3.7\,D}\right]$$

where

$$Re = \frac{vD}{\nu} \text{ (pure number)}$$

$$\frac{k_s}{D} = \frac{\text{pipe roughness}}{\text{pipe diameter}} \text{ (pure number)}$$

If the pipe is other than unobstructed, straight, and of constant circular cross section, the correction to be applied must be the subject of special agreement in the contract.

2.3.5 *Speed of Rotation During Test* - The difference between the specified speed of rotation and the test speed of rotation may be allowed as follows.

$$\left[\frac{n - n_{sp}}{n_{sp}}\right]$$

2.3.5.1 For flow rate and head: +20%
-50%

2.3.5.2 For efficiency: ± 20%

For a combined motor-pump unit, the motor efficiency change between specified and test speeds, shall be established at the time of agreeing to the contract. Lower speeds are also acceptable.

The following for efficiency correction shall be applied:

$$\frac{1 - \eta_1}{1 - \eta_s} = \left[\frac{n_s}{n_1}\right]^n$$

where

n_1 = Actual test speed

η_1 = Efficiency at actual test speed

2.3.6 *Control of Head* - The test conditions may be obtained among other methods, by throttling in either or both the inlet and outlet pipes. When throttling in inlet pipe is used, due consideration shall be given to possibility of cavitation or air coming out of the water, which might affect the operation of the pump, the flow measuring device (*see* **2.4.1.3**) or both.

2.3.7 *Execution of Tests*

The duration of the test shall be sufficient to obtain consistent results, having regard to the degree of accuracy to be achieved.

Where multiple readings are taken to reduce the error margin (*see* **2.3.8**) they shall be taken at equal intervals of time.

Where, for special reasons, it is necessary to determine performance over a range of operating conditions a sufficient number of observations, shall be taken to establish the performance within the limits of error stated in **2.3.8.**

All measurements shall be made under steady conditions of operation as defined in **2.3.8.** If steady conditions are not achievable, agreement shall be made between the parties concerned on the matter.

If the driving power available during a test on a testing stand is insufficient, and if the test has to be carried out at greatly reduced speed of rotation, the guaranteed characteristics can be adjusted to such reduced speed of rotation in accordance with **2.3.5.1, 2.3.5.2** or **2.5.2.1** respectively.

To verify the guarantee point, three measurements shall be recorded, one as close as possible to the guarantee point, and one closely on each side of it.

The test records shall be kept with two copies (one for the purchaser and one for the manufacturer); all test records and recording strips shall be initialled by the chief of tests and the representatives of both parties.

The evaluation of the test results shall be made as far as possible while the tests are in progress and, in any case, before the installation and instrumentation are dismantled in order that suspect measurements can be repeated without delay.

2.3.8 *Test Conditions*

2.3.8.1 *Definitions* - For the purpose of this hand book the following definitions shall apply:

Oscillations — Short oscillation cycles about a mean value occurring during the time that a single observation is being made.

Variations — Those changes in value which take place between one reading and the next.

2.3.8.2 *Permissible oscillations in readings and use of damping* - Where the construction or operation of a pump is such that oscillations of great amplitude are present, measurements may be carried out by means of an instrument capable of providing an integration over at least one complete cycle of oscillation. The calibration of such an instrument shall be made appropriately.

Restricted damping may be introduced in measuring instruments and their connecting lines where necessary to reduce the amplitude of oscillation within the values given in Table 2.

Where it is possible that damping will significantly affect the accuracy of the readings the tests shall be repeated using a symmetrical damping device, for example a symmetrical orifice or capillary tube.

Table 2 Maximum Permissible Amplitude of Oscillations as a Percentage of Mean Value of Quantity Being Measured

Measured Quantity	Maximum Permissible Amplitude of Oscillations
Rate of flow Head Torque Power	± 6
Speed of rotation	± 2

NOTES

1. Where a 6% change in flow would result in a calculated 12% change in head, the maximum permissible amplitude of the observed differential head shall be ±12%.
2. In the case of inlet total pressure head and outlet total pressure head measurement the permissible percentage oscillation shall be calculated on the pump total head.

2.3.8.3 *Number of sets of observations*

a) *Under Steady conditions* — In steady and well controlled test conditions, only one set of readings of individual quantities shall be recorded for the specified test condition. This set shall be recorded only after the observers have been satisfied that the oscillations and variations of the readings have settled down within the limits specified in Table 2.

b) *Under Unsteady conditions* — In such cases where the unsteadiness of test conditions gives rise to doubts concerning the accuacy of the tests, the following procedure shall be followed:

Repeated sets of observations of the measured quantities shall be made at the guarantee point, only speed and temperature being allowed to be controlled. Throttle valve, water level, gland, balance water, settings, etc, shall be left completely unaltered. The differences between these repeated readings of the same quantities will be a measure of the unsteadiness of the test conditions, which are atleast partly influenced by the pump under test as well as the installation.

A minimum of three sets of observations shall be taken at the guarantee point, and the value of each separate measurement and of the efficiency derived from the measurements in each set shall be recorded. The percentage difference between the largest and smallest values of each quantity shall not be greater than that given in Table 3. It will be noted that a wider tolerance is permitted if the number of readings is increased up to the maximum requirement of nine readings.

These tolerances are designed to ensure that the errors due to scatter, taken together with the systematic error limits given in Table 4 will result in overall measurement errors not greater than those given in Table 5.

Table 3. Limits of Variation Between Repeated Measurements of the Same Quantity (Based on 95% Confidence Limits)

(*Clause* 2.3.8.3)

Number of Sets of Obserbations	Maximum Permissible Difference Between Largest and Smallest Readings of Each Quantity %	
	Rate of flow Head Torque Power Efficiency	Speed of Rotation
3	1.8	1.0
5	3.5	2.0
7	4.5	2.7
9	5.8	3.3

The arithematic mean of all the readings for each quantity shall be taken as the actual value for the purposes of the test.

If the values given in Table 3 cannot be reached, the cause shall be ascertained, the conditions rectified and a new complete set of observations made, i.e. all the readings of the original set shall be rejected. No reading or selection of readings in the set of observations may be rejected because it lies outside the limits.

In the case where the excessive variation is not due to procedure or instrumentation errors, and cannot therefore be eliminated, the limits of errors may be calculated by statistical analysis.

2.3.9 *Accuracy of Measurement*

The limits of measurement errors laid down in this standard are those which refer to measurements taken and to quantities calculated therefrom; they apply to the maximum permissible discrepancies between measured and actual performances (*see* **2.5.4**).

An "error" is defined as a value equal to twice the estimated standard deviation. It is assumed that there is a 95% probability that the estimated value of the true error will not exceed twice the estimated standard deviation disussed in this portion. IS 9137 : 1978 specifies the methods of measurement and instruments to be used for the determination of rate of flow, inlet total head, outlet total head, pump total head, speed of rotation and pump power input.

Any device or method which by calibration or comparison has been demonstrated to be capable of measuring with systematic errors not exceeding the limits in Table 4 may be used. The devices or methods shall be agreed upon by both parties concerned.

Table 4 Permissible Systematic Errors of Measuring Instruments

(*Clauses* 2.3.8.3, 2.3.9)

Measured Quantity	Permissible Limit, %
Rate of flow Pump total head Pump power input	± 2.5
Electrical power input (for overall efficiency tests) Motor efficiency	± 2.0
Speed of rotation	± 1.4

If the recommendations concerning the systematic errors of instruments as given in Table 4 and those concerning the actual test procedure, are followed, it should be assumed that the overall limits of error will not exceed those given in table 5.

Table 5 Maximum Permissible Limits of Overall Errors

(*Clauses* 2.3.8.3, 2.5.4.1, 2.5.4.2)

Quantity	Permissible Limit, %
Rate of flow Pump total head Pump power input Electrical power input (for overall efficiency tests)	± 3.5
Speed of rotation	± 2.0
Overall efficiency (computed from the rate of flow, total head and electrical power).	± 4.5
Pump efficiency	± 5.0

2.4 Procedure for Measurement of Rate of Flow, Head, Speed of Rotation and Power Input

2.4.0 The following methods, among others, may be used.

2.4.1 *Measurement of Flow Rate*

2.4.1.1 *Weighing tank method* - This method is capable only of measuring the mean value of the flow rate during the period concerned.

It is subject to the errors of the weighing, of the time-measuring apparatus employed, of the time taken for the diversion of the flow into and from the weighing tank and those involved in the determination of density.

NOTE — In case two tanks are used alternately during the measuring period, the flow being diverted from one to the other, only the times of initial diversion into and final diversion from the measuring system shall be taken into account, not the times of the intermediate diversions from tank to tank.

2.4.1.2 *Volumetric tank method* —This method, as in the case of the weighing method, is only capable of measuring the mean value of the flow rate during the period concerned.

In every case a leakage test of the tank shall be carried out and correction made for leakage if necessary; where possible, initial calibration shall be carried out by weighing a liquid of known density into the measuring tank. Out door tanks shall be adequately sheltered so that the level and the level-measuring devices are not disturbed by wind or rain.

In the case of big outdoor tanks the method is in general subject to errors in measurement of levels which are not stationary and which may be non-uniform. In such a case the levels shall be simultaneously measured within stilling tubes, at not fewer than four widely separated positions within the tank.

Water levels may be measured with hook gauges, float gauges, piezometer or other instruments capable of maintaining the required accuracy.

2.4.1.3 *Orifice plates, venturi tubes and nozzles*

The measurement of flow rate may be carried out using devices designed and installed in accordance with IS 2952 (Part I) : 1964 for orifice plates and nozzles and IS 4477 (Part I) : 1967 for venturi tubes. Minimum straight lengths required upstream from the pressure difference device, especially, are given in IS 2952 (Part I) : 1964 in the case of orifice plates and nozzles, and in IS 4477 (Part I) : 1967 in the case of venturi tubes.

Pump will be considered to cause a flow disturbance equivalent to a single 90^0 bend lying in the same plane as the pump volute or the last stage of a multistage pump or the outlet bend of the pump.

The characteristics of these devices are calculated using above Indian Standards and the calibration is not required.

Care shall be taken to ensure that neither cavitation nor air is present in the flow-measuring devices. Special care shall be taken to ensure that the indications of the device are not affected by air coming out of solution at the control valve. The presence of air can usually be detected by operating the air vents on the measuring device.

Manometers used for differential presure measurement shall be of the liquid column type and shall meet the requirements of **2.4.2.6.**

2.4.1.4 *Notches, Wiers and flumes* —The details pertaining to methods of measurement are given in IS 6059 : 1971, IS 6062 : 1971, IS 6063 : 1971 and IS 9108 : 1979.

The smallest scale division of any instrument used for observing head shall be not greater than that corresponding to 1.5 % of the flow.

2.4.2 *Measurement of Head*

2.4.2.1 *Pressure tappings and instrument connecting lines* — Static pressure tapping shall comply with the requirements shown in Fig. 1 and be free from burrs and irregularities and flush with, and normal to, the inner wall of the pipe.

The diameter of the pressure tappings shall be between 2 and 6 mm or equal to 1/10 of the pipe diameter, whichever is less. The length of a pressure tapping hole shall be not less than twice its diameter.

The bore of the pipe containing the tappings shall be clean, smooth and resistant to chemical reaction with the liquid being pumped. Any coating such as paint applied to the bore shall be intact. If the pipe is welded longitudinally, the tapping hole shall be displaced as far as possible from the weld.

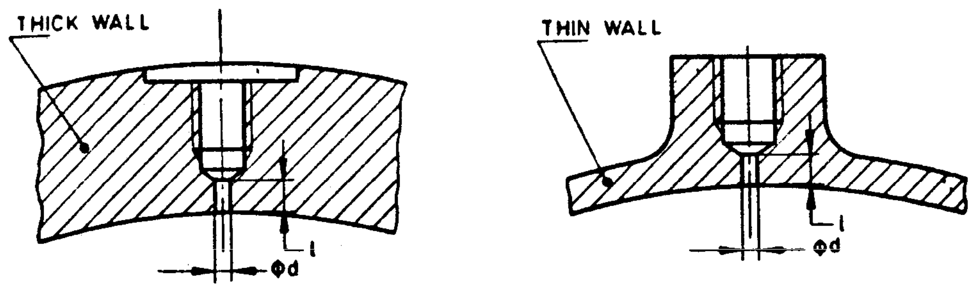
Pipes connecting pressure tappings to possible damping devices (*see* **2.3.8.2**) and to instruments shall be atleast equal in bore to the bore of the pressure tappings. The system shall be free from leaks.

It is recommended that transparent tubing be used so as to allow determination of the amount of water or air in the tubing.

2.4.2.2 *Inlet total head*

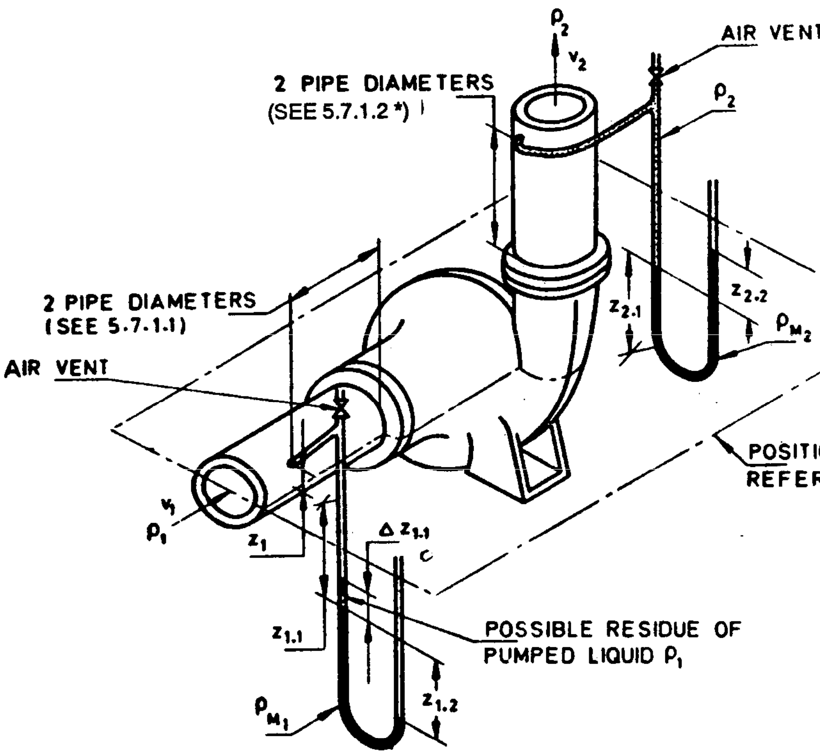
a) *Installation in accordance with* **2.3.4.1.1** .

These installations and the corresponding formulae are given in Fig. 2 and Fig. 3.



$l > 2d$ where $d = 2$ to 6 mm or 1/10 pipe diameter whichever value is the less.

FIG. 1 REQUIREMENTS FOR STATIC HEAD TAPPINGS



$H_2 = z_{2\cdot 1} + \frac{\rho M_2}{\rho_2} z_{2\cdot 2} + \frac{v_2^2}{2g}$

On the figure:

$z_{2\cdot 1} > 0$

$z_{2\cdot 2} > 0$

$H_1 = \frac{\rho M_1}{\rho_1} z_{1\cdot 2} + \frac{v_1^2}{2g} + z_1 + \Delta z_{1\cdot 1}$

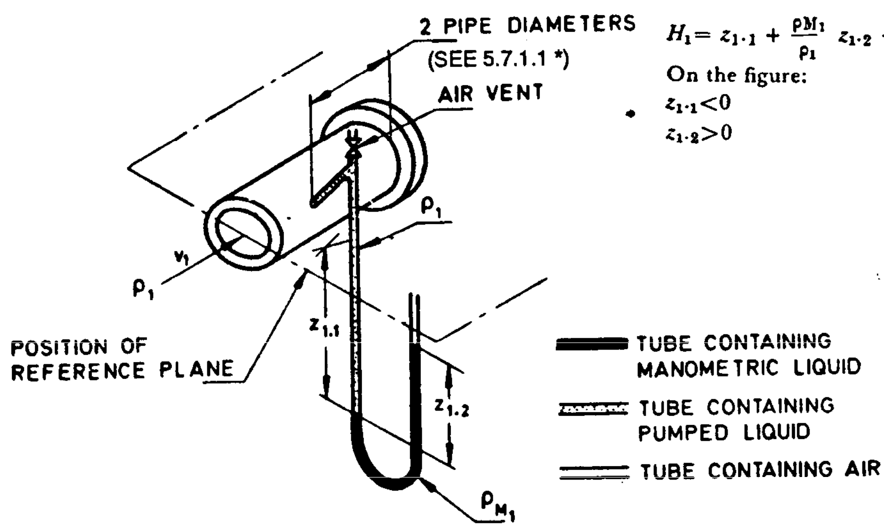
On the figure:

$z_{1\cdot 2} < 0$

$z_{2\cdot 2} > 0$

$\Delta z_{1\cdot 1}$ always < 0

a) The pump inlet is under vacuum



$H_1 = z_{1\cdot 1} + \frac{\rho M_1}{\rho_1} z_{1\cdot 2} + \frac{v_1^2}{2g}$

On the figure:

$z_{1\cdot 1} < 0$

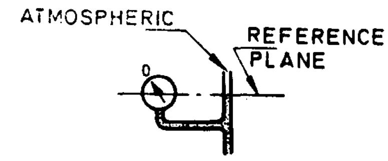
$z_{1\cdot 2} > 0$

b) The pump inlet is under pressure

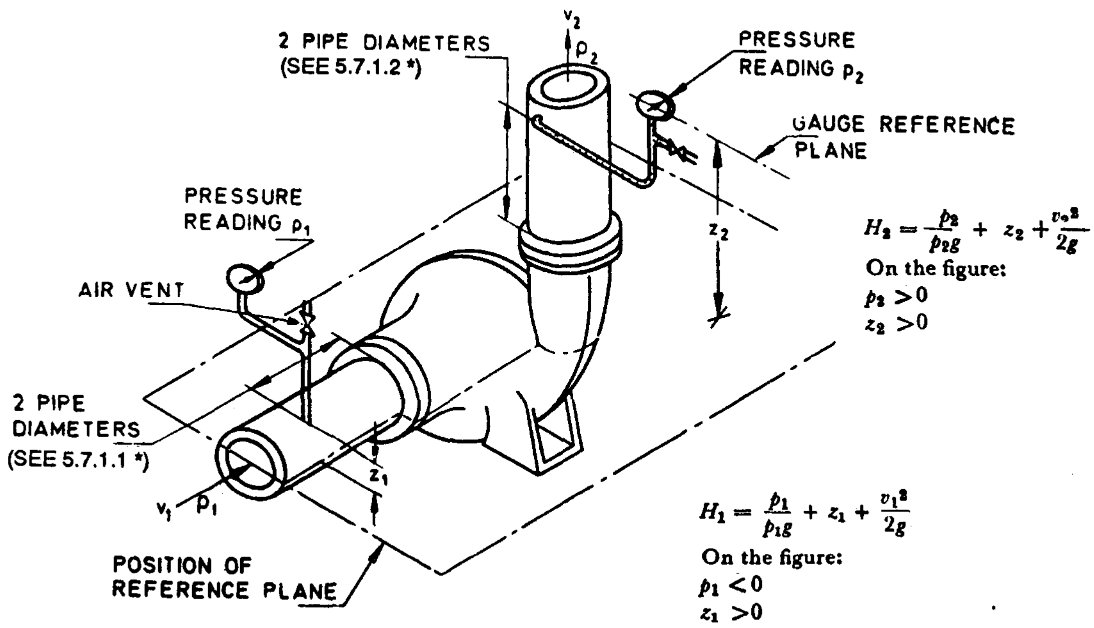
* As per IS 9137 : 1978.

The drawings show the principle but no full technical details.

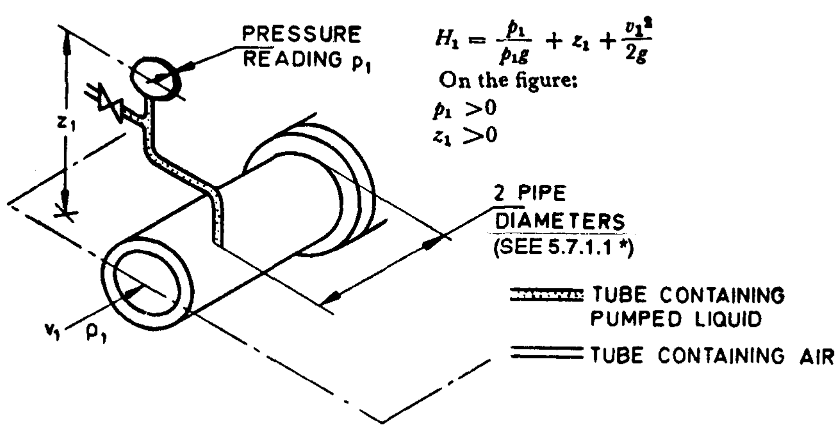
FIG. 2 TEST OF A CENTRIFUGAL PUMP BY MEANS OF LIQUID COLUMN GAUGES



a) Arrangement for determining reference plane of Bourdon type gauge



b) The pump inlet is under vacuum



c) The pump inlet is under pressure

The drawings show the principle but no full technical details.

* As per IS 9137 : 1978.

FIG. 3 TEST OF A CENTRIFUGAL PUMP BY MEANS OF BOURDON GAUGES

b) *Installation in accordance with* **2.3.4.2**

Where a pump is tested in combination with fittings forming part of the site or test installation, the provisions of **2.4.2.2 a)** shall be applied to the inlet flange of the fittings and not to the inlet flange of the pump.

This procedure debits against the pump all head losses caused by fittings on the inlet side.

c) *Installations in accordance with* **2.3.4.3**

The inlet total head is equal to the positional head with respect to the reference plane of the still surface of the liquid in which the pump is tested or from which it draws, plus the pressure head equivalent to the gauge pressure on that surface.

This assumption debits against the pump all head losses caused by fittings on the inlet side.

2.4.2.3 *Outlet total head*

a) *Installations in accordance with* **2.3.4.1.2**

These installations and the corresponding formulae are given in Fig. 2 and 3.

b) *Installations in accordance with* **2.3.4.2**

Where a pump is tested in combination with fittings forming part of the site or test installation, the provisions of **2.4.2.3** a) shall be applied to the outlet flange of the fittings and not to the outlet flange of the pump.

This procedure debits against the pump all head losses caused by fittings on the outlet side.

c) *Installations in accordance with* **2.3.4.3** *and* **2.3.4.4**

These installations and the corresponding formulae are given in Fig. 4.

However, if the pump discharges into a sump with a free surface, the outlet total head is equal to the positional head of the still surface of the liquid into which the pump delivers, plus the gauge pressure head.

This assumption debits against the pump all head losses caused by fittings on the outlet side.

2.4.2.4 *Total inlet and outlet heads - Special Cases*

It will prove necessary to permit exceptions from the above-mentioned standard arrangements in the following cases.

a) *Pumps conforming to the final site installation* — During the acceptance test, the pump shall be fitted with the pipe arrangements corresponding to the final arrrangement at site. In this case the friction losses between the test point for measuring the inlet pressure and the inlet flange, as well as between the outlet flange and the test point for measuring the outlet pressure, shall be determined in accordance with the method mentioned in **2.3.4.5** and added to the sum of the differences of positional head, of pressure head and of velocity head.

b) *Pumps with inaccessible ends* — If the inlet or outlet or both sides of the pump are inaccessible, the procedure prescribed above shall be followed in measuring the pump's head. Under certain circumstances, friction losses, such as mentioned in **2.3.4.5** and **2.3.2.4.** a) shall be taken into account.

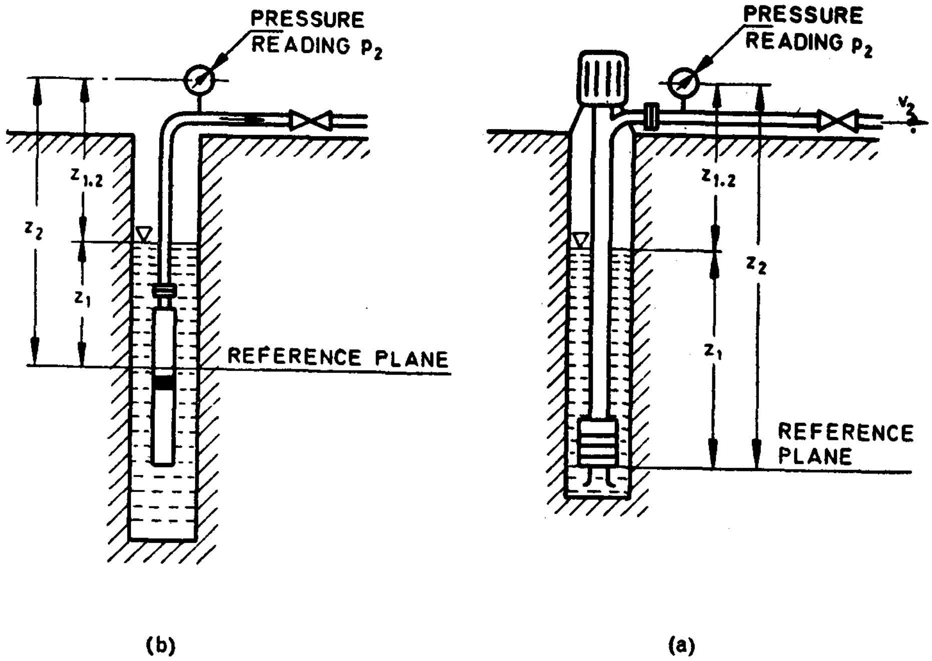
c) *Submersible pumps* — If the outlet flange of this type of pump is, for practical purposes, defined as placed at a certain distance from the pump proper, and is thus preceeded by an outlet pipe length and a bend or bends being always parts of the installation, the measurement of outlet head shall be made in accordance with **2.3.4.2.**

d) *Deep-well pumps* — In this case, friction losses between the pressure measuring points and the inlet or outlet flanges, respectively, that may have to be taken into account, shall be determined in accordance with the method given in **2.3.4.5.** Friction losses on suction are primarily caused by resistance to flow within the inlet strainer, the foot valve, and the inlet pipe. All of these head losses shall as far as possible be indicated at the time the contract is made by the pump manufacturer if he supplies such accessories, or by the purchaser if they are fitted by the latter. Should it prove impossible to submit such data the purchaser and the manufacturer, prior to the acceptance test, shall arrive at an agreement concerning the flow resistance data to be applied.

$$H_1 = z_1$$

$$H_2 = \frac{p_2}{\rho_2 g} + z_2 + \frac{v_2^2}{2g}$$

$$H = \frac{p_2}{\rho_2 g} + z_{1\cdot 2} + \frac{v_2^2}{2g}$$



The drawings show the principle but no full technical details.

FIG. 4 MEASUREMENT OF PUMP TOTAL HEAD H FOR VARIOUS TYPES OF SUBMERGED PUMPS

Friction losses at outlet result from resistance to flow within the column-pipe and the outlet bend.

Since deep-well pumps in general are not tested with the entire stand pipe attached, unless the acceptance test is performed at site, the pipe friction losses in regard to the pump total head shall be estimated and stated by the manufacturer to his purchaser.

Should it be considered necessary to verify the data indicated by an acceptance test at site, such a test shall be specified in the supply contract.

For tests on installations conforming to the requirement of **2.3.4.2 to 2.3.4.4,** the guarantees also apply to fittings.

2.4.2.5 *Pump total head* — The pump total head is calculated in accordance with the definition given in IS 9137 : 1978 which is as follows

$$H = H_2 - H_1$$

$$= z_2 - z_1 + \frac{p_2 - p_1}{g} + \frac{v_2^2 - v_1^2}{2g}$$

(where suffix '1' indicates suction side and suffix '2' indicates delivery side)

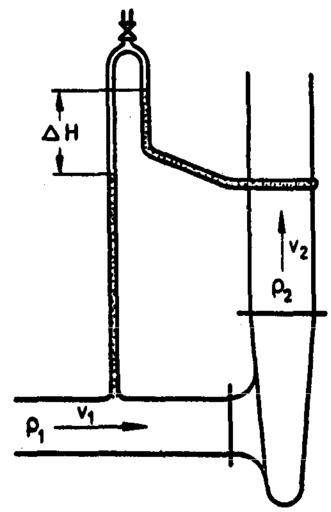
However, in certain cases the pump total head may be measured using one differential pressure device.

This type of installation and the corresponding formulae are given in Fig. 5

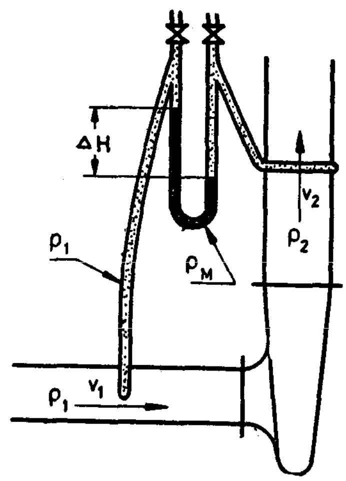
When this is deemed preferable, the pump total head may be replaced by an expression giving the increase in specific energy of the fluid conveyed by the pump

$$r = gH$$

The specific energy increase is obtained by multiplying both sides of the pump total head equation given above by g.



$$H = \Delta H + \frac{v_2^2 - v_1^2}{2g}$$



$$H = \frac{\rho_M - \rho_1}{\rho_1} \Delta H + \frac{v_2^2 - v_1^2}{2g}$$

This equation is valid for $\rho_1 = \rho_2$, which may be assumed for Class C tests.

FIG. 5 DIRECT MEASUREMENT OF PUMP TOTAL HEAD

2.4.2.6 *Instruments for pressure measurement*

a) *Liquid column manometers* — No calibration is required.

The minimum distance between two scale graduations shall be 1 mm.

If possible, the use of differential liquid columns less than 50 mm high shall be avoided. If this is impossible, attention shall be specially drawn to erorrs of measurement.

The length of the liquid column may be modified by using one manometric liquid in place of another.

For reading below 100 mm of liquid, the bore of manometer tubes shall be 6 mm at least for mercury and 10 mm for water and other liquids.

The cleanliness of the liquid in the manometer shall be maintained to avoid errors due to variation of surface tension.

The design of the manometers shall be such that parallax errors are minimized.

Water column manometers may be either open ended (for low pressue measurement only) or closed with the air in the column connecting both limbs compressed to the amount required to permit the differential head to be read on the scale.

The use of the liquid column manometer is shown diagrammatically in Fig. 2 and 5, to which reference should be made.

Connections between the pipes where pressure is measured and the manometer shall be made as shown in Fig. 2.

It is essential that there is no break in continuity (for example, by air pockets through failure to vent properly) of the water between the pipe and the reading surface in the manometer.

NOTE — For further details on manometers IS 9118 : 1979 may be referred to.

b) *Bourdon dial gauges* — When this type of gauge is used for inlet and outlet pressure measurements, to ascertain pump total head, it is recommended that the difference between two consecutive scale graduations be within 1.5 and 3 mm for both measurements, and that this difference corresponds to not more than 5% of the pump total head.

NOTE — For further details on Bourdon type pressure and vaccum gauges, *see* IS 3624 : 1987.

2.4.3 *Measurement of the Speed of Rotation*

The speed of rotation shall be measured by counting revolutions for a measured interval of time, by a direct-indicating techometer or, in the case of a pump driven by an ac motor, from observations of the mean frequency and motor slip data either directly measured (for example, using a stroboscope) or supplied by the motor manufacturer.

Where the speed of rotation cannot be directly measured (for example, for immersed pumps), it is usually sufficient to establish the frequency and voltage.

2.4.4 *Measurement of Pump Power Input*

The pump power input shall be derived from measurement of the speed of rotation and torque, or determined from measurements of the electrical power input to an electric motor of known efficiency, directly coupled to the pump.

2.4.4.1 *Measurement of torque* — Torque shall be measured by a suitable dynamometer, capable of complying with the requirements of **2.3.8.**

2.4.4.2 *Electric power measurements* — Where the electrical power input to an electric motor coupled directly to the pump is used as a means of determining the pump power input, the following conditions shall be observed :

a) The motor shall be operated only at conditions where the efficiency is known with sufficient accuracy,

b) Motor efficiency shall be determined in accordance with the recommendations of IS 4889 : 1968.

The electric power input to the driving motor shall be measured by the two-wattmeter method in the case of ac motors. This allows the use of two single-elements watt meters, or one double-element wattmeter or one single-element wattmeter and suitable switches.

In the case of a dc motor, either a wattmeter or an amperemeter and a voltmeter may be used.

The type and grade of accuracy of the indicating instruments for measuring electrical power shall be in accordance with IS 1248 (Part 1) : 1993, IS 1248 (Part 2 to 6) : 1983 and IS 1248 (Part 7 and 8) : 1984.

Where the power input to an electric motor coupled to an intermediate gear, or the speed of rotation and torque measured by a dynamometer between gear and motor, are used as a means for determining the guaranteed pump power input, it shall be stated in the contract in what way the losses of the gear shall be determined.

2.4.4.3 *Pumps with inaccessible ends* — In the case of combined motor-pump units (for example submersible pump or monobloc pump; or separate pump and motor with overall efficiency guaranteed), the power of the machine unit shall be measured at the motor terminals if accessible. When a submersible pump is involved, the measurement shall be effected at the incoming end of the cables; cable losses shall be taken into account and specified in the contract. The efficiency given shall be that of the combined unit proper, excluding the cable and the starter losses.

2.4.4.4 *Deep well pumps* - In this case the power absorbed by the thrust bearing and the vertical shafting and bearings shall be taken into account.

Since deep-well pumps in general are not tested with the entire stand pipe attached, unless the acceptance test is performed at site, the thrust and vertical shaft bearing losses in regard to power and efficiency shall be estimated and stated by the manufacturer to his purchaser.

2.4.5 *Measurement of Pumping Unit Efficiency*

To determine the efficiency of a pumping unit, only the power input and output are measured, with the driver working under conditions specified in the contract. In this test, the proportion of losses between driving agent and pump is not established, nor any losses associated with intermediate machinery such as gear box or variable speed device.

2.5 Analysis of Tests

2.5.1 *Test Data Required for the Analysis*

The quantities required to verify the characteristics guaranteed by the manufacturer are given in **2.2.1.** Methods for measuring these quantities are given in **2.4.**

2.5.2 *Translation of the Test Result to the Guarantee Basis* — Such translation serves to determine whether the guarantee would have been fulfilled if the tests had been conducted under the same conditions as those on which the guarantee is based.

2.5.2.1 *Translation of the test results into data based on the specified speed of rotation or frequency*

All test data obtained at the speed of rotation n, in deviation from the specified speed of rotation n_{sp} shall be translated to the basis of the specified speed of rotation n_{sp}.

If the deviations in speed of rotation from the specified speed of rotation n_{sp} do not exceed the permissible variations stated in **2.3.5** the measured data on the discharged flow rate Q, the total head H, the power input P, the net positive suction head (NPSH) and the efficiency can be translated as follows :

$$Q_{sp} = Q\left(\frac{n_{sp}}{n}\right)$$

$$H_{sp} = H\left(\frac{n_{sp}}{n}\right)^2$$

$$P_{sp} = P\left(\frac{n_{sp}}{n}\right)^3$$

$$(\text{NPSH})_{sp} = (\text{NPSH})\left(\frac{n_{sp}}{n}\right)$$

$$\eta_{sp} = \eta$$

If the deviations in speed of rotation from the specified speed of rotation n_{sp} exceed the permissible variations stated in **2.3.5** it will be necessary to stipulate the formula for translating the test results to the basis of the specified speed of rotation.

In the case of combined motor-pump units or where the guarantees are with respect to an agreed frequency and voltage instead of an agreed speed the flow rate, pump total head, power input, and efficiency data are subject to the above mentioned translation laws, provided that n_{sp} is replaced by the frequency f_{sp} and n by the frequency f. Such translation, however, shall be restricted to the cases where the frequency during the acceptance test varies by no more than 1 % from the frequency prescribed for the characteristics under guarantee. If the voltage used in the acceptance test is no more than 5% above or below the voltage on which the guaranteed characteristics are based, other operational data require no change.

If n_{sp} exceeds 20 percent variation, it shall be necessary to apply corrections on efficiency as given in **2.3.5.** The stipulation for H, Q and (NSPH) shall remain according to **2.5.2.1** irrespective of n_{sp} variations.

2.5.3 *Measuring Inaccuracies*

All measurements are inevitably subject to inaccuracies, even if the measuring procedure and the instruments used, as well as the analysis directives, fully comply with prevailing acceptance rules. When comparing the test results with the guaranteed characteristics, these inaccuracies shall be given adequate consideration. The fact should be stressed that the term measuring inaccuracies merely covers the errors that are unavoidable with all measurements, they refer in no way to the pump and the guaranteed charactristics. The maximum permissible limits of overall error for the quantities concerned for Class C measurements are defined in Table 5.

2.5.4 *Verification of the Guarantee*

2.5.4.1 *Curves QH and Q* η — Guarantee points $Q_G H_G$ and $Q_G \eta_G$ are plotted on a graph and continuous curves are then drawn through the measured points QH and another through the points $Q\ \eta$ of which Q is measured and η is calculated.

If the test made at a value of speed that is different from that specified as relevent to the particular guaranteed values, the test points shall be corrected to the specified speed of rotation in accordance with **2.5.2.** Similarly, if the test is made at a value of frequency different from that relevant to the particular guaranteed values, the test shall be corrected to the specified frequency.

Tolerances $\pm X_Q$ and $\pm X_H$ respectively shall be applied to the guaranteed duty point QH. These tolerances include the maximum permissible limits of overall error e_Q and e_H (*see* Table 5) and the constructional tolerance.

In the absence of a specific agreement as to the values to be used, the following values may be taken :

$$X_Q = 0.07$$

$$X_H = 0.04$$

If the guarantee point lies at a vertical distance $\pm\Delta H$ and a horizontal distance $\pm\Delta Q$ from the test curve (*see* Fig. 6), the following shall be evaluated:

$$\left(\frac{H_G X_H}{\Delta H}\right)^2 + \left(\frac{Q_G X_Q}{\Delta Q}\right)^2 \geq 1$$

Thus, if the total amount is greater than or equal to 1, the guarantee condition will be deemed to have been met, and if the total amount is less than 1, the guarantee condition has not been achieved.

2.5.4.2 *Efficiency* — The efficiency shall be derived from the measured QH curve where it is intersected by the straight line passing through the specified duty point $Q_G H_G$ and the zero of the QH axes.

The efficiency at the point of intersection shall be atleast 95% of that specified.

For combined motor-pump units this value is 95.5%.

These values result only from the measuring errors (*see* Table 5).

2.5.4.3 *Pump Power Input* — The pump power input within the range defined in **2.5.4.1** by the tolerances $\pm X_Q$ and $\pm X_H$ shall not exceed that agreed between the manufacturer and purchaser at the time of contract. This value applies to the conditions of use of the pump as specified in the contract.

Such an agreement may have to take into account different transmission losses and different gland and seal torques between works test and site operation.

2.5.5 *Test Report*

After scrutiny of the test results, the latter shall be summarized in a report, with as many copies as there are parties. The test report shall be signed either by the chief of tests alone or by him together with the representatives of the manufacturer and the purchaser.

The test report shall contain the following information

a) Place and date of the acceptance test;

b) Manufacturer's name, type of pump, serial number, and possibly year of manufacture.

c) Guaranteed characteristics, operational conditions during the acceptance test;

d) Specification of the pump's drive;

e) Description of the test procedure and the measuring appratus used including calibration data;

f) Observed readings;

g) Evaluation and analysis of test results;

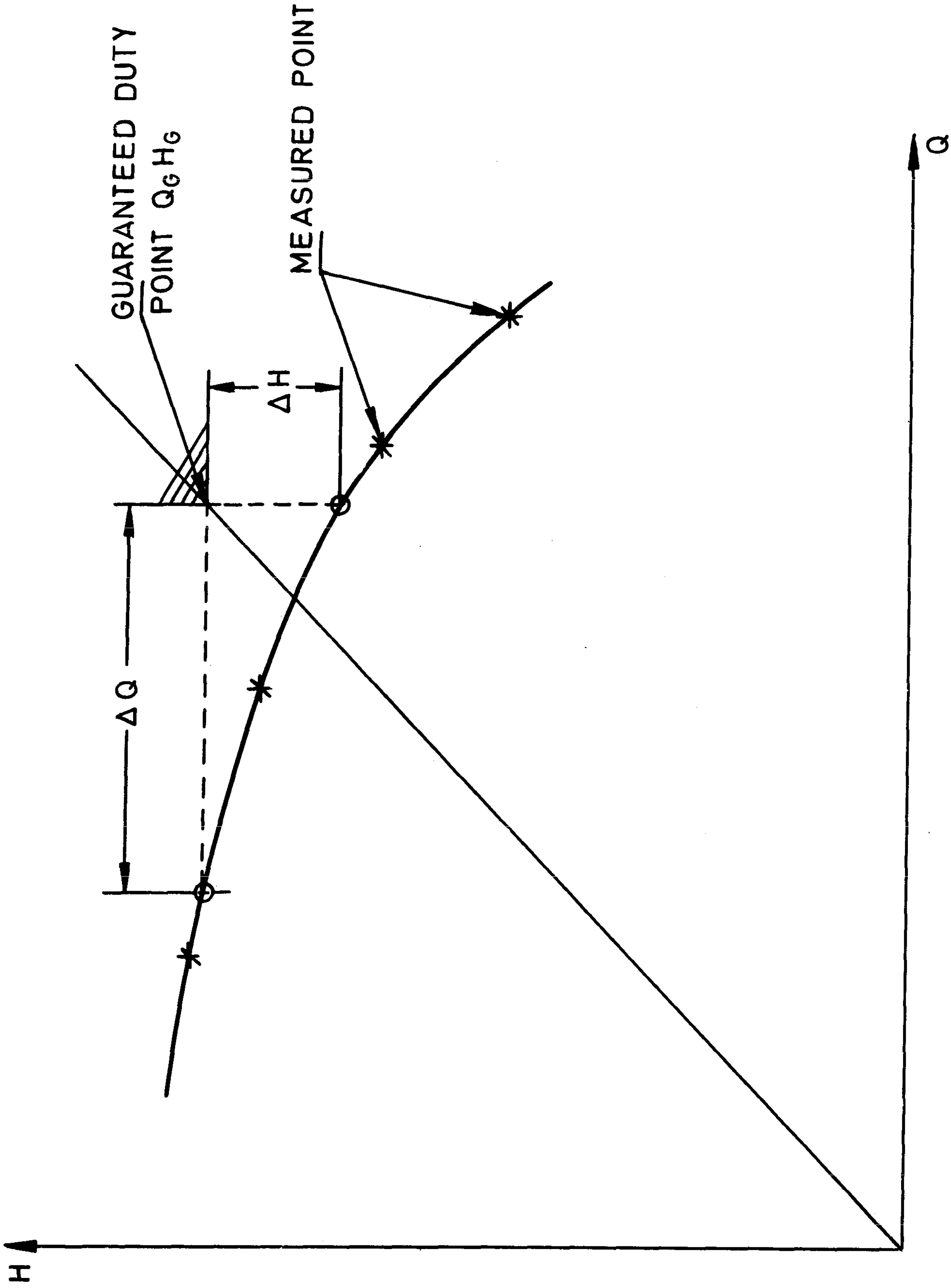


FIG. 6 CURVE *QH* FOR VERIFICATION OF GUARANTEE

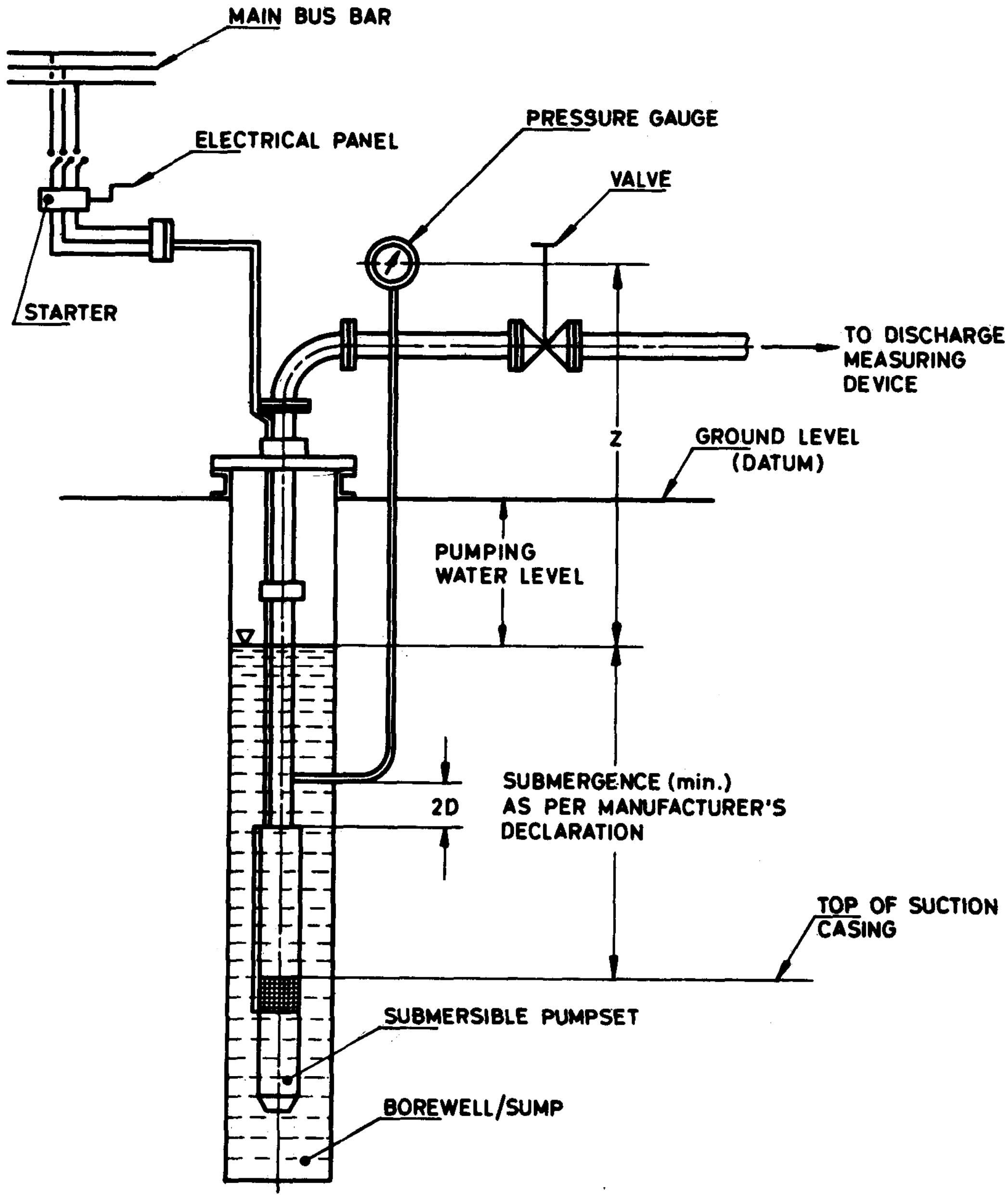


FIG. 7 TYPICAL TESTING SETUP FOR SUBMERSIBLE PUMPSETS

h) Conclusions:

1) comparison of the test results with the guarantees,

2) determination whether the guarantees covering certain specific areas were completely or only partly fulfilled or not fulfilled at all,

3) recommendation whether the pump can be accepted or should be rejected and under what conditions,

4) if the guarantees are not fully satisfied the final decision whether the pump can be accepted or not is up to the purchaser,

5) statements arising out of action taken in connection with any special agreements that were made.

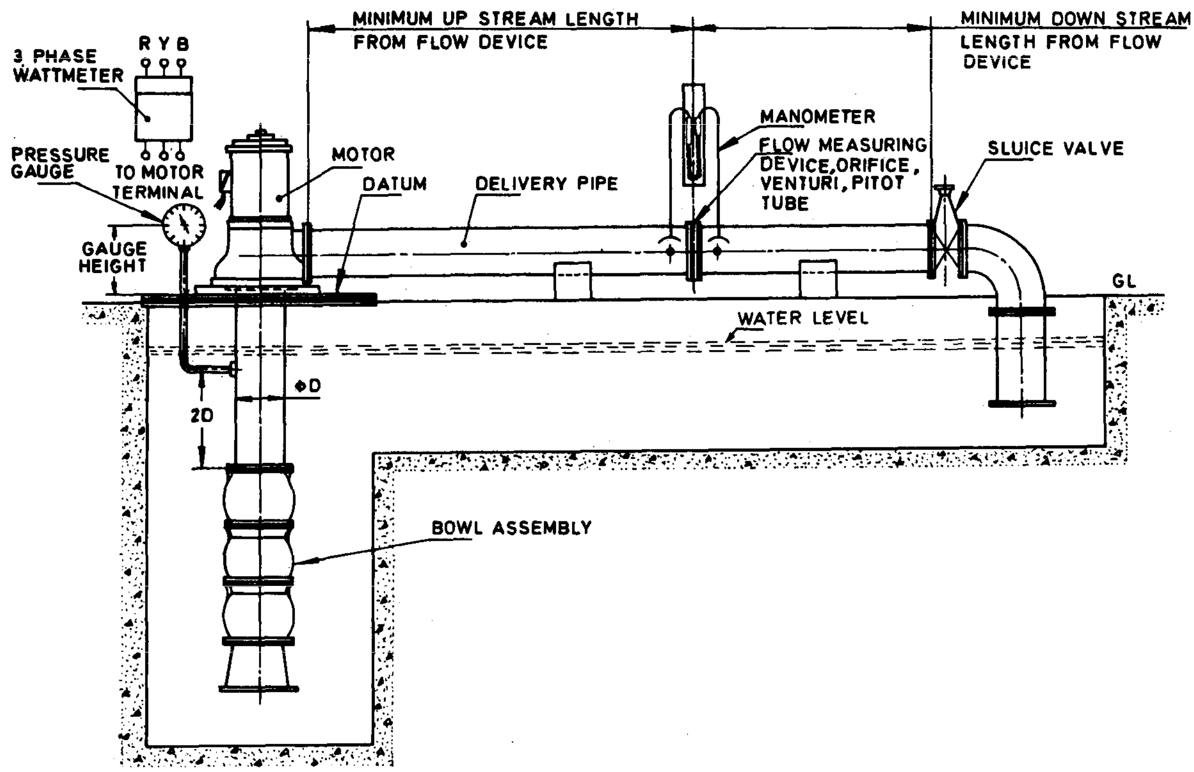
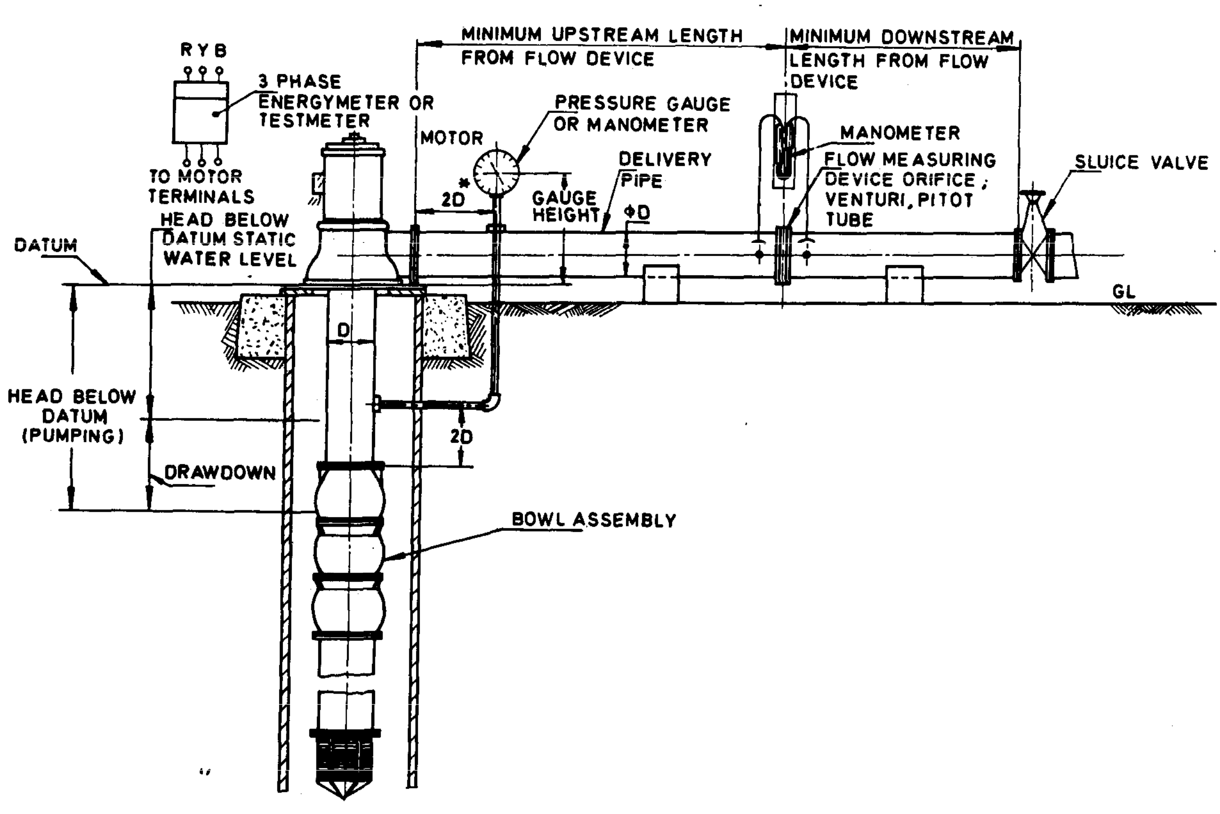


FIG. 8 LABORATORY TEST ARRANGEMENT FOR VERTICAL TURBINE PUMP



NOTE - If it is Possible to accommodate pressure tapping in the Discharge pipe line with 4 d straight distance from discharge head outlet flange, head can be measured.

FIG. 9 FIELD TESTING ARRANGEMENT FOR VERTICAL TURBINE PUMP

3 TESTING OF SUBMERSIBLE PUMPS

IS 8034 : 1989 provides a typical testing arrangement foi laboratory testing of submersible pumpsets which is reproduced as Fig. 7. Testing procedure for submersible pumps shall be in accordance with IS 9137 : 1978 which is discussed under clause **2** of this chapter and verification of performance for flow rate, head and over all efficiency with respect to guaranteed values shall also be done as per IS 9137 : 1978 *(see* **2.5.4**).

4 TESTING OF VERTICAL TURBINE PUMPS

IS 1710 : 1989 provides the requirements for vertical turbine pump tests. Given below are the major stipulations given in the standard.

4.1 Performance Tests

The expected field performance of the pump may be obtained by testing the bowl assembly in the laboratory and then calculating the required performance.

A typical laboratory test set up is shown in Fig. 8.

4.2 Laboratory Tests

As far as possible, full load and full speed tests shall be conducted. However laboratory test at reduced speed if required shall be done according to IS 5120 : 1977.

4.2.1 *Sampling* - For laboratory tests, the sampling plan as given in IS 10572 : 1983 shall be followed.

4.3 Field Tests

A field test gives an indication of the overall performance of a pump when it is operating under actual field conditions. Field tests are sometimes used as acceptance test. The accurancy with which field test can be made depends on the instruments used in the test, the proper installation of the instruments and the skill of the test personnel. It shall be recognized that environmental condition in a well or the design of a pump shall significantly affect field performance and also affect the apparent results of field test. Under most conditions, it is recommended that acceptance of the pump shall be based on tests made in laboratory.

Field test shall not be carried out until the pump has worked for at least 24 hours to allow running in time for the bearings.

If test is to be carried out at different heads, this shall be done by throttling the delivery valves, in this case delivery valve be placed after the minimum upstream and down stream length as required by flow measuring device. The control valve shall be at least 4 times the diameter away from the discharge head elbow. A typical diagrammatic arrangement for field test is illustrated in Fig. 9. For details, refer IS 9137 : 1978 discussed in clause **2** of this chapter.

4.4.1 *Speed*

The rotating speed of pump shall be measured by revolution counter or by an accurately calibrated tachometer or by stroboscope counting slip method.

4.4.2 *Discharge*

The discharge of the pump shall be measured by means of a standard venturi tube, nozzle, orifice plate, V-notch/ rectangular weir, pitot tube, traverse or any other recognized method. The method adopted for discharge measurement shall be suitable for the size of pump, its duty and situation. The pump manufacturer shall, if required give evidence of the proper calibration of the apparatus used. The surface conditions, size and length of the pipe preceding and succeeding the fluid measuring device are as important as the calibration of the device itself and shall be taken care of.

4.4.3 *Net Pump Effective Head*

For determining the net pump effective head, following measurements shall be taken and the readings shall be converted to datum reference:

a) Static water depth with pump in working condition,

b) Delivery head, and

c) Velocity head.

4.4.3.1 *Delivery head*

This shall be measured by means of a calibrated bourdan type gauge (reading converted to metre of liquid) located at a distance of 2*D* from the discharge elbow of the test pump (*D* is dia of delivery pipe) plus the distance from the datum to the centreline of gauge. It is recommended that mercury manometers be used in preference to bourdan type gauges when the head to be measured is 7.5 m or less. For precautions and connections for the gauge refer **13.8.4** of IS 5120 : 1977.

4.4.3.2 *Velocity head*

Velocity head shall be obtained from the actual measurement of the inside diameter of the discharge pipe at the point where the pressure tap is located.

4.4.4 *Pump Output*

This shall be calculated as follows :

$$\text{Power in kw delivered by the pump} = \frac{QH}{102}$$

Where Q = Discharge in l/s

and H = Effective head in m.

4.4.5 *Pump input*

The power input to the pump shall be determined with a vertical dynamometer or a calibrated electric motor. It is generally considered impractical to attempt to measure pump power input by means of transmission dynamometer in field.

4.4.6 *Overall Efficiency*

When the specifications calls for an overall efficiency guarantee, the actual job motor shall be used without calibration and efficiency calculated directly.

4.5 Recording and Computation of Test Results

4.5.1 All instruments test readings as well as corrected readings shall be recorded on the test sheet. Complete data concerning the pump driver and instruments identification shall also be recorded.

4.5.2 All the test results shall be coverted into performance at the specified speed from the actual readings, by similarity relations given in clause **2.5.2.1**..

4.4.3 The bowl assembly head, bowl efficiency and bowl assembly input power shall be plotted as ordinates on graph against the capacity as abscissa to show the anticipated field performance of the complete pump.

4.5. Guarantees

Guarantees of pumps with class C rating shall be checked in accordance with IS 9137 : 1978 (*see* **2.2** and **2.5.4**) and for pump with Class B rating shall be in accordance with IS 10981 : 1983.

5 TESTING OF JET CENTRIFUGAL PUMP COMBINATION

IS 12225 : 1987 provides the following major stipulation for testing of these pumps.

5.1 Method of Testing

The jet centrifugal pump combination shall be fitted with the jet pump assembly through proper sizes of pipes of required lengths with respective orifice plates for the pipes. One pressure gauge shall be fitted to the delivery pipe of the jet pump which is the suction pipe of the centrifugal pump. The electric motor shall be connected to the pump. The pump is primed and the motor is switched on. By throttling the discharge valve, the following readings shall be taken :

a) Total head (on the pressure gauge connected to the discharge pipe),

b) Corrected ejector head (on the pressure gauge connected to the suction pipe of the centrifugal pump which is the delivery pipe of the jet pump),

c) Discharge,

d) Power input,

e) Speed of the motor,

f) Voltage, and

g) Current.

The above readings shall be tabulated in the form of a test report for each pump. At least three test points, that is, duty point, maximum and minimum head shall be taken. The manufacturer shall give the maximum jet setting depth (ejector head + 6 metres) for the various types of pumps offered at which the maximum ejector efficiency is obtained. All the heads, discharge and power shall be corrected to the rated speed.

5.2 Performance Curves

The tabulated readings shall be drawn as a set of performance curves as follows :

a) Discharge of jet centrifugal pump combination versus total head.

b) Discharge of jet centrigugal pump combination versus depth of low water level for jet centrifugal pump combination.

c) Discharge of jet centrigugal pump combination versus power input.

5.3 Noting that the submergence of pump below water level affects the overall performance of the jet centrifugal pump combination (submergence of the pump is to be declared by the manufacturer along with minimum operating perssure), the standard also provides the method of testing jet centrifugal pump combination with required submergence. A reference to Appendix A of IS 12225 : 1987 may be made for details.

5.4 Testing method for including pipe friction in the test set up by use of orifice plate is also provided in the standard. The effect of friction in the length of delivery pipe and pressure pipe is simulated by means of orifice plates in the delivery and pressure pipes. A reference to Appendix B of IS 12225 : 1987 may be made for details.

6 TESTING OF DEEPWELL HAND PUMPS-INDIA MARK II

6.1 — Testing of deepwell hand pumps — India mark II is covered in IS 9301 : 1990. The relevent portion dealing with testing from this standard is given below.

6.2 Sampling of Pumps

Unless otherwise specified in the contract or order, the procedure given in IS 2500 (Part I) : 1992 shall be followed for sampling inspection. For the characteristics given under **6.3**, the single sampling plan with inspection level III and AQL of one percent as given in Tables 1 and 2 of IS : 2500 (Part 1) : 1992 shall be followed.

6.3 Visual and Dimensional Tests

6.3.1 All the pumps shall be examined for finish and visual defects.

6.3.2 All critical dimensions of the assemblies shall be checked for conformance with the drawings given in the Indian Sandard for this pump.

6.3.3 The handle shall have reasonably good surface contact with the top and bottom portions of the bracket.

6.3.4 Riser pipe holder welding shall be checked for verticality. Plain round mandrel of 300 mm length shall be screwed to the water tank coupling and the verticality shall be checked with the help of try-square. For the entire length of the mandrel a maximum of 1 mm tilt may be allowed.

6.3.5 The flanges shall be reasonably flat to provide proper matching of the holes to ensure unrestricted insertion of bolts.

6.3.6 After putting the pump on levelled platform, alignment of the rod with respect to the guide bush shall be checked as given below.

6.3.6.1 A rod of length 100 mm and diameter 12 mm shall be fitted to the chain coupling. The handle shall be raised and lowered gently. The rod shall pass through the guide bush freely.

6.3.6.2 The handle shall be checked for lateral play at the end of the handle which shall not exceed 2 mm on either side. The clearance between the handle and the bracket side shall not be less than 1.5 mm.

6.3.7 The stroke of the pump shall be 125 ± 4 mm.

6.3.8 The connecting rod and plunger rod shall be examined for straightness and the formation of the threads. The hexagonal coupler shall also be subjected to similar checks. The hexagonal coupler shall be stress relieved before welding to avoid cracks since these are manufactured from cold drawn bars.

6.3.9 When the pump head is assembled in the handle assembly, it shall be possible to insert handle axle by using soft hammer. The fitment of the bearing shall be checked to ensure that outer race of the bearing does not move when mild force is applied on the inner racing of the bearing and the inner race of the bearing shall rotate freely.

6.3.10 The cylinder assembly shall be checked for leakage of water under normal atmospheric pressure and there shall be no leakage.

6.3.11 The check valve and plunger valve shall move freely after assembly.

6.4 Routine Tests

Two complete pumps including cylinders out of the batch selected shall be subjected to the following tests in addition to the tests given in **6.3** above.

6.4.1 The pump assembly and cylinder assembly shall be dismantled and all the components shall be checked for critical dimensions conforming to the drawings. The connecting rods shall also be checked for dimensions given in IS 9301 : 1990.

6.4.2 The cylinder assembly (other than those selected for dimensional checks) of the pumps shall be placed fully submerged in a barrel of 200 litres water capacity. The pump shall be primed and test shall start only after getting continuous flow of water through the spout. The water shall then be collected in a container for forty continuous strokes to be completed in one minute and the discharge thus measured shall not be less than 15.0 litres.

6.5 Criteria for Conformity

The lot shall be considered as conforming to the requirements of this standard, if the pumps selected according to **6.2** and **6.3** satisfy the following requirements:

a) The number of pumps not meeting the requirements of a characteristic inspected under **6.3** does not exceed the corresponding acceptance number, and

b) The pumps selected according to **6.4** meet the requirements given in **6.4.1** and **6.4.2**

7 TESTING OF DEEPWELL HANDPUMPS (VLOM)-INDIA MARK III

7.1 Testing of these pumps is generally similar to testing of deepwell handpumps as per IS 9301 : 1990. It is covered under IS 13056 : 1991.

The relevent portion dealing with testing from this standard is given below.

7.2 Sampling

Unless otherwise specified in the contract or order, the procedure given in IS 2500 (Part I) : 1992 shall be followed for sampling inspection. For the characteristics given under **7.3** the single sampling plan with inspection level III and AQL of one percent as given in Tables 1 and 2 of IS 2500 (Part 1): 1992 shall be followed.

7.3 Visual and Dimensional Tests

7.3.1 All the pumps shall be examined for finish and visual defects.

7.3.2 All critical dimensions of the assemblies shall be checked for conformance with the figures given in IS 13056 : 1991.

7.3.3 The handle shall have reasonably good surface contact with the top and bottom portions of the bracket.

7.3.4 Riser pipe holder shall be checked for verticality. Plain round mandrel of 300 mm length shall be screwed to the water tank coupling and the verticality shall be checked with the help of try square. For the entire length of the mandrel a maximum of 1 mm tilt may be allowed.

7.3.5 The flanges shall be reasonably flat to provide proper matching of the holes to ensure unrestricted insertion of the bolts.

7.3.6 After putting the pump on perfect level over the platform, alignment of the rod with respect to the guide bush shall be checked as given below.

7.3.6.1 A rod of 100 mm length and 12 mm diameter shall be fitted to the chain coupling. The handle shall be raised and lowered gently. The rod shall pass through the guide bush freely.

7.3.6.2 The handle shall be checked for lateral play at the end of square section of handle which shall not exceed 2 mm on either side.

7.3.6.3 The clearance between the handle and bracket shall not be less than 1.5 mm.

7.3.7 The stroke of the pump shall be 125 ± 4 mm.

7.3.8 The connecting rod and plunger rod shall be examined for straightness and the formation of the threads. The hexagonal coupler shall also be subjected to similar checks. The hexagonal coupler shall be stress relieved before welding to avoid cracks since these are manufactured from cold drawn bars.

7.3.9 The manufacturer shall produce test certificates of all the raw materials of the components.

7.3.10 When pump head assembled with handle assembly, it shall be possible to insert handle axle by using soft hammer. The fitment of the bearing shall be checked to ensure that outer race of the bearing does not move when mild force is applied on inner race of the bearing and inner race of the bearing shall rotate freely.

7.3.11 The cylinder assembly shall be checked for leakage of water. The cylinder shall be filled with water and water level is checked after 5 minutes. There shall be no leakage of water.

7.3.12 The check valve and plunger valve shall move freely after assembly.

7.4 Routine Test

Two complete pumps including cylinder out of the batch selected shall be subjected to the following tests in addition to the tests in **7.3** above.

7.4.1 The pump including cylinder assembly shall be dismantled and all the components shall be checked in detail for critical dimensions conforming to the drawings (*see* IS 13056 : 1991 for component drawings)

7.4.2 The cylinder assembly (other than those selected for dimensional checks) of the pumps shall be placed fully submerged in a barrel of 200 litres capacity. The pump shall be primed and test shall start only after getting continuous flow of water through the spout. The water shall then be collected in a container for 40 continuous strokes to be completed in one minute and the discharge thus measured shall not be less than 15.0 litres.

7.5 Criteria for Conformity

The lot shall be considered conforming to the requirements of IS 13056 : 1991 if the pumps selected according to **7.2** and **7.3** satisfy the following requirements:

a) The number of pumps not meeting the requirements of a characteristic inspected under **7.3** does not exceed the corresponding acceptance number as specified in IS 2500 (Part I) : 1992.

b) The pumps selected according to **7.4** meet the requirements as given in **7.4.1** and **7.4.2.**

8 TESTING OF EXTRA DEEPWELL HANDPUMPS

8.1 Sampling

Unless other wise specifed in the contract or order the procedure given in IS 2500 (Part 1) : 1992 shall be followed for sampling inspection. For the characteristics given under 8.2, the single sampling plan with inspection level III and AQL of 1 percent as given in Table 1 and 2 of IS : 2500 (Part 1) : 1992 shall be followed.

8.2 Visual and Dimensional Tests

Requirement given under **6.3.1, 6.3.3** to **6.3.5, 6.3.8, 6.3.9**, and **6.3.11,** are applicable for these pumps also. Other requirements are given below.

8.2.1 All dimensions of the assemblies shall be chekced for conformance with the figures given in IS 13287 :1992.

8.2.2 After putting the pump on perfect level over the platform, alignment of the rod with respect to the guide bush shall be checked as given below.

8.2.2.1 A rod of length 100 mm and diameter 12 mm shall be fitted to the chain coupling. The handle shall be raised and lowered gently. The rod shall pass through the guide bush freely.

8.2.2.2 The handle shall be checked for lateral play at the end of square section of handle which shall not exceed 2 mm on either side.

8.2.2.3 The clearance between the handle and the bracket side shall not be less than 1.5 mm.

8.2.3 The stroke of the pump shall be 100 ± 3 mm.

8.2.4 The check valve and the plunger valve shall move freely after assembly.

8.3 Routine Tests

Two complete pumps including cylinders out of the batch selected shall be subjected to the following tests in addition to the tests in **8.2** above.

8.3.1 The pump assembly and cylinder assembly shall be dismantled and all the components shall be checked in detail for dimensions as per the figures given in IS 13287 : 1992. The connecting rods shall also be checked for dimensions.

8.3.2 The cylinder assembly (other than those selected for dimensional checks), of pumps shall be placed fully submerged in a barrel of 200 litres capacity. The pump shall be primed and test shall start only after getting continuous flow of water through the spout. The water shall then be collected in container for 40 continuous strokes to be completed in one minute and the discharge thus measured shall not be less than 12.0 litres.

8.4 Criteria for Conformity

The lot shall be considered conforming to the requirements of IS 13287 : 1992 if the pumps selected according to **8.1** and **8.2** satisfy the following requirements :

a) The number of pumps not meeting the requirements of a characteristic inspected under **8.2** does not exceed the corresponding acceptance number, and

b) The pumps selected according to **8.3** meet the requirements given in **8.3.1** and **8.3.2.**

CHAPTER 5

SPECIFICATIONS ON PUMPS

1 GENERAL

A number of Indian Standards exist covering specifications for different types of pumps used for supply of water which are discussed in this handbook. The major requirements as given in these specifications have been discussed in this chapter. However for details of the specification, a reference to the individual standard should be made.

2 HORIZONTAL CENTRIFUGAL PUMPS FOR CLEAR COLD WATER FOR AGRICULTURAL AND RURAL WATER SUPPLY PURPOSES

2.1 IS 6595 (Part 1) : 1993 covers the technical requirements for horizontal centrifugal pumps for handling clear, cold water for agricultural and rural water supply purposes.

2.2 Requirements

2.2.1 *Design Features*

2.2.1.1 The pump shall have suitable features properly designed as per IS 10804 : 1986 to ensure satisfactory performance, in particular, the design features, such as the following shall be incorporated:

a) The head restrictions shall be indicated on the nameplate to avoid over-loading of the prime-mover. However pump shall be capable to operate satisfactorily at minimum + 5 percent and minimum -15 percent of the specified duty point head upto 20m. Above 20 m head, the pump shall be capable to meet the discharge requirements at minimum — 3m of the duty point head.

b) Pump shall be capable to perform as per specified duty point at the manometric suction lift as specified in Table 1.

2.2.1.2 The minimum efficiency at the specified duty point shall be in accordance with Fig. 1 for speeds 1200 to 2000 rpm and in accordance with Fig. 2 for speeds 2001 to 3600 rpm.

Table 1 Manometric Suction Lift for Various Discharge Ranges and Speed Segments at Mean Sea Level and 33°C Water Temperature

(*Clause* 2.2.1.1.)

Sl.No.	Manometric Suction Lift m	Discharge Rate Range(l/s) Speed Range (rpm) 1200-1600	1601-2000	2001-2500	2501-2900	2901-3300	3301-3600
1	6.0	Up to 72	Up to 46	Up to 30	Up to 24	Upto 17	Up to 14
2	5.5	72 - 88	46 - 57	30 - 37	24 - 29	17 - 21	14 - 18
3	5.0	—	57 - 67	37 - 43	29 - 33.5	21 - 25	18 - 21
4	4.5	—	67 - 78	43 - 50	33.5 - 38.5	25 - 29	21 - 24
5	4.0	—	78 - 89	50 - 57	38.5 - 43.5	29 - 33	24 - 28
6	3.5	—	—	57 - 64	43.5 - 50	33 - 37	28 - 31

NOTE — While the manometric suction lift indicated above is to be maintained at specified duty point, it may not be always practicable to achieve this situation during testing. In such cases the requirements of this clause shall be deemed to have being met, if the manometric suction lift is maintained with in - 5%, + 10% of specified discharge rate.

2.2.1.3 *Shaft* — The shaft shall be of adequate size to transmit the required power over the entire range.

2.2.2 General Requirements

2.2.2.1 *Casing*

Casing shall be of robust construction and shall be tested to withstand 1.5 times maximum discharge pressure for 2 minutes.

2.2.2.2 *Impeller*

In case of pumps upto 2000 rpm. the impeller shall be statically balanced. In case of pumps above 2000 rpm impeller shall be balanced as per grade 6.3 mm/s of IS 11723 (Part 1) : 1992.

Note — Balancing here means the balancing of the imbalanced rotating mass in the impeller and not balancing of the axial hydraulic thrust in the impeller.

2.3 Material of Construction

2.3.1 It is recognised that a number of materials of construction are available to meet the needs for pumps handling clear, cold water. A few typical materials are indicated below merely for the guidance of the manufacturers and the users.

Sl. No.	*Material of Construction*	*Relevant Specifications*
1.	Casing	Grade FG 200 of IS 210 : 1993
2.	Impeller	Grade FG 200 of IS 210 : 1993 or grade LTB2 of IS 318 : 1981
3.	Casing ring and Impeller ring (if provided)	Grade FG 200 of IS 210 : 1993 or grade LTB2 of IS 318 : 1981
4.	Shaft sleeve (if provided)	Grade LTB2 of IS 318 : 1981 or Chrome steel 07Cr13
5.	Shaft	Grade 40 C8 of IS 1570 (Part 2/sec 1) : 1979

2.3.2 *Gaskets, Seals and Packing*

Suitable gaskets, seals and packing should be used. Material of these gaskets, seals and packing shall be such that it shall not be affected by the liquid being pumped.

2.4 Method of Test — The testing of the pumps shall be in accordance with IS 11346 : 1985.

2.5 Guarantees and Tolerances on Pump Performance

2.5.1 *Guarantee of Workmanship and Material*

The pumps shall be guaranteed by the manufacturer against defects in material and workmanship, under normal use and service, for a period of atleast 15 months from the date of despatch or 12 months from the date of commissioning whichever is less.

2.5.2 *Guarantee of Performance*

The pumps shall be guaranteed for their performance of the volume rate of flow, head and efficiency at the specified duty point only. If the customer has asked for guarantee on other points, these shall be subject to increased tolerances as agreed mutually.

2.5.2.1 Verification of guarantee shall be as per clause 7 of IS 11346 : 1985.

2.5.2.2 Power consumption by the pump shall not exceed the recommended primemover rating in the specified operating head range.

Power delivered to the pump shaft when directly connected shall be the power output of the driving element, when not directly connected, correction shall be made for the losses between the driving element and the pump. In the case of flat belt and V-belt drives, the allowance for belt losses may be taken as 6 percent and 3 percent, respectively.

2.5.2.3 The guarantee shall be deemed to have been met with if :

a) the measured values of head, volume rate of flow and pump efficiency are within the limits indicated in IS 11346 : 1985 ; and

b) in the specified head range power consumption does not exceed the prime mover rating.

2.5.2.4 The tolerances on guarantee shall apply to one particular point of working. If purchaser has asked for guarantee on other points these shall be subject to increased tolerance as agreed mutually.

2.5.2.5 The tolerance shall apply to guaranteed volume rate of flow and true value of efficiency.

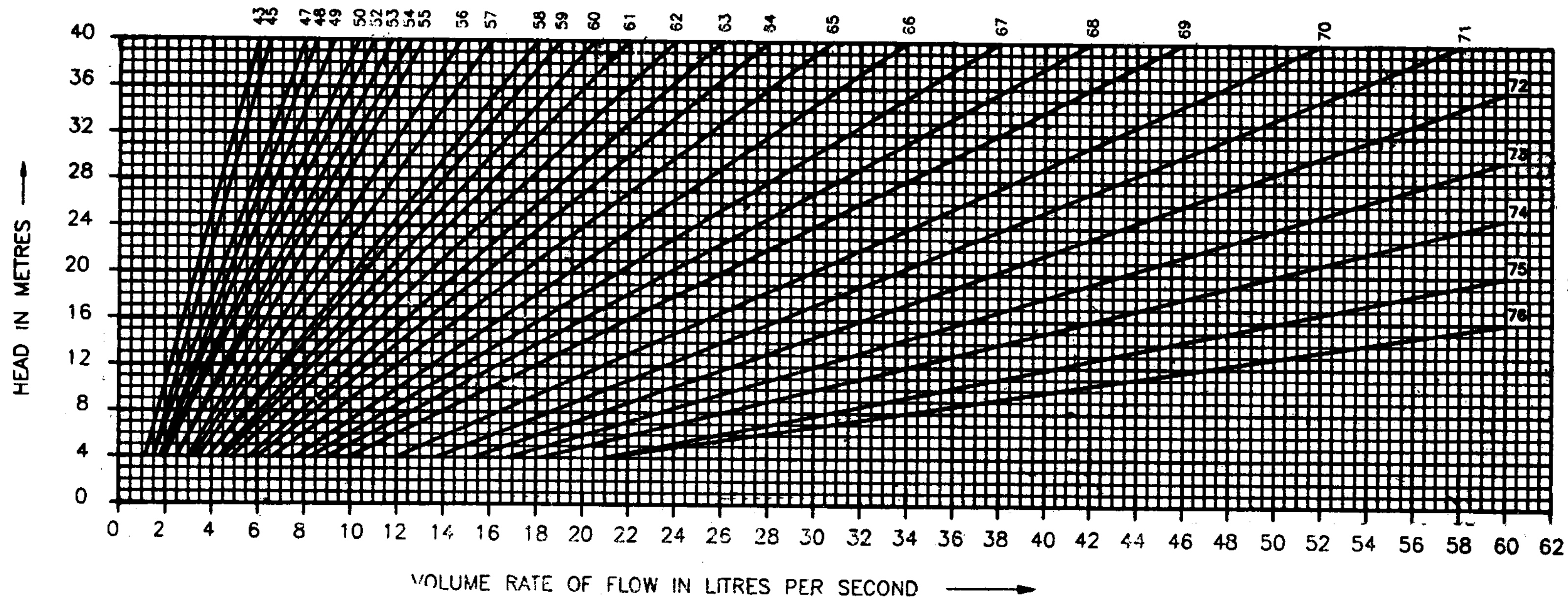


FIG. 1 MINIMUM EFFICIENCY IN PERCENT FOR HORIZONTAL CENTRIFUGAL PUMPS FOR AGRICULTURAL PUMPS

(SPEED 1200 to 2000 rmp)

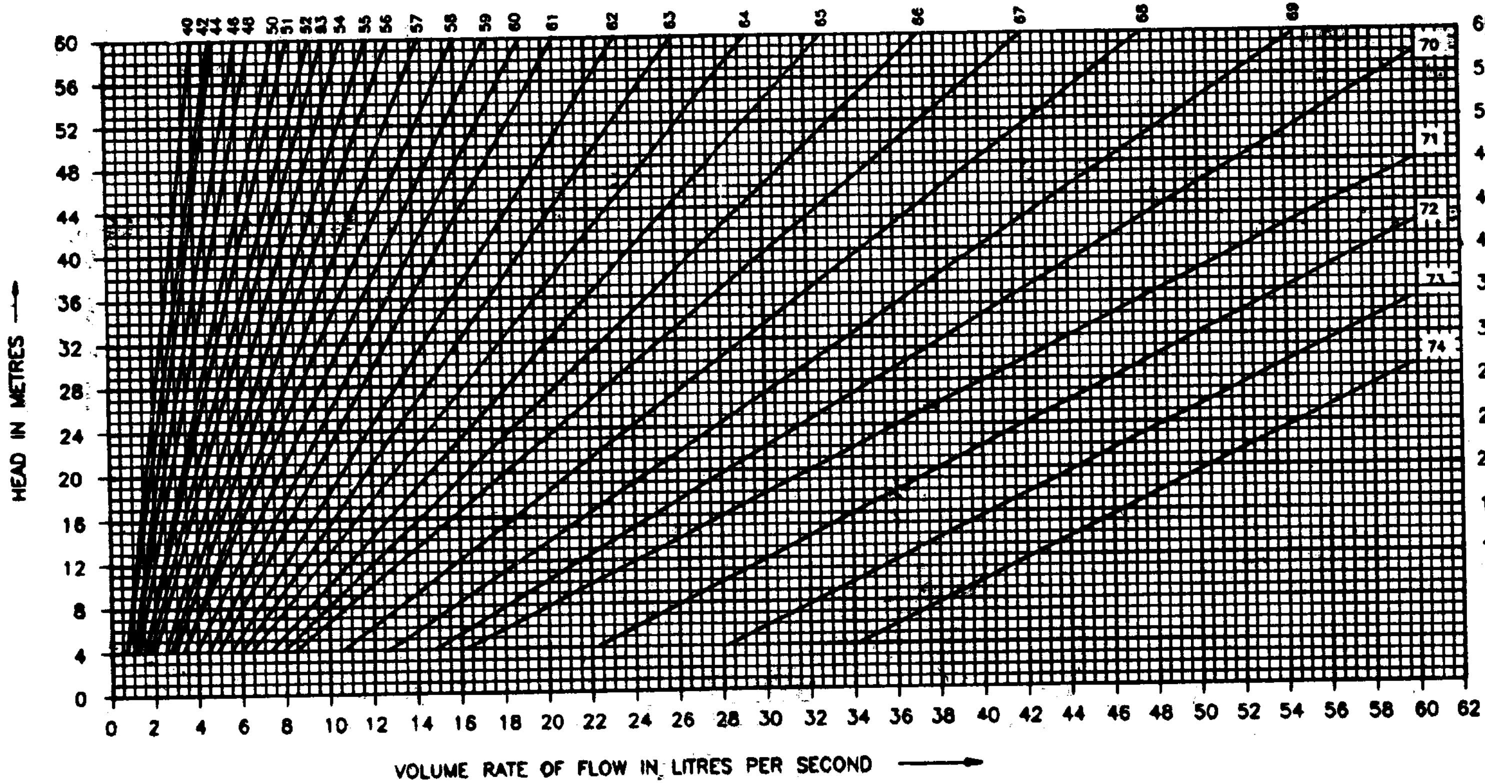


FIG. 2 MINIMUM EFFICIENCY IN PERCENT FOR HORIZONTAL CENTRIFUGAL PUMPS FOR AGRICULTURAL PURPOSE

(SPEED 2001 to 3600 rmp)

2.5.3. *Corrections and Allowances*

2.5.3.1 Power delivered to the pump shaft when directly connected shall be the power output of the driving element, when not direcly connected, corrections shall be made for the losses between the driving element and the pump. In the case of flat belt and V-belt drives, the allowances for belt losses may be taken as 6 and 3 percent, respectively.

2.5.3.2 *Correction in manometric suction lift for higher altitude and water temperature.*

a) *Correction for altitude*

Barometric pressure should be recorded at test place. The difference between atmospheric pressure at test place and 10.33 m water column (i.e. atmospheric pressure at mean sea level) shall be deducted from manometric suction lift figures given in Table1.

b) *Correction for temperature*

Manometric suction lift specified in Table 1 shall be increased or decreased as given in Table 2, when water temperature is below or above 33° C

Table 2 Correction for Temperature in Manometric Suction Lift.

(*Clause* 2.5.3.2)

Water Temperature °C	Vapour Pressure m	Correction in Manometric Suction Lift Above and Below 33° C Water Temp. m
10	0.13	+ 0.39
15	0.18	+ 0.34
20	0.24	+ 0.28
25	0.33	+ 0.19
30	0.43	+ 0.09
33	0.52	+ 0.00
35	0.58	- 0.06
40	0.76	-0.24
45	1.00	- 0.48
50	1.28	- 0.76

3 MONOSET PUMPS FOR CLEAR, COLD WATER FOR AGRICULTURAL PURPOSES

3.1 IS 9079 : 1989 specifies the technical requrements for electric monoset pumps for handling clear, cold water for agricultural purposes.

3.2 Requirements

3.2.1 *General Requirements* — Major requirements of general nature are as given below

3.2.1.1 *Casing* — Pump casing shall be of robust construction and shall be tested to withstand 1.5 times the maximum discharge pressure

3.2.1.2 *Impeller* — In case of 2-pole motors, the impller shall be dynamically balanced to grade 6.3 mm/s of IS 11723 : 1992. In case of 4-pole motors, the impeller shall be statically balanced.

NOTE — Balancing here means the balancing of the unbalanced rotating mass in the impeller and not balancing of the axial hydraulic thrust in the impeller.

3.2.1.3 *Shaft* — The shaft shall be of adequate size to transmit the required power. The shaft shall be finished to close tolerances at the impeller, pulley and bearing diameters. The impeller, pulley and shaft sleeve shall be firmly secured to the shaft by keys or nuts or both.

3.2.1.4 *Efficiency* — The overall minimum efficiency of monoset pumps at duty point as declared by the manufacturer for 2 and 4 pole shall be as given in Fig. 3 and 4 and beyond this range, the efficiency shall be declared by the manufacturer.

3.2.1.5 *Performance* — The specified range shall lie on the stable portion of the head characteristic curve. This is applicable in case of parallel operations of pumps only.

3.2.1.6 *Suction and delivery ends* — The size of the suction end of a double suction pump should preferably be one size larger than that of the delivery. This is to offset the increased loss in the suction. Typical sizes of pipes used are:

85/65, 100/75, 125/100, 150/125, 200/150 and 250/200 mm, etc.

3.2.1.7 For a high pressure pump, a reflux valve shall be connected on the delivery side.

3.2.1.8 *Liquid passages* — All the liquid passages in the casing and the impeller which are inaccessible to machining shall be finished to smooth surfaces as far as possible.

3.2.1.9 *Draining plugs* — Tapped drain holes with plugs shall be provided for draining the Liquid that may drip from the sealing arrangement. The sealing arrangement shall be sufficiently deep to provide for sufficient quantity of packing to prevent leakage of air.

3.2.1.10 *Bearings* — The bearings may be ball, roller or sleeve bearings. In the latter case, some sort of thrust bearings are necessary. If sleeve bearings are used, they are to be machined for close running fit. The bearings shall be so designed as to take up the necessary radial load as well as the net hydraulic axial thrust. Bearings shall be lubricated properly.

The bearings should be designed for a minimum life of 20 000 hours or 40 000 hours as required.

The bearing housings shall be designed in such a manner that no liquid being pumped should enter the housing.

Where there is a possibility of fluid entering the bearings, the pump shall be provided with suitable preventive arrangements, for example, deflectors.

3.2.1.11 *Stuffing boxes* — The stuffing boxes shall be extra deep and provided with a cooling water jacket if so required. In addition, provision for tapping of the leakage liquid shall also be made. The packing materials employed shall be suitable for withstanding the special conditions such as temperature, corrosion due to the liquid being handled, etc. Wherever possible, suitable mechanical seals may be used.

3.2.1.12 *Base plates* — The base plate which accommodates the pump and the prime mover, when provided, shall be rigid and stable so that alignment is not affected under normal working conditions.

3.2.2 *Design Requirements*

3.2.2.1 The pump shall have suitable features properly designed to ensure satisfactory performance. In particular, the design features, such as the following shall be incorporated:

a) The pump shall be capable to give discharge without overloading the prime mover, within the permissible current at rated voltage and supply frequency, at minimum + 5 percent and - 15 percent of guaranteed duty point head upto 20 m. Above 20 m, the pump shall be capable to give discharge without overloading the primemover, within the permissible current at rated voltage and supply frequency at minimum -3m of guaranteed duty point head.

b) The pump shall be capable of working under manometric suction lift of 6 metres at guaranteed duty point at mean sea level and at water temperature 33°C for pumps with 4-pole motors. For 2-pole motors, the following manometric suction lift at specified duty point at mean sea level at a temperature of 33°C shall be maintained.

Range of Volume Rate of Flow l/s	*Manometric Suction Lift (Min)* m
Up to 24.0	6.0
24.0 to 29.0	5.5
29.0 to 33.5	5.0
33.5 to 38.5	4.5
38.5 to 43.5	4.0

NOTE - While the manometric suction lift indicated above is to be maintained at guaranteed duty point, it may not be always practicable to achieve this situation during testing. In such cases, the requirements of this clause shall be deemed to have been met if the manometer suction lift is maintained at ± 5 percent of guaranteed duty point.

3.2.2.2 *Voltage and frequency variation*

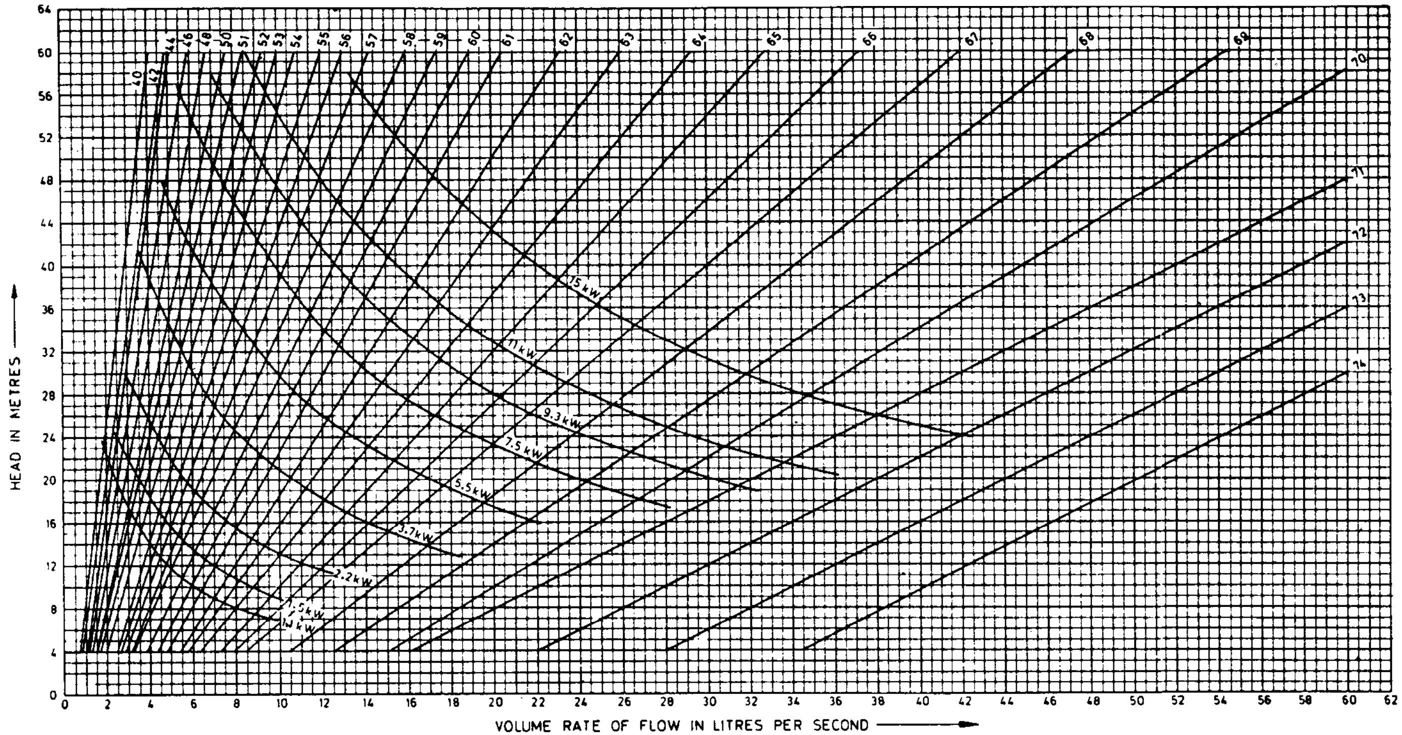
Motor of the monoset pump shall be capable of delivering the rated output :

a) With the terminal voltage differing from its rated value by not more than + 6 percent and - 15 percent.

b) The frequency differing from its rated value by not more than ± 3 percent, or

c) Any combination of a) and b).

3.3 Material of Construction - Following are the main stipulations about material of construction in the standard.



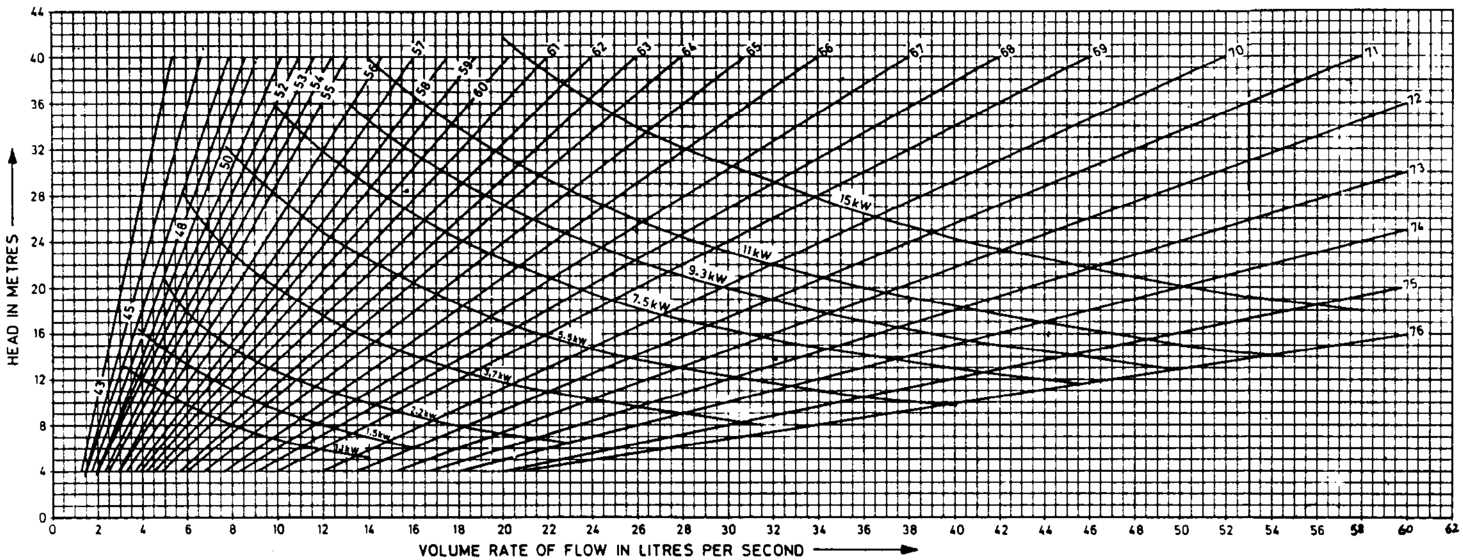
FOR MONOSETS

Motor Ratings kW	Motor Efficiency (%) *Min* Single Phase	Three Phase
0.37	54	—
0.75	63	—
1.1	68	73
1.5	70	74
2.2	—	75
3.7	—	79
5.5	—	80
7.5	—	81
9.3	—	81.5
11.0	—	82
15.0	—	83

NOTES

1. For overall efficiency of the pumpset, multiply pump efficiency by corresponding motor efficiency factor as given in the above table for motor ratings. Whenever the duty point lies between the two curves of ratings, the motor efficiency factor of higher rating shall be taken for multiplication.
2. The motor rating given alongside of curves are based on minimum efficiency and are for guidance only.

FIG. 3 MINIMUM EFFICIENCY IN PERCENT FOR MONOSET PUMP FOR AGRICULTURAL PURPOSES (2 POLE 50 Hz)



FOR MONOSETS		
Motor Ratings	Motor Efficiency (%) *Min*	
kW	Single Phase	Three Phase
0.37	56	—
0.75	66	—
1.1	70	76
1.5	72	77
2.2	—	77.5
3.7	—	80
5.5	—	82
7.5	—	83
9.3	—	85
11.0	—	85.5
15.0	—	86.0

NOTES

1. For overall efficiency of the pumpset, multiply pump efficiency by corresponding motor efficiency factor as given in the above table for motor ratings. Whenever the duty point lies between the two curves of ratings, the motor efficiency factor of higher rating shall be taken for multiplication.

2. The motor rating given alongside of curves are based on minimum efficiency and are for guidance only.

FIG. 4 MINIMUM EFFICIENCY FOR MONOSET PUMPS FOR AGRICULTURAL PURPOSE (4POLE, 50 Hz)

3.3.1 It is recognized that a number of materials of construction are available to meet the needs for pumps handling clear, cold water. A few typical materials are indicated below merely for guidance of the manufacturer and the user:

Sl No.	*Component*	*Material of Construction*
1.	Casing	Casting Grade FG 200 of IS 210 : 1993, or Bronze Grade LTB2 of IS 318 : 1981
2.	Impeller	Casting Grade FG 200 of IS 210 : 1993, or Bronze Grade LTB2 of IS 318 : 1981
3.	Casing ring and impeller ring (if provided)	Casting Grade FG 200 of IS 210 : 1993, or Bronze Grade LTB2 of IS 318 : 1981
4.	Shaft	Grade 40C8 of IS 1570 (Part 2/sec 1) : 1979
5.	Shaft sleeve (if provided)	Bronze Grade LTB2 of IS 318 : 1981, or Chrome steel 07 Cr13 of IS 1570 (Part 5) : 1985

3.4 Testing & Inspection

3.4.1 *Pump Tests* - Pump test shall be carried out in accordance with IS 11346 : 1985.

3.4.2 *Tests for Electrical Performance* - The general requirements of the motor with regard to types of enclosures, methods of cooling, duty-rating and earthing shall be in accordance with IS 996 : 1979 or IS 7538 : 1975.

3.4.2.1 *Single phase monoset* — Routine test, type test and voltage and frequency variation prescribed for single phase monoset are given below.

a) *Routine test* — It shall comprise of (a), (g) and (h) of **15.3.1** of IS 996 : 1979 besides the test for minimum breakaway torque at rated voltage and supply frequency.

These tests at (a), (g) and (h) respectively of **15.3.1** of IS 996 : 1979. are :

1) Test for no load current, power input and speed at rated voltage and frequency. (also capacitor voltage where applicable).

2) Insulation resistance test as per **12.6** of IS 996 : 1979.

3) High voltage test as per **12.7** of IS 996:1979.

b) *Type test* — It shall comprise of the routine test given above and temperature rise test given in IS 9079 : 1989.

3.4.2.2 *Three phase mono sets* — Routine test and type test for three phase monoset prescribed are as given below:

a) *Routine Test* - It shall be done in accordance with **16.3.2** of IS 7538 : 1975.

The following shall constitute the routine tests:

1) Insulation resistance test (before high voltage test only)

2) High voltage test

3) No load running of motor and reading of, current in three phases and voltage.

4) Locked rotor readings of voltage, current and power input at a suitable voltage.

5) Reduced voltage running up test at no load to check the ability of motor to run upto full speed on no-load in each direction of rotation with $\sqrt{3}$ of rated line voltage applied to stator terminals.

b) *Type test*

This shall comprise of the following tests as per IS 7538 : 1975 along with tests at 1), and 2) under **3.4.2.2** a) above and temperature rise test given in IS 9079 : 1989 for 3 phase monosets :

1) Measurement of stator resistance.

2) Locked-rotor readings of voltage, current, power input and torque of squirrel cage motors. (This may be done at a reduced voltage)

3) Reduced voltage running up test at no load to check the ability of motor to run upto full speed on no load in each direction of rotation with $\frac{1}{\sqrt{3}}$ of rated line voltage applied to motor.

4) No load running of motor and reading of voltage, current, power input and speed.

3.5 Guarantees and Tolerances on Pump performance

3.5.1 *Guarantee of Workmanship and Material*

The pumps shall be guaranteed by the manufacturer against defects in material and workmanship, under normal use and service, for a period of at least 15 months from the date of despatch or 12 months from the date of commissioning whichever is less.

3.5.2 *Guarantee of Performance*

The pumps shall be guaranteed for their performance of the volume rate of flow and the head at the guaranteed point. The overall efficiency of the pumps shall be guaranteed at the declared point only.

NOTE — The pump performance shall be declared at the rated speed of motor

3.5.2.1 The tolerance allowed on volume rate of flow and overall efficiency shall be as indicated in IS 11346 : 1985.

3.5.2.2 The guarantee shall be deemed to have been met with if the measured values of head, volume rate of flow and overall efficiency are within the limits indicated in IS 11346 : 1985. However, the over all efficiency value shall not be less than the over all efficiency values derived from Fig. 3 and 4. The monoset motor shall not get overloaded in the guaranteed head range of rated voltage and supply frequency by the maximum current not being more than 1.07 times of the maximum allowable full load current when the supply frequency is within the limits ± 3 percent of the rated frequency. The maximum allowable full load current value at rated voltage shall be the maximum full load current declared by the manufacturer and the declaration shall not be more than those specified in clause **12.4** of IS 996 : 1979 and clause **12** of IS 7538 : 1975 at rated voltage and supply frequency, where the limits are not specified in IS 996 : 1979 or IS 7538 : 1975, the same shall be the maximum full load current declared by the manufacturer.

3.5.2.3 The tolerence shall apply to guaranteed duty point only.

3.5.3 Manometeric suction lift is to be reduced for higher altitudes at the rate of 1.15 m for every 1000 m above mean sea level. The temperature correction shall be obtained from steam tables.

4 SUBMERSIBLE PUMPSETS

4.1 IS 8034 : 1989 prescribes the technical requirements for submersible pumpsets commonly used in boreholes (bore wells or tubewells) for handling clear, cold water.

4.2 Requirements - Given below are the main requirements for submersible pumpsets.

4.2.1 *Design features of components*

4.2.1.1 The impellers may be of the enclosed or the semi-open type.

4.2.1.2 The pump shaft may be guided through bearings (metallic or metal based rubber or of other bearing material, that is, carbon, ferro-asbestos or white metal etc); the bearing may be provided in each stage bowl and in the suction and discharge casing. In the case of a single stage pump, only metallic bearing may be provided in the stage bowl. In case of radial flow pump, bearings may be provided in suction and discharge casing and intermediate position at suitable span.

4.2.1.3 The surface finish of the shaft or of the protecting sleeve shall be 0.75 micron Ra, *Max.*

4.2.1.4 The inlet passages of the suction casing shall be streamlined to avoid eddies.

4.2.1.5 The strainer on the suction shall offer the best compromise amongst restraining large solids from entering the pump and containing the suction losses to the minimum.

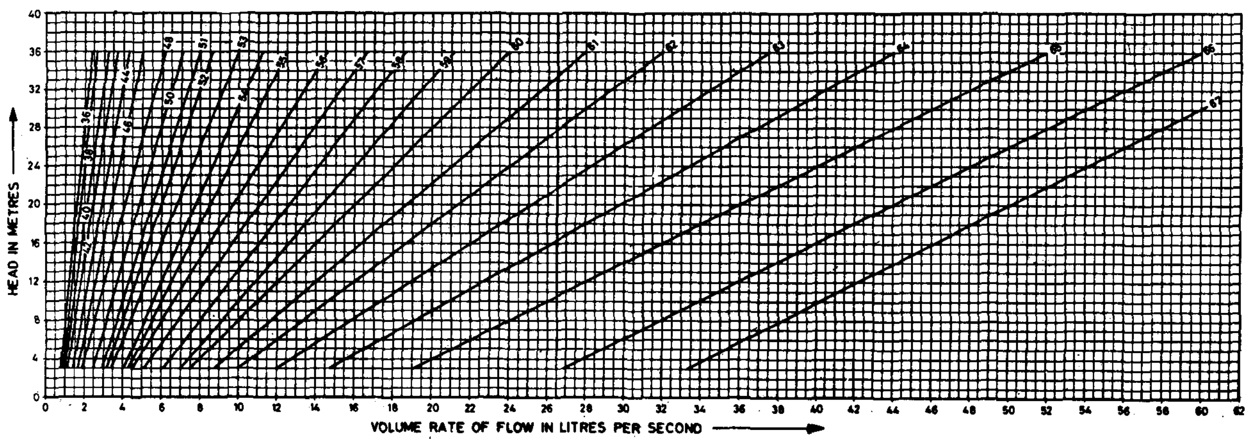
4.2.1.6 The outer periphery of the pump casing shall have provision for securing the cable and cable guards over the cable, so as to prevent damage to the cable.

4.2.1.7 The manufacturer shall have a system of controlling dimensional accuracy within a scheme of fits and tolerance limits. The system shall help interchangability and fitment at site of replacement spares during repair and maintenance.

4.2.1.8 Each impeller shall be balanced dynamically to grade 6.3 mm/s of IS 11723 (Part 1) : 1992.

4.2.2 *Requirements for Submersible Motor and Submersible Cable*

The submersible motor shall conform to IS 9283 : 1979 and the cable shall conform to clause **4.4** of IS 9283 : 1979.



Motor Rating kW	Motor Efficiency Factor Percent, *Min*		
	Bore Sizes, Nominal in mm		
	100	150	200
1.1	56	57	—
1.5	60	66	—
2.2	63	67	69
3.0	63	67	69
3.7	64	68	70
4.5	—	70	72
5.5	—	73	75
7.5	—	74	76
9.3	—	75	77
11.0	—	76	78
13.0	—	77	79
15.0	—	78	80

NOTES

1 The efficiency in figure represents three or more stages:

a) For two stage pump multiply efficiency given by a factor 0.98.

b) For single stage pump, multiply efficiency given by a factor 0.97.

2 The value of efficiency of motors below 1.1 kW and above 15.0 kW shall be as declared by manufacturer.

3 For overall efficiency of the pumpset, multiply pump efficiency by corresponding motor efficiency factor as given above. No reduction shall be allowed at part loads.

4 The efficiency chart includes non-return valve.

FIG. 5 MINIMUM EFFICIENCY IN PERCENT (FOR 2 POLE, 3 PHASE) SUBMERSIBLE PUMPSET

Table 3 Typical Materials of Main Parts of Submersible Pumpset

(*Clause* 4.3)

Sl. No	Name of the Part	Relevant Specification
i)	Bearing sleeve	Bronze grade LTB 3, 4 or 5 of IS 318 : 1981 or 12% chromium steel grade 04 Cr13-12Cr13 and 20Cr13 conforming to IS 1570 (Part 5) : 1985
ii)	Casing wear ring (if provided)	Bronze grade LTB 3, 4 or 5 of IS 318 : 1981
iii)	Bearing bush	Bronze grade LTB 3 or 4 of IS 318 : 1981
iv)	Discharge casing (if provided)	Cast iron grade FG 200 of IS 210 : 1993
v)	Impeller	Bronze grade LTB 2 of IS 318 : 1981 or cast iron grade FG 200 of IS 210 : 1993 or stainless steel grade 12 Cr13 of IS 1570 (Part 5) : 1985
vi)	Pump bowl/diffuser	Cast iron grade FG 200 of IS 210 : 1993
vii)	Pump shaft	Stainless steel 04Cr13, 12Cr13, or 20Cr13 of IS 1570 (Part 5) : 1985
viii)	Suction casing	Cast iron grade FG 200 of IS 210 : 1993

NOTES

1. The materials listed are to be considered as only typical and indicative of minimum requirements of the material properties. The use of materials having better properties is not prejudiced by the details above provided materials for components in bearing contact with each other do not entail galling, corrosion, magnetic induction etc.

2. To benefit from the advancement in technology of plastics, thermoplastic materials, such as, polyphenylene oxide (PPO), polycarbonate, acetal, nylon 66, PTFE, ABS, polyester PETP, etc, may be used for pump parts like bearing sleeve, casing, impeller wearing ring, bowl/diffuser, etc. However, typical materials of the main parts are indicated below for the guidance of the manufacturer and the user.

Sl. No.	*Name of the Part*	*Material*	
i)	Impeller	Glass filled polyphenylene oxide[1] (modified PPO), glass filled polycarbonate[1] properties shall be as given below.	
	Properties	*Modified Pholyphenylene Oxide*	*Polycarbonate*
	Hardness (Rockwell)	M90/L106	M91
	Taber abrasion resistance, g	0.035	0.017
	Coefficient of linear thermal expansion, m/m°C	4 x10^{-5}, *Max*	3 x 10^{-5}, *Max*
	Water absorption, 24h at 23°C, percent	0.06, *Max*	0.29, *Max*
	Notched impact strength Izod, J/m	80, *Min*	100, *Min*
	Specific gravity	1.21 ± 0.03	1.35 ± 0.03
	Tensile strength at break, N/mm^2	90, *Min*	90, *Min*
	Elongation at break, percent	4-6	3
	Mould shrinkage, percent	0.2-0.4	0.2-0.5
	Glass content, percent	20, *Min*	20, *Min*
ii)	Bowl/diffuser	Polyphenylene oxide (modified PPO), polycarbonate, polyacetal or polypropylene	
iii)	Wearing ring	PTEE, ABS or Nylon 66	
iv)	Bearing sleeve	Polyethylene (LD/HT), Nylon 66, PTEE, polypropylene	

[1] Please note glass filling is extremely essential for these grades of plastics in view of abrasion resistance and better life to the end users.

4.2.3 *Requirements for Pump Assembly*

4.2.3.1 Hydrostatic test shall be carried out on individual casing part or pump as a whole in assembled condition at 1.5 times the maximum discharge pressure.

4.2.3.2 The pump may be equipped with replaceable bearing wherever provided.

4.2.4 *Rating* - The output ratings of submersible motors of submersible pumpset shall be 0.37, 0.55, 0.75, 1.1 , 1.5, 2.2, 3.0, 3.7, 4.5, 5.5, 7.5, 9.3, 11.0, 13.0 and 15.0 kW. Beyond 15 kW the rating and efficiency shall be mutually agreed between the manufacturer and supplier

4.3 Material of Construction

It is recognized that a number of materials of construction are available to meet the needs for submersible pumpsets, handling clear, cold water. Typical material for few parts are indicated in Table 3 for the guidance of the manufacturers and the users.

4.4 Testing and Inspection

4.4.1 *Laboratory Tests* — Testing procedures as in IS 9137 : 1978 covered under chapter 4, shall be followed for laboratory test. A typical testing arrangement for submersible pumps is given in Fig 7 of Chapter 4.

4.5 Guarantee

4.5.1 *Guarantee of Workmanship and Material*

The pumps shall be guaranteed by the manufacturer against the defects in material and workmanship under normal use and service for a period of at least 15 months from the date of despatch or 12 months from the date of commissioning, whichever is less.

4.5.2 *Guarantee of Performance*

The pumpsets shall be guaranteed for their performance of the volume rate flow, head, and overall efficiency.

4.5.2.1 The pump shall be tested for operating head range. However, it shall not be less than + 10 per cent and -25 percent of the rated head. Below 30 m, the limits shall be from + 10 percent to -25 percent of the rated head or ± 3m whichever is less. In the above head ranges, motor shall not get over loaded above its rated current.

NOTE : Pump performance shall be declared at the rated speed of motor.

4.5.2.2 The minimum efficiency of the submersible pumpset at duty point declared by the manufacturer shall be as given in Fig. 5.

4.5.3 *Verification of Guarantee* - Shall be same as given in 7,7.1 and 7.2 of IS 11346 : 1985 for rate of flow, head and efficiency.

5 VERTICAL TURBINE MIXED AND AXIAL FLOW PUMP FOR CLEAR, COLD WATER

5.1 IS 1710 : 1989 covers the requirements for vertical turbine (Radial and Francis) mixed and axial type pumps for clear, cold water.

5.2 **Requirements** - The main requirements prescribed are as given below.

5.2.1 *General Requirements*

5.2.1.1 The manufacturer shall indicate in the specification of the pump the minimum size of the well in which the pump shall enter.

5.2.1.2 The pump shall be installed in the well in accordance with the manufacturer's recommendations.

5.2.1.3 The manufacturer shall indicate the submergence required for the satisfactory performance of the pump.

5.2.2 *Requirement for Prime Mover*

5.2.2.1 Unless otherwise agreed, the motor shall be of the drip-proof type and shall comply with IS 325:1978 where applicable. The motor shall be of continuous rating and of suitable size to drive the pump continuously over the specified characteristics range without getting overloaded. Rotation of vertical shaft shall be counter clockwise when viewed from driving end, unless otherwise specified by the purchaser.

5.2.2.2 For engine drive, the power shall be applied to the pump shaft through a propeller shaft with universal joints (spicer shaft) or pulley with flat or V-belt.

5.2.2.3 The pump shall be driven in such a way that it operates within ± 5 percent of the specified speed.

5.2.2.4 A thrust bearing of adequate capacity to carry the weight of all rotating parts, plus the hydraulic down-thrust, shall be provided in the driver or the discharge head as an integral part.

5.2.3. *Requirements for Suction Pipe and Suction Strainer*

5.2.3.1 Normally an open ended suction pipe shall suffice with properly developed tubewells. If the suction strainer is called for by the customer, it may be provided separately or integral with the suction pipe and shall have a net area of openings equal to at least three times the suction pipe cross sectional area.

5.2.3.2 Suction pipe with foot-valve and strainer may be suppplied.

5.2.4 *Requirements for Oil-Lubricated Pump and Column*

5.2.4.1 *Impeller shaft*

Where there are no shaft sleeves on the impeller shaft, shaft shall be of stainless steel conforming to Schedule V of IS 1570 (Part 5) : 1985 (Grades C 7 Cr 13, 15 Cr 13 or 22 Cr 13) and IS 7283 : 1992. If renewable sleeve of bronze or stainless steel is provided on the impeller shaft at bearing portions, the shaft may be made of steel conforming to Grade 40C8, 45C8 or 55C4 of IS 1570 (Part 2/Sec1) : 1979. As recommended by the manufacturer, shaft shall be guided by bearing provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the axis and the shaft ends shall be chamfered on the edges. Shaft shall have a surface finish of 0.75 micron Ra *Max* (*see* IS 3073 : 1967).

The size of the shaft shall be determined on the basis of the following formula of maximum combined shear stress given below :

$$S = \sqrt{\left(\frac{63.7F}{D^2}\right)^2 + \left(\frac{492p \times 10^6}{nD^3}\right)^2}$$

Where S is the combined shear stress in kg/cm^2, D is the shear diameter in mm at the root of the threads or the minimum diameter of any under cut, F is the axial thrust in kg of the shaft, including hydraulic thrust plus the weight of the shaft and all rotating parts supported by it, p is the power transmitted by the shaft in kW and n is the rotational speed in rev/min.

The maximum combined shear stress S shall not exceed 30 percent of the elastic limit in tension or shall be more than 18 percent of the ultimate tensile strength of the shaft steel used. However, for large size pump the shaft shall be checked for fatigue loading also, this may be recommended by the manufacturer. The straightness and machining tolerances shall be the same as those given under line shaft (5.2.4.5).

5.2.4.2 *Impeller*

The impeller may be of the enclosed or semi-open type. Impeller shall be fastened securely to the impeller shaft with keys, taper bushings, lock nuts or split thrust rings. They shall be adjustable vertically by means of a nut in the driver or an adjustable coupling between the pump and the drive. Impeller shall be properly balanced. Dynamic balancing is recommended. Closed impellers may have a renewable sealing/wearing ring fitted on to the front shroud or in the bowl or both.

5.2.4.3 *Bowls*

The castings of bowl shall be free of blow holes, sand holes and other detrimental defects, the bowls shall be capable of withstanding a hydrostatic pressure equal to one and a half times maximum discharge pressure (this includes shut off head).

The bowls may be equipped with replaceable seal rings on suction side of enclosed impellers. Water passages shall be smooth and the bowls may contain bushes to serve as bearings for the impeller shaft.

5.2.4.4 *Discharge case*

The discharge case shall be provided with means of preventing the leakage of water into the shaft enclosing tube and shall have types ports to permit the escape of water that leaks through the seal or bushing.

5.2.4.5 *Line shafts*

The design of the shaft shall also take into consideration the critical speed of the shaft in such a way that the critical speed shall have adequate margin with respect to the operating speed by at least 30 percent on either side.

The shaft shall be furnished with interchangeable sections having a length of 1.5, 2.5 or 3m. The butting faces of shaft shall be machined square to the shaft axis and the shaft ends shall be chamferred on the edges. To ensure correct alignment of the shafts, they shall be straight within 0.125 mm for 3 m length total dial indicator reading. The maximum permissible error in the axial alignment of the thread axis with the axis of the shaft shall be 0.05 mm in 150 mm. In the case of shaft with rigid couplings, the maximum permissible error in the axial alignment of the axis with the axis of the shaft shall be 0.05 mm in 150 mm.

The shaft shall have a maximum surface roughness of 0.75 micron Ra (*see* IS 3073 : 1967).

5.2.4.6 Steel coupling shall be designed with a minimum factor of safety of one-and-a-half times the factor of safety for shafts and shall have left-hand or right-hand threads depending on the direction of rotation of the pump to tighten during the pump operation. The outside diameter of the couplings shall be concentric with the bore and with a small transverse hole in the middle.

5.2.4.7 *Line shaft bearings*

The line shaft bearing shall be of bronze or any other suitable material and shall be spaced at intervals of 1.5, 2.5 or 3 m for 2 600 to 3 500, 2 000 to 2 600 and upto 2 000 rev/min, respectively. The bearings shall be recessed out or heavily chamfered at one end (the top end in the installed condition) to serve as a reservoir of oil for the bearings, and shall also contain oil grooves or separate by-pass hole to allow oil flow to the bearing below.

5.2.4.8 *Shaft enclosing tube*

The shaft enclosing tube shall be of one of the bores 32, 40, 50, 65 and 80 mm and shall conform to the requirements of either IS 1239 (Part 1) : 1990 'Heavy series' or IS 1978 : 1982.

NOTE — Larger sizes may be used by mutual agreement between the purchaser and the supplier.

The standard length of shaft enclosing tube shall be 1.5, 2.5 or 3m.

5.2.4.9 *Column pipe*

The column pipe shall be manufactured from tubes conforming to either IS 1978 : 1982 or Gr A of IS 2062 : 1992. For depths greater than 80 m, the column pipe shall be manufactured from tubes conforming to IS 4270 : 1992.

The standard lengths of column pipes shall be 1.5, 2.5 or 3 m.

The column pipe may be threaded, flanged or provided with other methods of connection.

5.2.4.10 *Discharge head assembly*

At the surface or underground discharge head assembly, an automatic lubricator shall be installed for electric motor driven pumps and manual or other types of lubricator shall be installed for engine driven pumps. The lubricator assembly, automotive or general type, shall be located at operating floor.

A tube tension plate may be installed on the discharge head to tighten up the shaft tubes for the purpose of aligning the shafts. A gland shall be provided to seal off any leakage from the discharge head.

The discharge head shall, in addition to other requirements (*see* **5.2.5.4**) be able to support the weight of the pump.

5.2.5 *Requirements for Water Lubricated Pump*

The same specification shall apply as for oil-lubricated pump except in cases given in **5.2.5.1** to **5.2.5.4**.

5.2.5.1 *Line shafts*

The shaft sections shall be provided with a non-corrosive wearing surface, except in the case of stainless steel shafts, particularly at the location of each guide bearing.

5.2.5.2 *Line shaft bearings*

These shall be designed to be lubricated by external water or the water being pumped and shall be placed in bearing holders held in position at the joint of the columns.

5.2.5.3 *Gland protection*

Water slinger of adequate diameter shall be provided to prevent water from creeping in to the motor.

5.2.5.4 *Discharge head*

The discharge head shall have an arrow indicating the direction of rotation of pump.

The discharge head may have a stuffing box with a renewable bushing. The head may include prelubrication connection to wet the line shaft bearings before starting the pumps, if it is not provided with a foot-valve and strainer.

Where manual control is used and a source of fresh water under pressure is not available, a prelubricating tank, with necessary valves and fittings to connect it to the pump, shall be provided. The size of the tank shall be adequate to permit thorough wetting of all the line shaft bearings before power is applied, with an adequate reserve for repeating the process in the event of the pump's failure to start in the first attempt.

5.2.6 *Essential Design Features of Pump*

5.2.6.1 The pumps shall satisfy the following basic design features:

a) It shall have a rising head charcteristics;

b) The impeller adjustment shall be such that the impellers run free in any installed condition in spite of the extension of line shaft caused by hydraulic down-thrust, the weight of shafting and impellers; and

c) It shall be designed for non-overloading of the prime mover.

5.3 Material of Construction

It is recognized that a number of materials of construction are available to meet the needs for these pumps. The typical materials of construction of various parts are given in IS 1710 : 1989 for guidance.

5.4 Testing and Inspection -Main stipulations/guidelines for testing and inspection of these pumps are covered under Chapter 4.

5.5 Guarantees

For guarantee of the pumps with Class C ratings **2.2.1** and **2.5.4** of Chapter 4 and for pumps with class B ratings, **4** and **9.4** of IS 10981 : 1983 shall be referred.

5.5.1 *Guarantee of Workmanship and Material*

The pumps shall be guaranteed by the manufacturer against defects in material and workmanship, under normal use and service, for a period of at least 15 months from the date of despatch or 12 months from the date of commissioning whichever is less.

5.5.2 *Guarantee of Performance*

The pump shall be tested for the operating head range. However, the range shall be between + 10 percent and -25 percent of the rated head. Below 30 m, the limit shall be -25 percent to + 2.5 percent or ± 3 m whichever is less. The tolerance on discharge shall be ± 2.5 percent and for the other duty points, tolerance shall be according to Annex A of IS 9137 : 1978 discussed **2.2.1.2** in Chapter 4, for mass produced pumps.

5.5.2.1 The efficiency of vertical turbine pump shall be guaranteed at the specified point of rating only and shall not be guaranteed to cover the performance of the pump under conditions varying therefrom nor for a sustained performance of any period of time. However, pump discharge may be guaranteed for the range of head between -25 percent and + 10 percent of the specified head when the latter is 30 metres or above. Below 30 meters the limits shall be from - 25 percent to +25 percent or ± 3 meters whichever is less.

6 JET CENTRUFUGAL PUMP COMBINATION

6.1 IS 12225 : 1987 specifies requirements for jet centrifugal pump combination used for pumping water from wells beyond suction capacity of horizontal/ vertical end suction centrifugal pumps. The standard covers twin type, duplex type and packer type jet centrifugal pump combinations.

6.2 Requirements — Main requirements prescribed in this standard are given below.

6.2.1 *Centrifugal pumps*

The centrifugal pump may conform (for constructional features) to IS 6595 (Part 1) : 1993 or IS 9079 : 1989.

6.2.2 *Prime mover (in case of coupled and belt driven sets)*

6.2.2.1 *For motor drive* - In case of coupled or and belt driven sets the motors shall conform to IS 7538 : 1975 or IS 996 : 1979. In case of mono sets the motor for monoset pump shall conform to testing and performance requirements of IS 9079 : 1989.

6.2.2.2 *For engine drive* - The engine shall conform to IS 11170 : 1985 or IS 7347 : 1974.

6.2.3 *Requirements for Pump Selection*

6.2.3.1 Jet centrifugal pump combination shall be selected in such a way that its capacity is not more than the yield of the well.

6.2.3.2 If the pump is to be installed on a tubewell or bore hole, the diameter of the well shall be known.

For each jet pump, there is a limitation of minimum size of well diameter. If the well diameter is less than specified, jet pump shall not go inside the well. The maximum diameter of outer pipe coupling or the maximum dimension of jet pump shall be less by 6 mm than that of bore well for ease of installation.

6.2.4 *Requirement for Pump Discharge Pressure*

It is important that in the operation of the jet centrifugal pump combination, discharge pressure which is specified on performance chart for jet centrifugal pump combination shall be maintained. If discharge head required is less than the minimum operational presure for the given jet centrifugal pump combination, pressure is created by throttling the pressure regulating valve. For all depths, it is necessary to ensure that this minimum pressure of water is maintained.

6.3 Material of Construction

Materials of construction prescribed for various components are as follows:

Sl. No.	*Name of Part*	*Relevant Specification*
i)	Nozzle	Brass Gr HTB 1 of IS 304 : 1981 or bronze Grade LTB2 of IS 318 : 1981 or suitable plastics
ii)	Venturi	Brass Gr HTB 1 of IS 304 : 1981 or bronze LTB2 of IS 318 : 1981 or suitable plastics
iii)	Foot valve	Bronze Gr LTB 2 of IS 318 : 1981 or brass Gr HTB1 of IS 304 : 1981
iv)	Strainer of foot valve	Suitable plastic/brass/ bronze/stainless steel
v)	Jet pump body	Cast iron Gr FG 200, *Min* of IS : 210-1993 or bronze Gr LTB2 of IS 318 :1981 or brass Gr HTB1 of IS 304 : 1981
vi)	Pressure regulating valve	
	1) Body	Cast iron Grade FG 200, *Min* of IS 210 : 1993 or bronze Gr LTB2 of IS 318 : 1981 or brass Gr HTB1 of IS 304 : 1981
	2) Diaphragm	Neoprene rubber (Shore hardness 50-55)
	3) Valve seat	Bronze Gr LTB2 of IS 318 : 1981
vii)	Slip coupling (optional)	
	1) Body	Cast iron Gr FG 200, *Min* of IS 210 : 1993
	2) Sealing ring	Neoprene rubber (Shore hardness 50-55)
viii)	Packer head/duplex head and flanges.	Cast iron Gr FG 200 of IS 210 : 1993

6.4 Testing and Inspection

Stipulations on testing and inspection of these pumps are covered under Chapter 4.

6.4.1 *Pressure Testing*

The pump casing and the jet unit shall be hydraulically tested to minimum 1.5 times system's maximum pressure.

6.5 Tolerance

At rated speed, the pump at duty point shall deliver minimum 92 percent of the rated discharge at a depth to low water level and total head not less than 92 percent of the rated head. The power absorbed at the duty point shall be not more than 110 percent of the declared duty point power. However, the prime mover shall not get overloaded.

7. DEEPWELL HANDPUMP - INDIA MARK II

7.1 IS 9301 : 1990 covers the requirements for deepwell handpumps - Indian Mark II for lifting water from well of depth 20 m or more upto 50 m. These pumps shall be used for bores fitted with casing pipes of nominal diameter from 100 mm to 150 mm.

7.2 Requirements

7.2.1 *General Requirements*

7.2.1.1 The material, tolerances, etc, shall be as given in respective figures in the standard for different parts of deepwell handpump.

7.2.1.2 The riser pipe holder welded in the water tank shall be machined from solid bar.

7.2.1.3 The riser pipe shall be 32 mm nominal bore, hot dipped galvanized, screwed and socked pipe in 3 metre length with a tolerence of $^{+0}_{-25}$ mm conforming to IS 1239 (Part1) : 1990 medium class. The socket shall be manufactured from seamless pipe or machined from solid bar conforming to Gr. A of IS 2062-1992 with the dimensions (length and diameter) specified in IS 1239 (Part 2) : 1992 and shall be hot dipped galvanized. One end of the riser pipe shall be fitted with hot dipped galvanized coupler and the other with a thread protector.

7.2.1.4 The welding shall be done in accordance with IS 9595 : 1980. Welding for stainless steel components shall conform to IS 2811 : 1987.

7.2.1.5 The casting shall conform to grade FG 200 or higher of IS 210 : 1993.

7.2.1.6 The bronze castings shall conform to Grade LTB 2 of IS 318 : 1981.

7.2.1.7 The connecting rod shall be of 12 mm diameter conforming to bright bar of type 4 and Grade 2 or 3 of steel other than free cutting steel conforming to IS 9550 : 1980. The electro-galvanizing shall conform to service condition No. 4 of IS 1573 : 1986. Alternatively, the connecting rod may be manufactured from stainless steel grade 04Cr18Ni10 conforming to IS 6603 : 1972.

NOTE - It is recommended to use stainless steel connecting rods where the water containing iron contents exceeds 1 ppm or *p*H value is less than 6.5.

7.2.1.8 The steel plates/sheets, angle iron and square bars for fabrication of pumps shall conform to Grade A of IS 2062:1992.

7.2.1.9 The locking of check valve guide with rubber seat retainer shall be done by means of punch locking.

7.2.1.10 Plunger rod of 12 mm diameter shall conform to Grade 04 Cr 18 Ni 10 of IS 6603 : 1972.

7.2.1.11 Each connecting and plunger rod shall be fitted with HDPE thread protector before despatch.

7.2.1.12 Polytetrafluoroethylene (PTFE) tape or equivalent shall be used on the riser pipe before installation.

7.2.2 *Requirements for Anti Corrosive Treatment*

7.2.2.1 *Electrogalvanzing*

a) The following shall be electrogalvanized and passivated according to the service condition No. 4 of IS 1573 : 1986 :

1) Connecting rod, and

2) Bearing spacer.

b) All bolts, nuts and washers in the assembly excepting high tensile bolt shall be electrogalvanized and passivated according to the service condition No. 3 of IS 1573 : 1986.

7.2.2.2 *Galvanizing*

The following assemblies shall be hot dip galvanized according to IS 4759 : 1984 :

a) Stand assembly,

b) Water tank assembly,

c) Head assembly, and

d) Handle assembly except the inside portion of bearing housing.

The galvanized assemblies shall be given chromate conversion coating Type C according to IS 9839:1981.

7.2.2.3 *Painting*

The exterior surfaces of cast iron components shall be given the following treatment:

a) One coat of red oxide primer, conforming to IS 2074 : 1992, and

b) Two coats of synthetic enamel paint conforming to IS 2932 : 1974.

7.2.2.4 Chain assembly shall be boiled in graphite grease for better anti-corrosion.

7.2.3 *Dimensional and Constructional Requirements*

Dimensional and constructional features of most of the components of the pump have been given in the IS 9301 : 1990 with the help of figures, for details of which, this specification may referred to. For construction features of main assemblies, *see* Fig. 6 to 12.

7.3 Material of Construction

For material of construction of various components *see* Fig 6 to 12.

7.4 Testing & Inspection

The stipulation for testing and inspecting have been covered already in Chapter 4.

7.5 Guarantee

The pump and accessories shall be guaranteed for 12 months from the due date of installation or 18 months from the date of supply, which ever is earlier against bad workmanship/bad material. The life of leather/ rubber components, shall however, be guaranteed for only six months from the date of supply.

8 DEEP WELL HANDPUMPS (VLOM)

8.1 IS 13056 : 1991 covers village level operation and maintenance (VLOM) deepwell handpumps, also known as India Mark-III deepwell handpumps, for lifting water from borewell fitted with casing pipes of nominal diameter 125 to 150 mm and static water level from 20 m up to 40 m.

8.2 Requirements

8.2.1 *General Requirements*

Some of these requirements are same as given under **7.2.1.1, 7.2.1.4, 7.2.1.5, 7.2.1.6, 7.2.1.7, 7.2.1.8, 7.2.1.11,** and **7.2.1.12**. Other requirements of general nature are given below.

8.2.1.1 The riser pipe holder welded in the water tank shall be machined from seamless tube or solid bar conforming to Grade A of IS 2062:1992.

8.2.1.2 The riser pipe shall be 65 mm nominal bore hot dipped galvanized, screwed and socketed pipe in 3 meter length with a tolerance of $^{+0}_{-50}$ mm conforming to IS 1239 (Part I) : 1990 medium class. One end of the riser pipe shall be fitted with hot dipped galvanized socket and the other with a thread protector.

8.2.1.3 The socket shall be manufactured from seamless pipe or machined from solid bar conforming to Grade A of IS 2062:1992 with the dimensions (length and diameter) as specified in IS 1239 (Part 2) : 1992 and shall be hot dipped galvanized.

8.2.1.4 The material, tolerances etc, shall be as given in the respective figures in IS 13056 : 1991.

8.2.2 *Requirements for Anti Corrosive Treatment*

These are same as given under **7.2.2** for Deepwell Hand pumps as per IS 9301 : 1990 except that **7.2.2.2** shall be modified to add third plate in the list of assemblies/parts which shall be galvanized according to IS 4759 : 1984.

8.2.3 *Dimensional & Constructional Requirements*

Dimensional and constructional features of most of the components of the pump have been given in the standard (IS 13056 : 1991) with the help of figures for the details of which the standard may be referred to. For constructional features of main assemblies (except cylinder assembly), Fig. 6 to 11 may be referred to. For constructional features of cylinder assembly for VLOM pump *see* Fig 13. For dimensional and constructional features of individual components, the relevent drawings of IS 13056 : 1991 may be referred to.

NOTE - While referring to Fig. 11 for the constructional and material features for axle washer for deepwell handpump (VLOM). IS 13056 : 1991 may be referred to.

8.3 Material of Construction

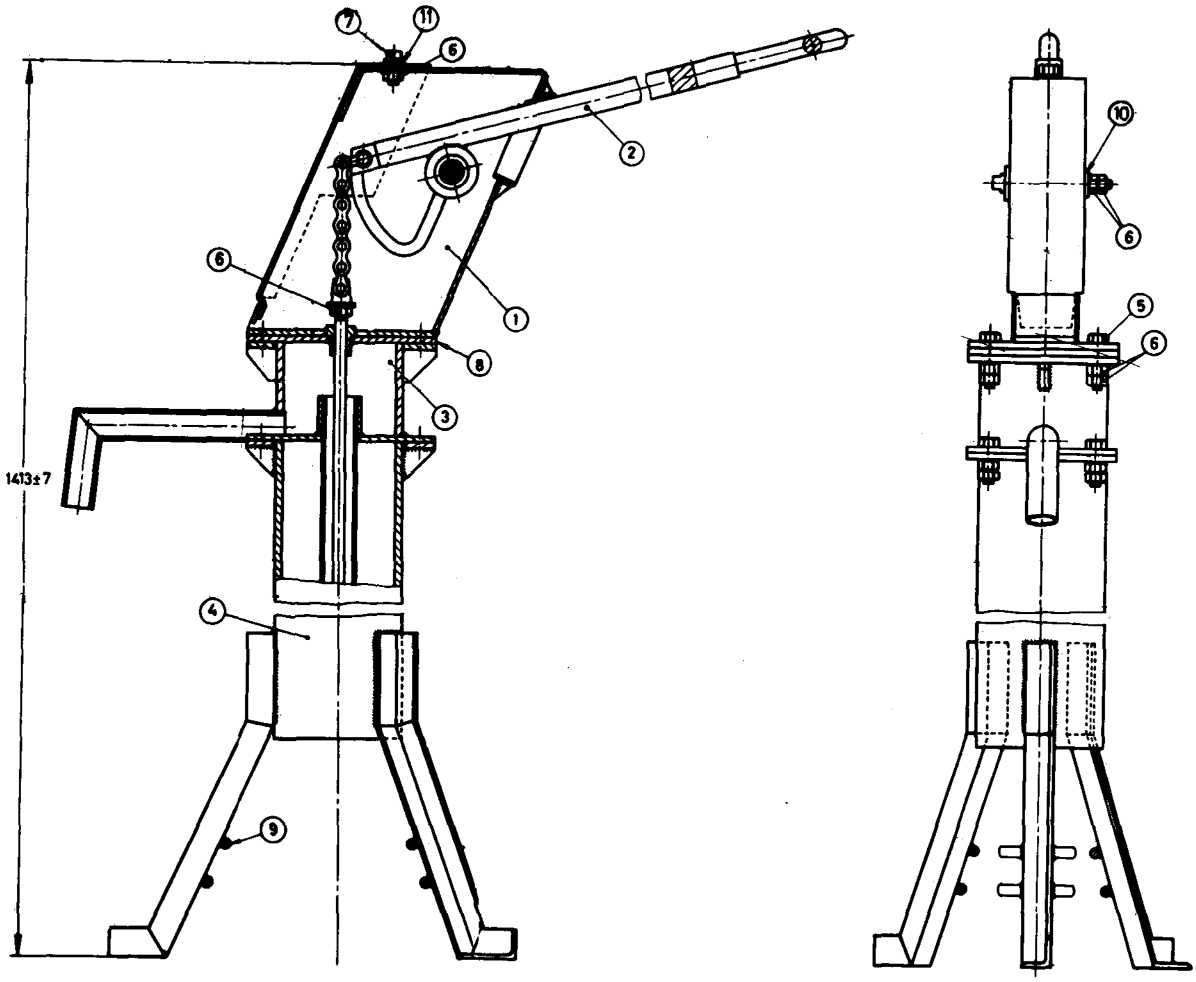
For material of construction of various components *see* Fig. 6 to 11 and Fig. 13.

8.4 Testing and Inspection

The stipulations for testing and inspection have been covered in Chapter 4.

8.5 Guarantee

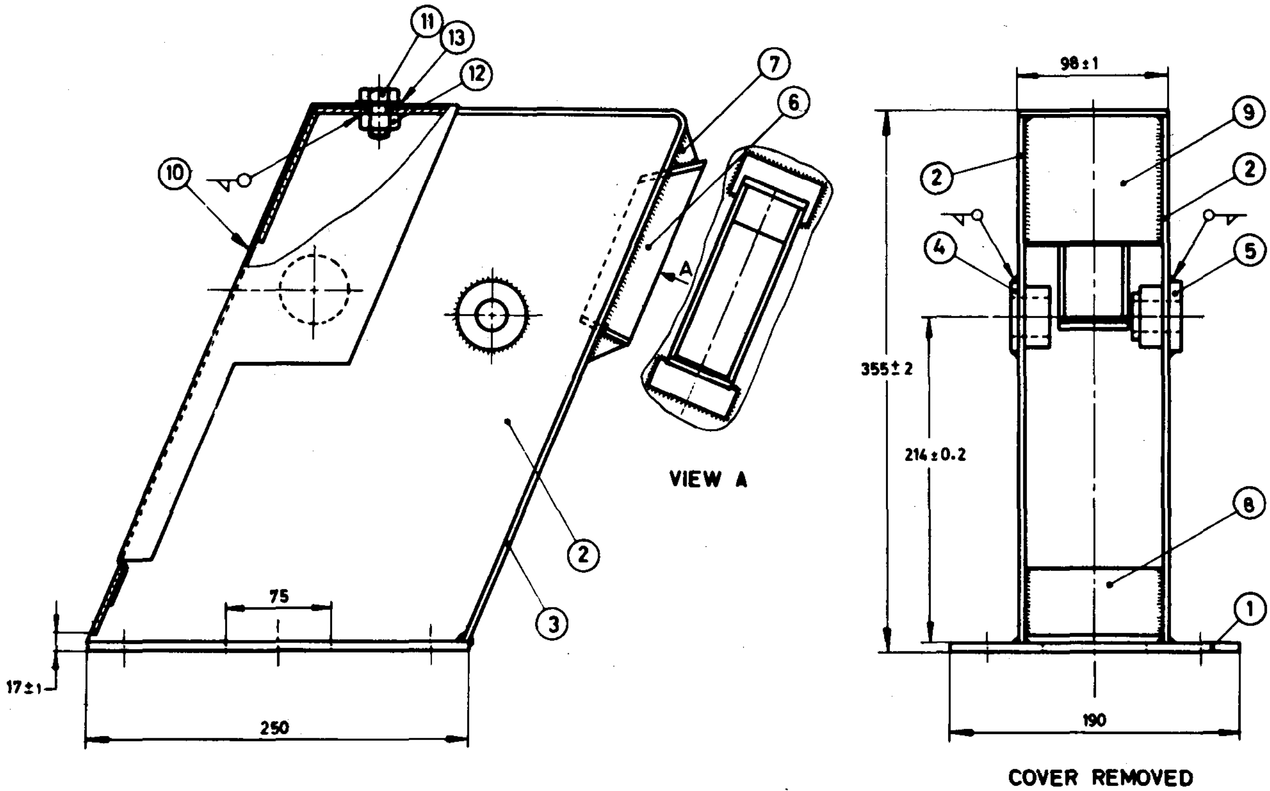
The pump and accessories shall be guaranteed for 12 months from the date of installation or 18 months from the date of supply whichever is earlier against bad workmanship/bad materials. The life of rubber leather components shall, however, be guaranteed for only 6 months from the date of supply.



Part No.	No. Of	Description	Material
11	1	Washer (As per Fig. 6H of IS 9301 : 1990)	Grade A of IS 2062 : 1992
10	1	Wahser (As per Fig. 6H of IS 9301 : 1990)	Grade A of IS 2062 : 1992
9	6	Spikes	Grade A of IS 2062 : 1992 or bright bar Type 4 Grade 2 or 3 of IS 9550 : 1980
8	1	Third plate	Grade A of IS 2062 : 1992
7	1	Hex bolt M12 x 20	IS 1363 (Part 1) : 1992
6	20	Hex nut M12	IS 1363 (Part 3) : 1992
5	8	Hex bolt, M12 x 40	IS 1363 (Part 1) : 1992
4	1	Stand	—
3	1	Waster tank	—
2	1	Handle assembly	—
1	1	Head assembly	—

All dimensions in millimetres.

FIG. 6 DEEPWELL HANDPUMP



Part No.	No. Of	Description	Material
13	1	Washer (As per Fig. 6H of IS 9301 : 1990)	Grade A of IS 2062 : 1992
12	1	Hex nut M12	IS 1363 (Part 3) : 1992
11	1	Hex bolt M12 x 20	IS 1363 (Part 1) : 1992
10	1	Front cover	Ordinary Grade of IS : 513 : 1986
9	1	Front top end plate	Grade A of IS 2062:1992
8	1	Front bottom end plate	Grade A of IS 2062:1992
7	2	Gusset	Grade A of IS 2062:1992
6	1	Bracket	Grade A of IS 2062:1992
5	1	Axle bush (left)	Grade A of IS 2062:1992
4	1	Axle bush (right)	Grade A of IS 2062:1992
3	1	Back plate	Grade A of IS 2062:1992
2	2	Side plate	Grade A of IS 2062:1992
1	1	Pump head flange	Grade A of IS 2062:1992

NOTES

1 Inside fillet welding of side plates and back plate to the flange should be 3.2 mm, *Min.*

2 Welding fillets in other places should be 4 mm, *Min.*

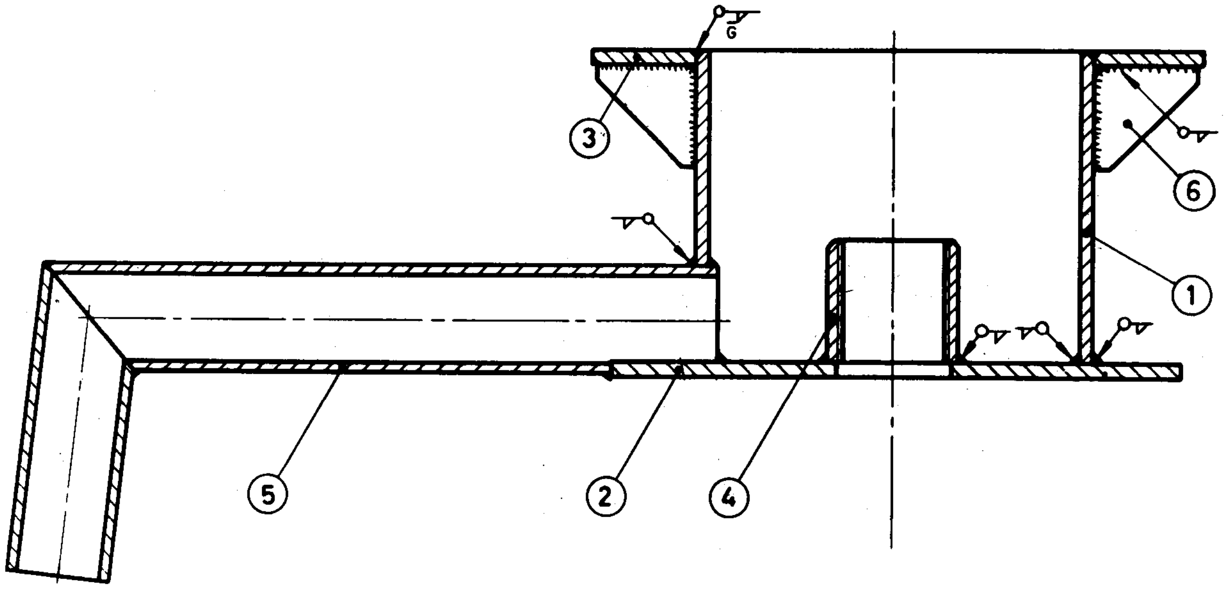
3 The side plate shall be welded inside and outside as shown in the drawing.

4 The head assembly shall be welded from inside and outside. The outside seal welding run shall be ground smooth.

5 Reaming of the lef and right axle bushes shall be done to ensure internal dimensions and alignment.

All dimensions in millimetres.

FIG. 7 HEAD ASSEMBLY



Part No.	No. Of	Description	Material
6	2	Gusset	Grade A of IS 2062:1992
5	1	Spout	IS 1239 (Part 1) : 1990
4	1	Riser pipe holder	Grade A of IS 2062:1992
3	1	Tank top flange	Grade A of IS 2062:1992
2	1	Tank bottom flange	Grade A of IS 2062:1992
1	1	Tank pipe	IS 1239 (Part 1) : 1990

NOTES

1 Fillet size of weld at all places shall be minimum 6 mm excepting spout where it shall not be less than 4 mm. The inside welding of the tank pipe shall be given a sealing run.

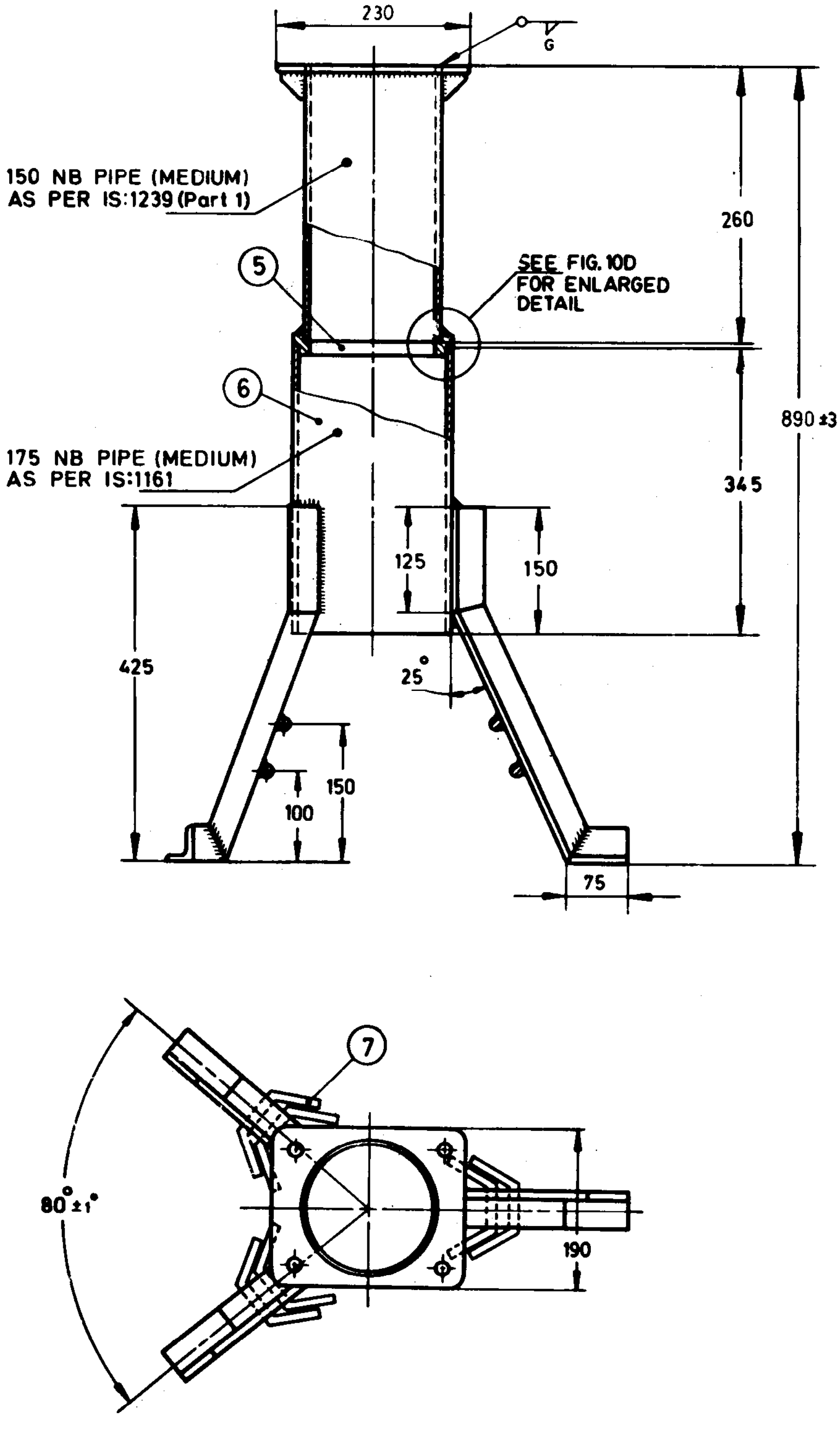
2 One side of the coupling to be faced.

3 Sealing run on the top flange to be ground smooth.

4 Verticality of riser pipe holder to be ensured during the fabrication.

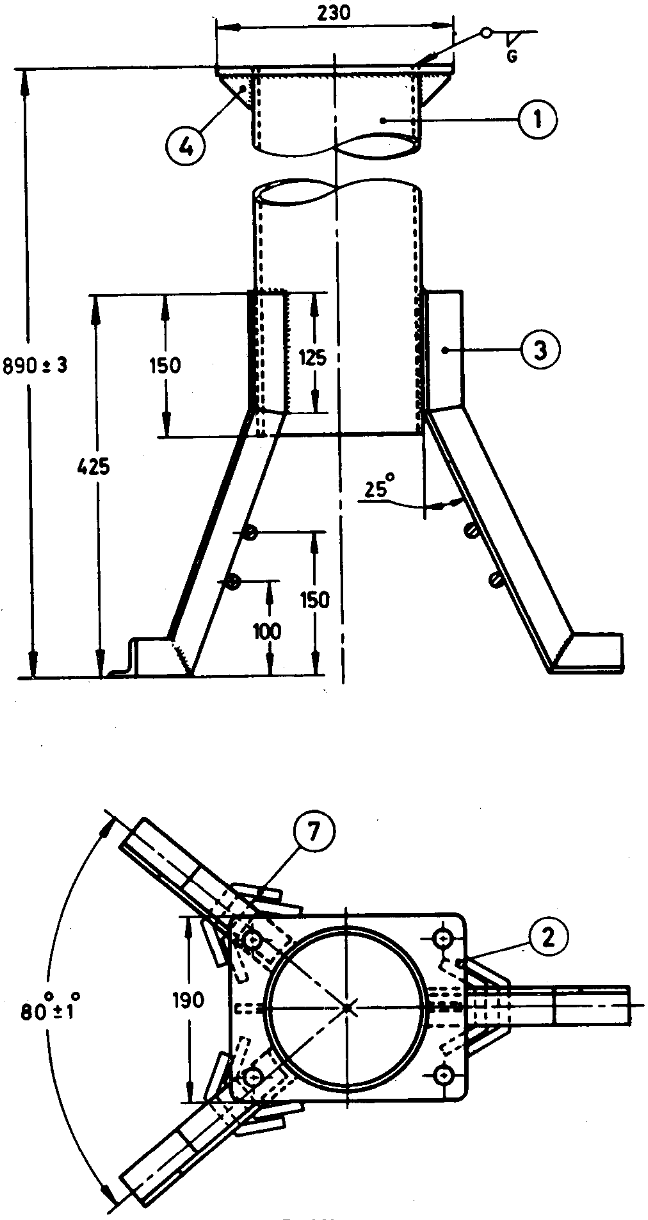
All dimensions in millimetres.

FIG. 8 WATER TANK



All dimensions in millimetres.

9A TELESCOPIC STAND ASSEMBLY



9B STAND ASSEMBLY

7	6	Spikes	Grade A of IS 2062:1992
6	1	175 NB pipe	IS 1161 : 1979
5	1	Reducer collar for telscopic stand assembly	Grade A of IS 2062:1992
4	2	Gusset	Grade A of IS 2062:1992
3	3	Leg	IS 808 : 1989
2	1	Stand flange	Grade A of IS 2062:1992
1	1	Stand pipe	IS 1239 (Part 1) : 1990
Part No.	**No. Of**	**Description**	**Material**

NOTES

1 *Stand Assembly* — Recommended for use in bore wells having 100 mm and 125 mm NB casing pipe.

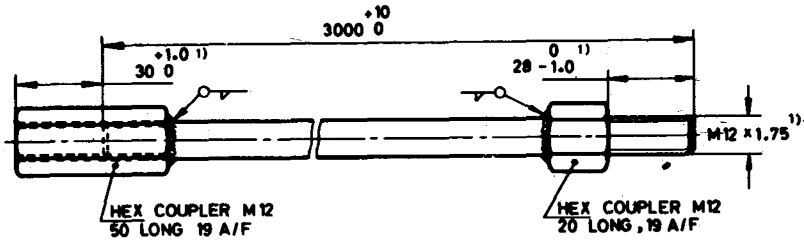
2 *Telescopic Stand Assembly* — Recommended for use in bore wells having 150 mm NB casing pipe.

3 The spikes shall be welded at 100 mm and 150 mm height respectively from the bottom of the leg.

4 In case of non-availability, 175 NB pipe may be rolled and welded from 4 mm sheet conforming to Grade A of IS 2062 : 1992 keeping other dimensions as per IS 1161 : 1979.

All dimensions in millimetres.

FIG. 9 STAND ASSEMBLY



NOTES

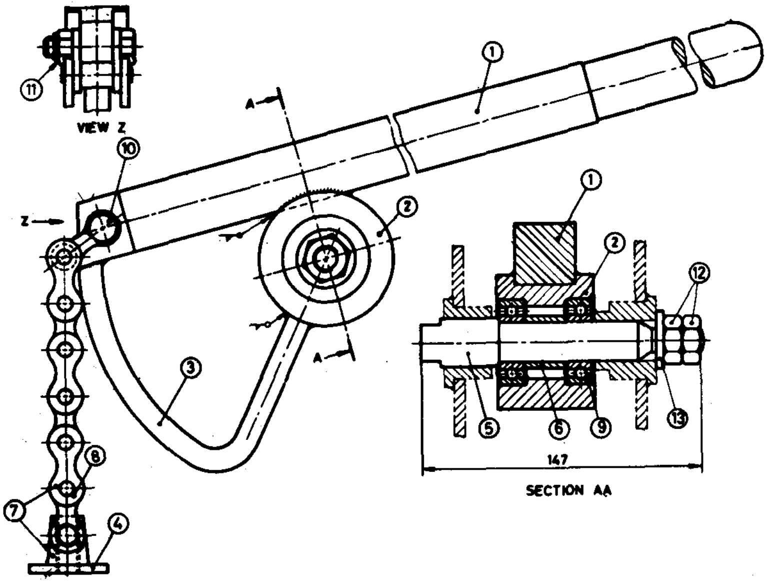
1 Electro-galvanizing according to IS 1573 : 1986 service condition No. 4 (Not applicable to stainless steel).

2 The tolerance of thread shall conform to IS 4218 (Part 4) : 1976 and IS 4218 (Part 5) : 1979, class 6 g for bolts and 6h for nuts

3 Tapping permitted after electro galvanising, if required.

All dimensions in millimeters.

FIG. 10 DIMENSIONS FOR CONNECTING ROD



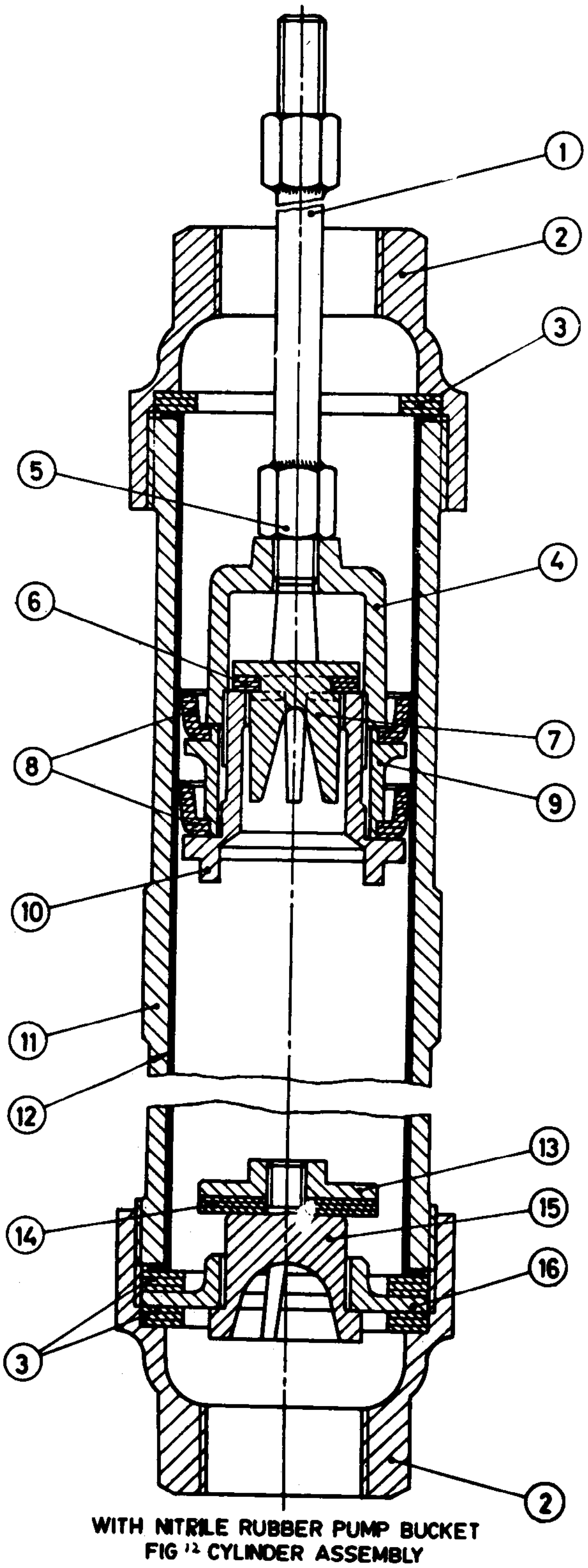
Part No.	No. Of	Description	Material
13	1	Axle washer (As per Fig. 6H of IS 9301 : 1990)	Grade A of IS 2062 : 1992
12	2	Hex nut—M12	IS 1363 (Part 3) : 1992
11	1	Prevailing torque type steel hex locknut M 10 x 1.5	IS 7002 : 1991
10	1	Hex bolt M 10 x 1.5 x 40 IS 1364 (Part 1) —8.8	IS 1364 (Part 1) : 1992
9	1	Single side shielded, Bearing	Designation 20 BC 0 PP IS 6455 : 1972
8	2	Roller Chain (25.4 mm pitch)	IS 2403 : 1991
7	1	Chain with coupling	
6	1	Spacer	Ni-Cr stainless steel, Ni 8% *Min* Cr 17% *Min*
5	1	Handle axle	Grade A of IS 2062:1992 or Class 2 of IS 2004 : 1991
4	1	Chain coupling	
3	1	Roller chain guide	Grade A of IS 2062:1992
2	1	Bearing housing (shall be fully packed with Lithium based grease)	Grade A of IS 2062:1992 Grade A of IS 2062:1992
1	1	Handle bar	Grade A of IS 2062:1992

NOTE

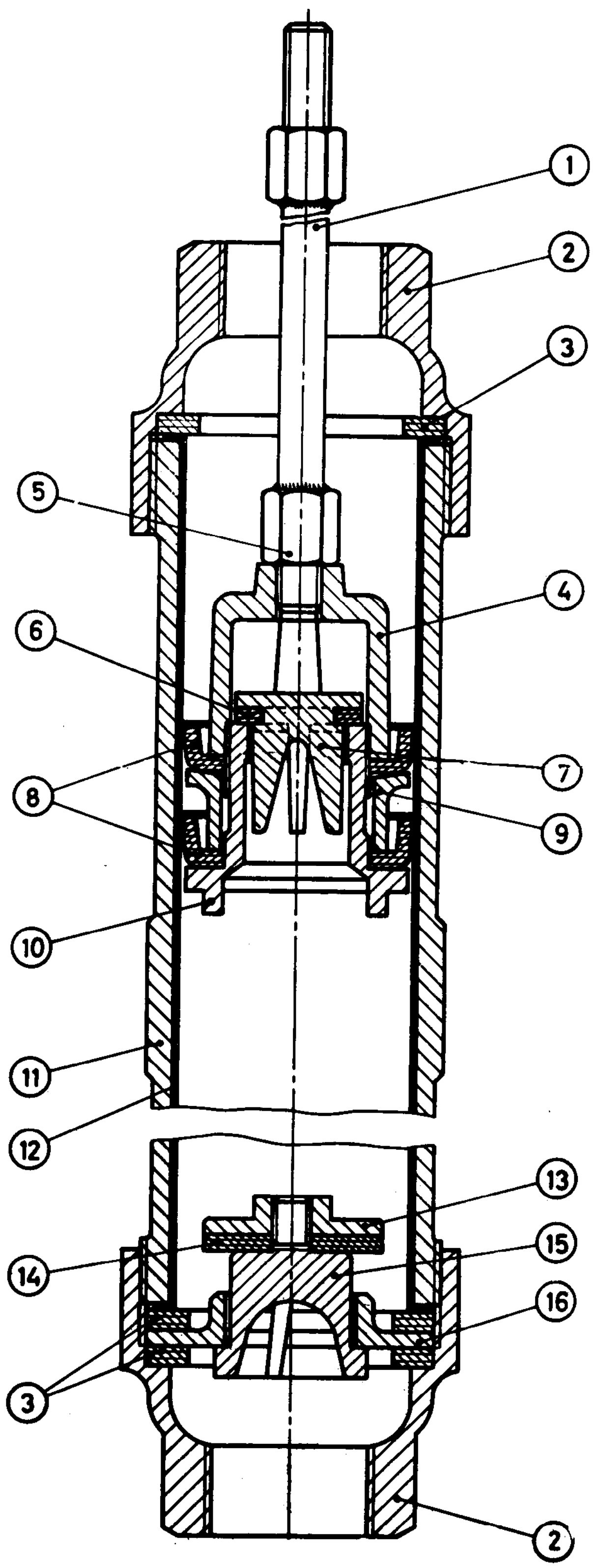
1 Welding fillet shall not be less than 6 mm at all places.

All dimensions in millimetres.

FIG. 11 HANDLE ASSEMBLY



WITH NITRILE RUBBER PUMP BUCKET



WITH LEATHER PUMP BUCKET

FIG. 12 CYLINDER ASSEMBLY (*Contd*)

16	1	Check valve seat	Grade LTB 2 of IS 318 : 1981
15	1	Check valve	Grade LTB 2 of IS 318 : 1981
14	1	Rubber seating (Lower valve)	Nitrile rubber.
13	1	Rubber seat retainer	Grade LTB 2 of IS 318 : 1981
12	1	Brass liner	Cu Zn 30 As of IS 407 : 1981 (Temper Annealed)
11	1	Cylinder body	Grade FG 200 of IS 210 : 1993
10	1	Follower	Grade LTB 2 of IS 318 : 1981
9	1	Spacer	Grade LTB 2 of IS 318 : 1981
8	2	Pump bucket	Leather as per IS 1015 : 1987/ Nitrile Rubber *
7	1	Upper valve	Grade LTB 2 of IS 318 : 1981
6	1	Rubber seating (Upper valve)	Nitrile Rubber*
5	2	Hex coupler M12x1.75	Gr 04 Cr 18 Ni 10 of IS 6603 : 1972
4	1	Plunger yoke body	Grade LTB 2 of IS 318 : 1981
3	3	Sealing ring	Leather as per IS 3020 : 1976/Nitrile rubber*
2	2	Reducer cap	Grade FG 200 of IS 210 : 1993
1	1	Plunger rod	Gr 04 Cr 18 Ni 10 of IS 6603 : 1972
Part No.	**No. Of**	**Description**	**Material**

NOTES

1 As an alternate, metal components to Grade LTB 2 of IS 318 : 1981 of cylinder assembly shall be forged from Naval Brass conforming to IS 6912 : 1985.

2 Lower valve assembly to be punch locked on top of M10 dia at two points.

3 All bronze castings shall be free from lead segregation and hardness shall be 55 HB, Min.

4 The brass liner shall be free from pitting and scaring mark and shall have smooth finish. No cracks in brass tube flaring operation shall be permissible.

*The physical properties of nitrile rubber shall be :

Shore hardness on A scale	80^{+5}_{-4}
Tensile strength	12.6 MPa, Min.
Elongation at break	150% Min.
Compression set, 24 h at 70°C	20%, Max.
Volume change, 22 h at 40°C	-0%, Max, + 25%
Resistance to low temperature at which rigidity modulus does not exceed 70 MPa	-10°C
Adhesion to corrosion of metals : 68 h at 70°C	There shall be no corrosion or pitting of the metals and the vulcanizates shall not adhere to the metal surfaces or show any sign of liquid exudation. Discoloration of the metal surfaces shall not be considered cause for rejection.

FIG. 12 CYLINDER ASSEMBLY FOR DEEPWELL HANDPUMP - WITH NITRILE RUBBER PUMP BUCKET

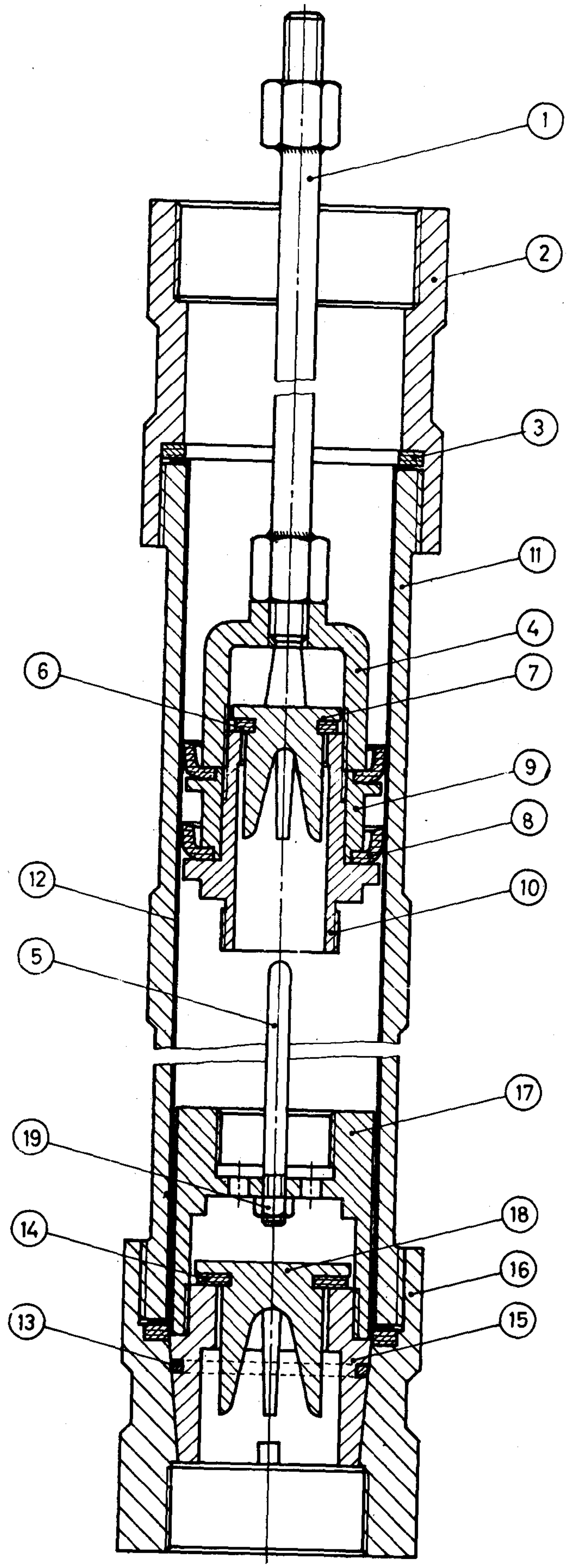


FIG. 13 CYLINDER ASSEMBLY FOR DEEPWELL HANDPUMP (VLOM) (*Contd*)

Part No.	No. Of	Description	Material
19	1	Check nut	SS 04 Cr 18 Ni 10 of IS 6603 : 1972
18	1	Check valve	LTB 2 of IS 318 : 1981
17	1	Cage	LTB 2 of IS 318 : 1981
16	1	Bottom cap	FG 200 of IS 210 : 1993
15	1	Check valve seat	LTB 2 of IS 318 : 1981
14	1	Rubber Seating (Lower valve)	Nitrile Rubber*
13	1	'O' Ring	IS 9975 (Part 1 to 4)
12	1	Brass liner	CuZn 30 As of IS 407 : 1981 (Temper annealed)
11	1	Cylinder body	FG 200 of IS 210 : 1993
10	1	Follower	LTB of IS 318 : 1981
9	1	Spacer	do
8	1	Pump bucket	Nitrile Rubber*
7	1	Upper valve	LTB 2 of IS 318 : 1981
6	1	Rubber seating (Upper valve)	Nitrile Rubber*
5	1	Push Rod	SS 04 Cr 18 Ni 10 of IS 6603 : 1972
4	1	Plunger yoke body	LTB 2 of IS 318 : 1981
3	2	Sealing ring	Nitrile Rubber*
2	1	Upper cap	FG 200 of IS 210 : 1993
1	1	Plunger rod	SS 04 Cr 18 Ni 10 of 6603 : 1972

NOTES

1 As an alternate, metal componets to Grade LTB 2 of IS 318 : 1981 of cylinder assembly shall be forged from Navel Brass conforming to IS 6912 : 1985

2 All bronze castings shall be free from lead segregation and hardness shall be 55 HB minimum.

3 The tolerance of threads shall conform to IS 4218 (Part 4) : 1976 and IS 4218 (Part 5) : 1979, Class 6 g for bolts and 6 H for nuts.

4 The brass liner shall be free from pitting and scaring marks shall have smooth finish. No cracks in brass tube flaring shall be permissible.

5 Till such time adequate gauging practices are available for knuckle threads inter-changeability between followers and cage to be ensured.

*The physical properties of nitrile rubber shall be :

Shore hardness on A scale	80^{+5}_{-4}
Tensile strength	12.6 MPa, Min.
Elongation at break	150% Min.
Compression set, 24 h at 70°C	20% *Max*
Volume change, 22 h at 40°C	+25% -0% *Max*
Resistance to low temperature at which rigidity modulus does not exceed 70 MPa	-10°C
Adhesion to corrosion of metals, 168 h at 70°C	There shall be no corrosion or pitting of the metals and the vulcanizates shall not adhere to the metal surfaces or show any sign of liquid exudation. Discoloration of the metal surfaces shall not be considered cause for rejection.

FIG. 13 CYLINDER ASSEMBLY FOR DEEPWELL HANDPUMP (VLOM)

9 SHALLOW WELL HAND PUMPS

9.1 IS 8035 : 1976 specifies the technical requirements for handpumps for lifting water from wells from depth not exceeding 8.0 m.

9.2 Requirements

9.2.1 *General Requirements*

9.2.1.1 The castings shall be moulded accurately in accordance with the design.

9.2.1.2 The castings shall be sound, clean and free from porosity, blow holes, hard spots, cold shuts, distortion and other harmful defects. They shall be well dressed and fettled and shall be readily machinable.

9.2.1.3 The castings shall not be repaired or welded.

9.2.1.4 While machining, the ovality and the waviness of the pump bore shall be reduced to the minimum possible.

9.2.1.5 The bore of the pump cylinder shall be machined to obtain a smooth finish. The poppet valve seating also shall be machined to obtain a smooth finish.

9.2.1.6 The side clearance between the fulcrum of the handle and its housing shall be minimum possible.

9.2.1.7 The pump body and other cast iron parts, except plunger parts, shall be painted to prevent corrosion.

9.2.1.8 The bearing length for the pinned/bolted joints shall be adequate to support the load.

9.2.2 *Dimensional Requirements*

The sizes and main dimensions of handpump body, leather cup and flapper valve have been specified in the standard (IS 8035 : 1976). A reference to the standard may be made for the dimensional details.

9.3 Material of Construction

9.3.1 It is recognized that a number of materials of construction is available to meet the needs for hand pumps. A few typical materials are indicated below merely for the guidance of the manufacturer and the user :

Name of Part	*Material*	*Relevant Specification*
Pump body, base, cover, handle and plunger parts	Cast iron	Grade FG 150 of IS 210 : 1993
Piston rod	Mild steel	Grade A of IS 2062:1992
Leather cup	Leather	IS 1273:1989
Flapper valve	Leather or polyethylene	

9.3.2 *Bolts and Nuts* — Bolts, nuts, washers, pins, etc, used for the assembly of hand pumps shall conform to latest version of relevant parts of IS 1367.

9.4 Tests

9.4.1 For the purpose of pump discharge test, twenty strokes shall be allowed for the pump body to get completely filled with water and start discharging. Thereafter water discharged from the pump for twenty strokes shall be collected and measured accurately The volume of water thus collected shall not be less than that specified in Table 4. The test shall be conducted at 1.5 metres static suction lift corresponding to mean sea level and at a temperature of 30°C.

9.4.2 The pump body shall be tested for hydrostatic pressure at a pressure of 0.2 MN/m^2 (2 kgf/cm^2).

Table 4 Expected Discharge

(*Clause* 9.4.1)

Nominal size mm	Discharge, *Min* litres
65	6.8
75	11.3
90	17.0

9.5 Guarantee

The pump shall be guaranteed by the supplier against defects in material and workmanship under normal use and service for a period of at least one year from the date of despatch.

10 EXTRA DEEPWELL HAND PUMP

10.1 IS 13287 : 1992 covers extra deepwell hand pumps for lifting water from borewells fitted with casing pipes of nominal dia 100 to 150 mm and static water level from 40 m to 90 m.

10.2 Requirements

10.2.1 *General Requirements*

10.2.1.1 The material, tolerances, etc, shall be same as given in respective figures. in IS 13287 :1992.

10.2.1.2 The riser pipe shall be 32 mm nominal bore, hot dipped galvanized screwed and socketed pipe in 3 metre length with a tolerance of $^{+0}_{-25}$ mm, conforming to IS 1239 (Part 1) : 1990.

The socket shall be manufactured from seamless pipe or machined from solid bar conforming to grade Grade A of IS 2062:1992 The dimensions (length and diameter) shall be as specified in IS 1239 (Part 2) : 1992 and shall be hot dipped galvanized. One end of the riser pipe shall be fitted with hot dipped galvanized socket and the other with a thread protector.

10.2.1.3 Welding for mild steel components shall be done in accordance with IS 9595 : 1980. Welding for stainless steel components shall conform to IS 2811 : 1987.

10.2.1.4 *Weights*

For cylinder setting upto 60m depth, no weights are required. Following weights shall be added at different intervals:

Above 60 m upto 70 mm	1 weight
Over 70 m upto 80 m	2 weights
Above 80 m up to 90m	3 weights

10.2.1.5 Each connecting rod and plunger rod shall be fitted with plastic thread protectors at the end before despatch.

10.2.2 Other requirements for these pumps are same as given under **7.2.1.5, 7.2.1.6** to **7.2.1.12** and **8.2.1.2**, of this chapter.

10.2.3 Requirements for Anti Corosive Treatment

These shall be same as given under **7.2.2** of this chapter except **7.2.2.2** which shall be substituted by following:

The following assemblies shall be galvanized according to IS 4759 : 1984 :

a) Stand assembly,

b) Water tank assembly,

c) Head assembly,

d) The handle asembly except the inside portion of bearing housing,

e) Counter weights, and

f) Third plate.

10.2.3 The galvanized assemblies shall be given chromate conversion coating Type C as per IS 9839 : 1981.

10.3 Testing & Inspection

The requirements for testing and inspection of these pumps shall be as given under Chapter 4.

10.4 Guarantee

The pump and accessories shall be guaranteed for 12 months from the date of installation or 18 months from the date of supply whichever is earlier against bad workmanship/bad material. The life of leather/ rubber components shall however, be guaranteed for only 6 months from the date of supply.

ANNEX A

LIST OF REFERRED INDIAN STANDARDS

IS NO.	Title
IS 210 : 1993	Grey iron castings (*fourth revision*)
IS 304 : 1981	High tensile brass ingots and castings (*second revision*)
IS 318 : 1981	Leaded tin bronze ingots and castings (*second revision*)
IS 325 : 1978	Three phase induction motors (*fourth revision*)
IS 407 : 1981	Brass tubes for general purposes (*third revision*)
IS 513 : 1986	Cold rolled low carbon steel sheets and strips (*third revision*)
IS 554 : 1985	Dimensions for pipe threads where pressure tight joints are required on the threads (*third revision*)
IS 808 : 1989	Dimensions for hot rolled steel beam, column, channel and angle sections (*third revision*)
IS 996 : 1979	Single phase small a.c. and universal electric motors (*second revision*)
IS 1015 : 1987	Leather pump buckets made from vegetable tanned leather (*first revision*)
IS 1161 : 1979	Steel tubes for structural purposes (*third revision*)
IS 1172 : 1993	Code of basic requirements for water supply, drainage and sanitation (*fourth revision*)
IS 1239	Mild steel tubes, tubulars and other wrought steel fittings:
(Part 1) : 1990	Part 1 Mild steel tubes (*fifth revision*)
(Part 2) : 1992	Part 2 Mild steel tubular and other wrought steel pipe fittings (*third revision*)
IS 1248	Direct acting indicating analogue electrical measuring instruments and their accessories:
(Part 1) : 1993	Part 1 General requirements (*third revision*)
(Part 2) : 1983	Part 2 Ammeters and voltmeters (*second revision*)
(Part 3) : 1983	Part 3 Wattmeters and varmeters (*second revision*)
(Part 4) : 1983	Part 4 Frequency meters (*second revision*)
(Part 5) : 1983	Part 5 Phasemeters, power factor meters and synchroscope (*second revision*)
(Part 6) : 1983	Part 6 Ohmmeters (impedence meters) and conductance meters (*second revision*)
(Part 7) : 1984	Part 7 Multifunction instruments (*second revision*)
(Part 8) : 1984	Part 8 Accessories (*second revision*)
IS 1273 : 1989	Leather pump buckets made from chrome tanned leather (*first revision*)
IS 1363	Hexagon head bolts, screws and nuts of product grade C:
(Part 1) : 1992	Part 1 Hexagon head bolts (size range M5 to M36) (*third revision*)
(Part 2) : 1992	Part 2 Hexagon head screws (size range M5 to M36) (*third revision*)
(Part 3) : 1992	Part 3 Hexagon nuts (size range M5 to M36) (*third revision*)
IS 1364 (Part 1) : 1992	Hexagon head bolts, screws and nuts of product grades A and B : Part 1 Hexagon head bolt (size range M1.6 to M64) (*third revision*)

IS NO.	Title
IS 1367	Technical supply conditions for threaded steel fasteners:
(Part 1) : 1980	Introduction and general information (*second revision*)
(Part 2) : 1979	Product grades and tolerances (*third revision*)
(Part 3) : 1991	Mechanical properties and test methods for bolts, screws and studs with full loadability (*third revision*)
(Part 5) : 1980	Mechanical properties and test methods for set screws and similar threaded fasteners not under tensile stresses
(Part 6) : 1980	Mechanical properties and test methods for nuts with specified proof loads (*second revision*)
(Part 7) : 1980	Mechanical properties and test methods for nuts without specified proof loads (*second revision*)
(Part 8) : 1992	Mechanical and performance properties for prevailing torque type steel hexagon nuts (*second revision*)
(Part 9) : 1979	Surface discontinuities on bolts, screws and studs (*second revision*)
(Part 9/Sec 1) : 1993	Surface discontinuities, Section 1 Bolts, screws and studs for general applications (*third revision*)
(Part 9/Sec 2) : 1993	Surface discontinuities, Section 2 Bolts, screws and studs for special applications (*third revision*)
(Part 10) : 1979	Surface discontinuities on nuts (*second revision*)
(Part 12) : 1981	Phosphate coatings on threaded fasteners (*second revision*)
(Part 13) : 1983	Hot-dip galvanized coatings on threaded fasteners (*second revision*)
(Part 14) : 1984	Stainless steel threaded fasteners (*second revision*)
(Part 16) : 1979	Designation system and symbols (*first revision*)
(Part 18) : 1979	Marking and mode of delivery (*second revision*)
IS 1570	Schedules for wrought steel:
(Part 2/Sec 1) : 1979	Part 2 Carbon steels (unalloyed steels), Section 1 Wrought products (other than wire) with specified chemical composition and related properties (*first revision*)
(Part 5) 1985	Part 5 Stainless and heat resisting steels (*second revision*)
IS 1573 : 1986	Electroplated coatings of zinc on iron and steel (*second revision*)
IS 1710 : 1989	Vertical turbine pumps for clear, cold, fresh water (*second revision*)
IS 1978 : 1982	Line pipes (*second revision*)
IS 2004 : 1991	Carbon steel forgings for general engineering purposes (*third revision*)
IS 2016 : 1967	Plain washers (*first revision*)
IS 2062 : 1992	Weldable structural steel (*fourth revision*)
IS 2074 : 1992	Ready mixed paint, air drying, red oxide-zinc chrome, priming (*second revision*)
IS 2403 : 1991	Short pitch transmission precsion steel roller chains and chain wheels (*second revision*)
IS 2500 (Part 1) : 1992	Sampling inspection procedures : Part 1 Attribute sampling plans indexed by acceptable quality level (AQL) for lot by lot inspection (*second revision*)
IS 2643 (Part 2) : 1975	Dimensions for pipe threads for fastening purposes : Part 2 Tolerances (*first revision*)
IS 2800 (Part 2) : 1979	Code of practice for tubewell : Part 2 Testing (*first revision*)
IS 2811 : 1987	Recommendations for manual tungsten inert gas arc welding of stainless steel (*first revision*)
IS 2932 : 1974	Enamel, synthetic, exterior (a) undercoating, (b) finishing (*first revision*)

IS NO.	Title
IS 2951	Recommendation for estimation of flow of liquids in closed conduits:
(Part 1) : 1965	Part 1 Head loss in straight pipes due to frictional resistance
(Part 2) : 1965	Part 2 Head loss in valves and fittings
IS 2952 (Part 1) : 1964	Recommendation for methods of measurement of liquid flow by means of orifice plates and nozzles : Part 1 Incompressible fluids
IS 2974	Code of practice for design and construction of machine foundations:
(Part 3) : 1992	Part 3 Foundation for rotary type machines (Medium and high frequency) (*second revision*)
(Part 4) : 1979	Part 4 Foundation for rotary type machines of low frequency (*first revision*)
IS 3020 : 1976	Leather for oil seals (*first revision*)
IS 3073 : 1967	Assessment of surface roughness
IS 3428 : 1981	Dimensions for relief grooves (*first revision*)
IS 3624 : 1987	Pressure and vacuum gauges (*second revision*)
IS 4218	ISO Metric screw threads:
(Part 4) : 1976	Part 4 Tolerancing system (*first revision*)
(Part 5) : 1979	Part 5 Tolerances (*first revision*)
IS 4270 : 1992	Steel tubes used for water wells (*second revision*)
IS 4477 (Part 1) : 1967	Methods of measurement of fluid flow by means or venturi meters: Part 1 Liquids
IS 4740 : 1979	Code of practic for packaging of steel tubes (*first revision*)
IS 4759 : 1984	Hot dip zinc coatings on structural steel and other allied products (*second revision*)
IS 4889 : 1968	Method of determination of efficiencies of rotating electrical machines
IS 5120 : 1977	Technical requirements for rotodynamic special purpose pumps (*first revision*)
IS 6059 : 1971	Recommendations for liquid flow measurement in open channels by weirs and flumes - weirs of finite crest width for free discharge
IS 6062 : 1971	Method of measurement of flow of water in open channels using standing wave flume fall
IS 6063 : 1971	Method of measurement of flow of water in open channels using standing wave flume
IS 6455 : 1972	Single row radial ball bearings
IS 6595 (Part 1) : 1993	Horizontal centrifugal pumps for clear, cold water : Part 1 Agricultural and rural water supply purposes (*second revision*)
IS 6603 : 1972	Stainless steel bars and flats
IS 6912: 1985	Copper and copper alloy forging stock and forgings (*first revision*)
IS 7002 : 1991	Prevailing torque type steel hexagon nuts (with non-metallic inserts) style 1, property classes 5,8 and 10 (*first revision)*
IS 7283 : 1992	Hot Rolled bars for production of bright bars and machined parts for engineering applications (*first revision*)
IS 7347 : 1974	Performance of small size spark ignition engines for agricultural sprayers and similar applications
IS 7538 : 1975	Three phase squirrel cage induction motors for centrifugal pumps for agricultural applications
IS 8034 : 1989	Submersible pumpsets (*first revision*)
IS 8035 : 1976	Shallow well handpumps

IS NO.	Title
IS 9079 : 1989	Monoset pumps for clear, cold water for agricultural purposes (*first revision*)
IS 9108 : 1979	Liquid flow measurement in open channels using thin plate weirs
IS 9118 : 1979	Method of measurement of pressure by means of manometer
IS 9137 : 1978	Code for acceptance test for centrifugal, mixed flow and axial pumps - Class C
IS 9283 : 1979	Motors for submersible pumpsets
IS 9301 : 1990	Deepwell handpumps (*third revision*)
IS 9550 : 1980	Bright bars
IS 9595 : 1980	Recommendations for metal arc welding of carbon and carbon manganese steels
IS 9694	Code of practice for selection, installation, operation and maintenance of horizontal centrifugal pumps for agriculture applications:
(Part 1) : 1987	Part 1 Selection (*first revision*)
(Part 2) : 1980	Part 2 Installation
(Part 3) : 1980	Part 3 Operation
(Part 4) : 1980	Part 4 Maintenance
IS 9839 : 1981	Chromate conversion coatings on electroplated zinc and cadmium coatings
IS 9975	O rings:
(Part 1) : 1981	Part 1 Dimensions
(Part 2) : 1984	Part 2 Material selection and quality acceptance criteria
(Part 3) : 1984	Part 3 Seal housing dimensions and tolerances
(Part 4) : 1984	Part 4 Terminology and definition of terms
IS 10572 : 1983	Method of sampling pumps
IS 10804 : 1986	Recommended pumping system for agricultural purposes (*first revision*)
IS 10805 : 1986	Foot valves, reflux valves or non-return valves and bore valves to be used in suction lines of agricultural pumping systems (*first revision*)
IS 10981 : 1983	Class of acceptance test for cetrifugal mixed flow and axial pumps - Class B
IS 11004	Code of practice for installtion and maintenance of deepwell handpumps
(Part 1) : 1992	Part 1 Installation (*first revision*)
(Part 2) : 1991	Part 2 Maintenance (*first revision*)
IS 11170 : 1985	Performance requirements for constant speed compression ignition (diesel) engines for agricultural purposes (up to 20 kW)
IS 11346 : 1985	Testing set up for agricultural pumps
IS 11723 (Part 1) : 1992	Mechanical vibration-balance quality requirements of rigid rotors Part 1 Determination of permissible residual unbalance (*first revision*)
IS 12225 : 1987	Specification for jet centrifugal pump combinations
IS 12699 : 1989	Code of practice for selection, installation, operation and maintenance of jet centrifugal pump combination
IS 12732 : 1989	Nomenclature and identification of components for deepwell handpumps
IS 13056 : 1991	Deepwell handpumps (VLOM)
IS 13287 : 1992	Extra deepwell handpumps

Note : For latest version of Indian Standards Reference may be made to Bureau of Indian Standards.

ANNEX B

LIST OF INDIAN STANDARDS AND OTHER PUBLICATIONS USED AS SOURCE MATERIAL

B-1 Indian Standard

IS No.	Title
IS 1172 : 1993	Code of basic requirements for water supply, drainage and sanitation (*fourth revision*)
IS 1710 : 1989	Vertical turbine pumps for clear, cold, fresh water (*second revision*)
IS 2951	Recommendation for estimation of flow of liquids in closed conduits :
(Part 1) : 1965	Part 1 Head loss in straight pipes due to frictional resistance
(Part 2) : 1965	Part 2 Head loss in valves and fittings
IS 5120 : 1977	Technical requirement for rotodynamic special purpose pumps (*first revision*)
IS 6595 (Part 1) : 1993	Horizontal centrifugal pumps for clear, cold, water : Part 1 Agricultural and water supply purposes (*second revision*)
IS 8034 : 1989	Submersible pumpsets (*first revision*)
IS 8035 : 1976	Shallow well handpumps
IS 9079 : 1989	Monoset pumps for clear, cold water for agricultural purposes (*first revision*)
IS 9137 : 1978	Code for acceptance test for centrifugal, mixed flow and axial pumps - Class C
IS 9301 : 1990	Deepwell handpumps (*third revision*)
IS 9694	Code of practice for the selection, installation, operation and maintenance of horizontal centrifugal pumps for agricultural applications
(Part 1) : 1987	Part 1 Selection (*first revision*)
(Part 2) : 1980	Part 2 Installation
(Part 3) : 1980	Part 3 Operations
(Part 4) : 1980	Part 4 Maintenance
IS 10596 (Part 4) : 1983	Code of practice for selection, installation, operation and maintenance of pumps for industrial applications : Part 4 Maintenance
IS 10804 : 1986	Recommended pumping system for agricultural purposes (*first revision*)
IS 10805 : 1986	Foot valves, reflux valves or non-return valves and bore valves to be used in suction lines of agricultural pumping systems (*first revision*)
IS 11004	Code of practice for installation and maintenance of deepwell handpumps:
(Part 1) : 1992	Part 1 Installation (*first revision*)
(Part 2) : 1991	Part 2 Maintenance (*first revision*)
IS 13056 : 1991	Deepwell handpumps (VLOM)
IS 13287 : 1992	Extra deepwell handpumps

B-2 Other Publications

1. India. Ministry of Agriculture, Department of Rural Development, Technology mission on drinking water in villages and related water management, 1987

2. India. Ministry of Urban Development, Central Public Health and Environmental Engineering Organization, Manual on water supply and treatment, 1976

3. India. Ministry of Urban Development, Central Public Health and Environmental Engineering Organization, Manual on water supply and treatment, 1993

4. India. Mark - III (VLOM) Deepwell handpump installation and maintenance manual, 1991, UNICEF, South India office, Madras

ANNEX C

SELECTION CRITERIA FOR JET CENTRIFUGAL PUMP COMBINATION

(*Clause* 7, Chapter 1)

C-1 The selection criteria for jet centrifugal pump combination are :

a) Water well size and capacity ;

b) Performance characteristics, namely, quantity, jet setting depth and discharge head ;

c) Type of prime mover; and

d) Type of installation.

C-1.1 Water Well Size and Capacity

C-1.1.1 *Open Well*

In open wells, there is no restriction on selection of pipe size for the jet centrifugal pump combination.

C-1.1.2 *Bore Well*

In bore wells, the size of pipe lines depends on the diameter of the bore. For the same bore well, if more quantity of water is to be pumped, in order to accommodate bigger flow area for the pressure pipe and delivery pipe of the jet pumps, packer/duplex type of jet pumps are preferred to twin type jet pumps. In all bore wells, for ease of erection, maximum jet pump outer dimension shall be always 6 mm less than the clear bore well size. The maximum quantity of water that can be pumped by using these jet pumps with optimum percentage loss of friction in combined pipeline of pressure and delivery of pump shall be as given in Tables 1 and 2.

Table 1 Dimensions and Maximum Output for Twin Type Jet Pumps

(*Clause* C-1.1.2)

Clear Bore Diameter mm	Jet Pump Maximum Dimension mm	Disharge Pipe mm	Pressure Pipe mm	Maximum Recommended output l/min
80	76	25	20	12
100	92	32	25	20
110	102	40	32	35
125	114	40	40	50
150	126	50	40	65
150	135	50	50	80
200	164	65	50	120
200	172	65	65	180
200	185	80	65	225
250	230	100	80	320

NOTE- The discharges indicated are for an optimum combined pipe friction of about 10 percent. By allowing higher frictional losses, more output can be obtained.

Table 2 Dimensions and Maximum Output for Packer/Duplex Type Jet Pumps

(*Clause* C-1.1.2)

Clear Bore Diameter mm	Outer Pipe Socket Diameter mm	Discharge Pipe Diameter mm	Output Pipe Diameter mm	Maximum Recommended output l/min
80	[illegible]	25	50	15
100	89	40	65	35
100	96 (TC)[1]	50	80	75
110	102	50	80	75
125	102	50	80	75
125	122(TC)[1]	65	100	170
150	127	65	100	170
150	147(TC)[1]	80	125	250
200	159	80	125	250

[1] TC means turned coupling

C-1.2 Performance Characteristics

Performance requirements as given here have been specified for this type of pumps.

C-1.2.1 *Water Quantity*

The quantity of water required shall be decided by two factors:

a) Actual consumer requirements, and

b) Availability or yield of well or bore well.

The maximum quantity that may be tapped shall be 80 percent of the tested yield of the well.

C-1.2.2 *Jet Setting Depth*

To take care of frictional losses, the jet setting depth shall be taken 1.2 times the optimum spring depth of the bore well and jet pump shall be placed 3 to 5 m above the bottom of the bore well for silt not to enter the jet pump and it shall be placed 2 m below the maximum draw down level or have adequate submergence as specified by manufacturer.

C-1.2.3 *Discharge Head*

The discharge head of the jet centrifugal pump combination shall be almost near the minimum operating head of the system which generally is taken as operating head of centrifugal pump minus 6 m. This shall allow the system to operate at the optimum efficiency.

C-1.3 Types of Installation

a) Vertical

Whenever the centrifugal pump is to be placed in a separate room away from well, horizontal installation is preferred and whenever space availability is limited and where pump has to be placed above the well, vertical mounting of the centrifugal pump shall be preferred.

b) Horizontal

When centrifugal pump is mounted horizontally, the length of the horizontal pipe line shall not be more than 1.5 to 2 m. In case the lengths are to be increased, one size higher diameter of pipe shall be used to keep the frictional losses minimum.

C-1.4 Type of Prime Mover

Jet centrifugal pump combination shall be selected accroding to the availability of power source :

a) Diesel engine shall conform to IS 11170 : 1985

b) Electric motor shall be conform IS 996 : 1979.

Note - If jet centrifugal pump combination is to be driven by both, belt driven type centrifugal pump shall be preferred. If the pump is to be driven by only electric source, mono block or direct coupled pump shall be preferred.