GOVERNMENT OF HIMACHAL PRADESH

HANDBOOK ON QUALITY CONTROL

Part- B

Jal Shakti Vibhag

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PREFACE

The Government of H.P. felt its necessity that IQCS may be constituted to have an independent quality check and positioned in CM office. The squad shall be headed by the Team Leader and ably assisted by specialist/expert having vast experience in Civil Engineering works, Mechanical, Electrical works and IPH works being executed by the various departments.

WAPCOS Ltd., A Govt. of India Undertaking, Ministry of Jal Shakti, Chandigarh office has been entrusted with the task of implementing this program for total quality management concept aimed at embedding awareness of quality in all infrastructure departments of Govt. of H.P. including but not limited to PWD, IPH, HPSEB, Urban development, Forest, Tourism, RDD and HPSIDC etc.

In this respect this handbook has been prepared which is brief, handy and instant helpful at site for field engineers. It is an effort just like to express too much in too few words. It summarizes all quality assurance, specifications and prepared on basic sources viz HPPWD specifications for building and roads, rural road manual, MORTH and handbook of quality control Vol.- 1 and Vol- 2. The IPH contents have been taken from CPEHEEO, AWWA manual, Pollution Control Board and Relevant Standard codes etc. The handbook has been prepared by in cooperating relevant extract from HPPWD specification keeping in view subsidiary departments also and prevalent practice being followed at present.

In preparing this handbook the sincere efforts have been made by the team of WAPCOS Ltd. along with the officers of Jal Shakti Vibhag, Himachal Pradesh.

We dedicate this effort to the state and hope this handbook shall be very useful for all the field engineers for various departments of Govt. of HP and advised that it may always be kept with them at site as ready and instant reference. We are further hopeful that the state authorities would evolve suitable mechanism to implement the needed quality assurance plan with objective of achieving the economic and social development of the State and improving the quality of life of people.

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Chandigarh Office

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HANDBOOK ON QUALITY CONTROL AND SPECIFICATIONS

PART- B

(JAL SHAKTI VIBHAG)

CHAPTER- 1

Standard Water Supply System in Village/ Town

Sources of Water

Ground water: Open well, tube well/bore well, hand pump are sources which make water available from ground.

Open Well: Where ground water is available at low depth (less than 15 meters - and water is available all year round, open well is used.

Hand Pump: Where safe ground water is available upto 60 m depth, hand pump is ideal choice for a cluster or habitation.

Bore Well/Tube Well: Where ground water is at greater depth and open wells or hand pumps are not viable, bore well or tube well is installed.

Surface Water: River, pond, dam site are sources where surface water is available.

Moreover, rain water can be harvested and store directly in storage tanks. The water is portable after first rain and can be used for drinking purpose also.

Classification of Water based on its Availability

A. **Local Source:** Sources which are available at village/town level like river, pond, open wells and bore wells.
B. **Distant source:** When perennial reliable and safe source is not available, pipeline from distant sources can be laid. This bulk water is available from river, pond, dam, bore wells or storage tank itself, where water is available.

Pump House and Pumping Machinery:

1. Pump is used to fetch water from source like bore well, open well, sump or ground water storage and supply it to pipelines or elevated storage.
2. Three main components of WSM :
   a) Pump, b) motor, c)Pump house (security and safety of machineries).

Rising Main: Delivery line carrying water from pump to storage tank (elevated or ground) is called rising main.

Storage Facilities

Elevated Surface Reservoir (ESR) or elevated storage tank:

1. ESR is constructed, where water is supplied at elevated height or distance is large or topography is undulating.
2. Generally, ESR height is more than 15 m.

Ground Service Reservoir (GSR):

1. The plinth level is generally not more than 3 m.
2. Its capacity based on pumping hours, demand and hours of supply, electricity available for pumping.
3. System with higher pumping hours requires less storage capacity.

Storage capacity of such tanks is half to one day daily water requirement.

Sump:

1. It is additional storage tank and not used for direct distribution of water.
2. It is used as intermediate or contingency storage to store water before it is pumped to ESR/GSR.
3. The capacity of sump is more than ESR or GSR or two to five days water requirement at village/town level or cluster level. It is not used for direct distribution of water.

1. **Service Reservoirs**

a) SRs have to be inspect regularly
b) Leakage from structure SR and through the pipes and valves has to be attended to on priority.
c) Internal corrosion is prevented by cleaning and painting at regular intervals.
d) Toxic paints should not be used for interior surface of SRs.
e) Painting of steel tanks once in a year and external painting with waterproof cement paint for exteriors of RCC tanks once in 5years is usually done.
f) After inside painting SRs shall be disinfected before putting into use for a period sufficient to give chlorine residuals of at least 0.2 mg/l.

Cleaning of service reservoirs: Routine inspection is the best way to determine when a tank requires maintenance and cleaning. The best time of the year to take up cleaning of SRs is during the period of lowest water consumption.

SPARES AND TOOLS: Spares and tools required are similar as tools and spares required for transmission main system.

Additional tools required for cleaning of service reservoirs are: Housekeeping accessories & coir brushes etc.

Annexure A: Check Lists For Clear Water Sump, ESR & GSR.

Water Distribution

For efficient distribution, water should reach tail end with required flow and pressure in the piping system / distribution system.

There are three main types of distribution system:-

A. Gravity Fed Distribution

a) Gravity Fed Distribution used when ground level of source is sufficiently high compared with the area to be served.
b) Such system is highly reliable and economical.

B. Pumping System

a) Water is supplied by continuous pumping at constant pressure without intermediate storage.
b) It requires stand by prime mover to maintain continuous water supply.
c) It works only in condition where continuous water supply, reliable water source is available and where intermediate storage cannot be installed.

C. Dual/Combination

a) Dual combination systems are used where there is variation in topography in area.
b) Minimum Residual pressure in a distribution system should be 7 m for single storied 12 m for two storied and 17 m for three storied building.

Distribution Lines:

The lines carrying water from storage to its end use (Stand Post/ household tap etc.) are called distribution lines.

Distribution pipelines consist of main pipeline connected from secondary storage; sub-main pipes connected from main pipeline and service/branch pipes connected from sub-main for distribution to households.

Stand Post: Stand post with one or more taps are installed at cluster level or near the storage tank, in the villages/towns where household tap connection is not available or possible.

It should have normal output of 12 litres/minute. One stand post is estimated for every 250 persons. In case of independent habitation, even if population is less than 250 and there is no potable water source, one stand post can be provided.

Moreover, stand posts should not be more than 500 m from any such targeted household.

Cattle Trough: These are masonry/RCC structures to provide water to cattle.

Bathing or Washing Cubicles: These masonry structures are generally constructed to facilitate washing clothes and bathing

Type of Water Supply

A. Continuous

a) Continuous water supply is possible where adequate quantity of water is available.
b) It remains fresh and rusting of pipes will be low.
c) Losses of water will be more in case of any leakage.

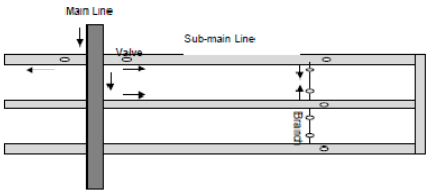
B. Intermittent

a) Intermittent supply is divided into zones and each zone is supplied with water for fixed hours in a day or as per specified day.
b) It is followed when there is low water availability.
c) Pipelines are likely to rust faster due to wetting and drying.
d) Maintenance can be easily done during non supply hours.

Pipeline Distribution Networks

1. Pipeline distribution network are aimed at design of suitable routes for piping.
2. It is important for proper water pressure, capital cost, operation and maintenance cost and maintenance (O & M) strategy adopted.

A. Dead end distribution system

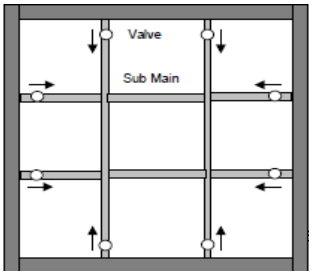


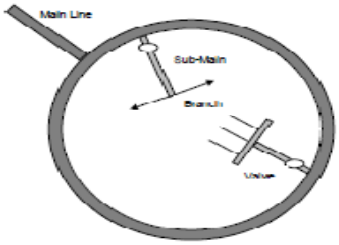
1. Sub main pipes are connected at right angle from main pipe line and branches pipes are connected to sub mains at right angles.
2. In case of failure in pipeline, it will be difficult to supply water to the area ahead of affected area.
3. Pressure at the tail end will be low compared to other area and there will be stagnation of water.

B. Grid System

1. Main, sub main and branch pipes are interconnected to each other.
2. Total length of pipeline required is high, but this helps in equitable water pressure.
3. Blockage of pipes in one area does not affect the supply in the rest of area as there are multiple supply points to any area.

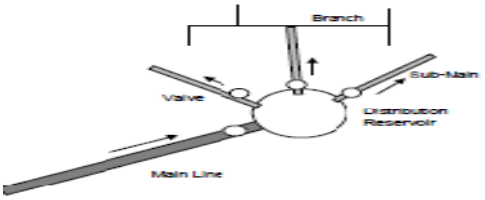
C. Ring System





1. The Whole system is enclosed by main pipeline in radial or rectangular shape.
2. Smaller areas are enclosed by sub main pipeline.
3. In case of failure of system, very small area will be affected.
4. The area ahead of affected area can get water from other point.

D. Radial System



1. The area is divided into different zones.
2. The water is pumped into the distribution reservoir kept in the middle of each zone and the supply pipes are laid radially ending towards the periphery.

Issues Causing Problems In The Distribution System

1. Intermittent system
2. Non-availability of required quantity of water
3. Low pressure at supply point
4. Leakage of water
5. Unauthorized connections
6. Extension of area of distribution system
7. Age of the system
8. Lack of records.

Note: List of spare parts tools, preventive maintenance and maintenance schedule is similar to the transmission system.

Annexure B Check list for Distribution System.

Rising Mains/ Transmission Mains:

Problems in Transmission Mains:

a) Leakage
b) Leakage through appurtenances
c) Air Entrainment
d) Water Hammer
e) Age of the system

Maintenance of Pipeline:

1. Main Breaks
2. Deterioration of pipes
3. Flushing of pipelines
4. Flushing and cleaning of pipelines
5. Cement Mortar Lining.

List of Spare Parts:

1. Check nuts
2. Spindle rods
3. Assorted bolts
4. Nuts and washers for flanged joints
5. Gaskets for a flanged joints for all sizes of sluice valves
6. Man hole covers
7. Gland rope
8. Grease
9. Cotton waste
10. Rubber gaskets
11. Spun yarn
12. Pig lead
13. Lead wool

List of Tools:

1. Key rods for operation of all sluice valves
2. Hooks for lifting man hole covers
3. Pipe wrench (Size 200 mm, 300mm, 450mm)
4. DE Spanner set
5. Ring Spanner Set
6. Screw Drivers
7. Pliers
8. Hammers
9. Chiesels
10. Caulking Tools for lead and spun yarn
11. Ladles and pans
12. Crow bars
13. Spades
14. Iron Buckets
15. Dewatering pumps

In case of large diameters

1. Excavators
2. Cranes
3. Diesel welding sets
4. Welding electrodes
5. Gas cutting accessories
6. Gas cylinders

Annexure C: Check Lists for Transmission Main

CHAPTER- 2

BASICS ON WATER PUMPING

Pumping Machinery is used for transfer of water from one place to another.

- **Project Execution and Design Period**

a) Project Execution Period

The time lag between Preparation, Design, Tendering, Construction and Completion/ Commissioning of the proposed scheme should not exceed as specified under:

i. Mini pipe water supply scheme upto 01 years
ii. Standalone water supply scheme 01 to 02 years
iii. Multi village water supply scheme 02 to 03 years

b) Project Design Period

Project components may be designed to meet the requirements of the following design period

S. No.	Items	Design period in years
1	**Source** a. Surface b. Ground Water	 30 20
2	Intake works	30
3	**Pumping**	
	i. Pump House (Civil Works)	20
	ii. Electric motors and pumps	10
4	Water Treatment Units	20
5	Pipe connection to several treatment units and other small appurtenances	20
6	Raw water and clear water conveying mains	20
7	Clear water reservoirs at the head works, balancing tanks and service reservoirs	20
	(overhead or ground level)	
8	Distribution system	20

- **Population**
- **Water Demand**
- **Present status of Water Supply and Sanitation**
- **Institutional set up and detail of formation of VWSC**
- **Details of preparation of Water Safety and Security Plans**

- **Proposed Scheme – Details of Scheme Components**
- **Cost Estimates**
- **Life – Cycle Cost Approach**

Reference - Manual for preparation of DPR for Rural Piped WSS, Ministry of Drinking Water & Sanitation GOI, February, 2013 Section 3 to 11.

Types of Pumps

(a) **Centrifugal Pump (IS: 1520)** It accelerates liquid in a radial direction from the rotating shaft.

Pump consists of following parts:

- Casing
- Delivery Pipe
- Delivery Valve
- Impeller
- Prime Mover
- Suction Pipe
- Strainer and Foot Valve

b) Turbine Pump It accelerates fluids liquid more toward the axis of the rotating shaft. It produces high head of over 300 mtrs at relatively low rpm as compared with other pumps.

(c) Submersible pump (IS: 8034) Motor (IS: 9283) It is a device which has a hermetically sealed motor close coupled with pump. It prevents pump cavitations. Such pumps are used for water yield of 1000 liters per minute.

The main parts of a submersible pump are:

(a) Electric motor enclosed in a stainless sleeve.
(b) Pump body with multiple impellers, foot valve and strainer.
(c) Rising main of GI or stainless steel pipes connected with sockets or PVC hose.
(d) Electrical cable for connecting the motor to the starting panel (power source).
(e) Starting Panel.

Criteria for Pump Selection for water supply

a) Type of pumping required, i.e. whether continuous, intermittent or cyclic.
b) Present and projected demand and pattern of change in demand.
c) The details of head and flow rate required.
d) Type and duration of the availability of the power supply.
e) Selecting the operating speed of the pump and suitable drive/driving gear.
f) The efficiency of the pumps and consequent influence on power consumption and the running costs.
g) Ease in installation.

Quality Assurance: Manufacturer quality control plan should be in such a way to meet the requirement of inspection and test plan. Engineer must be aware of the details of design and characteristics of the equipment for the witnessing of performance test by the 3rd party inspection.

Test of the Pumps at factory site.

1. **Material Inspection**

a) Certificate Number
b) Chemical Composition
c) Surface Finish
d) NDE applied result

2. **Run out test**
3. **Centrifugal Pump NPSH Test**
4. **Mechanical Ring Test**
5. **Performance Test**
6. **Centrifugal Pump dismantling inspection**
7. **Clearance Checking**
8. **Visual and Dimensional control**
9. **Name plate, painting and coating inspection & reporting.**

Erection of pumping set at site:

1. Erection on concrete foundation.
2. Installation of the base frame.
3. Alignment.

a) Pipe work.
b) Suction conditions.
4. Delivery condition.
5. Shaft ceiling arrangement.

Commissioning and Testing

1. **Before the pump is brought into service, the pipe work associated with the pumping unit must be disconnected and flushed through. This will clear scale or deposits.**
2. **Clean the Bearing & refilled with a correct grade and quality of a lubricant.**
3. **Centrifugal pumps must not be run when dry.**
4. **Pre - start Check**

a) Bearings are properly lubricated.
b) The delivery valve is closed and suction valve is fully open.
c) Power supply for the driving unit is available, and all relays, alarms trips and interlocks are operational and are set to their correct values.
d) Direction of rotation of drive motor in uncoupled condition. (Directional arrow is marked on the pump casing).

5. Starting and running checks.

a) Start the pump by pressing the manual start button or initiate the start sequence-refer to driving instructions.

b) Check that the pump rotates in the correct direction.

c) Check that the pump is generating not less than its rated delivery pressure as indicated on the name plate.

If the pump generates rated pressure as indicated on the pump name plate and the bearing temperature remains normal i.e. 40 – 60^{o} C, Gland is not overheating, and no interruption in balance flow, suction and delivery pressure and ampere meter indicating normal conditions than pump is okay. This procedure must be witnessed by competent engineers for Quality Control Assurance.

List of Spare parts.

1. Coupling Pin.
2. Coupling Bush.
3. Distance Sleeve.
4. Housing Bearing.
5. Gland (Split)
6. Impeller
7. Neck Rings.
8. Suction Cover
9. Logging Ring.
10. Air Cock.
11. Impeller Key
12. Coupling key.
13. Packing
14. Driving End Sleeve
15. Driving End Sleeve Nut.
16. Back End Sleeve.
17. Back End Sleeve Nut.
18. Neck Bush.
19. Balance Value.
20. Seating And Bush.
21. Guide Tips
22. Delivery cover.
23. Balance Valve cover
24. Partition Plate.
25. Middle plate.

Do's	Don'ts
1. Pump in series should be started and stopped sequentially. 2. Operate delivery valve gradually. 3. Pumps in parallel should be started with time lag. 4. Before starting always check pump is free to rotate. 5. Before starting check water level in the tank.	1. Don't run pump out side, the recommended range. 2. Don't run pump with liquid other than specified. 3. Don't run pump with less NPSH than recommended. 4. Don't run pump when misaligned.

Motors

1 Directly coupled motor.
2 Squirrel cage Induction motor.
3 Wound Rotor Induction or slip ring motor.
4 Synchronous motors.

General principle of motor:- a current carrying conductor will experience a force when placed within a magnetic field. The principle of electric motor is that it converts electric energy into Kinetic energy through the interaction of the two magnetic fields.

For Inspection of motor at manufacturer shop following test are required:

- Visual and dimensional check.
- Dielectrically and insulation test.
- Measurement and calculation of no load and short circuit characteristics efficiency, power factor current slip, losses torque etc.
- Measurement and control of alignment air – gap, bearings.
- Heat run test.
- Noise and vibration measurement.
- No load test.
- Final report.
- Handling and Storage.

Erection of Motor at Site.

1. Erecting on concrete foundation.
2. Installation of the base frame.
3. Alignment.
4. Attachment with lubrication piping system if the cooling of the motor is done with the coolant / lubrication.
5. Running of Motor on no load
6. Running of Motor on load.
7. If all the parameters required are normal as per the desired standard the motor may be recommended for use and this process at site should be witnessed with the competent engineers to ensure the quality assurance of the machinery.

Spare parts.

1. Drive end shield.
2. End shield fixing bolt.
3. Drive end out seal.
4. Pre load washer.
5. Drive end bearing.
6. Eye bolt.
7. Bearing retention circlip.
8. No drive end bearing.
9. Bearing circlip.
10. Fan cover.

11. Terminal board.
12. Fan Circlip.
13. Detachable feet.
14. Pad mounting bracket.
15. Fan end shield.
16. Winding wire.
17. Fire cloth.
18. Varnish.
19. Wooden Stick.
20. Cable.

Do's	Don'ts
1. Do add a controlled bleed off loop to the pump's outlet to limit its minimum speed, also, an accumulator can allow the pump to get turned off at dead load condition. 2. Do limit the pump speed change rate to stay above the pump minimum inlet pressure to avoid cavitation. 3. Bearing ordered direct from bearing manufacturer must be specified as 63-90 CN bearing. 100 – 355 C_3 bearing.l 4. Do break down the cycle by pressure flow and time compute each segment for power. 5. Do use the larger of the two computed HP Values compare flow at maximum pressure and pressure at maximum flow.	1. Don't operate the motor below the minimum recommended pumps speed. It may damage the pump. 2. Don't accelerate / deaccelerate a pump too fast. 3. Don't just use maximum flow and maximum pressure to compute power. 4. Don't oversize the electric motor have large drives to power.

Repair and Maintenance of Pump House, Pump Motor, Stater and Panel system.

Maintenance of Pumping Station for Screens

i. Screen should be cleaned at a frequency depending on ingress load of floating matters.
ii. Cleaning frequency should be at least once in a week, or, if head loss in screen exceeds 0.20 m.
iii. The screen, catch tray and screen handling arrangement shall be thoroughly inspected once in six months and any item broken, eroded, corroded should be rectified.

Maintenance of Different Valves are as under:

1. Foot Valve

a) Clean foot valve once in 1-3 months depending on ingress of floating matter.
b) Clean flap of the foot valve once in 2 months to ensure leak proof operation.
c) Inspect the valve thoroughly once in a year.

2. Sluice Valve and Knife gate Valve

a) Check gland packing of the valve at least once in a month.
b) Ensure that packings inside the stuffing box are in good trim and impregnated with grease.
c) Ensure that the leakage is within the limit.
d) Grease should be applied to reduction gears and grease lubricated thrust bearing once in 3 months.
e) Check tight closure of the valve once in 3 months.
f) A valve normally kept open or closed should be operated once every three months to full travel of gate.
g) Inspect the valve thoroughly for flaws in guide channel, guide lugs, spindle, spindle nut, stuffing box etc. once in a year.
h) Don't operate sluice valve with oversized hand wheel or cap or spanner as this practice may result in rounding of square top.
i) Valve should never be operated under throttled condition. Such operation may result in chatter, wear and failure of valve spindle.

3. Reflux (non-return) valve

a) Check proper operation of hinged door and tight closure under no-flow condition once in 3 months.
b) Particular attention should be paid to hinges and pins and soundness of hinged door.
c) Dampening arrangement should be thoroughly examined once in a year and necessary maintenance and rectification as per the manufactures instruction shall be carried out.
d) Dampening arrangement checks for oil leakage and replace oil once in a year.

4. Butterfly valve

a) Check seal ring and tight shut-off once in 3 months.
b) Lubricate gearing arrangement and bearing once in 3 months.
c) Inspect the valve thoroughly including complete operations once in a year.
d) Change oil or grease in gearing arrangement once in a year.

5. General

a) Operate bypass valve wherever provided once in 3 months.
b) Flange adapter / dismantling joint provided with valve shall be loosened and retightened once in 6 months to avoid sticking.

Maintenance of Pumping Station for Sump / Intake well

i. Floating matters in the sump / intake should be manually removed once in a month.
ii. It should be disposed off away from pump house.
iii. Desilting of intake / sump should be carried out once in year after monsoon.
iv. The entire intake after monsoon should be disinfected

v. The sump/ intake should be fully dewatered and inspected once in a year

vi. For leakage test sump should be filled to FSL and drop in water level for reasonably long duration (2-3 hours) should be observed.

vii. If leakage is beyond limit rectification work may be done.

Maintenance of Pumping Station for pump house

i. The pump house should be cleaned daily. Good house keeping and cleanliness are necessary for pleasant environment.

ii. Entire pump house, superstructure and sub-structure shall be adequately illuminated.

iii. Wooden flooring and M.S. grating wherever damaged should be repaired on priority

iv. All the Roof leakages should be rectified on priority. All facilities in sub-structure i.e. stair case, floors, walkways etc. should be cleaned daily.

v. Painting of civil works should be carried out at least once in two years.

Note:-

The manufacturer's O & M manual must be followed with diligence.

Operation & Maintenance of Pumping Machinery and Pump House

- Generally failures in water supply are attributed to pumping machinery.
- Timely inspection, follow up actions on observations of inspection and planned periodical maintenance can avoid sudden failures.

Important points for Pump Operation

- Voltage range should be within the range ±10% of rated voltage.
- In low and medium specific speeds pumps need to be started against closed delivery valve. High specific speed draws more power at shut off such pumps started with delivery valve open
- Delivery valve should be operated gradually.
- Parallel pumps should be started and stopped with a time lag between two pumps to restrict change of flow velocity to minimum and to restrict dip in voltage in incoming feeder
- Series pump should be started and stopped sequentially.

(i) Pumps should be started and stopped sequentially but with minimum time lag. Any pump next in sequence should be started immediately after the delivery valve of previous pump is even partly opened.

(ii) Due care should be taken to keep the air vent of pump next in sequence open before starting that pump.

Drip of leakage in stuffing box should be 80 drops per minute as per the manual

The running of duty pumps and stand by pump should be scheduled so that no pump remains idle for long period and all pump are in ready to run condition

- Undue vibration should be checked and rectified.
- By-pass valves of all reflux valve sluice valve and butterfly valve shall be kept in closed during normal operation of the pumps.
- Frequent starting and stopping should be avoided

Don't /Undesirable Operation

- The pump should never be operated either at head higher than maximum or minimum recommended.
- Operation on higher suction lift resulting in cavitations in the pump.
- Throttlling results in inefficient running as energy is wasted.
- Clogged foot valve also causes cavitation in the pump similar to operation on higher suction lift.
- Low submergence gives rise to vortex phenomenon causes excessive vibration.

Checking of pump before starting

- Power is available in all three phases
- Trip circuit for relays in healthy state
- Check voltage in all phases. Voltage is in almost same and within ±10% of rated voltage
- Check function of lubrication system in case of lubricated
- Check stuffing box to ensure that it is packed properly
- Check and ensure the pump is free to rotate.
- Check over current setting if the pump is not operated for week or long period
- Before starting check water level in the sump.

Starting and Operation of Pumps

- For starting centrifugal pump priming should be done.
- Close the delivery valve and then loosen slightly
- Switch on motor check direction if pump does not rotate. It should be switched off immediately
- If the pointer on vacuum gauge gradually rise and become steady the priming is proper
- The delivery pressure gauge should rise steadily to shut off head.
- When motor attains steady speed and pressure becomes steady the delivery valve should be gradually opened in steps to ensure the head does not drop below recommended limit
- Ammeter reading should be less than rated motor current
- Check for undue vibration
- After 10-15 minutes check the bearing temperature stuffing box packing end leakage through mechanical seal

- Voltage should be checked every half an hour and should be within limit

Stopping The Pump Under Normal Condition

- Close the delivery valve gradually.
- Switch off- the motor.
- Open the air vent in case of VT and submersible pump.
- Stop lubricating oil or clear water supply used for lubrication.

Stopping after Power Failure / Tripping

- On tripping the pumps should not start automatically on resumption of power supply.
- There may be sudden increase in flow velocity in pumping main causing sudden rise in pressure may prove disastrous to pumping main.
- It may cause overheating of pump.
- Restarting of all pumps shall also cause overloading of electrical system.

To Prevent Auto - Restarting On Resumption Of Power

- Close all delivery valves on delivery piping of pump.
- All switches and breakers shall be operated to open i.e. off position.

Starting of the pumps in case of tripping

- Open air vent in case of VT & submersible pump
- Close lubricating system oil or clear water supply in case of lubricated or clear water lubricated VT pump.
- Information about power failure should be given to all concerned particularly to upstream pumping station to stop pumping.

Preventive Maintenance of Pumping Machinery

- Lack of preventive maintenance can cause premature failure of the equipment.
- These guidelines should not be considered as total as characteristics of equipment and site conditions differ from place to place.

Daily Maintenance of Pumps

- Clean the pump motor and other accessories
- Check coupling bushes / rubber spider.
- Check stuffing Box

Routine observation of irregularities

- Change in sound of running pumping set.
- Abrupt change in bearing temperature.
- Oil leakage from bearings.
- Leakage from stuffing box or mechanical seal.
- Change in voltage and current.
- Change in vacuum and pressure gauge.

Monthly Maintenance

- Check free movement of gland of the stuffing box and check gland packing replace if necessary.
- Clean and apply oil to the gland bolt.
- Inspect the mechanical seal for wear and replace if necessary.
- Check condition of bearing oil and replace or top up if necessary.

Quarterly Maintenance

- Check alignment of pump and drive end play in bearings.
- Clean oil lubricating bearing and replenish with fresh oil or greasing accordingly.
- Tighten the foundation bolts and holding bolts of pump and motor mounting on base plate or frame.
- Check vibration level.
- Clean all instruments in the pump house.

Annual Inspection and Maintenance

- It requires thorough and critical inspection.
- Clean bearing and bearing housing and check bearing play.
- Check stuffing box gland lantern ring mechanical seal rectify if necessary.
- Check clearance in wearing ring.
- If discharge indicates reduction beyond limit 5 – 7 % require repairs.
- Check impeller, diffuser, volute and casing for rough surface.
- All vital instruments used should be calibrated.
- Conduct performance test of the pump for discharge head and efficiency.

Guideline for overhauling of Pumps

- Submersible pump - 5000 to 6000 Hours
- VT pump - 12000 Hours
- Centrifugal Pump - 15000 Hours

Safety Procedures & Practices In Electrical Work

Following Indian Standards (IS) detail comprehensive guidelines for safety in electrical installation

- IS 5216 (Part I) – General
- IS 5216 (Part II) – Life Saving Technique
- IS 5216 (Part III) – Safety Posters
- IS 5216 (Part IV) – Special guidance for safety in electrical work in hazardous areas.
- General guidelines and precautions as follows should be observed for safe working in electrical installations

Test Instruments

- Insulation tester
- Tongue tester
- AVO meter
- Test lamp
- Earth resistance tester
- Wattmeter, CT and PT
- Dial gauge.
- Tachometer

Daily Maintenance of Motor

- Examine earth connections and motor leads
- Check temperature of motor
- Check whether oil rings are working in bearing housing.
- Check for any abnormal bearing noise.

Monthly Maintenance Schedule of Motor

- Check belt tension
- Blow dust from motor
- Examine oil in oil lubricated bearing for contamination
- Check insulation resistance by meggering

Quarterly Maintenance Schedule for motors

- Like pump clean oil lubricated bearings and bearing housing
- Check contact faces of brushes of slip-ring motors. If contact face is not smooth file to proper shape and full contact over slip rings
- Check insulation resistance of the motor
- Check tightness of cable gland lug and connecting bolts.
- Check tightness of foundation bolts and vibration level
- In half yearly maintenance clean winding of motor and varnish if necessary and check slip rings.

Annual Inspections and Maintenance of Motors

- Like pump clean bearing & bearing housing of motor
- Blow out dust from windings of motors thoroughly with clean dry air.
- Air pressure should not damage the insulation
- Clean and varnish dirty and oily windings
- Check condition of stator, stamping insulation terminal box fan etc.
- Check insulation resistance to earth and between phases of motor windings.
- Check air gap
- Check resistance of earth connections.

L.T. Starters Breakers & Panel

Circuit diagram of breaker/relay circuit should be pasted on door of switch gear and original copy should be kept in record

I. Daily

- Clean the external surface
- Check for any spark or leakage current
- Check for overheating

II. Monthly

- Blow the dust and clean internal components in the panel, breaker and starter
- Check and tighten all connections of cable, wires, jumpers and bus-bars. All carbon deposits shall be cleaned

III. Quarterly

- Check all connections as per circuit diagram.
- Check fixed and moving contacts and clean with smooth polish paper, if necessary.
- Check oil level and condition of oil in oil tank. Replace the oil if carbon deposit in suspension is observed or colour is back.
- Check relay setting.
- Check insulation resistance.
- Check condition of insulators.

IV. Yearly

- Check and carry out servicing of all components, thoroughly clean and reassemble.
- Calibrate voltmeter, ammeter, frequency meter etc.

H.T. Breakers Contactors & Protection Relays

Circuit diagram of breaker/relay circuit should be pasted on door of switch gear and original copy should be kept on record

I. Monthly

- Check spring charging mechanism and manual cranking arrangement for operation
- Clean all exposed insulators
- Check trip circuit and alarm circuit.
- Check opening & closing timing of breaker.

II. Quarterly

- Check control circuits including connections in marshalling boxes of breakers and transformer
- Check oil level in MOCB/LOCB/HT OCB and top up with tested oil

III. Yearly/Two yearly

- Testing of protection relay with D.C. injection shall be carried out once in a year
- Servicing of HT breaker and contactor shall be carried out once in 2-3 years
- Check dielectric strength of oil in breaker and replace if necessary
- Check male & female contacts for any pitting and measure contact resistance

CHAPTER - 3

PIPE MATERIAL FOR PIPE LINE & WATER DISTRIBUTION

Define Standards Codes and Specifications

Standard

Standard can be defined as a set of technical definitions and guidelines

- "how to " instructions for designers and manufactures
- They serve as a common language to defining quality and establishing safety criteria for the product

  Examples ASTM, ISO, API, MSS etc

Code

A code is a standard that has been adopted by one or more governmental bodies and can be enforced by law

Or

when it has been incorporated into a business contract

- Requirements are mandatory only if said code is law.
- If not code will serve a generally accepted guidelines for design fabrication construction and installation

  Examples ASME Code BIS, DIN, IS etc

Specification

- Specifications provide specific/ addition requirements for materials components or services beyond the code or standard requirement.
- Often generated by the private companies to address additional requirements applicable to specific product or application.
- Must meet requirement.

Type of Pipe

1. Galvanized Iron (GI) Pipes IS: 1239(1): 2004 & Part (2): 2011

- Affected by acidic or alkaline water. It is highly suitable for distribution system and are available in light, medium, heavy grades depending on the thickness of pipe.
- Medium grade pipes thickness is as per IS: Codes. IS: 1239(1): 2004 & Part (2): 2011
- Normally 15 -150 mm pipes are used for water supply system

Quality Assurance / Control

Inspection / Tests are witnessed with 3rd party inspection at factory site.

METHOD AND STANDARDS

It shall conform to IS: 1239 (I) -2004 with respect to dimension, weight per meter and Hydraulic test pressure.

The Galvanizing of pipes shall also conform to relevant IS: Codes as given below:

Test	Frequency	Ref Codes	Acceptance/Standard
1. Mass of Zinc Coating	One test per lot	IS: 6745-1972	360 g/m^2 minimum total mass of Zinc (inside and outside) per surface area (inside and outside) of the coated surface. The Zinc coating shall be free from imperfection like flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rums, rust, blister, white deposit etc.
2. Visual Test	One test per lot	IS: 2629-1985	
3. Free Bore Test	One test per lot	IS: 2633-1986	
4. Uniformity of Galvanized Coating	One test per lot	IS: 4736:1986 (Amendment No. 4 Nov, 2007).	
5. Adhesion Test	One test per lot	IS: 2629:1985	

2. Steel Pipes IS: 3183 : 2012 & 3589 : 2001.

- Available in various diameters for water supply and cut lengths of different sizes & thickness.
- Pipes are joined with flanged / butt welded joints.

Inspection/ Tests is witnessed with 3rd party inspection at factory site.

METHOD AND STANDARDS

It shall conform to IS : 3183 & 3589 with respect to dimension, weight per meter and Hydraulic test pressure , Flattening Test, Bend test, Weld Tensile Test, Longitudinal Tensile Test, Transverse Tensile Test & all longitudinal and transverse tensile test shall include yield strength, tensile strength and elongation determination is in accordance with IS codes.

3. Poly Vinyl Chloride (PVC unplasticised) Pipes

- Available in size 20 – 315 mm (Nominal internal diameter) for water supply with pressure class of 2.5 , 4, 6, 8, 10, 12.5 kg per cm^2 for water supply.
- Ideally pipes with 6 kg per cm^2 should be used.
- Jointing of PVC pipe can be made by solvent cement or rubber ring joint

Inspection / Tests are witnessed with 3rd party inspection at factory site.

METHOD AND STANDARD

The dimension test should be carried out in the field and other types should be carried out in the laboratory before use.

Pipes of 1.0 m length each size should be sampled out for test.

Field test	Ref. Codes	Standards
Length of pipe Mean outside dia.(Min/ Max) Diameter at any point.(Min/ Max) Wall Thickness .Average (Min/Max) Visual appearance Dimensions of sockets	IS: 4985- 2000	As per Table-1 ,, ,, ,, Smooth, clean, both end square cut Ls = 0.5dn + 6mm Ls = minimum socket length dn = nominal outside dia of pipe

Lab Test	Ref. Codes	Standards
Reversion test	IS : 12235(5)-2004	Shrinkage not more than 5%
Short term hydro static pressure test 4.19xPN (MPa) at 27oC for one hour	IS : 12235 (8)-2004	Pipe shall not fail during the prescribed test duration.
Resistant to external blows at 0◦C	IS : 12235 (9)-2004	TIR not more than 10%
Vicat softening temperature	IS : 6307-1985	VST of specimen shall not be less than 800◦C
Density Sulphated ash content	IS : 13360 (3) Sec- I- 1995	Density of pipe shall be between 1.40 and 1.46 gm /cc 11.0 % (Max.)

3. HDPE

- Normally, 20 - 315 mm diameters pipes are used for water supply and distribution system and pressure ranging from 6 – 10 kg per $cm^{2.}$
- Available in coils in small diameters upto 110 mm dia.
- Above 110 mm diameter, available in length starting from 6 m.

HDPE pipes from 16 mm to 1000 mm nominal diameter of pressure rating from .25 Mpa to 1.6 Mpa in material grade PE63, PE80, and PE100.

For use of buried water mains and services and water supply above ground. both inside and outside buildings.

Material should free from toxic hazard, not support microbial growth etc. and anti-oxidant percentage shall not more than .3% by mass of finished resin as per IS: 10141 – 1982.

Inspection / Tests are witnessed with 3rd party inspection at factory site.

METHOD AND STANDARDS

The pipe shall conform to IS: 4984-1995

Test	Acceptance/ Standard
1.**Dimensions** (i) Outside Dia. (ii) Wall thickness 2. Hydraulic Characteristics 3. Reversion Test	As per Table No localized swelling, leakage, weeping, or bursting during subjecting to internal pressure creep test. Longitudinal reversion shall not be more than 3%
Density 3. Melt Flow Rate (MFR) 5. Carbon Black Content and Dispersion	 940.5 to 946.4Kg/m3 at 270C and shall not differ from the nominal value by more than 3kg/ m3 0.41 to 1.10 at 1900C with nominal load of 5kg and shall be within 20% of the value declared by the manufacturer. 2.5+ 0.5% with uniform dispersion.

4. Ductile Iron Pipes (IS: 8329 : 2000)/ Cast Iron Pipes (IS:1536 : 2001)

- DI pressure pipe available in range from 80- 1000 mm diameter in lengths from 5.5- 6 m
- Available in thickness class K7 and K9 with barrel wall thickness arranging from 5- 13.5 mm
- Available in pressure class (C25, C30, C40) etc.

Inspection/ Tests are witnessed with 3rd party inspection at factory site.

Size, length, internal diameter, wall thickness, tolerances on external diameter, ovality shall in accordance with specified coed, standards and specifications, permissible deviation from straight and flanges etc shall in accordance with specified standard code and specification & Hydrostatic test, Zinc Coating, Cement Mortar lining, Bituminous Coating accordance with IS:8429.

Test	Frequency	Ref. Code	Acceptance/ Standard
1. Tensile test.	One test per lot	IS: 1608	**As per table 10.1.2 in IS 8329 : 2000**
2. Brinell hardness test	One test per lot	IS: 1500	**Not exceed 230 BHN on the external unmachined surface.**

Inspection / Tests are witnessed with 3rd party inspection at factory site for Quality Control / Assurance

METHOD AND STANDARDS

It shall be as per IS: 458-2003 and should also conform the test requirement as per IS: 3597-1998.

Test	Frequency	Ref. Code	Acceptance/ Standard
1. Tolerances in Dimensions Wall Thickness	At the start of work for source approval Once for every Lot for each size	IS: 458-2003	Up to and including 30 mm + 2mm, -1mm Over 30 mm and up to and including 50mm + 3mm, - 1.5 mm Over 50 mm and up to and including 65mm + 4mm,- 2.0 mm Over 65 mm and up to and including 80mm + 5mm, - 2.5 mm Over 80 mm and up to and including 95mm + 6mm, - 3.0 mm Over 95 mm + 7mm, - 3.5 mm
Internal Dia. Of pipe or socket	IS: 458-2003		Up to and including 300 mm ± 3mm Over 300 mm and up to and including 600 mm ± 5mm Over 600 mm ± 10 mm
Overall Length	IS: 458-2003		±1% of standard Length
2. Three Edge Bearing	IS: 458-2003		Shall withstand the design Load
3. Water absorption	IS : 3597-1998		After 10 minutes, 2.5 % of dry Mass Max, and total absorption at the end of 24 Hours shall not exceed 6.5% of dry mass
4. Hydrostatic test			No leakage under the design pressure.
5. Straightness			The deviation from straightness when tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed 3 mm for every m length
6. Reinforcement	IS: 458-2003		On breaking the Pipe and extracting the reinforcement, it shall be as per the provision

Asbestos Cement pressure pipes, IS: 1592

- The classis of the pipes is C5, C10 , C15, C20, C25 & there working pressure are 2.5, 5, 7.5, 10, & 12.5 Kg/cm^2 respectively and there random lengths are available 3 to 4 m
- From nominal dia of pipe 50 mm to 1000 mm
- Joints of these pipes are PI detachable joint / victolic Joints. AC coupling joints.

Inspection / Tests are witnessed with 3rd party inspection at factory site for Quality Control / Assurance

METHOD AND STANDARDS

It shall conform to IS: 1592 with respect to dimension, Thickness of wall and external diameter, Length, Tolerances, Bursting, Crushing, Bending.

Hydraulic pressure tightness test, Hydraulic pressure bursting test, Transverse crushing test, Longitudinal bending test , Hydraulic pressure bursting non-immersed test , are carried out as per IS: 5913 and there No. of samples for test in accordance with the IS: 7639.

Test	Ref. Code	Acceptance / Standard
Line test	IS 6530	On 100 m length of laid pipeline for at least each size ordered above 5000 m'. This is to be done at random at factory of origin.

LAYING OF DISTRIBUTION PIPELINES

Critical Activities of pipeline:

- Excavation
- Completion of excavation Trenches for Pipe laying.
- Laying and jointing of pipes in correct alignment.
- Pressure / leakage Testing of pipeline.
- Backfilling in layers and watering & proper compaction of the at least 3 layers.

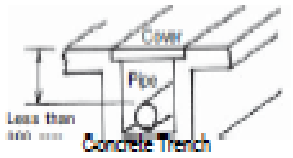
i. Preparation Prior to Laying of Pipes

- **Trenches excavation.**

Type of pipe	Minimum cover below road (mm)	Minimum clearance from either side of pipe in trenches (mm)
Steel (MS/GI/DI)	1200	200
Plastic (PVC/HDPE)	1000	200

Nominal Pipe Size (Inches)	Trench Width (Inches)	Nominal Pipe Size (Inches)	Trench Width (Inches)
3	27	20	44
4	28	24	48
6	30	30	54
8	32	36	60
10	34	42	66
12	36	48	72
14	38	54	78
16	40	60	84
18	42	64	88

- Maintain levels after excavation. Place extra formworks and shuttering where needed in case the soil is soft to prevent collapse of soil.
  If excavation is done more than planned size, fill with the soil and compact it.
  If the soil is hard or rocky the depth may be reduced.
  In hard rock, use blasting for excavation.
- Rock Excavation: Rock must be excavated so that it will not be closer than 6-inches to the bottom and sides of the pipe for diameters up to 24-inches and no closer than 9-inches for diameters 30-inches or larger
  If excavation is not possible, PVC pipes should be encased in masonry/concrete or steel pipes to prevent breakage and pressure of moving vehicles.



Encasement of pipe with polythene

- **Installation methods**

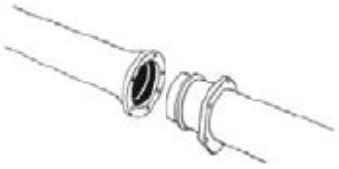
  Encasing the pipe in loose polyethylene from corrosion provides an effective and economic method of protection

Minimum Flattened Polythylene Tube Widths for Push-on Joint Pipe.

Nominal Pipe Size (inches)	Flat Tube Width (inches)	Nominal Pipe Size (inches)	Flat Tube Width (Inches)
3	14	20	41
4	14	24	54
6	16	30	67
8	20	36	81
10	24	42	81
12	27	48	95
14	30	54	108
16	34	60	108
18	37	64	121

1. In case of PVC, tape should be fixed with the help of blow lamp on the pipe.
2. A Polythylene / PVC tape should be fixed on joints after jointing the pipe.

Preparation



- All care should be taken to clean the inner surface of the pipe before laying.
- Proper cleaning of pipes and joints are required before jointing the pipes.
- **Jointing of pipes**

  Pipes should be laid and joined with fittings on side of trenches in suitable lengths and lowered after suitable lengths are prepared.

Lowering of pipes

Lower the cut pipes and fitting into trench manually. Care should be taken that they are not thrown in trenches. Mechanical device for lowering pipes can be done only in case large size pipes (>160 mm) are used. After laying, the open end of the pipes should be temporally plugged to prevent access of water, soil or any other foreign matter

Joining and Laying of MS Pipeline

Preparatory

- Cut the pipes as per required length and thread with threading die and filed for proper cleaning where needed Clean the edge and surfaces with clean cloth. Light sand paper or emery can be used lightly for cleaning if needed.

Jointing of pipes

a) Threaded joint:

- Below 200 mm threaded pipes are lowered down in trenches and lay to aligned.
- White lead is applied on the threaded end with spun yarn and inserted into socket of another pipe. The pipe is then turned and tightened.
- In case of MS Pipe below 200 mm threaded pipes are lowered down trenches and lay to aligned and gradient.
- White lead is applied on the threaded end with spun yarn and inserted into socket of another pipe. The pipe is then turned and tightened.
- Any threads exposed after jointing should be painted or coated with approved anti-corrosive paint to prevent corrosion.

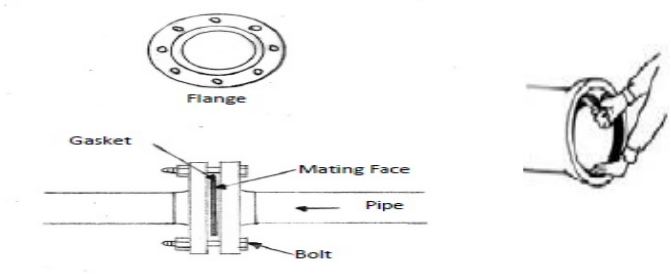
b) **Push-on Joints:**

- The push-on joint consists of a special bell, plain end, and rubber gasket. The bell is provided with an internal groove in which the appropriate gasket is seated.
- The plain end is beveled, and the joint is assembled by pushing the plain end into the bell, which compresses the gasket and forms a watertight seal.

(c) **Mechanical Joints:**

The mechanical joints have four parts. A flange cast with the bell; a rubber gasket that fits in the bell recess; a gland, or follower ring, to compress the gasket; and tee head bolts and nuts for tightening the joint.

(d) **Flange Joint:**

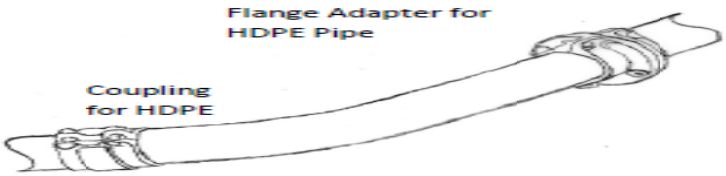


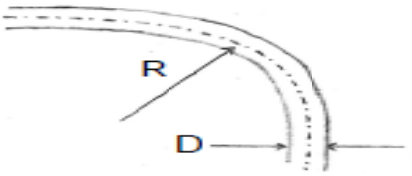
1. Welding:

- Large diameters pipes, normally above 200 m are joined by welding.
- Pipes are first lowered down manually or with chain pulley.
- Pipes are laid in level alignment before joining.
- Pipe ends are butted against each other.
- Cement mortar is applied after welding.

Joining and Laying HDPE Pipeline (Mainly for Service/Branch Connections)

- Small diameter pipes are flexible and available in coils and do not need special like bend, elbows etc.
- The radius (R) of the bend should be greater than 20 times the outside diameter of the pipe (D).
- Small radius bend can be made easily by the application of heat.
- The pipe should be heated to a temperature of 130°C in an inert liquid.
- After the pipes are bent, they are joined with mechanical joints, and fixed with bolts.
- Use of synthetic rubber gasket can also be done with it to improve water tightness of pipes.
- For joining HDPE pipes to any other pipe, HDPE-to-metal transition couplings, outlets and fittings are used.
- The pipe line may be laid along side of the trench and jointed there.
- There after the jointed pipeline shall be lowered into the trench carefully without causing undue bending, manually or with chain pulley, sling etc .
- The pipeline shall be laid inside the trench with a slack/looseness of about 1.0 m per 100 m of pipe line as they contract later on.
- For mechanical joints, thrust anchor are required in trenches for support it.

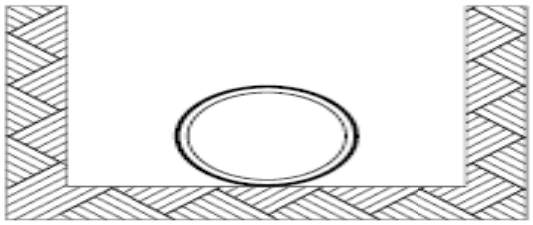




Pipe Installation:

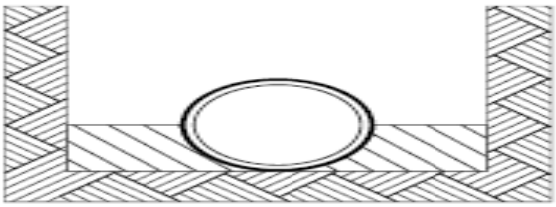
- **Type 1**

Flat-bottom trench. Loose backfill, (Fully consolidated).



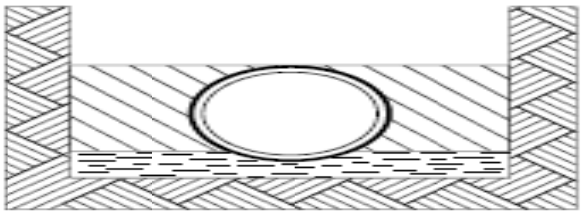
- **Type 2**

Flat-bottom trench. Backfill lightly consolidated to centerline of pipe.



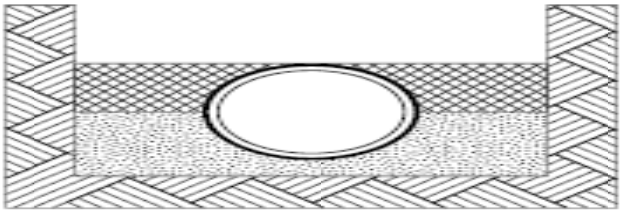
- **Type 3**

Pipe bedded in 4-inch minimum loose soil. Backfill lightly consolidated to top of pipe



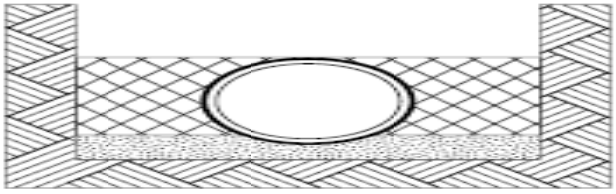
- **Type 4**

Pipe bedded in sand, gravel, or crushed stone to depth of 1/8 pipe diameter, 4-inch minimum. Backfill compacted to top of pipe.



- **Type 5**

  Pipe bedded to its centerline in compacted granular material, 4-inch minimum under pipe. Compacted granular or select material to top of pipe.



iii. Filling Excavated Pit after Laying of Pipes and Testing of Piping System

- All backfill material should be free from cinders, ashes, slag, rubbish, vegetable or organic matter, boulders etc. Sand used for back fill should be natural sand, fine or course.
- Gravel used for back fill should be natural gravel with no boulders larger than 50 mm.
- Back fill can be done with excavated materials like clay, sand, gravel, etc.
- After laying of piping system, fill the trench upto 300 mm and compact by tamping.
- Carry out leakage testing of piping system after partial back filling.

The Welding of pipes in the field should comply with IS: 816- 1969. Electrodes used for welding should comply with IS 814: 1991.

1. The welded joints shall be tested in accordance with procedure laid down in IS 3600 (Part 1) 1985. One test specimen taken from at least one field joint out of any 10 shall be subjected to test.
2. Non- destructive testing of the completed weld may be carried out on pipelines by radiographic (see IS 4853:1982) or ultrasonic method (see IS 4260: 1986) as agreed upon between the user and the manufacturer / dye penetrate test.

TESTING OF PIPE FOR LEAKAGE

The leakage can be detected in 2 ways:

1. Direct observation - spots of wet places in the pipeline indicates leakages.

2. Hydraulic test with pressure.

- Leakage test can be carried out after every 500-1000 m for such test and mainly for the mains.
- Pressure gauge should be fixed at lowest end of pipe.
- The water should be filled in from lowest point in network to be tested and air vents should be provided at higher points.

- Filling of the pipe system shall not exceed the amount of water charged into the system as follows:

Up to DN200 diameter	1.5 litres/second
Up to DN300 diameter	3.0 litres/second
Up to DN400 diameter	6.0 litres/second
Up to DN500 diameter	9.0 litres/second
Up to DN600 diameter	14.0 litres/second
Up to DN800 diameter	22.0 litres/second

- The test pressure shall be applied by a suitable pump equipped with connection valves and gauges, etc. to the satisfaction of the Engineer's Representative. The gauges and meters shall be new and accompanied by a certificate for test and calibration.
- During such filling of pipe line with water, air should be released from air vent pipes and care should be taken to close air vents only when complete air has been released from the pipe line and smooth flow of water starts.
- Calibrated tank can be installed for water supply and collection.
- For leakage test, 1.5 times the working test pressure of the pipes selected is done.
- The period for test pipe should be 24 hours.
- If the drop in pressure occurs the quantity of water added in order to re-establish the test pressure should be measured.
- Standard Allowable Volumes of leakage by diameter (Liters/Per Kilometre/Per Hour.
-

Nominal Pipe Diameter	**Leakage Rate (Litres/ Km/ Hours)**
100 mm	0.18
150mm	0.41
200mm	0.72
300mm	1.13
350mm	1.62
350mm	2.21

400mm	2.88
450mm	3.65
500mm	4.50
600mm	6.48
700mm	8.82
800mm	11.52
900mm	14.58
1000mm	18.00

- About 1 to 2 percent of the total volume of test water in the pipe will be needed as makeup water due to the expansion of HDPE pipe in the initial phase
- It is recommended that plastic pipes should be tested only upto 1.5 times the rated working pressure for a duration of 1 to 2 hours without any leakage.
- The maximum allowable leakage should not exceed .365 / 1000 m length of pipe/ cm dia of nominal bore per kg of test pressure.
- It will vary with the pipe length, number of joints in pipeline and diameter of pipe. Consult the site engineer for its details.

Note: solvent joined pipes should not be tested before 24 hours of fixing.

Fill the remaining pit in layer of 50mm with required compaction and watering.

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- Fill the remaining pit in layer of 50mm with required compaction and watering

Disinfection of Pipeline

- The mains of water supply line should be disinfected before it is used.
- Flush the pipe with water of sufficient velocity to remove dirt and other foreign material.
- Later disinfection with chlorine water can also be done. Chlorine concentration of 20 mg/litre can be used for chlorination of mains.
- Chlorine water should remain for 24 hours in the main for proper disinfection.
- Hence, all the valve, etc. should be closed along mains before the procedure.
- The chlorine water can then be disposed off and pipeline be cleaned with fresh water.

CAUSES OF FAILURE IN PIPELINES

1. HANDLING AND STORAGE OF PIPES

a) Damage during transport & careless unloading etc.

b) Defective stacking and storage.

2. LAYING OF PIPELINES

a) Deviation form proper laying procedures and improper welding.

b) Improper bedding support after laying and slipping & sinking of trench sides.

c) Poor backfill material, improper compaction, overburden on pipe trenches, point loads, traffic vibration etc. are the main problems in laying of pipe lines.

3. JOINTING OF PIPES

a) Defective jointing materials.

b) Slipping of jointing material like rubber rings and lead etc.

4. CHARACTERSISTICS OF SOIL

5. EXCESSIVE TEMPERATURE CHANGES

6. **INTERNAL PRESSURE**

a) Excessive test pressure, pressure surge, water separation, vacuum etc.

Special Observation on Failure of Pipes.

1. **Pipe Barrel**

Brittle type fractures

It generally occurs in cast iron asbestos cement and PVC. It occurs as circumferential breaks or longitudinal cracks which may run straight but more often irregularly curved along the pipe barrel.

2. Ductile type failures

It occurs in polythene and ductile iron pipe.

3. Blow outs

It is usually associated with high pressure e.g. pumping surges in weakened brittle materials.

4. Pinholes

It is localized chemically or electrically induced corrosion which thins and weakens the pipe wall until a small plug is blown out by internal pressure.

5. Generalised Deterioration

It is a manufacturing defect and it is usually the result of some form of chemical attack.

FAILURE OF JOINTS:

1. **General**

a) Failure of joints occur due to careless installation practices causing displacements of the seal / or eventual separation of the mating surface.

b) Stress cracking of pipe material around the joint.

c) Biodegradation of the sealing components.

2. **Flanged Connections**

Flange connections due to unequally tightened bolts.

3. **Crushing of pipe ends.**

When pipe ends touches or bind and are then subjected to high compressional or bending force.

4. **Lead joints.**

Hardening of lead in association with joint movement may lead to more serious leakage.

5. **Sealing rings or gaskets.**

Do's & Dont's/ Safety Practices during Repair and Operation of Water Mains

1. **Planning**

a) A safety practice during construction and maintenance of the water distribution system has two major aspects - preparation & planning and operation.

b) Usually previous methods are followed and these are revised on past experience.

c) Proper maps of the system must be maintained and studied. A study of the character of the area in which the work is to be carried out is an accident prevention item.

2. **Traffic Control**

a) Warning signs must be placed well ahead of the work area.

b) Vehicles can be parked between work area and the coming traffic.

c) Use red warning lights or flashers during the night.

d) Use a flag man for one way operation.

e) Traffic police must be informed and their help taken.

SAFETY PRACTICES IN REPAIR AND LAYING OF PIPES

1. Excavations should be closely watched. Type of soil must be studied and necessary precautions taken to provide adequate side slopes or to shore up the trench. The proximity of poles and building must be taken into consideration.
2. All soil must be stacked at least three feet from the edge of the trench.
3. Repair of broken mains is a hand job. The ground is usually saturated or washed out. Care must be taken to protect other utilities especially electric cables which can be dangerous. Welding must be done in dry conditions.
4. The workmen must use safety hats and other protective equipment.
5. Only one trained and experienced man should give signals to a crane operator.

6. The inspection of the equipment to be used should be done before it is sent to the site. In case of a burst main, the advance crew should carry plans showing the location of valves to be closed, barricading equipment, signage, valve and chamber keys etc. Portable pumps to drain out the water should also be sent.
7. The pipe for replacement must be blocked to prevent it from rolling. Proper equipment should be used when lowering it into the trench. Sufficient men should also be engaged.
8. When the job is completed, cleaning up must be done to prevent hazards to others.

WELDING AND TESTINGOF WELDING

- A Welding joint is a point or edge where two or more pieces of metal or plastic are joined together according to the particular geometry
- Butt, Corner, Edge, Lap, Tee are welding joints

(American Welding society AWS)

Welding Codes used in Welding

• Electrodes shall be confirm to	IS: 814
• Welding Symbol	IS : 813
• Workmanship quality of weld etc. should be in accordance with	IS : 823
• Inspection and testing reference should be made to	IS : 822
• Operates qualification should be in accordance with	IS: 817
• Should be subjected to appropriate qualifying test specified in	IS: 1181
• Safety requirements reference be made to	IS: 818

Electrode Coding

- B.S or BEAMA: British standard or British electro coal and Allied Manufacturing Association) method.
- AWS or ASTM: American Welding Society or American Society of Testing Material) method
- IS (Indian Standard) method

Electrode Sizes

- The electrode size refer to the diameter of its core wire each electrode has certain current range.
- Welding current increases with the electrode size (diameter)
- Size are generally for are welding are 3.15 mm 2.5mm – 4mm
- Standard length of electrodes are generally manufactured in the length of 250 mm to 450 mm

Welding layers

- Thickness of the weld generally equal to the thickness of the plate up to 4 to 5 mm.
- For above thickness the weld thickness should be as per following table

Thickness-of plate (mm)	3-5	6-8	10-16	18-24	26-55	over 58
Thickness - of Weld (mm)	3	5	6	10	14	20

Procedure of Welding

1. Joint Preparation (CAS code pressure piping) (ANSI for end preparation)
2. Treatment before welding
3. Tacking
4. Final Welding

Welding Defects

External defects:

External defects are undercut, cracks, blow holes and porosity etc.

Internal Defects:

Internal defects are blow hole, porosity, flag inclusion, internal stresses root penetration etc.

Welding Testing

Inspection of Welds can be carried out by following methods.

A. **Radiography**

Placing the radiation source on one side of the the pipe and attaching the film on the other side.

B. **Liquid Penetrant Test**

i. **Dye Penetrant Test**

- It contains two different solutions (i) Red Liquid (Dye) (ii) Volatile Liquid (as Developer).
- Apply a red Liquid (dye) by spraying brushing or dipping the metal surface and allowing it to penetrate into the cracks and crevices.
- A dwel time of at least 15 to 30 minutes.
- The surface is then cleaned with cloth or cleaner.
- A fine white powder highly volatile liquid (Developer) is carefully sprayed or brushed over the metal surface.
- Evaporation of volatile liquid will leave the dry white powder on the metal surface.
- The dye previously penetrated in the cracker will be observed by the white powder outlying the crack in red.

ii. **Fluorescent Penetration Test**

- In this case the surface is illuminated under near ultraviolet or black light.
- The liquid where there are discontinuities in surface will then delineate them by fluorescence.

Repairs of Defective Weld:

- Defect are generally removed by grinding chipping or machining.
- After welding the weld should be cleaned properly.
- Satisfactory repair can be carried out more readily on the first attempt.

CHAPTER- 4
WATER TREATMENT AND QUALITY CONTROL

1. Water Quality and Testing

Water Source	Type of quality issues
	Surface Water
Lakes and Ponds	Development of algae on top, development of Micro organisms, high turbidity in bottom layers. May be affected by organic and chemical pollutants by disposal of waste water.
River, irrigation canals	Organic debris, mineral salts (health of river depends upon BOD, MPN, DO level and silt). May be affected by organic and chemical pollutants by disposal of waste water.
	Ground water
Well, tube wells, hand pump etc.	Salinity, fluoride, alkalinity, hardness Chemical contaminations due to disposal of domestic waste/industrial chemical near by

Annexure D <u>Tolerance and Classification of Water</u> IS Code: 2296-1982

Annexure E IS Code: 10500-1991 potable drinking water

Types of tests to be conducted:

a. Physical test.

b. Chemical test. c. Bacteriological test.

Bacterial Indicator:

- Many type of harmless bacteria colonize the human intestinal track and are routinely shed in the feces
- Each person discharges from 100 to 400 billion coli-form bacteria per day in addition to other kinds of bacteria.
- Domestic waste water contains wide variety and concentration range of non pathogenic and pathogenic bacteria .

<u>E- Coli</u>

- The E-coli is one of the coli-form bacteria population and is more representative of fecal sources than other coli-form genera
- E-coli = Escherichia-coli
- E-coli is taken as a specific indicator of fecal contamination and possible presence of enteric pathogen (standard method 1998).

Viruses

- Enteric viruses multiply in the intestinal tract and are released in the fecal matter of infected persons. (.02 to .08 micrometer).
- The viruses are extremely small particles ranging from 20 to 80 nano meters (nm) in diameter in comparison a human red blood cell average 7600 nm in diameter
- Replication of viruses can only take place in a living host cell

Sampling Frequency CPHEEO Guideline

Minimum Sampling Frequency and number from Distribution System		
Population	**Maximum Intervals between successive sampling**	**Minimum number of samples to be taken from entire distribution system**
Upto 20,000	One Month	1 sample per 5,000 population per month
20,000 – 50,000	Two Weeks	
50,000 – 100,000	Four days	
>100,000	One day	1 sample per 10,000 of population per month

Where there are issues of biological contaminations, samples should be taken every week from the specified water source.

Sampling Methods

a. Sampling for physical and chemical test

- Samples should be collected in inert materials like glass or polythene.
- Sample bottle must be cleaned prior to taking samples as directed by laboratories.
- About 2.5 litres is required for testing from each sample.
- Prior to filling, the sample bottle must be rinsed 2-3 times with water to be collected.
- Sample should reach the testing place within 72 hours of collection.
- Certain parameters like pH, temperature chlorine etc may change during transport and it is advisable if they are tested on spot by specific kits.
- Samples collected from wells should be taken only after the well has been pumped for sufficient times so that the sample will represent ground water.

b. Sampling for bacteriological test

- Sterilized bottle, as directed by laboratory should be used for sample collection.
- While collecting sample, hand should not touch the bottle neck or stopper. Bottle should be held from the base, filled without rinsing and stopper be closed immediately. Bottle should have some air space left and should not be filled completely. Finally, brown paper should be wrapped for avoiding further contamination of water.
- Size of sample should be at least 250 ml (1/4th of litre).

- The sample should preferably be analysed within one hour after collection. The test of the sample should be done maximum within 24 hours.

Note for collecting sample from various sources

- While taking sample from river, lake, etc. sample should be taken from middle of bank. Stagnant water should be avoided for sample.
- While taking sample from tap (HH or stand post), water should be allowed to flow for two to three minutes prior to taking sample. Tap from which sample is collected should be clean and free from grease etc.
- While taking sample from hand pump, water should be allowed to flow for four to five minutes prior to collection of sample.
- While collecting sample from well/bore well, sample be collected from discharge end through fitted mechanical pump.

Water Testing Kits

Several testing kits are available in market to test water quality at village/town level.

1. **FTC (Field test kits)**

   Such kits include testing of water for turbidity, pH, hardness, chloride, iron, nitrate, fluoride, residual chlorine, arsenic and bacteriological quality.

2. **Jal Tara Water Testing Kits (Designed by Development Alternatives)**

   A standard Jal Tara kit can test 14 parameters:

Physical: pH, Temperature, turbidity, hardness

Chemical: chlorine, fluoride, iron, nitrate, residual chlorine, dissolved oxygen phosphorous, ammonia

Biological: Coliform bacteria

100 tests can be performed by this kit. However, 10 test for Coliform can be done.

<u>Testing Procedure in Laboratories</u>

TEST FOR TURBIDITY:

Purpose

i. Water which appears dirty and unclean on visual examination must be tested for determining its level of turbidity.
ii. Insoluble suspended particles originating from soil, silt, clay mineral matters, organic debris, carcass, plankton etc
iii. Microscopic organisms are the general cause of turbidity in water. Turbidity of usable water should not exceed 10 NTU (Nephelometric Turbidity Unit)

Result

i. Turbidity of water upto 10 NTU is acceptable

Reaction

i. Turbidity water decreases Consumer acceptance

ii. Sudden increase in turbidity is often indicative of bacterial growth

TEST FOR pH:

1. pH scale is used for determining the nature of water.
2. pH is the unit for measuring the acidic or alkaline property of water.

Purpose

i. The chemical or biochemical reaction of water depends on the pH value of that water.

ii. The pH value of water should, therefore, be determined before using.

iii. A special kind of paper is available for pH test.

iv. The colour of the paper, when dipped in water changes depending on the nature of water.

Result

Water is acceptable if the pH value ranges between 6.5 to 8.5

Reactions

i. Water pipelines get corroded if the pH value is too low, means the water is acidic

ii. If pH is high sedimentation occurs in pipelines may reduce diameter of pipe.

iii. pH plays an important role in such water treatment processes as chlorination, coagulation, softening and corrosion control.

TEST FOR CHLORIDE

Purpose

1. Chloride is almost universally present in water.
2. The presence of little amount of these salts in water does not cause any harm.
3. Access presence of chloride definitely affects our health.
4. It necessitates the need for the amount of chloride present in water to be determined.

Reagents required to test Chloride

1 - 5% w/v Potassium Chromate solution in distilled water (Chloride Free).

2 - 47.91 g Silver Nitrate dissolved in 1000 ml Chloride free distilled water and solution standardized against Sodium Chloride Solution.

Result

To carry out this test it requires two Reagent.

After adding Reagent No.2

i. If the colour changes from yellow to brick red, the water is acceptable (chloride less than 1000 mg/l)

ii. If the colour remains same as before i.e. yellow, the unacceptable. (Chloride more than 1000 mg/l)

Reaction

i. If the chloride content is high in water the water becomes salty
ii. Consumption of water with high chloride content is bad for health and corrodes water supply pipelines and other tools.

TEST FOR IRON

Purpose

i. Iron content is generally high in water, specially in ground water.
ii. Presence of iron in drinking water is usually considered good for health provided it does not cross the limit.
iii. The maximum permissible limit for iron is 1 mg/l or water.
iv. This makes this test necessary the iron content in usable water

Reagents required to test iron

1. 40% w/v Citric acid solution
2. Thioglycolic acid (Reagent grade)
3. Ammonia solution containing 20% w/w NH3.

Result

If the iron content of water

i. 1.0 mg per litre the water is acceptable

Reaction

If the iron content is too high A bad odour develops

i. Water becomes reddish and turbid, and clothes get rusty stains
ii. Brownish-red scales appear on the walls of storage vessels
iii. Excess iron content in water promotes growth of iron bacteria

TEST FOR NITRATE

Purpose

1. Presence of small amount of nitrate in drinking water is not unusual.
2. The presence of nitrates in excess is indicative of organic pollution.
3. It is of utmost importance to detect the amount of nitrate in water.

Reagents required to test nitrate

1. 5 g Brucine dissolved in 90 ml Glacial Acetic acid and 10 ml distilled water
2. Sulphuric acid concentrated, Nitrogen free.

Result

Excess of 45 mg/l the water is unacceptable

Reaction

In case of excess nitrate in water

i. Infants suffer from blue baby disease (methemoglobinemia)
ii. Miscarriage in oriparous creatures often occur
iii. Death of cattle offsprings (mostly in cows and pigs) may take place

TEST FOR FLUORIDE

Purpose

1. Fluoride helps build up strong and healthy bones and teeth in children and it prevents dental diseases.
2. Excess fluoride more than 1.5 mg/l in usable water may adversely effect human health.
3. It is essential to test the amount of fluoride present in water before using.

Reagents required to test fluoride

8 - 0.3 g Ziconium Oxychloride and 0.07 g Alizarins dissolved separately in distilled water and mixed and diluted to 1000 ml with mixed acid solution (112 ml HCL in 500 ml distilled water and 37 ml Sulphuric acid in 500 ml distilled water).

Result

i. 1.5 mg/l, the water is acceptable

Reaction

If the fluoride content in water exceeds the limit (i.e. 1.5 mg/l)

i. Teeth are affected, and higher amount may cause Skeletal fluorosis
ii. Vomiting, gripe, blood in stool, cramps, nervous disorders, etc. may occur in case of acute toxicities with excess fluoride in water. Liver and heart muscles gradually get destroyed If the water does not contain any fluoride
iii. Dental diseases may develop

Fluoride content in water should be as low as possible

TEST FOR RESIDUAL CHLORINE

Purpose

1. Chlorine is not only used as a disinfectant but it is also a strong oxidizing agent.
2. Chlorine in water completes its action within 25-30 minutes.
3. The amount of residual chlorine in usable water should not exceed 0.2 – 0.5 mg/l.

Reagents required to test residual chlorine

1. Ortho-Toluidine Solution- 1.35 gms of Ortho- Toluidine dihydrochloride in 500 ml distilled water.

Add this solution with constant stirring to a mixture of 350 ml of distilled water and150 ml Conc. HCL

Result

i. Ranges between 0.2 – 0.5 mg/l, the water is acceptable

Reaction

An unpleasant taste and odour develops due to an excess amount of residual chlorine in water

TEST FOR ARSENIC

Purpose

1. The amount of arsenic present in drinking water exceed 0.05 mg/l consumption of such water is extremely dangerous for health.
2. So it necessitate it to detect the amount of arsenic present in drinking water.

Reagents required to test Arsenic

1. Lead Acetate- 10 gm Lead Acetate of AR/GR/EXCELAR grade Pb $(C_2H_3O_2)_2.3H_2O$ in 100 ml distilled water.
2. Conc. Hydrochloric Acid (HCl)- AR/GR/EXCELAR grade
3. Potassium Iodide Solution- 15 gms of AR/GR/EXCELAR grade Potassium Iodide (KI) in 100 ml distilled water and store it in dark coloured bottle.
4. Stannous Chloride Solution- 40 gms of Arsenic free Stannous Chloride ($SnCl_2.2H_2O$) of AR/GR/EXCELAR grade in 100 ml Conc. HCl and warm.

Result

i. If the colour of the mercuric bromide paper does not change, the water is acceptable
ii. If the colour changes to reddish yellow, there is presence of Arsenic in water and it is unacceptable
iii. If it is confirmed by this test that there is arsenic in water, the water sample has to be sent to the nearest laboratory for detailed analysis.

Reaction

If the quantity of arsenic exceeds the permissible limit, prolonged consumption of such water can cause

i. Cancer of skin, lungs and liver
ii. Loose motions
iii. Impairment in the functions of heart, lungs, reproductive organs and nervous system
iv. Acute toxicity in the body if the arsenic content is too high

BACTERIOLOGICAL TEST

Purpose

1. Many micro – organisms cause infection / disease through water.
2. So water should be free from disease causing bacteria, virus etc.
3. It causes disease likepolio, jaundice, cholera, typhoid, dysentry, diarrhoea or enteric diseases.
4. Therefore, bacteriological test of water is very essential to ensure its safety.

Result

i. If the colour of the water in the bottle does not changes, water is safe and acceptable
ii. If the water in the bottle turns black/Yellow, the water is unacceptable
iii. The screw cap bottle need to be thoroughly washed and boiled for at least 10 min before use.

ASSESSMENT OF MICROBIOLOGICAL QUALITY

Colour code Scheme for Thermotolerant Coliform or E.Coli in water

Count per 100 ml	Category & Colour Code	Remarks
0	A (blue)	In conformity with WHO guidelines
1-10	B (green)	Low risk
10-100	C (yellow)	Intermediate risk
100-1000	D (orange)	High risk
>1000	E (red)	Very high risk

SAFETY IN THE LABORATORY/ Do's and Don'ts

1. **SAMPLING SAFETY**

a) Never take field samples with bare hands. Always wear gloves.
b) Do not climb over or go inside guardrails. Use poles, ropes, dippers, or other long distance samples.
c) When collecting gas samples, do not open tank cover completely. Install a sampling port, if needed.
d) Wear an effective gas mask when taking gas samples.

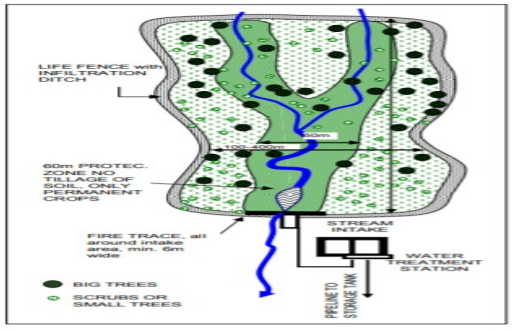
2. Regarding Housekeeping, Safety with Chemicals, Safety with Equipments, Safety with Glass, Safety in Laboratory Procedures, First Aid and Fire Prevention in the Laboratory, Standard Operating Procedure should be followed.

CHAPTER- 5

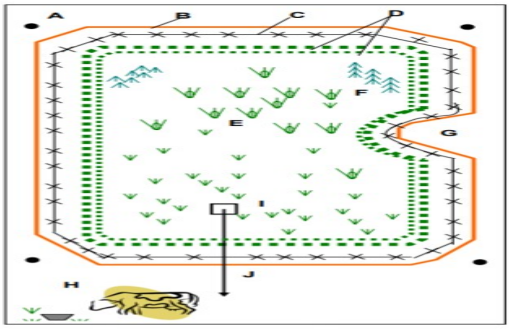
PROTECTION FOR WATER SOURCES & TREATMENT SYSTEM

Surface Water / Sanitation of catchment area

- Spring catchment area should have a minimum size of 100mx300m long but this can vary according to local conditions. Most successfully protected catchment are not larger than 50,000 m2 or 5 hectares bigger areas difficult to maintain
- For stream of River – An area of 30 m wide on both banks of streams should be fully protected up stream from the intake point
- An addition strip of 50 to 100m wide can only be used for farming that does not involve soil tilling or the use of chemicals. The length of protected banks upstream of the water intake should generally be between 500 and 1000m depending on local conditions
- For bigger scheme a distance of 10 km upstream and 2 km down stream from the point of proposed intake should be protected -



River catchment



Spring catchment

Tube Wells Protection / Sanitation

The annular space between casings should be sealed by gravel packing to a depth of 6 m & casing pipe should be set into the bed rock for rocky areas.

Protection for water sources

(Hand pump)

- Concrete platform including drain need to be constructed to ensure discharge of waste about 10 metres away from the hand pump
- Diameter of tube well platform should not be less than 185 cm
- Properly sloped (1:2) masonry apron should be constructed around the well to prevent accumulation and percolation of dirty water just around the well.

Protection of surrounding of the hand pump

- Defecation near the well site and indiscriminately anywhere in the village should be stopped by common agreement and enforcement by social pressure.

- Compost and garbage pits, Laundary, bathing, watering and washing of animals should not be allowed within at least 10 metres radius of the tube well.

Protection for water sources

(Open wells/Dug wells)

- At least 1 metre wide masonry apron should be constructed around the well to prevent accumulation of dirty water just around the well and its percolation
- A smooth drainage channel should be constructed at least upto 2 metres from the well to prevent stagnation of water around the well as well as seepage into the well
- A leak proof parapet about 1m height should be made around the well.
- Lining constructed should be leak proof
- It is desirable to cover the well with a concrete slab.

Do	Do Not
• Inform and involve all stakeholders in the water catchment protection activities. • Settle compensations. • Obtain catchment land title for WMC. • Train caretakers. • Use life poles in dead fence. • Plant trees. • Dig storm water gutters. • Plant Vetiver rows against erosion. • Do fire tracing. • Collect user fees and pay caretaker. • Meet with the WMC at least twice per year. • Give support to WMC when necessary. • Communicate regularly with stakeholders.	• Upset people by not including them. • Make the catchment too big. • Use force on unwilling stakeholders when there is room for talk. • Allow farming in the catchment. • Allow grazing in the catchment. • Allow fire in the catchment. • Allow hunting in the catchment. • Allow excreting in the catchment. • Let the caretaker do all the work alone. • Let people use the water if they do not pay the fee. • Give money without monitoring the result.

Water Treatment Systems

Type of Filtration	Purpose	Type of unit
Sedimentation	Removal of suspended solids like sand, clay, silt etc.	Sedimentation tanks
Sedimentation with coagulation	Removal of suspended solids, colour, odour, taste, turbidity etc.	Sedimentation with chemical input
Filtration	Removal of micro organism and colloidal matter	Slow / rapid sand filter

Water softening plant	Removal of water hardness / salts	RO (reverse osmosis plant)
Disinfection	Removal of pathogenic bacteria	Chlorination
Specialised water treatment plants	Removal of fluoride	De-fluoridation units, Nalgonda System

Village/Town Level Water Treatment Systems

- The treatment units should be located in such a manner where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required.
- Sufficient area should be reserved near the treatment units for further expansion in future.

Types of Water Treatment System at Village/Town Level

1. **Primary Screening**

   Screens are fixed in the intake works or at the entrance of treatment plant so as to remove the floating matters as leaves, dead animals etc.

2. **Sedimentation**

   In this process, suspended solids are made to settle by gravity under still water conditions. The sedimentation tanks may be rectangular or circular in shape.

Jar Test

- Jar test which determines the most effective dose of chemicals by trial and error method
- Commonly use coagulants are alum & lime (Powder hydrated line)

3. **Coagulation and Flocculation**

- The purpose of coagulation and flocculation is to remove particulate impurities especially settlable solids (particularly collides) and colour from the water being treated.
- Alum dosing recommended chemical dose of [$Fe_2(So_4)_3Al_2(SO_4)_324H_2o$] (IS:299)
- Excessive turbidity may cause increase in dose it may be double or more to the recommended dose.
- Only 20-30% alumina can is used to settle to colloidal turbidity and remaining is wasted.

Monsoon	Winter	Summer
50mg/l	20mg/l	5mg/l

Factors influencing the sedimentation

i. Size shape and weight of floc.

S. No.	Type of Material	Dia (mm)	Rate of settlement (m/h)
1	Coarse sand	0.1 0.5	365.75 193.84
2	Fine Sand	0.25 0.10	97.53 29.26
3	Silt	0.05 0.005	10.61 0.14
4	Fine clay	0.001 0.0001	0.005 0.00005

Rating of Sedimentation Tank		
Idle efficiency	**Good efficiency**	**Poor efficiency**
Above 63%	30 to 50%	5 to 30%
Efficiencies of the sedimentation tanks should be given due consideration to reduce load in next stages of water treatment plant.		

ii. Viscosity and temperature of water

iii. Effective average period available for sedimentation (Detention period)

iv. Effective depth of tank

v. Surface Area.

vi. Surface overflow rate or surface loading

vii. Velocity of Flow.

viii. Inlet and outlet design

4. Flocculation equipment

The main requirement of mix is that all the coagulant be rapidly mixed with all the water instantly.

Plant below 300m^3/hr requires mixer like Gravitational or hydraulic mixing, Mixing and stirring Devices, Baffled channels of Basins, Tangential Flow, Pipe flocculation etc.

5. Mechanical mixture

Plant above 300m^3/hr requires mechanical mixer called flash mixer

- More flexibility in operation least head loss of the order .4 to 1m.
- Detention time 30 to 60 seconds

Velocity of flow .9m/sec

Depth 1 to 3 m

RPM of blades 400- 1400

6. Flocculation

After flash mixing, subsequent Flocculation process requires controlled agitation with Velocity of flow of speed of a pedal ranging from .2 to .6m/sec.

Depth of tank 3 to 4.5m

Detention time 10 to 40 min

Normally 30min

Velocity of Flow .2 to .8m/sec

Normally .4m/sec.

Total pedal area 10 to 25% of cross-sectional areal.

7. Sedimentation with Coagulation / Clarifier

- In this process certain chemical / coagulant are added in the process along with sedimentation for impurities to settle down. This process is useful in removal of colour, odour and taste from water. Turbidity and bacteria can also be removed to certain means.
- Coagulants are added based on pH of water. They are added in powder or solution form to raw water through some mechanical means.

8. Filtration

Slow Sand Filter

- Schmutzdecke layer at the top of the filter bed is formed called house of micro organisms to consume bacteria and also remove, color, odor, and taste form water.
- Such filter is made up of tank containing sand in top layer (size 0.2-0.3mm) up to thickness of 750-900 mm.
- Average flow of water from such filter is about 2400-3600 litres/m^2/day. .
- The sand needs to be replaced every 6-8 weeks as it gets clogged with impurities. Gravel can be washed and cleaned and replaced again.

Rapid Sand Filter

- Discharge. 4.8 to 6 m^3/m^2/hr.
- The layer of sand usually 60 to 75 cm.
- The depth of water over the sand top varies between 1m to 2m.
- The free board shall be at least 50 cm.

Under drain system

- Supporting media is replaced by v-wire screen (s.s) and discharge is between 5 to 7 $m^{3.}/m^2$/hr.
- Remaining features are similar to RSF.

Annexure F Operational parameters for Water Treatment Plant units for tests.

Do's & Don'ts / Safety in Plant Maintenance

Maintenance Hazards, Cleaning, Painting, Assess to equipment, Lighting, Ventilation, Safety from Equipment, Lubrication Safety, Safety in confined spaces, Standard Operating Procedure should be strictly followed.

CHAPTER - 6
DISINFECTION

Type of Disinfection

1. **Physical Disinfection**: Boiling
2. **Chemical Disinfection**: Chlorination , Liquid Chlorine IS:646- 1986 (Second revision- Reaffirmed 1991)
3. **Chlorinated Lime**: (Bleaching Powder) / Hypochlorination IS- 1065- 1989 Reaffirmed 1996.

Chlorine Demand

This is the difference between the amount of chlorine added to water and amount of free or combined available chlorine remaining at the end of specified contact period.

Disinfection of dug wells.

4 mg of bleaching powder for every litre of dug well water very effectively destroys the micro-organisms in water and the residual chlorine remains in the range of 0.2-0.5 mg/l.

Volume of water = $\frac{3.14 \times \text{diameter}^2 \times \text{height}}{}$ x 1000 litre

Disinfection of Tubewell

A strength of 60 mg/ litre chlorine is maintained in the water column of the tube for 30 minutes. When Residual chlorine becomes nil, the tube well is allowed to be used for the users.

Water chlorination

Bleaching powder Ca(ocl)2 it contains 34% of available chlorine by weight .

	Quantity of Chlorine	
Quantity of water to be used (litres)	**Powder form chlorine / bleach (grams)**	**Chlorine Solution (milliliter)**
	25-30% powder	5% Solution
1000	5	25
5000	15	125
1 Lakh	500	1500
5 Lakh	2500	12500

Chlorine dose may be increased/ decreased in accordance of pH of water

pH Value	Contents of residual,%			Chlorine dose to give the same efficiency of kill
	Cl2	HOCl	OCl	
4.0	0.5	99.5	0.0	
5.0	0.0	99.5	0.5	0.1
6.0	0.0	96.5	3.5	0.1027
7.0	0.0	72.5	21.5	1.27
8.0	0.0	21.5	72.5	3.7
9.0	0.0	1.0	99.0	28.0

Minimum chlorine residuals for drinking water at 20°C (After Butter Field)

PH	6-7	7-8	8-9	9-10	10-11
Free available Chlorine mg/l after 10 min	.2	.2	.4	.8	.8

Disinfection By Product (Waste Water Engineering by METCALF & EDDY)

- When chlorine is added to water containing organic matter a variety of organic compounds containing chlorine is formed known as disinfection by products (DBPs)
- Many of them are known as suspected potential human carcinogens
- Typical classes of compounds includes
- Trichaloromethanes (THMs) halo acetate acids (HAAs)
- Trichlorophenol and aldehydes
- More recently N-nitrosodimethlamine (NDMA) has been found in the effluent from waste water treatment plants. It is most powerful carcinogens known
- NDMA appears to be formed during the chlorination process

Pre-chlorination

- Pre- chlorination is done at (i) Source (ii) in the flocculation basin (iii) at the filter inlet
- It removes colour odor taste producing substances and prevent algal growth from raw water

Post-Chlorination

- Post chlorination is the application is the application of chlorine after the treatment process
- It is added here principally to destroy pathogenic organism including the virus

Re chlorination

- Where the distribution is very large it becomes difficult to maintain minimum chlorine residual of .2 mg/l at the end of the system
- It may be done in service reservoirs or directly into distribution system

Super chlorination

- When raw water is with doubtful quality or subjected to rapid fluctuation in quality
- Chlorine dose 10 to 14 mg/l for 10 to 30 minute
- But it necessitates dechlorination of treated water before use with sodium thiosulphate.

  In case of virus in water residual chlorine should be 0.5 Mg per litre for atleast one hour with dose of 8 mg per litre may deactivate the virus.

Equipments for Chlorination at Cluster/Village/Town Level

a) **Differential Pressure Type Chlorinator (with use of bleaching powder).**
b) **Drip type equipment.**
c) **Gas Chlorinator:**
d) **Nalgonda System for Fluoride Removal**
e) **Reverse Osmosis System (RO)**

Household Water Treatment Systems

- Basic filtration and boiling.
- Domestic chlorination

CONVENTIONAL CHLORINATION

The conventional chlorination facility i.e. adding chlorine for disinfection of water treatment consists of three essential parts:

1. Chlorine supply system
2. Metering system
3. Diffuser system

In addition to above, there are ancillary equipment, safety equipment, metering & control instrumentation and chlorine residual analysers.

CHLORINE SUPPLY SYSTEM

a) Chlorine Gas Supply System
b) Evaporator Supply System or Liquid Chlorine Supply System
c) Chlorine Gas Filter
d) External Chlorine Pressure Reducing Valve

METERING SYSTEM: CHLORINATOR

A chlorinator is a device for feeding chlorine to a water supply. It also serves as gas metering device. Chlorinators are classified into two categories.

- Pressure type
- Vacuum type

PRESSURE TYPE CHLORINATOR

a) Dry Feed Type
b) Aqueous Solution Feed Type

Operation of Pressure Chlorinator with Aqueous Solution – Gravity Feed Type.

a) **Start up of the chlorinator**
b) **Shutting down**

Operation of Pressure Chlorinator with Aqueous Solution – Injector Solutionizer Type

a) **Start up of the Chlorinator**
b) **Shutting down**

Vacuum Type Chlorinator

Start up of Gas Chlorine System

Start up of Liquid Chlorine System

Procedure for stopping the plant.

Maintenance of Chlorination Equipment

SUGGESTED MAINTENANCE OF CHLORINE EQUIPMENT PRESSURE CHLORINATIOR – AQUEOUS SOLUTION FEED TYPE …….. REFER TABLE 6.1.

SUGGESTED MAINTENANCE OF CHLORINE EQUIPMENT AND FITTINGS – VACUUM TYPE CHLORINATOR…….REFER TABLE 6.2

COMPARISON OF CHLORINATORS ……REFER TABLE 6.3

IMPORTANT FACTS ABOUT CHLORINE FROM SAFETY POINT OF VIEW ……..REFER TABLE 6.4

SAFETY ASPECTS OF CHLORINE

CYLINDERS

TONNERS

CONTAINDER VALVES

STORAGE & HANDILING OF CHLORINE CYLINDERS

Chlorine is stored in special grade steel containers. As per IS:4379-1967, the colour of Chlorine container should be ‘golden yellow’.

(a) Storage Area

(b) Cylinder & Drum Containers

(c) Use of Cylinders & Drum Containers in Process System

(d) Disconnecting Containers from Process System

(e) Loading and Unloading of Containers

(f) Transportation of Container

(g) Emergency Kit

(h) Health Hazards

(i) First Aid - Trained Personnel and Equipment

(j) Fire & Explosion Hazards:

(k) Emergency Measures

(l) Personal Protective Equipment

(m) Employees Selection

(n) Employees Training

(o) Neutralisation of Chlorine

(p) Emergency Response Planning…….Refer clause 6.5.5 (a) to (p) of CPHEEO Manual 2005.

Reference: Manual on Operation & Maintenance of Water Supply System CPHEEO, 2005 Clause 6.4 & 6.5.

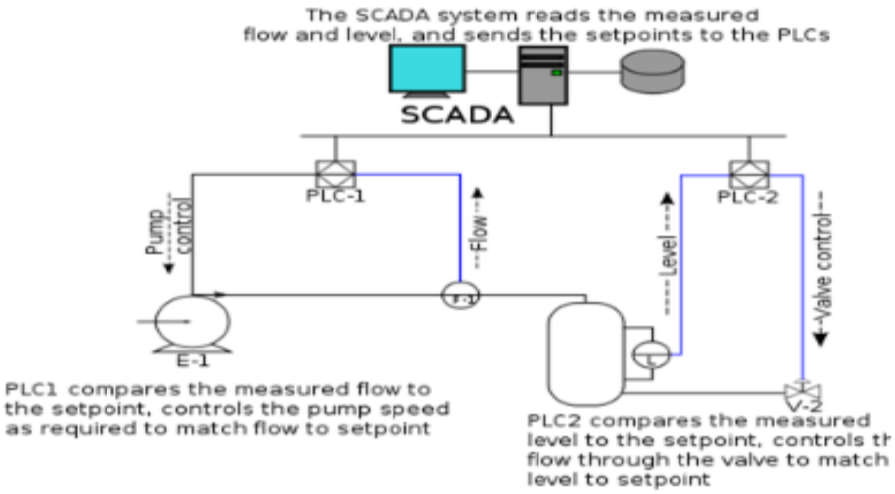
Do's & Don'ts / Safety measures

a) Chlorine is stored in special grade steel containers. As per IS:4379 – 1967, the colour of Chlorine container should be 'golden yellow".
b) Both chlorine cylinder as well as tonners must be fitted with standard valves conforming to IS:3224
c) Obtain storage licence from controller of explosives under Gas Cylinder Rules 1981 if the quantity of Cl_2 containers to be stored is more than 5 Nos.
d) Two portable foam type fire extinguishers should be provided in the premises.
e) Corrosive substances shall not be stored nearby which react violently with each other.
f) Unauthorized person should not be allowed to enter into the storage area.
g) The floor level of storage shed should be preferably 30 cms higher from the ground level to avoid water logging.
h) Ensure that tall containers are properly fitted with safety caps or hooks.
i) Chlorine should not be stored in open area with direct sunlight as it will disintegrate. Chlorine containers should be closed immediately after its use.
j) Chlorine should not be used in excessive amounts in drinking water as it may lead to health problems.
k) Potential problems

a. Chlorination is less effective in alkaline water (pH above 8.0);
b. When the water contains excessive organic matter or suspended material, it will need to be pretreated;
c. Chlorination affects the taste of water.

CHAPTER- 7
SCADA System

1. SCADA stands for supervisory control and data acquisition.
2. It is a type of software application program for process control.
3. IT is a central control system which consists of controller's network interfaces, input/output, communication equipment, and software.
4. It is used to monitor and control the equipment in the industrial process which includes electrical power, water distribution system etc.
5. It takes the reading of the meters and checks the status of sensors in regular intervals so that it requires minimal interference of humans.



1. This SCADA system used to gather data from sensors and instruments located in remote areas.
2. The computer then processes this data and presents it promptly.
3. It gathers the information (like a leak on a pipeline occurred) and transfers the information back to the system while giving the alerts that leakage has occurred and displays the information in a logical and organized fashion.
4. The SCADA system used to run on DOS and UNIX operating systems.

Architecture:

1. The SCADA system is a centralized system that monitors and controls the entire area.
2. It is a pure software package that is positioned on top of the hardware.
3. It gathers data on the process and sends the commands control to the process.
4. The SCADA is a remote terminal unit which is also known as RTU.

5. Most control actions are automatically performed by RTUs or Programmable Logics Controller (PLC).
6. The RTUs consists of the programmable logic converter which can be set to specific requirement.
7. The SCADA system monitors the overall performance of the loop.
8. The SCADA system is a centralized system to communicate with both wired and wireless technology to Clint devices.

EX: If too much pressure is building up in a gas pipeline the SCADA system can automatically open a release valve.

Hardware Architecture:

It is classified into two parts:

- The Clint layer which caters for the man-machine interaction.
- The data server layer which handles most of the process data activities.

1. The SCADA station refers to the servers and it is composed of a single PC.
2. The data servers communicate with devices in the field through process controllers like PLCs or RTUs.
3. The PLCs are connected to the data servers either directly or via networks or buses.
4. The SCADA system utilizes a WAN and LAN networks, the WAN and LAN consist of internet protocols used for communication between the master station and devices.
5. The physical equipment like sensors connected to the PLCs or RTUs.
6. The RTUs convert the sensor signals to digital data and sends digital data to the master.
7. According to the master feedback received by the RTU, it applies the electrical signal to relays.
8. Most of the monitoring and control operations are performed by RTUs or PLCs.

Software Architecture

1. The servers are responsible for data gathering and handling.
2. It consists of a software program to provide trending, diagnostic data, and manage information such as scheduled maintenance procedures, logistic information, detailed schematics for a particular sensor or machine, and expert-system troubleshooting guides.
3. It means the operator can see a schematic representation of the plant being controlled.

EX: alarm checking, calculations, logging, and archiving; polling controllers on a set of parameters, those are typically connected to the server.

Working Procedure of SCADA system:

It performs the following functions:

- Data Acquisitions
- Data Communication
- Information/Data presentation
- Monitoring/Control

Data Acquisitions:

1. The real-time system consists of thousands of components and sensors.
2. It is very important to know the status of particular components and sensors.
3. Some sensors measure the water flow from the reservoir to the water tank and some sensors measure the value pressure as the water is a release from the reservoir.

Data Communication:

1. The SCADA system uses a wired network to communicate between users and devices.
2. Real-time applications use a lot of sensors and components which should be controlled remotely.
3. The SCADA system uses internet communications.
4. All information is transmitted through the internet using specific protocols.
5. Sensor and relays are not able to communicate with the network protocols so RTUs used to communicate sensors and network interfaces.

Information/Data presentation:

1. The normal circuit networks have some indicators which can be visible to control but in the real-time SCADA system, there are thousands of sensors and alarm which are impossible to be handled simultaneously.
2. The SCADA system uses the human-machine interface (HMI) to provide all of the information gathered from the various sensors.

Human-machine interface:

1. The SCADA system uses the human-machine interface.
2. The information is displayed and monitored to be processed by a human.
3. HMI provides access to multiple control units which can be PLCs and RTUs.
4. The HMI provides the graphical presentation of the system.
5. It provides a graphical picture of the pump connected to the tank.
6. The user can see the flow of the water and the pressure of the water.
7. The important part of the HMI is an alarm system that is activated according to the predefined values.

For example, The tank water level alarm is set 60% and 70% values. If the water level reaches above 60% the alarm gives a normal warning and if the water level reaches above 70% the alarm gives a critical warning.

Monitoring/ Control:

1. The SCADA system uses different switches to operate each device and displays the status of the control area.
2. Any part of the process can be turned ON/OFF from the control station using these switches.
3. SCADA system is implemented to work automatically without human intervention but in critical situations, it is handled by manpower.

Chapter - 8

QUALITY ASSURANCE/ QUALITY CONTROL FOR WATER TREATMENT PLANT

Rationale for Adopting QA/QC Measures

- Keys to ensuring clean, safe and secure water drinking water is to implement QA/QC measures throughout the drinking water system, from source to the consumers tap; this will enable to curtail the entry of pathogens and chemical contaminants at any point in the drinking water supply system Additional benefits of implementing QA/QC measures include:
- Public health protection by providing safe water to the consumers;
- protected source waters;
- Well maintained treatment and distribution systems;
- Good management of costs involved in treating and supplying the water;
- Identification of potential hazards and elimination of the hazards through risk assessment;
- provides a framework for communication with the consumers (public) and with employees;
- provides an opportunity for water utility managers and employees to identify their areas of responsibility and become involved;
- increased involvement of stakeholders and public;
- Reduction in health care costs; and
- Increased environmental protection

Risk Based Approach to QA/ QC

Hazard refers to a source of (potential) harm to the functioning of any aspect of the drinking water system or human health. Risk refers to the chance or possibility of a hazard causing this harm to the functioning of any aspect of the drinking water system or human health.

Potential Hazardous/Contamination Events

a) Catchments, groundwater systems, storage reservoirs, and intakes:

- Variations in raw water quality;
- Sewage, industrial, and septic tank discharges;
- Chemical (fertilizer or pesticide) use in catchment areas;
- major spills;]
- surrounding land use (eg: agriculture, forestry, industrial area, mining, disposal or landfill sites);
- storm water flows and discharges;
- unconfined and shallow aquifers;
- groundwater under direct influence of surface water;
- inadequate well-head protection and unhygienic practices;

- saline aquifers, contaminated aquifers;
- seasonal variations (heavy rain falls, droughts);
- open/uncovered reservoirs;
- Unsuitable intake location;
- algal blooms;
- Soil erosion; and
- bush fires and natural disasters.
- Sabotage and natural disasters.

b) Treatment systems: significant flow variations through water treatment;

- Inappropriate treatment processes;
- Improper design of treatment units;
- Use of unapproved or contaminated water treatment chemicals and materials;
- Chemical dosing failures;
- Inadequate mixing;
- Inadequate filter operation and backwash recycling;
- Inadequate operational monitoring;
- Inadequate disinfection;
- Equipment malfunctions;
- Failure of alarms and monitoring equipment;
- Power failures;

c) Storage Reservoirs and Distribution Systems:

- Open/ uncovered reservoirs;
- Human, animal, and bird access;
- Sediment builds up and slimes;
- Use of unapproved coating materials;
- Aged pipes;
- Corrosion of reservoirs and piping system;
- Contamination due to cross-connections and backflow;
- Biofilms, sloughing and regrowth;
- Pipe breaks/leaks;
- Inadequate system flushing and reservoir cleaning;
- Commissioning new pipe mains;
- Inadequate disinfection after construction;
- Inadequate pressure;
- Insufficient chlorine residual;

- Formation of disinfection by-products;
- Failure of alarms and monitoring equipment; and
- Natural disasters and sabotage.

d) Consumer's Potential Consumer Misuse; and

- Inappropriate plumbing and construction material.

As a general guidance, the QA/QC measures need to address the following key elements of the DWQMS:

- policy and commitment to safe drinking water;
- evaluation of drinking water supply system;
- implementation of operational procedures and process control;
- verification of treated water quality;
- emergency response plan;
- training of water utility personnel; and
- record maintenance and reporting

Policy and Commitment to Safe Drinking Water

It is important for all of the water utility personnel to consider formalizing their commitments and priorities related to drinking water by developing policy statements that support public health goals.

Evaluation of Drinking Water Supply System

- the water treatment utilities should know what pollution sources are close to their intake and what type of contaminant(s) gain entry into the system.
- There are many potential raw water quality problems for a surface water source, including:
- Turbidity – can be difficult to remove depending on the size and concentration of particles;
- Pathogens – can cause intestinal illness and other diseases;
- Natural organic matter (NOM) – difficult to remove and can form carcinogenic compounds while combining with certain disinfectants;
- Algae – can cause taste and odor problems; and
- Synthetic organic compounds (SOCs) and inorganic compounds (IOCs) – can cause adverse health effects and affect treatment decisions.

One of the most important requirements for any water treatment system is the ability to meet the water quantity demands of consumers at all times, because prolonged interruptions or reductions in the source water supply may cause low pressures in the distribution system that pose a public health hazard.

Groundwater is obtained through wells dug or drilled into aquifers.

Aquifers are geologic formations, or groups of formations that yield significant quantities of water to springs and wells. For ground water, many of the contaminants originally found in the surface water are removed as it seeps into the ground and through the aquifer, due to the natural filtration effect as water passes through soils and long travel times in the aquifer. Groundwater generally moves quite slowly, especially under non-pumping conditions. Gravity and pressure differences are important factors in groundwater movement.

Unconfined aquifers interact closely with streams and lakes. In conditions where unconfined aquifers are close to the surface water, the aquifer feeds the stream or lake by discharging to the surface water. In these conditions, if drinking water is drawn from a surface water source, it is necessary to assess the nearby-unconfined aquifer. In the case of water treatment utilities drawing groundwater under the direct influence of surface water, direct influence shall be determined in order to make an assessment of a system's vulnerability. The determination shall be based on site-specific measurement.

Implementation of Operational Procedures and Process Control

All components of a process control program shall be documented with copies available to all. Documentation needs to include a description of:

- operational procedures for relevant activities;
- authorities and their responsibilities;
- operational monitoring plans including: o operational parameters to be monitored;
- inspection requirements;
- sampling location and frequency;
- sampling methods and equipment;
- checking and interpreting results; and
- documentation and records management including how monitoring results are recorded and stored;
- reporting and communication requirements;
- maintenance procedures; and
- preventive and corrective actions to be implemented

The water treatment utility authorities shall ensure that the equipment and infrastructure associated with rapid mixing, flocculation, sedimentation, filtration and disinfection are designed properly and have sufficient capacity (size, volume, and detention time) to handle peak flow rates

Requirements include:

- where available, the use of online measuring devices which monitor operational parameters continuously;
- automation where possible to respond to any changes in water quality;

- backup equipment if failure of processes occurs;
- backup facilities to protect against failure of power supplies;
- the capability to control plant flow rates including filtration and backwash rates;
- provisions to control the addition of chemicals at different dosages;
- provisions for effective mixing facilities; and
- suitable filter media and sufficient surface wash and backwash capability.

The use and maintenance of appropriate monitoring equipment is also essential to providing accurate process control information

Only appropriate chemicals and materials shall be used in the water treatment facilities. It shall conform to IS: specification

- Examples of some preventive and corrective actions for which operational procedures need to be documented include:
- reducing plant flow rate (reducing loading to the system);
- switching to alternate water source, if possible;
- jar testing for coagulant control and optimization;
- changing treatment chemicals;
- varying chemical feed rates and feed points;
- adjustment of pH;
- varying mixing intensity in rapid mix units;
- cleaning of accumulated sludge and mud from sedimentation basins;
- checking and changing the detention time of sedimentation basins;
- checking and changing the loading rate to sedimentation basins and filters;
- checking and changing the backwash flow rate;
- changing disinfectant dose; and
- mains flushing and cleaning.

Verification of Treated Water Quality

Verification of treated water quality provides an assessment of the performance of the system and the quality of water supplied to the consumers. This incorporates monitoring of treated water quality, which is considered as only one aspect of an overall preventive strategy to assure a safe and reliable drinking water supply to the consumers.

Key health-related characteristics under treated water quality monitoring include:

- microbiological organisms (coli forms);
- chemicals used in treatment processes, disinfectant residuals, and any DPBs;
- turbidity; and
- any health-related characteristic that can be reasonably expected to exceed the guideline
- value.

However, characteristics related to significant aesthetic impacts shall also be monitored. The treated water quality monitoring plan that is to be adopted by all of the water utilities is shown in Appendix

Annexure- G List of Measurements, Alarms, Status Indicators, etc. (SCADA)

CHAPTER- 9
SEWERAGE TREATMENT PLANT

A sewage treatment plant ("STP") has to handle the designed quantity of sewage and deliver satisfactory quality of treated water, on a consistent, sustained basis over typically 10-15 years.

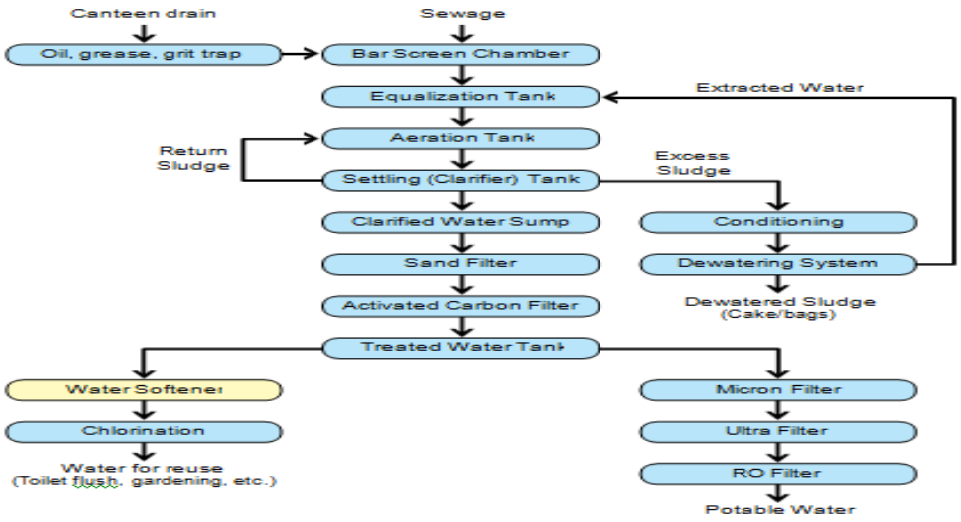
The Operating Principle of STPs

It is a simple process:

A small amount of microorganisms converts a large mass of polluted water into clean water. This process also produces a co-product: A vastly reduced, compact solid biomass (the excess microorganisms produced by growth and multiplication of the original population of microorganisms).

Typical Process in an STP

The flow chart of a typical STP is shown below (optional units are shown in yellow)



The following table illustrates the quality of water obtainable from a well-designed, engineered and operated STP at very affordable treatment costs[2]

Parameter	In Raw Sewage	After Treatment	What it means to you…
pH	6.5-7.5	6.5-7.5	The acidity/alkalinity balance is not affected/ altered.
BOD	200- 250 mg/L	< 10 mg/L	The biodegradable material in the sewage consumes oxygen when it degrades
Turbidity	Not specified	< 10 NTU[2]	The outgoing treated sewage has low turbidity (suspended particles that cloud the water).
E. Coli	Not specified	NIL	The STP removes the harmful bacteria completely.

UNDERSTANDING THE STP STAGES

Bar Screen Chamber

Function

The function of the bar screen is to prevent entry of solid particles/ articles above a certain size; such as plastic cups, paper dishes, polythene bags, condoms and sanitary napkins into the STP.

- The gaps between the bars may vary between 10 and 25 mm.
- Larger STPs may have two screens: A coarse bar screen with larger gaps between bars, followed by a fine bar screen with smaller gaps between bars.
- In smaller STP's a single **fine bar screen** may be adequate..

Oil and Grease/Grit Trap

Function

The grease and grit trap is placed at the discharge point of the canteen/ kitchen area itself to arrest solid and fatty matter at source. The wastewater output from this unit is taken to the equalization tank.

Equalization Tank

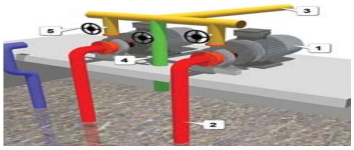
Function

Its main function is to act as buffer: To collect the incoming raw sewage that comes at widely fluctuating rates, and pass it on to the rest of the STP at a steady (average) flow rate.

Raw Sewage Lift Pumps

Function

To avoid deep excavations, a pumping stage is introduced to lift sewage to the next unit in the STP, which is the aeration tank in small STPs rated below 5000 m^3/day.



This strategy yields a double benefit:

a) All downstream units may be placed at a convenient level above ground, resulting in cost savings. At the same time, the maintenance of STP becomes easier.

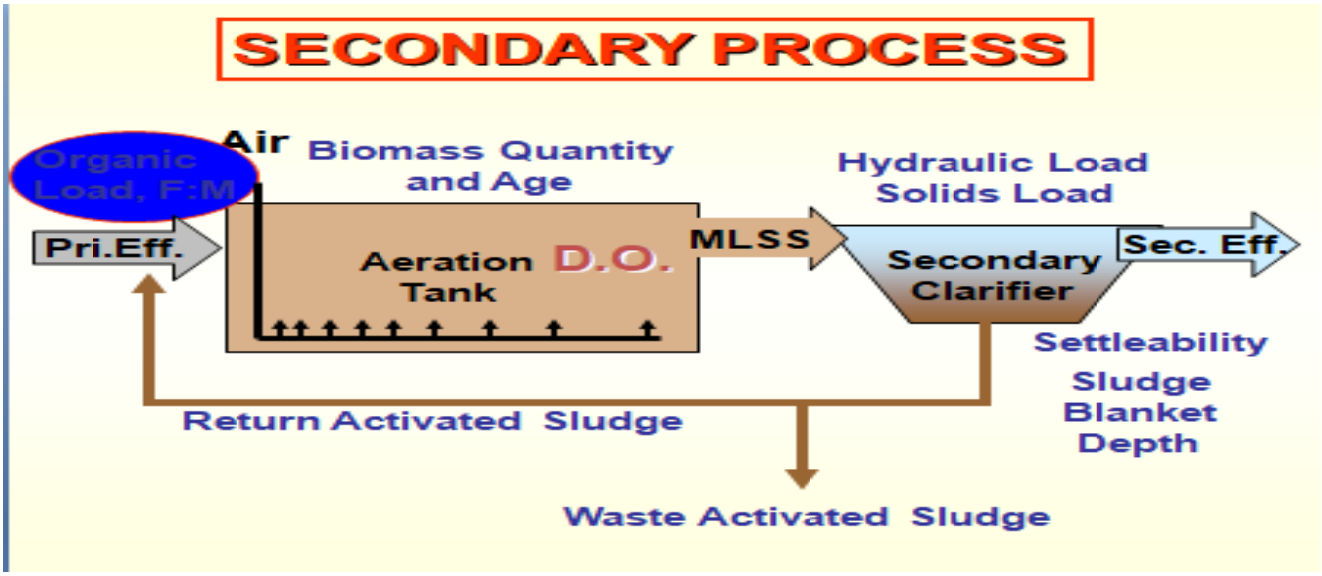
b) The pumping rate can be set at a calibrated uniform flow, so that downstream units are not affected by fluctuating flows.

Aeration Tank

Function

The main function of the Aeration tank is to maintain a high population level of microbes. This mixture is called MLSS (Mixed Liquor Suspended Solids).

The mixed liquor is passed on to the clarifier tank, where the microbes are made to settle at the bottom. The settled microbes are recycled back to the aeration tank. Thus they are retained for a long period within the system.



Biological Decomposition

Oxidation:

$COHNS + O_2 + \text{Bacteria} \longrightarrow CO_2 + H_2O + NH_3 + \text{Energy} + \text{Other end products}$

It forms sum end product such as minerals that remains in the solution and as discharged with effluent.

Synthesis:

$COHNS + O_2 + \text{Bacteria} + \text{Energy} \longrightarrow C_5H_7NO_2$

It transforms the colloidal and dissolved matter into new cells that forms in term the dense biomass that can be removed by sedimentation.

Endogenous Respiration:

$C_5H_7NO_2 + 5O_2 \longrightarrow 5CO_2 + NH_3 + 2H_2O$

Biological Wastewater Treatment

Three Steps

1. Transfer of Food from Wastewater to Cell.

- Adequate Mixing
- Enough Detention Time

2. Conversion of Food to New Cells and Byproducts.

- Acclimated Biomass
- Useable Food Supply
- Adequate D.O.
- Proper Nutrient Balance
- 100 : 5 : 1
- C : N : P

3. Flocculation and Solids Removal

- Proper Mixing
- Proper Growth Environment
- Secondary Clarification

TERMINOLOGY USED IN THE BIOLOGICAL TREATMENT

- ✓ **MLSS**
- ✓ **MLVSS**
- ✓ **F/M RATIO**
- ✓ **DO**
- ✓ **HRT**
- ✓ **SRT**
- ✓ **SVI**
- ✓ **AEROBIC**
- ✓ **ANAEROBIC**
- ✓ **ANOXIC**

Secondary Clarifier/ Settling Tank

Function

- Allow settling of biomass solids in the Mixed Liquor (biomass slurry) coming out of the aeration tank, to the bottom of the clarifier.
- To thicken the settled biomass, in order to produce a thick underflow.
- To produce clear supernatant water, in the overflow from the clarifier.

Mechanized Clarifier Tank

In a mechanized clarifier tank, the sludge settles at the bottom over a wide area, and a few rubber wiper blades (called “squeegees”) sweep it to a pit at the center of the tank, from where a pump takes it to the aeration tank.

Sludge Recirculation

Function

The indivisible combination of the aeration tank, settling tank and sludge recirculation constitutes an “activated sludge biological treatment system”. All three must be fine-tuned to act in unison to produce the desired high level of treatment.

The optimum desired age of the microbes is between 25 to 30 days. At the same time, an STP needs to maintain a high level of microbes in the aeration tank. Both these objectives are achieved by recirculating the sludge from the settling tank, and also bleeding out of excess microbes from the system at regular intervals.

Clarified Water Sump

Function

Overflow water from the clarifier is collected in an intermediate clarified water sump; This sump acts as a buffer tank between the secondary and the tertiary treatment stages in an STP.

In a well-run STP, the treated water quality at this stage is good enough for reuse on lawns and gardens with sufficient disinfection, and water for garden use may be directly taken from this sump, without having to overload the tertiary units.

Also, during lean inflow periods to the STP, backwashing of the filters is carried out. At this time, this tank must hold sufficient buffer stock of water for backwash purposes.

Pressure Sand Filter (PSF)

Function

The pressure sand filter (PSF) is used as a tertiary treatment unit to trap the trace amounts of solids which escape the clarifier, and can typically handle up to 50 mg/l of solids in an economical manner.

This unit is essentially a pressure vessel that is filled with graded media (sand and gravel)

The water filtered with PSF is passed on to the next stage in the STP chain: the Activated Carbon Filter.

Activated Carbon Filter (ACF)

Function

An activated carbon filter, like the Pressure Sand Filter, is a tertiary treatment unit. It receives the water that is already filtered by the Pressure Sand Filter and improves multiple quality parameters of the water: BOD, COD, clarity (turbidity), color and odor.

Disinfection of Treated Water

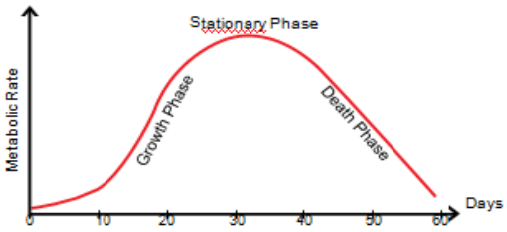
Function

- The treated water is disinfected to destroy and render harmless disease-causing organisms, such as bacteria, viruses, etc.
- The most common methods of disinfection include Chlorination, Ozonation and UV radiation.
- Of these, Chlorine finds widespread application. The primary action of the chemical involves damaging the cell wall, resulting in cell lysis and death.
- In most STPs, the common form of Chlorine used is Sodium Hypochlorite (Hypo) available commercially at 10-12 % strength, being safe, easy to handle and having a reasonable shelf life.

Excess Sludge Handling

Function

Biological treatment of wastewater perforce produces excess biological solids due to the growth and multiplication of bacteria and other microorganisms in the system. The excess biomass thus produced needs to be bled out of the system, and disposed off efficiently.



Managing the Microbes

The desired median age of microbes to be maintained in the system is 25-30 days, because they can digest the sewage at the maximum rate at the age of 25-30 days, as shown below. However, the sewage remains for less than 20 hours in aeration tank and settling tank.

Microbes are much like humans in their metabolic activities, although they are life forms that are orders of magnitude lower than an average human being. They feed on the pollutants (= food) present in the wastewater: They require Oxygen (from the air pumped into the aeration tank) for their respiration.

They need vitamins and minerals in the form of nutrients such as Nitrogen and Phosphorus (already present in abundance in domestic sewage), and a whole lot of other elements at nano levels for their health and well being, to grow and to multiply.

Any imbalance in even one of the above ingredients in the recipe (Population density, Food, Oxygen, or Nutrients) will render the process extremely vulnerable to failure. Indeed, Microbes are much more sensitive to the slightest of environmental disturbances than humans.

The basic biochemical reaction occurring in an Aeration tank may be summarized by the following simplistic equation:

Microbes + Pollutants (food) + O_2 More microbes + CO_2 + H_2O + energy release + byproducts

A typical growth reaction with a number of other products, the most important of which is Carbon Dioxide:

- Accumulated Carbon Dioxide gets converted to Carbonic acid and corrodes metallic parts in the STP.
- The carbonic acid also depresses the pH of the wastewater, thus affecting treatment performance.

MLSS

MLSS (Mixed Liquor Suspended Solids) is a measure of bacteria that is contained in the aeration tank.

In the strict sense, MLSS is a gravimetric unit – mg/L and the normal design level is between 3500 to 4000 mg/L in the Aeration Tank. However, in the field, since the operator does not have ready access to an electronic weighing machine, we do a volumetric measurement using a 1 liter measuring cylinder (or jar).

Take one liter of the Aeration Tank sample (The Mixed Liquor) and allow to settle in the jar for 30 minutes. At the end of the 30 minutes, measure the volume occupied by the settled sludge. If it is 350 mL, we take the MLSS to be 3500 mg/L. If it is 400 mL, the take MLSS to be 4000 mg/L.

The assumption here is that the STP is functioning normally, and therefore the so-called “Sludge Volume Index – SVI) is 100, meaning dry solids weighing 1 gram occupy 100 mL volume after 30 minutes of settling. And so, 4 gram of microbes (4000 mg) will occupy 400 mL volume in the cylinder.

The STP is operated within a band of say 3500 mg/L (350 mL) and 4500 mg/L (450 mL). When the MLSS exceeds 450 mL, the excess sludge is taken out of the system to bring the MLSS down to the say 350 mL, and the process continues until the sludge again builds up to 450 mL.

Normally STP should be operated in a smaller band within the allowable MLSS limits.

MLSS level can be less than the design level only under the following conditions :

1. The STP is in the start-up phase.
2. STP design and engineering is poor, so sludge is slipping out of the system.
3. STP operation is poor.
4. There has been a sudden shock to the STP (pH drop/ toxic elements etc.)

Chapter- 10

QUALITY ASSURANCE AND QUALITY CONTROL OF SEWERAGE TREATMENT PLANT

Calibration and Quality Control Procedures

a. Lab Facility. The lab is kept clean and orderly at all times. Specific facility tasks are addressed in the checklist in following table

Cascade STP Laboratory Quality Assurance Checklist				
General				
		Yes	**No**	**Comments**
1	Is the Quality Assurance (QA) Manual up-to-date and available to all lab personnel?			
Laboratory Procedures				
		Yes	**No**	**Comments**
1	Are EPA approved methods (e.g. Standard Methods) used and readily available to, and used by, all lab personnel?			
2	Are calibration and maintenance of instruments/equipment satisfactory?			
3	Does a written schedule for required equipment maintenance exist?			
4	Are quality control (QC) procedures in the QA Manual used consistently?			
5	Are QC records adequate to determine if lab is in control?			
Laboratory Facilities and Equipment				
		Yes	**No**	**Comments**
1	Is distilled or demonized water available (as required by the method)?			
2	Is dry, uncontaminated, compressed air available (if needed)?			
3	Is the fume hood air-flow measured periodically and is it adequate?			
4	Is the laboratory sufficiently lighted?			
5	Are adequate electrical sources available in the lab?			
6	Are instruments appropriate for the method and in good condition?			
7	Are troubles shooting procedures and written requirements for daily operation of instruments available to each instrument operator?			

8	Are standards available to perform required QC checks?			
9	Is proper volumetric glassware used?			
10	Is glassware cleaned?			
11	Are solvents and standard reagents properly stored?			
12	Are calibration and check standards frequently cross-checked?			
13	Are standards discarded after recommended shelf-life has expired?			
14	Are reagent bottles marked with date received, date opened, and when known, the expiration date?			
15	Are blanks run each day for appropriate analyses (e.g. BOD, TSS)?			
16	Are sufficient SOPs on hand for lab operations (e.g. clean-up, hazard response)			
17	Are gas cylinders replaced at 100-200 psi?			
18	Are the thermometers used in incubators (e.g. BOD, fecal coliform incubators) traceable to a NIST-certified thermometer?			
Laboratory's Precision, Accuracy, and Control Procedures				
		Yes	**No**	**Comments**
1	Are duplicates analyzed for all analyses and are the results recorded?			
2	Are control samples required by the QA Manual introduced into the train of actual samples to ensure valid data are being generated?			
3	Are control charts maintained and used routinely?			
4	Is the lab within control (i.e. is precision good)?			
Data Handling and Reporting				
1	Are round-off rules documented and uniformly applied?	**Yes**	**No**	**Comments**
2	Are significant figures established for each analytical procedure?			
3	Are results checked by at least one person other than the analyst?			
4	Are correct formulas used to calculate final results?			
5	Do report forms exist to provide complete data documentation and permanent records and to facilitate data processing?			

6	Are data reported in proper form and units?			
7	Are lab records maintained for three years?			
8	Is all data recorded in indelible ink with corrections initialed?			
9	Is a list of initials, identifying to whom they belong, filed in the lab?			
10	Are lab notebooks and pre-printed data forms bound permanently to provide good and defensible documentation?			
11	Does an efficient filing system exist?			
Laboratory Personnel				
		Yes	**No**	**Comment**
1	Are enough analysts present to perform necessary analyses?			
2	Do analysts have on-hand necessary references for procedures being used			
3	Are analysts trained in procedures performed?			

b. Instrument Calibration. Instruments are calibrated on a daily basis just before use and every two hours during prolonged periods of use on any given day. Those requiring calibration are the pH meter/probe, and the DO meter/probe. Equipment calibration requirements are indicated in Table

Minimum quality control procedures frequency.

Parameter	Calibration	Check Standards	Blanks	Duplicates
BOD	Air calibrate DO probe each day	Each day	Each day 1	More than 1 dilution of final effluent each day
TSS	Balance check each month & each year by a service rep	1 per month	Each day 1	10% of effluent samples
pH	Each day	At end of each set of samples	N/A	1 per month on final effluent
Chlorine residual	N/A	1 per month	Each day 1	1 per month
Fecal Coliforms	N/A	Positive control (diluted influent) for each media lot	Beginning and end of each filtration series	More than 1 dilution of final effluent each day

c. **Equipment Maintenance.** For maintenance of equipments manual should be used diligently.

d. **Analytical Reagents**. Only analytical grade reagents are used

e. **Lab ware Cleaning.** After each use, glasswares and sample bottles and equipment for microbiological evaluations are sterilized in accordance with the current approved Standard Methods.

f. **Quality Control Analyses.** QC measurements are made for all analyses related to "plant performance" samples as indicated by "PP" in Table

Plant Performance Parameters.

Sampling Location	Sample				Standard Methods	Preservation	Holding Times	Container Requirements
	Analysis	Use	Freq.	Type				
Primary Treatment								
Primary influent	BOD	PP	D	C	IS 3025 Part 44	Cool, 4^{O}C	6 hours	P, G
	TSS	PP	D	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4^{O}C	7 days	P,G
	pH	PC	W	G	EM 4500-H APHA 23rd Edition	None Required	Stat	P,G
	COD				OR 5220 B of APHA 23rd Edition			
	O & G				PG 5520 A of APHA 23rd Edition.			
Primary effluent	BOD	PP	W	C	IS 3025 Part 44	Cool, 4^{O}C	6 hours	P, G
	TSS	PP	W	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4^{O}C	7 days	P, G
	F Col	PP	D	G	9221 G & E APHA 23rd Edition.	Cool, 4<8 ^{O}C 0.008% $Na_2S_2O_3$	2 hours	P, G
	pH	PP	D	G	EM 4500-H APHA 23rd Edition	None Required	Stat	P, G

Activated Sludge								
Primary effluent	BOD	PP	D	C	IS 3025 Part 44	Cool, 4^{O}C	6 hours	P, G
	TSS	PP	D	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4^{O}C	7 days	P,G
	pH	PC	D	G	EM 4500-H APHA 23rd Edition.	None Required	Stat	P,G
Mixed Liquor	DO	PC	D	G	4500-O	None Required	Stat	P,G
	Temp	PC	D	G	2550	None Required	Stat	P,G
	TSS	PC	D	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4°C	7 days	P,G
	NO_3	PC	D	G	EPA 353.2		48 hours	P,G
Return sludge	TSS	PP	W	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4°C	7 days	P, G
Final effluent	BOD	PP	D	C	IS 3025 Part 44	Cool, 4°C	6 hours	P,G
	TSS	PP	D	C	2540D	Cool, 4°C	7 days	P,G
	F Col	PP	D	C	9221 G & E APHA 23rd Edition	Cool, 4<8°C, 0.008% Na2S2O3	2 hours	P,G
	Cl Res	PP	D	C	4500-Cl	None Required	Stat	P,G
	pH	PP	D	C	EM 4500-H APHA 23rd Edition.	None Required	Stat	P,G

Cl Res = Chlorine residual
VS = Volatile solids
G = Grab
TS = Total solids
EM= Electrometric Method
PG= Partition Gravimetric
TSS = Total Suspended Solids
W = Once per week
Temp = Temperature
OR= Open Reflux
VSS = Volatile suspended solids
D = Once per day
NO3 = Nitrate nitrogen
PC = Process control
P,G = Plastic or glass
F Col = Fecal Coliforms
PP = Plant performance
C = Composite
Stat = 15 minutes

EDTA ethylenediaminetetraacetic acid

DOs

- Electrical supply to the treatment plant must be maintained constantly.
- Check aeration pattern in the treatment zone is evenly distributed.
- Check air pumps inlet free from dirt and filter changed if necessary.
- Be aware before you put anything down the sink, toilet or drains.
- When using cleaning product little and often so the treatment plant isn't overloaded.
- Bleach can be used sparingly.
- It's best to spread your washing throughout the week.
- Use the same washing, cleaning, dishwashing, and all other cleaning products. The bacteria in the sewage treatment plant work more effectively with cleaning products they are familiar with.
- Service engineer to carry out regular service schedule in accordance with you 'Operation and Maintenance Manual'.
- The tank to be emptied of excess sludge – the interval is based on the size of the plant and its loading.

DON'Ts

- Turn off electrical supply to the sewage treatment plant.
- Strong chemicals, house hold bleach, medicine, mouthwash, garden chemicals, disinfectants, etc. down toilet or sink.
- Put incontinence pads, cotton wool, baby wipes, disposable nappies, tampons, sanitary towels, condoms, etc down the toilet.
- Service the sewage treatment plant unless your trained service engineer.
- Use any replacement parts other than recommended manufactures part.
- Make any alterations, modify, repairs, other than permission from the manufacture. Works must be carried out by a trained service engineer.
- Surface water or roof water to enter the sewage treatment plants.
- Macerator fitted to the kitchen sink.

Chapter - 11

Mechanism of Quality Assurance / Quality Control for Purchasing & Construction

Responsibilities of Key Organizations

S. No.	Task	Activities	Unit
1	Technical approval of Design, Drawing and Cost Estimates	Approval	Concerned Dept.
2	Tender, Allotment and Upkeep of Contract Documents	Invitation, Receive tenders, evaluation	Concerned Dept.
CONTRACT ADMINISTRATION AND OVERALL SUPERVISION			
1	Administration and management of contracts including interpretations of technical specifications.	Management	Concerned Dept.
2	Revised drawings and designs	Submission, review and approvals	Concerned Dept.
3	Provide layouts / levels for works. Checking of levels and layouts	Primary Secondary	Contractor Concerned Dept
4	Adequacy of the input such as material, labour, equipment with reference to technical requirement.	Primary Secondary	Contractor Concerned Dept
5	Material register	Documentation Review	Contractor Concerned Dept
6	Maintain work site in neat, orderly and safe manner.	Primary Secondary	Contractor Concerned Dept
7	Minimize inconveniences to the public.	Primary Secondary	Contractor Concerned Dept
8	Inter departmental coordination		Contractor Concerned Dept
9	Continuous on sites supervision during construction and ensuring safety.	Primary Secondary	Contractor Concerned Dept
10	Monitoring of progress , find cause of delay, remedial measures and issue instructions to contractor	Primary Secondary	Contractor Concerned Dept
11	The contractor fulfills all contractual obligation, proper storage of materials, regulations , contract conditions, specifications and instructions.	Primary Secondary	Contractor Concerned Dept

12	Ensuring that site order book are properly maintained	Primary Secondary	Contractor Concerned Dept
13	Test records and results are available for review and assessment	Primary, Secondary	Contractor Concerned Dept
14	Contractor prepares and submit monthly progress report in time.		Contractor
15	Preparation of drawing of completed works.	Primary Secondary	Contractor Concerned Dept
QUALITY ASSURANCE AND INSPECTIONS			
1	Training on using manual to contractor staff	Training	Concerned Dept
2	Provide effective supervision of the works in order to ensure the quality and conformity with the standards and specifications prescribed in the contract.	Primary Secondary	Contractor Concerned Dept
3	Inspect all work sites regularly to ensure that the work is being implemented in accordance with the approved standards and that the quality control procedures set forth under the contract are followed.	Primary Secondary	Contractor Concerned Dept
4	Take samples and test independently testing wherever considered necessary. Insure that proper records of the tests conducted are maintained	Primary Secondary	Contractor Concerned Dept
5	Inspect interim work as required to accept or reject completion stages before permitting the contractor to proceed with further works. Enter all approvals in the site order book and have it signed by all parties	Primary Secondary	Contractor Concerned Dept
6	Inspect the completed works insuring that any defects in materials or workmanship are properly identified in a timely manner	Primary Secondary	Contractor Concerned Dept.
7	Conduct monthly inspections and site coordination meetings for all works to review the overall progress and quality of the works.	Primary Secondary	Contractor Concerned Dept
8	If any work item or construction material is sub standard or unacceptable, deduct such work or	Primary Secondary	Contractor Concerned Dept

	supply of material from the progress payment or defer payment until the contractor rectifies the deficiencies		
MEASUREMENT AND PREPARING BILLS AND PAYMENTS			
1	Conduct joint measurements of the works with the contractor and record them in the stipulated format for payment.	Primary Secondary	Contractor Concerned Dept
2	Prepare necessary release order of security and payment after completion of the defect liability period as per the contract.	Prepare and verified Hand receipt	Concerned Dept
REPORTING			
1	Submit monthly project progress report.	Submission	Contractor
2	Prepare and submit Monthly Progress Reports in the approved format that includes Quality Control Status, physical and financial progress	Submission	Contractor Concerned Dept
3	Submit a quarterly progress report.	Submission	Contractor Concerned Dept
INTER DEPARTMENTAL AFFAIRS			
1	Identify power connection, road crossings, pipe line inter connections with existing system, permission for use of land, etc.	Primary Secondary	Contractor Concerned Dept
2	Obtain permissions from other departments and organizing the works as required through them.	Primary Secondary	Contractor Concerned Dept
OTHER RESPONSIBILITIES			
1	QA/QC Training module for IPH DEPT. engineers	Training	Consultant
2	QA/QC Training module for contractors	Training	Contractor Concerned Dept
3	QA/QC Training to GPWSC	Training	Contractor Concerned Dept
4	QA/QC Module	Linked to MIS	Consultant

Quality Assurance /Quality Control Duties

Activity/Item	Contractor's QA/QC Duties
Designs/Drawings for contract	• Maintain design / drawing register at site • Use only approved drawings for construction
Test laboratory and equipment	• Intimate Concerned Dept. the details, date of completion with requisite manufacturers' and calibration certificates of equipments. • Maintain the equipments in good condition and calibrate as necessary
Material receipts Materials testing	• Enter receipts in material register • Materials to be tested only in approved laboratories • Prepare concrete mix proportions as per volume as required by contract and submit test results to Concerned Dept. • Take test samples in presence of Concerned Dept. when requested • Perform material tests. • Submit test reports to Concerned Dept. with monthly reports Maintain test log
Rejected materials	• Entries to be made in material register at site. • Tag and record all rejected materials. • Intimate Concerned Dept. in writing the proposed date of removal of material from site and confirm after removal
Material consumption	• Enter daily consumption of materials in material register and indicate balance quantity
Construction equipment	• Intimate Concerned Dept. the details, date of mobilization along with requisite insurance certificate • Maintain equipments in good working condition. • Intimate breakdown of construction equipments.
Construction	• Intimate Concerned Dept. in writing when construction is going to commence and what activities are proposed to be undertaken • Intimate Concerned Dept. in advance when critical works, such as concreting, embankment, paving, pipeline laying and jointing, testing, etc., would be undertaken, along with the test certificates of the materials proposed to be used in

	these works. No critical activity shall start unless the material is tested. Certificates are verified and approved by the Engineer. • Concreting to take place only after pour card is signed. • To provide any other necessary QA/QC requirement.
Daily work progress	• To maintain in daily log
Testing of works in progress	• Perform tests as per contract requirements. • Submit test reports to Concerned Dept.. • Maintain test log during the execution of works.
Rejected work items	• Intimate Concerned Dept. in writing the proposed date of removal from site and confirm after removal. • Rectify defective work and invite Concerned Dept. for re-inspection.•
Instructions from Engineer	• Enter change orders, site instructions, letter and minutes of meetings issued by the Engineer and Consultants in the Instruction Log.
Inspection of Engineer	• Take instructions in Site Order Book. • Intimate Concerned Dept. of compliance.
Progress scheduling and control	• Prepare and maintain project schedules and undertake work in accordance with approved schedule.
Reporting	• Prepare and submit Monthly Progress Reports and other reports as per contractual requirements.
Records	Maintain the following records on Site/Contractor's Office/Laboratory as given in Annexure C. • Site Order book • Material Register • Daily Progress Report. • Concrete pour Register • Test Record • Design &Drawing Record • Non conforming item record • Cube test record
Workmanship	All the work executed against the contract shall be of good workmanship
Disposal Of Debris	All the Debris should be disposed of properly after completion of construction work.

QUALITY ASSURANCE BY DEPARTMENTAL ENGINEERS DURING INSPECTION

S. No.	Key parameters of Quality Assurance	SE	EE	AE
1	**SITE DOCUMENTS**			
	Site Order book	✓	✓	✓
	Material Register	✓	✓	✓
	Daily Progress Report.	-	-	✓
	Test Record	✓	✓	✓
	Design and Drawing Record	-	✓	✓
	Non Conforming Item Record	✓	✓	-
2	**MANDATORY TESTING**			
	Hydro testing of sewer	-	-	✓
	Hydro testing of pipeline	-	-	✓
3	**AVAILABILITY OF FIELD AND LAB EQUIPMENTS**	✓	✓	✓
4	**MANUFACTURING CERTIFICATES**			
	GI Pipe / GI Fittings/ PVC /MS /SW /RCC Pipes	✓	✓	✓
	Manhole covers and Footrest	-	✓	✓
	Electrical cables/fans and fixtures	-	-	✓
	Switches/sockets and boards	-	-	✓
	Flow measuring devices	-	✓	✓
	Control Panel	-	✓	✓
	Lightening arrestor	-	✓	✓
	Level indicator and controllers.	-	-	✓
	Silver ionization plant / Chlorination Plant / RO / UV	✓	✓	✓
	Any other item as per agreement	-	-	✓
5	**DEPARTMENTAL TEAM INSPECTION**			
	DI, CI,PVC, MS,SW,HDPE/MDPE	✓	✓	-
	Pumps , Motors & D.G. Sets	✓	✓	-
	Manhole Frames and covers	✓	✓	-
	R.C.C. Pipes	✓	✓	-
6	**CHECK LIST GUIDE FOR WORKS**			
	Tube well/surface water	-	✓	✓
	Laying and jointing of pipeline, Back filling, Hydro testing	-	✓	✓

	Pump & machinery of Tubewell / Cannal / Surface Water	-	✓	✓
	Disinfecting plant		✓	✓
	Pump chamber	-	✓	✓
	Development of water works	-	✓	✓
	O.H.S.R / U.G.S.R	-	✓	✓
	Water treatment plant (canal based)	-	✓	✓
	Sewer laying & treatment plant	-	✓	✓
	Control panel for 3 phase pump & motor	-	✓	✓
	Centrifugal pump and motor	-	✓	✓
7	**PERIODICAL SITE INSPECTIONS**	✓	✓	✓
8	**POST QUALITY INSPECTION OF FINISHED WORKS**	✓	✓	-
9	**QUALITY CERTIFICATION**	-	✓	✓
10	**MONTHLY REPORTING AND REVIEW MEETINGS**	✓	✓	-

QUALITY FIELD INSPECTION REPORT

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>Name of scheme</td><td>:</td><td></td></tr>
<tr><td>2</td><td>Name of Block</td><td>:</td><td></td></tr>
<tr><td>3</td><td>Name of District</td><td>:</td><td></td></tr>
<tr><td>4</td><td>Technically sanctioned Estimated Cost in Lacs</td><td>:</td><td></td></tr>
<tr><td>5</td><td>Name of Agencies with Agreement No.
Package No 1 :
Package No 2 :
Package No 3:
Package No 4:</td><td>:</td><td></td></tr>
<tr><td>6</td><td>Detail of Package with Tendered Cost in Lacs ,Date of commencement, completion and progress in Percentage.
Package No 1 :
Package No 2 :
Package No 3 :</td><td>:</td><td>
<table>
<tr><th>Pack No.</th><th>Tend. Cost in lacs</th><th>Date of start</th><th>Date of Compl.</th><th>% progress</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>4</td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>7</td><td>Name of Circle</td><td>:</td><td></td></tr>
<tr><td>8</td><td>Name of Division</td><td>:</td><td></td></tr>
</table>

9	Name of Sub-division	**:**	
10	Name of S.E	**:**	
11	Name of E.E	**:**	
12	Name of A.E	**:**	
13	Name of J.E	**:**	
14	Name of Head of deptt. E-in-C	**:**	
15	Scheme Inspected by C.E with date/ reference	**:**	
16	Scheme Inspected by S.E with date/ reference	**:**	
17	Scheme Inspected by E.E with date/ reference	**:**	
18	Scheme Inspected by E.E (QMSW) with date reference	**:**	
19	Date of field inspection	**:**	

Annexure H: CHECKLIST GUIDE FOR WORKS

S. No.	Description of Work	Form No.	Remarks
1	Tube well.	Q/CL-1	Mandatory
2	Laying and jointing of pipe line, back filling, hydro testing	Q/CL-2	Mandatory
3	Pumping machinery & fittings of delivery pipe in pump chamber (Tube well based scheme)	Q/CL-3	Mandatory
4	Pump chamber.	Q/CL-4	Mandatory
5	Development of water works.	Q/CL-5	Mandatory
6	O.H.S.R	Q/CL-6	Mandatory
7	Water treatment plant (Canal based scheme)	Q/CL-7	Mandatory
8	Laying of sewer & Treatment plant.	Q/CL-8	Mandatory
9	Control panel for 3 phase pump & motor.	Q/CL-9	
10	Centrifugal pump, motor & fittings of delivery pipe in pump chamber (Canal based scheme)	Q/CL-10	
11	Quality certificate.	Q/CL-11	Mandatory

Quality Control of WTP
Check list for Water Treatment Plant, Rising Mains, Distribution System & Tanks.
Annexure- A
Check list for Clear Water Sump and Reservoir

S. No.	Checks required/ undertaken	Status	Frequency of reporting
1	Proper closure of washout valves; any abrupt stoppage during operation.		
2	Proper operation of inlet valves; any abrupt stoppage during operation.		
3	Proper operation of outlet valves; any abrupt stoppage during operation.		
4	Proper operation of bye pass valves; any abrupt stoppage during operation.		
5	Does any valve pass water even after closure?		
6	Leaks through valves; glands and bolts and nuts.		
7	Leaks through pipes and joints at SR.		
8	Status of valve chambers and their covers.		
9	Status of finial ventilators; fly proof mesh intact or is to be replaced.		
10	Status of manhole covers; are they corroded?		
11	Functioning of water level indicators.		
12	Functioning of flow meters.		
13	Status of ladders and railing: are they corroded?		
14	Check whether quality of the water in the SR is OK.		
15	Possibility of SR water getting polluted.		
16	Check for the need for cleaning and disinfecting the SR.		
17	Check for the presence of residual chlorine in the water stored in SR.		
18	Check for signs of corrosion of interior of roof due to chlorine.		
19	Check for Structural damages of the SR.		
20	Check for Leaks through the structure of the SR.		
21	Status of interconnecting pipe work? Is it corroded?		
22	Status of lighting arrestor.		
23	Status of out-fall drains of scour and overflow at SR.		
24	Availability of :		
24.1	Spares		
24.2	Consumables		
24.3	Tools		
25	Check for need for painting.		
26	Check for availability of drawings and designs of the SR.		

Annexure B
Check list for Distribution System.

S. No.	Checks required / undertaken	Status	Suggested frequency of reporting
1	Check whether the Operation of valves is smooth without any abrupt stoppage during closure.		
2	Check whether closures of a valve results in complete stoppage of flow or if any flow passes the valve (passing valve).		
3	Check for status of scouring and then proper closure of washout valves.		
4	Check for leaks through pipes.		
5	Check for leakage through valves at gland, bolts or any other place.		
6	Check for leaks at the appurtenances.		
7	Check for any signs of corrosion of pipelines.		
8	Check for the status of Manhole covers over the chambers; are they corroded.		
9	Inspect for any possibilities of pollution of the distribution system water stored.		
10	Status of out-fall drain for scour and overflow.		
11	Assess the need for painting of the piping work.		
12	Check for availability of spares for valves and pipes and jointing materials.		
13	Review the method of giving consumer connections in the field.		
14	Preparation of water budget for each zone served by one reservoir.		
15	Number of connections given.		
16	Number of meters out of order.		
17	Status of hydrants and PSPs.		
18	Status of Distribution System.		
19	Review of pressure.		
20	Review of flows.		
21	Age of pipes/C value of pipes.		
22	Corrosive water.		
23	Study of inflows and outflows		
24	Identify source of leakage.		
25	Metering.		

26	Status of bulk metering and consumer.		
27	Review facilities for repair of consumer meters.		
28	Unauthorized connections if any.		
29	Status of fire hydrants and PSPs.		
30	Availability of updated system map.		
31	Need for any interconnections.		

Annexure C
Check Lists For Transmission Main

S. No.	Check required / undertaken	Status	Suggested frequency of reporting.
1	Check whether the operation of valves is smooth without any abrupt stoppage during closure.		
2	Check whether closure of a valve results in complete stoppage of flow or if any passes the valve (passing valve)		
3	Check for status of scouring and then proper closure of washout valves.		
4	Check for leaks through pipes.		
5	Check for leakage through valves at gland, bolts or any other place.		
6	Check for leaks at the appurtenances including expansion joints.		
7	Check for any signs of corrosion of pipelines.		
8	Check for the status of manhole covers over the chamber covers; are they corroded.		
9	Inspect for any possibilities of pollution of the transmission system.		
10	Check status of out-fall drain for scour valves and chances of contamination oat scours.		
11	Assess the need for painting of the exposed piping work.		
12	Check for availability of spares for valves, expansion joints and pipes and jointing materials.		
13	Carry out review of pressures.		
14	Carry out review of flows.		
15	Check age of pipes / C value of pipes.		
16	Check for corrosive water.		
17	Study inflows and outflows into the reservoirs linked to the transmission system.		
18	Identify source of leakage.		
19	Metering		
19.1	Status of bulk meter.		
19.2	Review facilities for repair of meters.		
20	Availability of updated system map.		

Annexure - D
Tolerance and Classification of Water
IS Code: 2296-1982

Class of Water

Classifications	Type of use
Class A	Drinking water source without conventional treatment but after disinfection
Class B	Outdoor bathing
Class C	Drinking water source with conventional treatment followed by disinfection.
Class D	Fish culture and wild life propagation
Class E	Irrigation, industrial cooling or controlled waste disposal

Tolerance Limit

Sl	Parameter and Unit	A	B	C	D	E
1	Taste	None	--	--	--	--
2	Odour	Unobj	--	--	--	--
3	Colour (True) (Hazen unit)	10	300	300	--	--
4	pH (max) (min : 6.5)	8.5	8.5	8.5	8.5	8.5
5	Conductivity (25oC) uS/cm	--	--	--	1000	2250
6	DO (mg/L) (minimum)	6	5	4	4	--
7	BOD (3d, 27oC) (mg/L)	2	3	3	--	--
8	Total Coliforms (MPN/100 mL)	50	500	5000	--	--
9	TDS (mg/L)	500	--	1500	--	2100
10	Oil and Grease (mg/L)	--	--	0.1	0.1	--
11	Mineral oil (mg/L)	0.01	--	--	--	--
12	Total Hardness (mg/L as CaCO3)	300	--	--	--	--
13	Chlorides (mg/L as Cl)	250	--	600	--	600
14	Sulfates (mg/L as SO4)	400	--	400	--	1000
15	Nitrates (mg/L as NO3)	20	--	50	--	--
16	Free CO2 (mg/L)	--	--	--	6	--
17	Free NH3 (mg/L as N)	--	--	--	1.2	--
18	Fluorides (mg/L as F)	1.5	1.5	1.5	--	--
19	Calcium (mg/L)	80.10	--	--	--	--
20	Magnesium (mg/L)	24.28	--	--	--	--
21	Copper (mg/L)	1.5	--	1.5	--	--
22	Iron (mg/L)	0.3	--	50	--	--
23	Manganese (mg/L)	0.5	--	--	--	--

Agriculture

Being an agrarian economy, this is a very compelling use for India, but should never be used for edible crops or plants that produce millets, etc.

Key Principles should be paid attention before deciding use of treated sewage for agriculture.

Refer CPHEEO Manual on Sewage & Sewerage Treatment Systems (Part A), Nov 2013- Section 7.3.1.1(a) to (g).

The deleterious effects of the constituents of the irrigation water on plant growth can result from

i. direct osmotic effects of salts in preventing water uptake by plants,
ii. direct chemical effects upon the metabolic reactions in the plant and
iii. any indirect effect through changes in soil structure permeability and aeration.

Annexure E

IS Code: 10500-1991 Portable Drinking Water

Parameter	Desirable Value	Maximum Permissible Value	Effects if not controlled
Colour	5 hazen unit	25 hazen unit	Unacceptable by people
Odour	Odourless	Odourless	Unacceptable by people
Turbidity	5 NTU	10 NTU	Unacceptable by people
Soluble Salts/TDS	500 mg/l	2000 mg/l	Stomach ache
pH	6.5 – 8.5	6.5 – 8.5	Intestinal problems
Hardness	300 mg/l	600 mg/l	Not appropriate for cooking, washing clothes. Flaking in pipes.
Calcium	75 mg/l	200 mg/l	Not appropriate for cooking.
Chlorides	250 mg/l	1000 mg/l	Corrosion, taste differs
Sulphate	200 mg/l	400 mg/l	Indigestion, stomach problems
Magnesium	30 mg/l	100 mg/l	Stomach ache
Nitrates	45 mg/l	100 mg/l	Can lead to Blue baby (1-6 months child)
Fluorides	1.00 mg/l	1.50 mg/l	Fluorosis of teeth, bones and muscles
Alkalinity	200 mg/l	600 mg/l	Taste differs
E-coli	Count 0 in 100 ml		Infectious disease and intestinal problems
Coliform	<10 in 100 ml	Not detected in more than 50% sample in year	

Annexure F
Operational Parameters for Water Treatment Plant Units for tests.

Operational Parameter	Treatment Step / Process					
	Raw Water	Coagulation	Sedimentation	Filtration	Disinfection	Distribution System
pH		✓	✓		✓	✓
Turbidity (or particle cont)	✓	✓	✓	✓	✓	✓
Temp	✓		✓		✓	✓
Dissolved Oxygen	✓					
River / Stream flow	✓					
Total coliforms	✓				✓	✓
Background bacteria					✓	✓
Colour	✓					
Conductivity	✓					
Alkalinity	✓	✓	✓			
Organic carbon	✓		✓			
Algae and algal toxins	✓					✓
Chemical Dosage		✓			✓	
Flow rate		✓	✓	✓	✓	
Headloss					✓	
CT					✓	
Disinfectant residual					✓	✓
Disinfection by -products					✓	✓
Pressure						✓

Annexure – G

List of Measurements, Alarms, Status Indicators etc.

For plants of 1 ML/d (220,000 igpd) capacity and greater, the following instruments should be provided as a minimum for the relevant processes listed.

Raw Water Instrumentation:

- low-level switches to shut down the raw water pumps. These should be hard-wired to the starters;
- running and trip indication for raw water pumps; and
- raw water turbidity, pH, pressure, flow rate, and flow volume.

Rapid Mixer:

- Running and trip indication.

Flocculators:

- Running and trip indication; and
- speed (if variable speed type).

Solids Contact Clarifiers:

- recirculator speed indication;
- Running and trip indication;
- level indication;
- blow down valve status; and
- turbidity and pH following clarification.

Softening:

- if lime softening is used, pH following recarbonation; and
- recarbonation CO_2 feed status.

Filter Instrumentation:

- turbidity on each individual filter effluent and filter to waste. This can be a single instrument for each filter if piping arrangement permits;
- for constant rate filters: differential head loss across the filter media;
- filter flow rate;

where the backwash sequence is automated, provide open and close limit switches or position on all filter valves and status on backwash equipment; and

- **filter run time.**

Backwash Instrumentation:

- running and trip indication for backwash pump(s);
- running and trip indication for air blowers (if air scour is used);
- backwash flow rate and flow total; and
- elapsed time since last backwash.

Clear well and Distribution Pump Instrumentation:

• level indication for clearwell and other tanks;

• running and trip indication for the distribution pumps;

• low-level switches to shut down the distribution pumps. These should be hard-wired to the motor starters;

• turbidity, chlorine residual, fluoride residual (if fluoridation is practised), pH, pressure, flow rate, and flow total on plant discharge;

• for variable speed pumps, indicate the pump speed.

Chemical Systems:

• running and trip indication for chemical loading, batching and pumping equipment;

• low and high level alarms in storage bins, silos or tanks;

• level indication for tanks;

• weigh scales for hydrofluosilicic acid day tanks or storage if no day tank is used;

• weigh scales for gaseous feed chemicals such as chlorine or sulphur dioxide;

• speed indication on variable speed pumps;

• rotameters (or other flow monitoring device) for carrier water feed systems; and

• chemical feed flow rate is desirable but not mandatory.

Miscellaneous Instrumentation:

• run time meters on all pumps and major electrically driven equipment;

• speed, run time, oil pressure and temperature gauges, fault signal switches and manual start and shut down on engines;

• where the plant is automated or operated remotely from either within the plant or outside, provide open and close limit switches or position indicators on all major valves, status on all major equipment and security instruments including door switches, building temperature switches and smoke alarms; and

• any additional instrumentation recommended by equipment manufacturers.

Alarms and Status Indication

As a minimum, the following alarms need to be provided:

• high turbidity on the raw water, clarifier effluent (if applicable), filter effluent, and plant discharge;

• high and low pressure on the raw water line;

• high flow rate on the raw water line.

• high and low level in clarifiers or flocculators;

• high torque on solids contact clarifier recirculator and rake;

• high torque on flocculators;

• high level in filters;

• high and low level in chemical storage tanks;

• high and low chemical feed rates (if measurement is provided);
• high flow rate on each filter individually (also low flow rate on declining rate filters);
• high and low levels in each clearwell, pumpwell, and reservoir;
• high and low pH on the raw and treated water (if on-line measurements are provided);
• high and low chlorine residual on the plant discharge (where online measurements are provided);
• high head loss on the filters (if constant rate type);
• trip or failure to run on each pump;
• high and low pressure on the plant discharge line;
• high flow rate on the plant discharge line;
chlorine gas detection in the chlorine storage rooms;
• chlorine scale low weight (where scales are equipped with transmitters); and
• valve operation failure (where valves are provided with limit switches.

Field Instruments

Level Instruments

Where access to the top of the reservoir is convenient (such as in a clearwell), an ultrasonic level transmitter should be used. Where access to the bottom of the reservoir is convenient (such as at a tower or above-ground reservoir), a pressure transmitter can be used.

Flow Instruments

On-line flow meters should generally be one of the following types:
• turbine (or nutating disk);
• magnetic; and
• ultrasonic (either transit-time or Doppler).

All of these types of instruments can be equipped to provide both flow rate and flow total measurements.

Price, line size, flow rate, flow range, pipe material, required accuracy, and water quality will dictate the selection of the type of instrument.

Water Quality Instruments

The most frequently used water quality measurements are turbidity, pH, and chlorine residual. On-line turbidity measurement is relatively inexpensive and should be provided in any plant, on the raw water, flocculator or clarifier effluent (if applicable), each filter effluent, and final plant discharge lines. In larger plants, on-line pH and chlorine residual are generally used, but manual testing can be done in smaller plants.

Process Controls

Pumping Systems

Regardless of the function of the pumping system, its control will normally be achieved through monitoring level, flow and/or pressure. The choice of control parameter(s) will depend on the system's function and features. Controls and monitoring for raw water pumping and finished water pumping are normally required.

Treatment Processes

Travelling Screens

Two methods may be used to control the operation of travelling screens:

• simple manual start/stop which requires the presence of the operator to start and stop the screen. This method is not recommended where sudden changes in raw water quality could result in heavy debris accumulation on the screens; and

• automatic activation by differential level or time. This method uses the differential level across the screen to provide the start condition. Once started, the screen needs to be run at least one "cycle" and stop automatically when the differential level is returned to the clean screen value.

Chemical Feed Systems

Liquid/Gas Chemical Feed

Basic chemical dose rate control can be achieved by flow pacing (i.e., adjusting chemical feed rate based on the flow of the stream it is to be injected into). This can be achieved using a variable speed metering pump (liquid) or flow control valve (gas) linked to a flowmeter on the receiving stream. For finer dosage adjustment, feed rate can also be controlled based on downstream instrumentation (e.g., residual chlorine analyzer providing feedback signal to chlorine dosing pump). *Dry Chemical Feed*

Dry chemical feed systems typically include a packaged bulk storage combination feeder and mixer. The feeder can be gravimetric or volumetric, and will be controlled by a 4-20 mA signal from the flow transmitter on the plant flowmeter.

Rapid Mixing

Control of the rapid mixer will be simply on or off; the unit should operate continuously whenever the plant is in operation.

Flocculation

Flocculation requirements should be addressed in terms of the unit process parameters.

Clarification

Careful monitoring and control is most important to successful clarification. Adequate instrumentation to measure water quality parameters (e.g., turbidity) prior to and after clarification is essential.

Dissolved Air Flotation (DAF)

The process variables in DAF are:

• flow rate;

• recycle rate; and

• float removal cycle.

Filtration

Two types of filtration are used for water treatment:

• Rapid gravity filtration; and

• Slow sand filtration.

Rapid Gravity Filtration (RGF)

Constant Rate: Flow through a constant rate RGF is controlled by a flow control valve on the filter effluent or by influent flow splitting and filter level control. For the flow control type, the effluent valve position is controlled by a flow rate signal from a flow meter, usually located on the filter effluent. For the level control type, the effluent valve position is controlled by the water level in the filter.

A filter run will be terminated, and the bed backwashed, based on one or any of the following:

• run time;

• headloss across the bed;

• effluent turbidity; and

• effluent particle count (optional).

Declining Rate: Flow through a declining rate RGF is not directly controlled as is the case with constant rate RGF. The rate simply decreases as the filter plugs. An effluent valve with manually adjustable stops is set to ensure the flow rate through a clean bed is not excessive. Once set, this valve will return to the set position after backwash (or after being closed for maintenance, etc.).

A filter run will be terminated based on one or any of the following:

• run time;

• effluent flow rate;

• effluent turbidity; and

• effluent particle count (optional).

A time initiated backwash can be automatic. Smaller plants feeding smaller systems may benefit from backwashing overnight when demand is low - and the operator is not present. In such cases, a timer can be hard-wired into the filter control panel to initiate the backwash, or alternatively, the time control can be programmed into the plant's programmable logic controller (PLC).

Slow Sand Filtration

Because of the very slow flow rate through SSF, head loss, flow rate, and effluent quality can remain very stable for many weeks. Adjustments to the flow rate can be made manually by the operator.

Instrumentation should be provided to routinely monitor raw and treated water quality. A sudden increase in head loss accompanied by a reduction in flow rate signals that the filter is plugged.

Disinfection

The dosage is controlled on the basis of the measured residual; an analyzer/ controller measures the residual downstream of the point of injection and adjusts the rate of injection accordingly via a control signal to the metering pump (liquid feed) or gas flow control valve (gas feed).

Control System Documentation

The following documents need to be provided following completion of the control system:

• Record drawings to show any changes to the original design and including any drawings produced during construction;

• annotated listings of control system programs and packaged system configuration;

• manufacturer's literature for all control and instrumentation components;

• final wiring diagrams complete with wire and terminal coding;

• motor control schematics;

• instrument loop diagrams;

• panel wiring and layout details;

• PLC or DCS wiring schematics;

• instrument calibration sheets; and

• operating instructions.

Annexure H

Check lists for Work done in Water Supply System & Sewerage Treatment System

FORM No. Q/CL-1

CHECK LIST FOR TUBEWELL

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :

S. No.	Description of Work	Form No.	Remarks
1	Whether tube well site is prone to flooding and free from filled up earth?		
2	Whether any village pond is located adjacent to water works site?		
3	Whether the drilling point of tube well is as per approved lay out plan?		
4	Whether tube well site was investigated hydro geologically & geo-physically to assess the availability of water? (applicable to area where there is water scarcity)		
5	Whether Geologist/Hydrologist has been engaged for installation of tube well?		
6	Whether the type of drilling, size of tube well boring is as per contract agreement?		
7	Whether samples of strata was collected accurately and kept in boxes for further analysis?		
8	Whether electric logging has been done?		
9	Whether screen slot size and gravel size has been designed by proper sieve analysis from approved agency?		
10	Whether M.S. Pipes used are of proper thickness, free from rust and with bituminous painted as per approved specification, Test certificate obtained and Departmental inspection conducted?		
11	Whether Stainless steel wire cage strainers are of proper thickness, and as per approved specifications, Test certificate obtained and Departmental inspection conducted?		
12	Whether the tube well assembly has been approved by concerned S.E.?		
13	Whether lowering of tube well assembly has been done in the presence of SDE in-charge and SDE deputed by Superintending Engineer?		
14	Whether Cement/clay, seal plug is provided between the annular spaces of boring & lowering assembly to prevent contamination of good quality water bearing strata as per recommendations of the Geologist / Hydrologist?		
15	Whether certificate to the effect that “Certified that the lowering of the pipe assembly and screen/ strainer has been done in our presence and that the quality, sizes and length of pipes and screen/strainer are as per record / entry made and are correctly located and lowered in the bore” has been recorded and is duly signed by SDE–in-charge & SDE deputed for lowering from other division and duly countersigned by the Executive Engineer- in-charge?		

16	Whether verticality of tube well is checked and recorded?		
17	Whether capacity of Air Compressor (Both CFM and PSI) used is as per specifications given in bid document and is certified by the Engineer-in-charge?		
18	Whether capacity of Submersible pumping set used for development is sufficient w.r.to developed and designed discharge?		
19	Whether tube well development hours are as per contract and log book maintained? a) With compressor b) With submersible pump set.		
20	Whether running hours of air compressor and submersible pumping set are witnessed and certified by authorized officer of IPH DEPT. and representative of GPWSC?		
21	Whether final performance test done & recorded?		
22	Whether strata chart and assembly chart showing all details of tube well has been submitted by contactor to IPH DEPT./ GPWSC?		
23	Whether result of water sample tests (Physical/Chemical/ Biological Examination) after development with submersible pumping set are conforming to drinking water standards?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-2

CHECK LIST FOR LAYING AND JOINTING OF PIPE LINE, BACK FILLING, HYDROTESTING

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B.No.:

S. No.	Description	Yes/No/NA	Remarks
A. Stage 60% Payment schedule: - Supplying of pipe and valves, excavation, laying, jointing, and fixing of valves.			
1	a) Whether pipes are of proper specifications and as per approved make as per DNIT? b) Whether pipes have been tested at manufacturer's premises an has been inspected by two officers deputed as per instructions of th department and test certificates are available?		
2	Whether the Sluice Valve/Air Valves etc. are as per specification and MC/department has been obtained?		
3	Whether the CI/GI/PVC specials are as per specification and department has been obtained?		
4	Whether the trenches have been excavated to correct depth as per specifications and dimensions?		
5	Whether the pipe line has been laid true to the alignment with proper bedding made as per specifications?		
6	Whether Jointing material used as per specification?		
7	Whether all the lanes are provided with pipe lines as per approved drawing?		
8	Whether the completion drawing of pipe line prepared and submitted with running bills?		
B. Stage 40% Payment schedule :- Completion, testing and commissioning.			
1	Any busting of pipeline noticed in the village.		
2	Whether all the leakages observed during testing have been repaired properly?		
3	Whether the trenches were backfilled in layers, and properly watered and consolidated as per specifications?		
4	The filling is carried out to required level and without any settlement?		
5	Field compaction / density test conducted?		
6	Whether the road metal was separately collected and all type of		

	roads reinstated properly after laying of pipes?		
7	Whether GPWSC/Panchayat are satisfied with restoring of roads and streets and a certificate to this effect has been given by the GPWSC/Panchayat before clearing payments of brick paving/ cement concrete restoration work?		
8	Whether the valve chambers constructed as per drawing and tested for water tightness?		
9	Whether the distribution system hydraulically tested?		
10	Whether the distribution system properly disinfected before providing connections to consumers?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-3

CHECK LIST FOR PUMPING MACHINERY & FITTINGS OF DELIVERY PIPE IN PUMP CHAMBER (TUBEWELL BASED SCHEME & Chlorinator)

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :

S.No.	Description	Yes/No/NA	Remarks
1	Whether submersible pump and motor conforming to approved specifications and make as per contract agreement, the MC obtained and Departmental inspection done?		
2	Whether Sluice valve, reflux valve and Air valve are ISI marked and as per specifications & the MC has been obtained?		
3	Whether the pipes and specials, rubber packing, nut and bolts are as per specifications?		
4	Is there any leakage from fittings? a)Inside the pump chamber b) Outside the pump chamber		
5	Is Air Valve/Non Return Valve installed properly?		
6	Is double earthing done for machinery and is in order?		
7	Whether diameter and length of column pipe lowered is as per approved specification?		
8	Whether the jointing of column pipes is done properly to prevent leakage of water?		
9	Whether discharge available from the pump is close to actual discharge of pump? (Actual measurement of discharge by filling OHSR/ or through V-Notch)		
10	Is motor taking normal current?		
	CHLORINATOR		
1	Whether chlorinator and accessories is as per specification?		
2	Whether permission has been obtained and inspection has been conducted by competent authority		
3	Whether the chlorinator is installed and working properly?		
4	Whether testing kit for residual chlorine test available for water sample testing?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-4

CHECK LIST FOR PUMP CHAMBER

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B. No.

S.No.	Description	Yes/No/NA	Remarks
A. Stage 40% Payment schedule :- Up-to roof level			
	UPTO PLINTH LEVEL		
1	Whether Bench Mark pillars are fixed and layout is correct as per approved drawing for excavation of foundation?		
2	Whether Depth of foundation is correct as per approved drawing?		
3	Whether Earth bedding condition checked?		
4	Whether following materials used are as per specifications and Test for materials conducted as per frequency? Bricks Fine aggregate Coarse aggregate		
5	Whether following manufactured materials used are as per specification and Test for materials conducted and MC obtained? Cement Steel for reinforcement		
6	Whether Concrete bedding laid as per specification?		
7	Whether proper arrangement of curing and curing period maintained as per specification?		
8	Whether Ist class Brick work in foundation and plinth is as per specifications and necessary test for mix proportion of mortar conducted?		
9	Whether Horizontal / vertical D.P.C. provided as per specifications?		
	UPTO ROOF LEVEL		
10	Whether Ist class brick work in super structure is as per specifications and proper wet bricks are used. Test for mix proportion of mortar conducted?		
11	Whether Brick work in super structure is in true plumb and top of all walls are in level?		

12	Whether Thickness of joints in brickwork is kept 1 cm± 20 %?		
13	Whether All horizontal and vertical joints are being filled correctly?		
14	Whether proper curing period maintained as per specification?		
15	Whether size of doors/windows and other joinery work as per drawing has been kept?		
16	Whether proper section and gauge of hollow pressed steel chowkhats have been provided with proper grouting?		
17	Whether foot rest provided as per drawing and specification?		
B. Stage 60% Payment schedule: - Completion & finishing			
1	Whether Proper Centering and shuttering has been provided for R.C.C. slab?		
2	Whether steel Reinforcement laid as per design and drawing?		
3	Whether R.C.C. Slab is laid of required thickness and in level?		
4	Whether proper size of Girder (proper I-section) has been provided (Medium weight)?		
5	Whether proper size of opening in the roof has been provided with cover as per drawing for lowering of pump?		
6	Whether surface cleaned of all loose mortar and efflorescence before plastering?		
7	Is the finishing of plaster inside/outside is proper and mix is as per required proportion?		
8	Whether the floor has been laid in panels, correct thickness and proper sand filling done under floor?		
9	Whether proper underground conduit for electric cable has been provided for machinery etc?		
10	Whether electrical fixtures installed are as per approved specifications and quantity?		
11	Whether top finishing and slope of floor is correct?		
12	Whether proper tile terracing has been done on roof as per specification?		
13	Whether proper quality and type of wood has been used with correct thickness of shutters as per specification?		
14	Whether thickness of Glass used in window panes is correct as per specification?		
15	Have grills been provided as per standard drawings?		
16	Whether Gravel Pit of proper size has been constructed, channels		

	grouted and MS Sheet cover provided as per drawing?		
17	Whether V-notch houdi with proper specifications has been constructed according to drawing?		
18	Whether Quality of distemper/cement based paint (Snowcem) is as per specification?		
19	Whether Quality of paint used on wood work/steel work and on other components is as per contract?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-5

CHECK LIST FOR DEVLOPMENT OF WATER WORKS

1. Name of work : 3. Name of contractor :

2. Contract Agreement No. :

S. No.	Description	Yes/No/NA	Remarks
1	Whether Bench Mark pillars are fixed and layout is correct as per approved drawing for excavation of foundation?		
2	Whether Depth of foundation is correct as per approved drawing?		
3	Whether Earth bedding condition checked?		
4	Whether following materials used are as per specifications and Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) □ Coarse aggregate		
5	Whether following manufactured materials used are as per specifications and Test for materials conducted and MC obtained? a) Cement b) Structural steel		
6	Whether Concrete bedding laid as per specification?		
7	Whether Ist class Brick work in foundation and plinth is as per specifications and necessary test for strength of mortar conducted?		
8	Whether D.P.C. provided as per specifications?		
9	Whether Ist class brick work in super structure is as per specifications and proper wet bricks are used. Test for mix proportion and strength of mortar conducted?		
10	Whether Brick work in super structure is in true plumb and top of all pillars in level?		
11	Whether Thickness of joints in brickwork is kept 1 cm± 20 %?		

12	Whether All horizontal and vertical joints are being filled correctly?		
13	Whether proper curing period maintained as per specification?		
14	Whether Gate Pillars and corner Pillars have been		
15	Whether proper size and number of Iron pickets has been embedded in PCC of approved mix as per drawing?		
16	Whether proper size/ type of D-hooks have been provided as per drawing?		
17	Whether barbed wire provided as per IS : 278-2009 and is of proper gauge and fully stretched in correct alignment?		
18	Whether proper size of iron Gate has been fixed with proper fittings and in alignment as per drawing?		
19	Whether paths at water work has been constructed according to proper section and camber as per drawing?		
20	Whether Quality of paint on steel work and on other components is as per specification?		
21	Whether proper sign board according to specifications has been installed?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-6

CHECK LIST FOR OHSR

1. Name of work: 4.R.B. No. :
2. Contract Agreement No. :
3. Name of contractor
4. R.B. No. :

S. No.	Description	Yes/No/NA	Remarks
A. **Stage 30% Payment schedule:- Foundation and column up-to ring beam**			
1	Is Soil Bearing Capacity has been got checked from approved/ reputed institute?		
2	Whether Bench Mark pillars and center pillar were fixed and layout/depth of foundation is correct as per approved drawing?		
3	Earth bedding condition checked for any filled up soil.		
4	Whether following materials used are as per specifications and W Test for materials conducted as per frequency? a) Fine aggregate b) Coarse aggregate		
5	Whether following manufactured materials used are as per specifications and Test for materials conducted and MC obtained? a) Cement b) Steel for reinforcement		
6	Whether all requisite tests have been conducted for the following items as per frequency?. a) Excavation and bedding b) Plain cement concrete c) R.C.C. (Slump test, Compressive strength)		
7	Whether PCC laid as per drawing and specifications?		
8	Whether proper steel centering and dent less shuttering is being used ?		
9	The reinforcement in the following members provided is as per drawing/design and whether it has been checked by EE/SDE? a) Foundation b) Columns c) Braces d) Landings		

10	Whether Concrete Mixer/Vibrator was used at site and standby arrangement made?		
11	Whether Concrete pour Register with date of casting each bit of concrete is being maintained?		
12	Whether R.C.C. in the following members laid as per dimensions given in approved drawing with desirable smooth finishing? . a) Foundation b) Columns c) Braces		
13	Whether verticality of R.C.C. columns checked before and after pouring of concrete?		
14	Whether proper curing period maintained as per specification?		
B. **Stage 30% Payment schedule: - From ring beam up-to roof slab and completion of stair case.**			
1	Is the reinforcement in the following members provided is as per drawing/design and whether it has been checked by EE/AE? a) Bottom Ring beam b) Bottom dome and gallery c) Tank wall d) Top ring beam e) Top dome f) Staircase and landings		
2	Whether R.C.C. in the following members laid as per dimensions given in approved drawing with desirable smooth finishing? a) Bottom Ring beam b) Bottom dome and gallery c) Tank wall d) Top ring beam e) Top dome f) Staircase and landings		
3	In Stair Case whether G.I. Pipe railing and angle iron pickets is as per drawing and specification?		

4	Whether Bell Mouth Puddle collars, Double Flanged Puddle Collars have been fixed in position and are of proper specifications and approved make?		
5	Whether proper curing period maintained as per specification?		
C. Stage 40% Payment schedule: - Arrangement and erection of C.I D/F pipe and specials, all balance work including plinth protection, automatic water level controller and testing of structure etc.			
1	Whether the CI/ DI/ DF pipes are as per specifications and MC obtained and pipes have been fixed in true plumb?		
2	Whether inlet and overflow pipes have been properly installed in the tank so as to ensure proper working depth of OHSR and a free board of 0.60 mtr.?		
3	Whether following C.I. valves, specials have been fixed in position and are of proper specifications and approved make?		
3.1	Duck Foot Bends (IS 13382-1992)		
3.2	Sluice Valves		
3.3	Expansion Joints (IS 1536-1989)		
3.4	M.S. Clamps		
3.5	Joining Material (Nut Bolts/Rubber insertion)		
4	Is pipes extended by 2.75 mtr. Length beyond Duck Foot Bends?		
5	Is overflow pipe further extended by providing D/F Bend at its end and vertical pipe of 2 mtr. Length and a D/F Bend duly fitted with expanded metal mesh of 10 mm sq. provided at end?		
6	Whether angle posts are painted in two coats after primer?		
7	Whether **R.C.C. roof ventilator is** provided with proper ail (mesh) cover as per drawing?		
8	Is **water level indicator** with proper specification and polythene ball of minimum 30 cm dia. Has been provided as per drawing and Whether plumb/ indicator is as per size and specifications? Or if, Electronic float		

	system is provided it is as per specification and working properly?		
9	Whether **water sealed Manhole Cover** of suitable size with proper specifications / Drawing with locking arrangement have been provided?		
10	Whether **Lightening Conductor** with proper earth electrode and specifications and drawing has been provided?		
11	Whether **Steel Ladder** from balcony landing to top of the Dome provided as per drawing and specification?		
12	Whether **Aluminum Ladder** inside the tank provided as per specifications and drawings and one end fixed to the top dome and other end with the bottom dome?		
13	Whether vertical pipes, clamps, railings, steel ladder and fittings are painted with two coats of paints after applying primer coat?		
14	Whether the OHSR has been tested for water tightness and found no leakage or seepage?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-7

CHECK LIST FOR WATER TREATMENT PLANT (CANAL BASED)

1. Name of work : 4.R.B. No. :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B. No. :

S. No.	Description	Yes/No/NA	Remarks
1	Whether Bench mark Pillars constructed for every units and the foundation, invert, hydraulic and formation levels have been ensured as per drawing?		
2	Whether following materials used are as per specifications? Whether Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) Coarse aggregate d) Filter media		
3	Whether following manufactured materials used are as per specifications? Whether requisite Tests for materials conducted and MC obtained? a) Cement b) Steel for reinforcement c) LDPE sheet d) Manhole cover and Footrest e) Vent pipes		
4	Whether all requisite tests have been conducted for the following items as per frequency?. a) Excavation and bedding b) Plain cement concrete c) Cement Mortar d) R.C.C. (Slump test, Compressive strength)		
5	Whether Intake chamber has been constructed as per drawing with screen?		
6	Whether the sedimentation cum storage tank has been constructed to correct dimensions as per drawing/ specifications and tested for water tightness? Whether the float arm has been provided as per drawing /specification and working properly?		

7	Whether the scour cum suction well has been constructed to correct dimensions as per drawing/ specifications and tested for water tightness?		
8	Whether the high level tank has been constructed to correct dimensions as per drawing/ specifications and tested for water tightness?		
	Whether following units of water treatment plant are constructed as per approved design drawing and specifications? a) Sedimentation tank b) Flash mixer. c) Clariflocculator. d) Chemical house. e) Back wash over head tank.		
9	Whether the filter beds has been constructed to correct dimensions as per drawings /specifications and tested for water tightness?		
10	Whether Filter Media is from approved quarry and placed in filter beds to correct position and thickness as per drawing and specification?		
11	Is the clear water tank has been constructed to correct dimensions as per drawing / specification and tested for water tightness?		
12	Whether the Valves and specials are as per specifications and MC obtained?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

Note : Check list for components namely OHSR, Pump chamber, Centrifugal pump and motor, Control panel, Development of water works compound and Disinfecting unit shall be required to be filled separately on prescribed format .

FORM No. Q/CL-8

CHECK LIST FOR SEWER LAYING & TREATMENT PLANT

1. Name of work : 4.R.B. No. :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B. No.

S.No.	Description	Yes/No/NA	Remarks
A : SEWER LAYING JOINTING AND APPURTENENT WORKS			
1	Whether Bench mark Pillars for site rail constructed for every line and the foundation, invert levels have been ensured as per drawing?		
2	Whether following materials used are as per specifications and Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) Coarse aggregate		
3	Whether following manufactured materials used are as per specifications? Whether Test for materials conducted and MC obtained? a) Cement b) Steel for reinforcement c) Manhole cover and Footrest d) Ventilating shaft		
4	Whether following manufactured materials used are as per specifications? Whether Departmental Inspection for materials conducted and MC obtained? a) PVC / SW /CI /DI / RCC pipes etc. b) Manhole cover and Footrest		
5	Whether all requisite tests have been conducted for the following items as per frequency?. a) Foundation bedding b) Plain cement concrete c) Cement Mortar d) R.C.C. (Slump test, Compressive strength)		

6	Whether the alignment of sewer is in accordance with the approved plan?		
7	Whether the trenches have been excavated as per specifications?		
8	Whether the shoring and strutting has been done as per specifications?		
9	Whether the excavated earth has been kept away from trench as per specifications?		
10	Whether the suitable diversion has been made for proper movement of traffic?		
11	Whether the sewer has been laid true to the alignment and gradient with proper bedding in all streets as per drawing and specifications?		
12	Whether the jointing material used as per specification and joint tested before backfilling?		
13	Whether Oblique junctions are laid against each house?		
14	Whether the trenches were backfilled in layers, and properly watered and consolidated as per specifications?		
15	Field compaction / density test conducted?		
16	Whether all type of roads metal was separately collected and road reinstated properly after laying of sewers?		
17	Whether the manhole chambers constructed as per drawing and specifications and tested for water tightness?		
18	Whether Ventilating shaft are erected at suitable places as per drawings?		
19	Whether the completion drawing of sewer line with L- section prepared and submitted with running bills?		

B : SEWAGE TREATMENT PLANT			
1	Whether Bench mark Pillars constructed for every units and the foundation, invert, hydraulic and formation levels have been ensured as per drawing?		
2	Whether following materials used are as per specifications and Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) Coarse aggregate		
3	Whether following manufactured materials used are as per specifications? Whether Test for materials conducted and MC obtained? a) Cement b) Steel for reinforcement c) LDPE sheet d) Vent pipes		
4	Whether all requisite tests have been conducted for the following items as per frequency? a) Excavation in foundation b) Plain cement concrete c) Cement Mortar d) R.C.C. (Slump test, Compressive strength)		
5	Whether following units of sewage treatment plant are constructed as per approved design drawing and specifications? a) Collecting tank/sump Pump chamber as per checklist B/CL-5 a) Facultative pond / Maturation pond b) Sludge Drying Beds c) Sludge Curing Platform d) Composting Pits etc.		
6	Whether construction of rest room including toilet as per type design, drawing and specification has been constructed?		
7	Whether the sewage pumps, control panels are as per specifications and installed properly?		
8	Whether Sluice valve and reflux valve are ISI marked and as per specifications & the permission has been obtained by the competent authority?		

9	Whether the pipes and specials, rubber packing, nut and bolts are as per specifications?		
10	Is there any leakage from fittings? a)Inside the pump chamber b) Outside the pump chamber		
11	Is Valves and fittings installed properly?		
12	Whether the efficiency of the plant checked?		
13	Whether Generating set has been installed as per required capacity/specifications on proper foundation?		
14	Completion drawing with actual hydraulic line prepared and submitted with running bill?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

Note: Check list for components namely Pump chamber, Development of water works compound shall be required to be filled separately on prescribed format .

FORM No. Q/CL-09

CHECK LIST FOR CONTROL PANEL FOR 3 PHASE PUMP & MOTOR

1. Name of work :

2. Contract Agreement No. :

3. Name of contractor :

S.No.	Description	Yes/No/NA	Remarks
1	Whether the main switch is of suitable capacity of L&T or any other reputed make?		
2	Whether the MCB/ MCCB units are of specified make?		
3	Whether the 3 Phase starter is of suitable capacity L&T or any reputed make?		
4	Whether the single phase preventor of L&T or reputed make is provided and working properly?		
5	Whether the panel box is of approved thickness and has been power painted?		
6	Whether it is suitable for 415 V AC. With variations up to 6 % on either side?		
7	Whether Shunt Capacitor is of proper KVAR capacity and of reputed make, or approved by HPSEBL?		
8	Whether Ampere meter is of suitable range and of L&T make or any other reputed make?		
9	Whether Volt meter is of suitable range (500V) and of L&T make or any other reputed make?		
10	Whether the ELCG is of L&T /Havell or reputed make?		
11	Whether three phase Indicators lamps are of L&T/Alstom (22.5mm Led type or equivalent reputed make?		
12	Whether Fuse bases and HRC fuses are of L&T/Havell make or equivalent?		
13	Whether selector switch for Ammeter and Voltmeter are of L&T, Kaycee make or equivalent?		
14	CT for Ammeter are of AE,EE, GE make or equivalent?		
15	Contractors relays and timers are of L&T, Siemen make or equivalent?		

16	Switch fuse unit is of L&T, Siemen, GE make or equivalent?		
17	Wires are of Finolex, Kent, Plaza make or equivalent?		
18	Whether Permission from competent authority has been obtained and inspection is carried out accordingly ?		
19	Whether the control panel has been fitted properly?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-10

CHECK LIST FOR CENTRIFUGAL PUMP, MOTOR & FITTINGS OF DELIVERY PIPE IN PUMP CHAMBER (FOR CANAL BASED SCHEME)

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :

S.No.	Description	Yes/No/NA	Remarks
1	Whether the pumping set is of reputed make as per technical specifications, permission obtained and inspection conducted by competent authority?		
2	Whether the shaft, impeller and bearing are as per technica specifications?		
3	Whether the speed of motor is as per specifications?		
4	Whether the actual discharge of pump is as per specifications?		
5	Whether the alignment of the shaft is correct?		
6	Whether it is suitable for 415 V AC. with variations up to 6 % on either side?		
7	Whether combined efficiency of pump set is as per specifications?		
8	Whether head and discharge are correct as per specifications?		
9	Whether foundation and base plate are as per specifications and foundation bolt are of proper size and length?		
10	Whether the pump set has been power painted?		
11	Whether the suction lift is with in the limit (4.5 m IS: 9694 Part-I)?		
12	Whether the suction pipe joints are airtight and pump starts without priming?		
13	Whether Sluice valve, reflux valve and Air valve are ISI marked and as per specifications & the MC has been obtained?		
14	Whether the pipes and specials, rubber packing, nut and bolts are as per specifications?		

15	Is there any leakage from fittings? a)Inside the pump chamber b) Outside the pump chamber		
16	Is Air Valve/Non Return Valve installed properly?		
17	Is double earthing done for machinery and is in order?		
18	Is there any excess vibrations observed on running of pump?		
19	Is there any over heating of bearings?		
20	If the velocity in suction and delivery pipe is with in the limit(Less than 1.5m,not exceed 2m)?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

QUALITY CERTIFICATION

1. Name of Work:
2. Contract Agreement No:
3. Name of Contractor :
4. Name of Structure / Location:

QUALITY CERTIFICATE

This is to certify that we have inspected the conduct of the works in accordance with established Quality Control procedures and that the items included in this Interim Payment Certificate satisfy the required quality of works and are acceptable with regard to the specifications and standards as prescribed under the Contract. Requisite Test Certificates are attached.

Enclosures

1
2
3
4
5
6
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8
9
10

Signature / Date:

Date: ---------- J.E/A.E. E.E.

(Concerned Department)

Note: This Quality Certificate shall be completed and attached t each Interim Payment before payment is made.

Brand of Material and Equipments

S. No.	Material/ Equipment	Make / Brand
1	Reinforcement steel	TISCON,SAIL, Rathi, Kamdhenu, RINL
2	Structural steel	IISCO,TISCO,SAIL, Rathi, Kamdhenu, Ispat
3	Water proofing	Cico, Dr. Fixit, Dr. Forex
4	AC Sheets	Everest, Armco, Charminar, Uppal
5	SW pipes	Burn & Co., Perfect Potteries, Girco, Navroji, Oriental ceramics
6	CI/DI pipes	Jindal saw, Electrosteel, Electrotherm
7	MS pipes	SAIL, Jindal ,Tata, Surya, EST or equivalent
8	UPVC pipes & fittings	Supreme, Polygold, Finolex, Devendra, Diplast, Prakash, Swastika, Tirupati
9	GI pipes	Jindal, Tata, TTC, TST, Tirupati
10	HDPE Pipes	Dura line
11	Oil distemper and other paint	Shalimar, British paint, any Asian brand, Berger
12	Water proof cement	Snowcem, Asian, Berger
13	Metallic Red oxide primer	Shalimar, Asian brand, Berger
14	Paint	Nerolac, Jhonson Nicholson, Asian, Berger
15	CI valves	Kirloskar, IVC
16	CI fittings	BRM/HSCC / Electrosteel / Oriental / Upadhyay/Bir
17	GI fittings	UNIK, SVW, NMC
18	Sluice gates and screens	Jash
19	Flush Doors	Dura, Green Ply, Euro
20	Ply Board	Dura, Green Ply, Euro
21	Door fittings	Classic (Al.) ,304 (S&S)
22	Glass pane	Glass pane
23	Ceramic Tiles	Somany, Jonson& Jonson, Perry, Kajaria
24	Sanitary ware	Perry ware, Hindustan, Cera , Jonson
25	CP fitting	Jaquar , Roca, ARK
26	Storage tank	Syntex , Polycon
27	SS Strainer	Johnson, Super or equivalent
28	Filter media	From Pathankot or other approved source Conforming to IS : 8419 (1).
29	LDPE Film	Conforming to IS : 2508
30	Electric motors	Crompton greeves, Kirloskar, Siemen, Jyoti, ABS
31	Pumps	KSB, BS, Crompton, WIPL
32	Cables	Asian/ FGI/ Dalton/ FCI / CCI/ Universal

33	Three Phase Starter	L&T/ Unilec/ Kilburn/ Siemen/ ABB/ GE
34	Switch gear	L&T/ Siemen
35	Shunt Capacitor	GE/ Asian/CGL/ Madhav or approved by PSEB
36	MCB up to 10 HP MCCB above 10 HP	Havells/ Datar/ S&SCS Havells/ Datar/ S&SCS
37	Contractors, Relays and Timers	L&T / Siemen
38	Indicating lamps	L&T /Alstom/ Siemen,(22.5mm Led Type)
39	Ampere meter/ Voltmeter	GE, EE, L&T, AE
40	Transformer	NGEF, KEC, Kanohar, Marson
41	Panel board	L&T , Havell, GE
42	ELCB	L&T, Havell, MDS
43	Fuse bases	Havell, L&T, GE
44	HRC fuses	Havell, L&T, GE
45	Selector switch for ammeter and voltmeter	L&T, Kaycee
46	CT for ammeter	AE, EE, GE
47	Wire	Finolex, Kent, Plaza
48	Thimbles	Dowell,
49	Single phase preventor	L&T, Minillec
50	Switch fuse unit	L&T, Siemen, GE
51	Chlorinating Plant	Aqus ,Servel
52	Silver Ionization Plant	Jet clear, Bharti water

Light / Medium & Heavy Duty Machinery being used in the department at present (Mechanical Wing)

Chapter - 1

Heavy Duty Construction Equipments

Heavy construction equipment are used for various purposes in large projects.

Selection of different types of heavy equipment depends on the size of the work and economy of the project. These make construction process easier and faster.

Types of Heavy Construction Equipment

1. Excavators
2. Backhoe
3. Dragline Excavator
4. Bulldozers
5. Graders
6. Wheel Tractor Scraper
7. Trenchers
8. Loaders
9. Tower Cranes
10. Pavers
11. Compactors
12. Telehandlers
13. Feller Bunchers
14. Dump Trucks
15. Pile Boring Machine
16. Pile Driving Machine

Do's and Don'ts of Lifting Equipment

Do's

- Check the equipment is right for the job, including all the associated parts.
- Make sure all the parts are suitable for the weight you need to lift.
- Use the equipment according to the manufacturer's guidelines.
- Wear the correct safety gear. Items such as hats, jackets, and safety shoes should all be used relevant to the machine being used.
- Only used certified equipment.
- Attain, and then keep hold of, thorough examination reports.
- Make sure your load is securely and properly attached.
- Find the centre of gravity when lifting an unbalanced load at a low height – there will be less harm if it drops.
- Rehearse the lift if possible.

Don’ts

- Remove any safe guards on the machine; they are there for safety after all.
- Distract anybody operating the machinery.
- Wear lose fitting clothes or anything that could cause a problem. Long hair should be tied back securely and jewellery should not be worn.
- Use unsuitable equipment such as damaged or makeshift chains.
- Exceed the stated maximum lifting load possible by the machine.
- Use equipment that has a danger sign on it, unless you are qualified to do so.

Dos and Don’ts of Machinery Safety For Workers

Do’s

- Check the machine is well maintained and fit to be used, ie appropriate for the job and working properly and that all the safety measures are in place – guards, isolators, locking mechanisms, emergency off switches etc;
- Use the machine properly and in accordance with the manufacturer’s instructions;
- Make sure you are wearing the appropriate protective clothing and equipment required for that machine, such as safety glasses, hearing protection and safety shoes.

Don’ts

- Use a machine or appliance that has a danger sign or tag attached to it. Danger signs should only be removed by an authorized person who is satisfied that the machine or process is now safe;
- Wear dangling chains, loose clothing, rings or have loose, long hair that could get caught up in moving parts;
- Distract people who are using machines;
- Remove any safeguards, even if their presence seems to make the job more difficult.

Do’s And Don’ts of Heavy Equipment Maintenance

Do

- **Follow Service Schedules –** It is a vital part of maximizing the life of equipment. From oil changes and track adjustments to scheduling annual maintenance inspections and replacing critical components, service schedules are like a roadmap to achieving maximum return on investment.
- **Perform Daily Inspections –** The best way to stay in tune with the health of your equipment is by training your operators to perform daily inspections. Walk-around inspections are done at the beginning and the end of shifts, with operators reviewing dozens of fault points and using all of their senses to identify signals the equipment may require immediate services or repairs.

Don't

- **Ignore Warning Signs** – Dashboard warning lights and audible alarms are never a welcome sight, but we should be thankful they're there to tell us when there's an issue with our equipment. Additional signs not to be ignored include diminished performance, unusual sounds coming from the engine, power train, transmission or hydraulics, low fluid levels and leakage, the smell of noxious fumes or smoke coming from the exhaust system.
- **Cut Corners** – There's never a time to choose cheap products or trust unreliable sources when maintaining heavy equipment. Using quality products and partnering with a reputable service provider helps reduce long-term operating costs, eliminates safety concerns and extends the life of your equipment.

List of Spare Parts for Heavy Duty Machinery Dozer D-50 A15 & Wheel Dozer BEML G-14, D- Chassis Parts.

S. No.	Description
1	Stg. Clutch Service Kit
2	Hyd. System. Ser. Kit
3	Cutting Edge (5 Hole)
4	Bit End – LH
5	Bit End – RH
6	Bolt
7	Bolt
8	Nut
9	Hyd. Cylinder Seal Kit – 90 mm (BEML)
10	Element Hyd. Tank
11	Link Track shoe
12	----------do----------
13	Pin Master
14	Bushing Master
15	Bolt shoe
16	Nut Shoe
17	Carrier Roller assy
18	Track Roller assy
	(Single Flange)
19	----------do---------- (Double Flange)
20	O-Ring
21	O-Ring
22	Bolt
23	Bolt (T.R.)
24	Shaft
25	Bearing Needle
26	Plate Pressure
27	Universal Joint assy.
28	Bolt Cross Pin
29	Nut
30	Cross Pin assy.
31	Seal Oil
32	Lever Main Clutch Booster
33	Washer Spring

List of Spare Parts for JCB (3D & 3DX) Parts.

S. No.	Description
1	Pre Cleaner assy.
2	Seal Bonnet Pre Cl.
3	Pipe Exhaust Ext.
4	Fuel line Main
5	Feed pump rep. kit
6	Banjo Bolt 19mm
7	Water pump assy
8	Water pump pulley
9	Diesel flexible pipe 24” long
10	Diesel flexible pipe 60” long
11	Bolt
12	Nut
13	Kit Drive Plate
14	Kit spider (rear drive shaft)
15	Strap
16	Screw
17	Bolt (rear drive shaft)
18	Nut
19	UJ Kit (rear drive shaft)
20	Wipe arm
21	Wiper blade
22	Fan Belt
23	Combination switch
24	Fuse 60 Amp
25	Fuse 20 Amp
26	Fuse 15 Amp
27	Fuse 10 Amp
28	Fuse 5 Amp
29	Solenoid switch Mico 12 V
30	Toe Plate (8 Tooth)
31	Tooth
32	Locking spacer
33	Pivot pin
34	Pivot pin
35	Pivot pin
36	Pivot pin
37	L.T. Wire
38	Insulation tape
39	Battery Terminal
40	Fuel leak off pipe
41	Bulb 1141
42	Bulb 67 No.
43	LT Tube 12V
44	Head light assy. 12V
45	Bimetal Bush
46	Bimetal Bush
47	Seal Kit (Bucket ram)
48	Seal Kit (Dipper Ram)
49	Hose top
50	Hose water pump
51	Hose Bottom radiator

List of Spare Parts for JCB Robot – 135/155 Parts.

S. No.	Description
1	Toe Plate – 1676 mm- wide 14 holes. (Weld On)
2	Strip wear
3	Cutter Upper
4	Bush
5	Bush 50x40x60L
6	Seal
7	Shim
8	Bolt M10x80 mm
9	Bolt M10x90mm
10	Nut Lock M10
11	Pin Pivot Grooved
12	Pin Pivot Q-H RHS -40 Dia 184
13	Pin Pivot Q-H RHS – 40 Dia 138
14	Plunger
15	Spring
16	Pin Release
17	Engine Oil Filter
18	Pump Water
19	Gasket
20	Hose by Pass
21	Elmt. Fuel Sed.
22	Elmt. Filter Safety
23	Elmt. Filter Prymery
24	Head ligh assy 12 V vertical
25	Front Glass

List of Spare Parts for D-50/G14-D 1 ENGINE PARTS (CUMMINS)

S. No.	Description
1	M. oil Filter
2	Diesel Filter
3	Hose radiator
4	Fan belt C-51
5	Fan belt B-44
6	Water pump assy
7	Hose diesel flexible tank to filter
8	Ampere meter
9	Gasket copper
10	Manifold fuel supply
11	Alternator assy 24V
12	HL Bulb 24 V
13	HL TUBE 24 V
14	Armature assy 24 V
15	Half clutch assy 24 V
16	Copper brush set 24 V
17	Field coil auxiliary 24 V
18	Brush box assy

Chapter - 2

Light / Medium Vehicles

Routine light / medium Vehicle Maintenance

Get in the habit of conducting regular vehicle maintenance and you'll avoid potentially costly breakdowns as well as extend the life of your vehicle. You can handle basic routine vehicle maintenance yourself, by following a regular schedule as outlined in your owner's manual.

1. **Acquaint yourself with your owner's manual.**

Take note of the intervals for maintenance items as the engine oil and filter, tire rotation, belts and hoses, and so on.

1. **Change your oil and oil filter.**

Oil is your engine's life blood. It serves as a lubricant, keeping important engine parts from grinding against each other and destroying the engine. Motor oil not changed regularly can also damage your engine as accumulated contaminants cause friction, rubbing parts together.

2. **Check your tires monthly.**

The only thing separating vehicle from the road is its tires. They need to be properly inflated to do their job, as well as to lessen the chance of a blowout.

3. **Inspect all other fluids.**

Motor oil isn't the only fluid to check. Your vehicle has brake and transmission fluids, coolant, and washer fluid.

Like motor oil, you'll check transmission fluid with a dipstick. Determine brake fluid, coolant, and washer fluid levels by removing related covers and visually inspecting each. By the way, NEVER remove the radiator cap to check coolant.

4. **Examine belts and hoses.**

Inspect the hoses and belts in the engine bay. These hoses direct coolant flow to ensure the engine doesn't overheat. If a hose has separated or shows cracks or bulges, then have it replaced.

Similarly, check the belts too. The timing belt, as found in most vehicles and small SUVs, is critical to the operation of your engine.

5. **Check Transmission Fluid:** It is essential that you have your transmission fluid checked and changed when needed to avoid costly transmission damage or replacement. Follow the vehicle manufacturer's recommendations.

6. **Check Transmission Case Fluid:** In four-wheel or all-wheel drive vehicles, the transfer case is what shifts power from the transmission to the axles. You'll need to have the transfer case fluid checked according to the vehicle manufacturer recommendations to make certain that it is properly filled and leak-free.

7. **Inspect shocks and Struts:** The shocks and struts on your vehicle function to control the impact and rebound as your vehicle passes over bumps in the road and are an essential part of your auto's steering system. They should be inspected by a professional every 50,000 miles.

8. **Coolant Fluid Exchange:** The radiator in your vehicle is a vital component that helps keep your engine cool and functioning properly. Check your vehicle manufacturer's recommendation to find out how often your coolant should be exchanged,

9. **Spark Plugs:** If your spark plugs aren't functioning properly, your engine will lose power and won't run at optimal capacity. Have a professional check and replace any faulty spark plugs depending on vehicle mfr recommendations or when you feel a decrease in your engine's power.

10. **Serpentine Belt**: Visually inspect the belt to ensure that it is free of cracks or other wear and tear. Replace id damaged or according to your vehicle manufacture's recommendation.

11. **Front and Rear Differential:** Like many parts of your vehicle, the differentials need to be kept lubricated to ensure proper functionality. Have a professional check and change fluid whenever your vehicle manufacturer recommends it.

Seasonal Checkups

1. **Replace windscreen wipers:** Windshield wipers need to be replaced about once every year, or whenever the effectiveness is compromised.

2. **Check battery performance:** Extreme temperatures affect the performance of the battery so regular battery testing will ensure that battery will perform when you need it to.

3. **Change Tires:** Depending on where you live and the winter driving conditions you might encounter, you might want to switch your tires in cold, snowy months to a winter/snow

tire. When the temperature hovers at or below freezing consistently, the tire compounds in non-winter tires hardens, decreasing traction and handling performance while increasing braking distance. Winter tires are have tread patterns and compounds designed to remain soft in the cold and provide grip in snow, slush, and icy driving conditions.

4. **Check Coolant Level:** It's also important to check your antifreeze levels in your radiator in winter months to keep your radiator or engine components from freezing. A 50/50 mix of antifreeze to water is generally recommended, but check your owner's manual or with a professional to be certain. Sticking to a car maintenance schedule, and keeping good records of what you've done, can help extend the life of your vehicle and protect you against breakdowns, expensive repairs, and other unwelcomed surprises.

5. **Change oil if pH declines**

List of Spare Parts for Light / Medium Vehicles

M&M Bolero - Camper

S. No.	Nomeclature of spare part	15	Clutch release and contact
1	Insulator front SD25, engine	16	Assy. Clutch cable
2	Gasket cylinder head	17	Washer plain
3	Ring piston set SD	18	Bush nylon
4	Gasket , rocker arm cover	19	Gasket air cleaner
5	Gasket, inlet manifold (BS II)	20	Filter element assy (straine)
6	Gasket, oil pan	21	Hose air cleaner to inelt m
7	Plug, drain magnetic	22	Assy accel.cable comp (ball)
8	Gasket, injection pump	23	Rubber pad foot plate
9	Pipe leakoff pipe assy	24	Head lamp assy (Lumax)
10	Bolt, banjo M12x1.5	25	Snchronizer ring land 2
11	Injector assy	26	Tie rod socket assy left
12	Temperature sensor (BS II)	27	Tie rod socket assy Right
13	Copper washer (BS II)	28	Disc brake
14	Clutch driven plate	29	Assy. Pad & anti rattle spring

List of Spare Parts for Light / Medium Vehicles

Maruti Swift Dezire & Ciaz

S. No.	Nomeclature of spare part
1	Spark Plug
2	Cover Clutch
3	Disc Clutch
4	Release Bearing with retaine
5	Unit Head Lamp L
6	Unit Head Lamp LH
7	Lamp unit RR & RH
8	Lamp unit RR
9	Blade Assy
10	Arm Assy front (D)
11	Service kit (D)
12	Service kit (P)
13	Arm Assy front
14	Arm Assy rear
15	Wheel Cups
16	Arm Assy Rear with Dom b
17	Arm Assy Rear with Dom b

List of Spare Parts for Light / Medium Vehicles

Maruti 800cc

S. No.	Nomeclature of spare part
1	Spark plug
2	Filter, oil
3	Mounting engine front
4	Mounting Transmission
5	Fly wheel
6	Bearing
7	Belt timing
8	Element air cleaner
9	Pipe exhaust
10	Pump assy water
11	Disc clutch
12	Bearing clutch release
13	Bush bar mounting
14	Hub front wheel
15	Bearing font wheel
16	Bearing rear wheel
17	Pad front brake
18	Disc front brake
19	Bumper front
20	Bump rear

List of Spare Parts for Light / Medium Vehicles

Tata, S/Mazda and Ashoka ley lands.

S. No.	Nomeclature of spare part
1	Fan belt 1210
2	Radiatior assy 1210
3	Engine foundation part 1210
4	Engine foundation Reas 1210
5	Fuel pipe set main 1210
6	Fuel Flexible pipe small- 1210
14	Stearing worm
15	Stearing Bearing
16	Tie Rod end Kit
17	Drag Line Kit
18	Frot Main Leaf
19	2nd Leaf Front
20	Rear main leaf
21	Rear leaf 2nd
22	Frond Shakle
23	Front Bracket
24	Rear Shackle assly
25	Rear Bracket assly
26	Fly wheel Ring
27	Clutch Plate
28	Pressure plate
29	Clutch Bearing 1210
30	Clutch Bearing 1612
31	1st Speed gear 40
32	2nd Speed 40
33	Gear Sleeve 1st Rev.
34	Gear Sleeve 2nd 3rd
35	U.J. cross 1210
36	U.J. cross 1216
37	Universal joint
38	Front wheel oil seal 1210

7	Fuel Flexible pipe big – 1210
8	Water pump assy 1210
9	Fuel Pressure Line Set 1612
10	Hose pipe Set 1612
11	Cyl head gasket 1612
12	Tappet gasket 1612
13	Fan Belt 1612
39	Rear Wheel oil seal 1210
40	F.W. Bearing 32308
41	Rear wheel bearing 32216
42	Crown Wheel Pinion
43	Crown big 47487
44	Pinion big 307
45	Axle geas 1210
46	Bevel gear 1210
47	Diff. Splines 1612

Note:- The Mechanical Equipments and Material are being used in I&PH Department has already been mentioned with relevant chapters including their spare parts list & maintenance and operation procedure.

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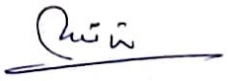
NOTE

This Handbook has been approved as a reference by Jal Shakti Vibhag, Govt. of Himachal Pradesh vide letter no. JSV-SE(P&I-I)-D-1-Tech Committee/2020-21-3404-10 dated 05/03/2021. However, the provisions in the relevant manuals (CPHEEO – Water Supply, Sewerage & Sewerage Treatment System, O&M), CPWD Manual & relevant IS Codes with upto date amendments shall supercede the provisions in this handbook in case of any variation.

For WAPCOS Ltd.



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