12.3.6 METHOD OF CONTROL

The common method of control of water treatment plant can be manual, semiautomatic, or automatic.

The system to be adopted will depend upon location, capacity, skilled man power availability, spare parts availability etc. The adoption of any particular system also depends upon the determination of the extent of information required by the operating personnel for proper operation of the plant.

12.3.6.1 Manual

This control involves the use of instruments to read plant variables manually. Adjustment in the processes when required are made manually by turning of a valve, pushing a button or such simple operation.

12.3.6.2 Semi Automatic

This control involves the use of instruments to automatically control a function or series of functions after control points are set manually or button is pushed to initiate an automatic sequence operation programme.

12.3.6.3 Automatic

This control involves use of instruments to automatically control and maintain in balance the process of functions. A close loop system is used with feed back of operation. When there is change in any process variable, the change is sensed and transmitted to a control instrument that adjusts a device to restore the system to balance.

12.4 DESIGN PRINCIPLES AND PRACTICES

There is no "Standard" design for an instrumentation or control system applied to a water treatment plant. However, there are certain basic considerations that govern the application of instrumentation and control to water treatment plant design concepts regardless of plant capacity, water quality or man-power factors. Examples of these considerations include flow measurements, rate controller, loss of head control, and level indication, etc.

The various requirements of control system, therefore, are grouped so that requirements can be selected based on above principles.

12.5 LEVEL MEASUREMENT

Level measuring units determine the amount of material in containers of all types either continuously or at intervals. There is no universal method available, due to wide range of processes within the container. Therefore, different measuring methods have been developed. With the exception of weight measurement, all measuring method determine the amount of material in the container by measuring the level within the container. The possible methods may be:

(i) Mechanical measuring methods: Here mechanical devices are employed such as flaps, membranes, float operated system, use of static pressures etc.

(ii) Physical measuring methods: Here certain physical characteristics are utilised such as electrical conductivity of material, use of optical ultrasonic beams etc.

12.5.1 ESSENTIAL INSTRUMENTS

The following level measuring instruments are considered essential:

(a) Chemical Tanks

Each chemical tank in the plant should be provided with float operated type local level indicator except in cases where the line tanks have M.S. cup type agitators rotating in the horizontal plane which lead to fluctuating solution levels. Float and wire rope should be of corrosion resistant material. The indicator should be either vertical arrow scale type or horizontal arrow scale type but the graduations should be of such a size that reading can be viewed clearly from a distance not less than 2.5 to 3.0 m.

(b) Overhead Tank

Generally all water treatment plants have an overhead tank which caters to the water requirements for chemical solution preparation and filter backwashing. The overhead tank is usually at a higher elevation. It is necessary to have a remote indication of the water level in overhead tank in the filter house or chemical house or near overhead tank filling pumps in case the overhead tank is filled by pumps in the treatment plant area. In case of a float operated level indicator, the float should be S.S. 316 or equivalent and coupled to a two wire transmitter foı signal for remote indication.

(c) Tanks/Sumps

For safety of the pumps against dry running, each tank/sump where draw-off is by pumping, should be provided with magnetic type or electronic level switch which will be actuated by low level in the tanks. It is advisable to instal displacer type tank top mounted magnetic or electronic control switches. It should also be possible to adjust the actuation level of these switches in field. The auto-stopping of respective pumps should be controlled through these level switches. Level switch displacer and wire rope should be of SS-316 while switch assembly can be housed in Al-alloy enclosure, which should be weatherproof.

(d) Loss Of Head For Filters

For loss of head across filters, a float operated direct reading meter is used. The pressure of water beyond the filter outlet valve and the pressure of water above the sand bed are directly transmitted to float chambers where two different floats correspond to the two different levels. Separate chain, sprocket and counter weight arrangements on each float cause the indicator pointer over the engraved dial to rotate in one case and the dial itself in case of the second level. The dial and the indicator pointer move in the same direction and the difference between two levels in two float tanks is obtained directly from the gauge calibrated accordingly. A more simple system is often used where differential is read from a graduated glass tube manometer.

The floats used for the Loss of head Meter is generally of G.I. but in cases where the water proves to be corrosive FRP or any other corrosion resistant material can be used for longer trouble free life.

12.6 FLOW MEASUREMENT

In treatment of water, a distinction is made between two configurations of measurements of water quantities.

(a) Open system where flow rate is a function of water level.

(b) Close system where flow rate is a function of liquid velocity.

Each system has its specific applications. The first method is used where water can be transported by gravity, where as the second method is normally used when the flow is under pressure.

The flow measurement in open channel implies that the system is connected to outside air. The water flowing through the channel has an open surface and cross section of channel is restricted in order to increase the velocity of the liquid. The acceleration results from the conversion of potential energy. The resulting level difference is suitable for the measurement of flow rates.

Various systems have been developed using this basic principle for measurement of flow for many units of water treatment plant. The instruments for this purpose may be of following types.

(i) Flow rate measurement with float device.

(ii) Flow rate measurement with bubble injection.

(iii) Flow rate measurement with capacitive measuring system.

(iv) Flow rate measurement with Echo sounder devices.

Each system has its own advantages and disadvantages. Therefore, the selection has to be made on a case to case basis. Generally the types which are quite extensively used at various units of water treatment plant are the float operated ones which comprise of a float operated flow indicator operating in conjunction with Parshall flume which acts as a basic flow element. Float and wire rope material should be non-corrosive while indicator enclosure should be weather-proof suitable for outdoor installation. In case a flow transmeter is also incorporated in the enclosure for remote indication of flow, then the electronic circuit should be coated with humidity resistant paint to make it suitable for high humidity atmosphere, say up to 95% RH.

The methods incorporating bubble injection and capacitive measuring system have inherent disadvantages and hence their application is limited.

The system which is becoming very popular for such an application is Echo sounder device, due to its freedom of movement, lack of wear, easy installation and simple transmission of measured devices, accuracy and reliability. A sensor which is mounted above the channel transmits a sonic or ultrasonic signal which is reflected from the surface of the water and returns an echo. The travelling time of signal is a proportion of the water level. The measuring amplifier generates a linear current which is proportional to the level and transmits it to a linearizer which converts the current into a signal proportional to flow rate.

Meters, recorders, analogue/digital converters etc. can be connected to the output of linearizer. Since the liquid does not come in contact with any part of the instrument and due to the absence of any moving parts, such systems may require less maintenance.

12.6.1 Flow Measurement In Closed Systems

Where flow measurement is in closed systems, rotameters, turbine flow meters, electro magnetic flow meters, venturi or orifice meters etc., can be used depending upon the application. Some of measuring devices in closed system are:

a. Propeller/turbine meter

b. Venturi tube

c. Pitot tube

d. Variable area meters

e. Kennison or parabolic nozzle

f. Electromagnetic flow meters

g. Ultrasonic flow meters

(a) Propeller/Tubrine Meter

These operate on the principle that liquid impinging on the propeller or turbine will rotate it at a speed proportional to the flow rate. The meter is self contained and requires no auxiliary energy. The meter, however, should run full at all times. The accuracy is generally ± 2%. However, this meter should not be used with liquid containing solids in suspension.

(b) Venturi Tube

This operates on a principle that a fluid flowing through a meter section that contains a convergence and constriction of known shape and area will cause a pressure drop at the constriction area. The difference in pressure between inlet and the throat pressure is proportional to the square of the flow. The accuracy is generally around 0.75% of flow rate. The venturi tube must run full at all times.

(c) Pitot Tubes

Pitot tubes operate on the principle where velocity head is converted to static through a meter section that contains a convergence and constriction of known shape and area will cause a pressure drop at constriction area. The difference between inlet and throat pressure is proportional to the square of the flow. Pitot tube must be calibrated individually. The accuracy of pitot tubs is around ± 1% of actual flow rate. Upstream piping configuration substantially effect the accuracy of measurement.

(d) Variable Area Meter

The area meter or rotameter operates as the pitot tube with float position a function of viscous drag that is differential head or pressure. In the variable area meter, the constriction area varies while maintaining an essentially constant pressure drop.

The meter consists of a plummet or float and an upright tapered tube. This plummet is lifted to a state of equilibrium due to various forces acting upward and downward. The reading scale attached to the tube is essentially linear because of constant differential pressure. The accuracy is usually ± 2% of maximum scale.

(e) Kennison or Parabolic Nozzle

This operates on the principle that liquid flow through partially filled and properly graded pipes when passed through known constriction will produce a hydraulic head at a specific area of constriction. This head is essentially directly proportional to flow provided nozzle has free discharge. The accuracy for these nozzles is usually ± 2%.

(f) Electro Magnetic Flow Meters

This meter has an insulating inner finer and operates on the principle that any conductor, be it a bar of steel or column of conductive liquid passing through the lines of force of a fixed magnetic field which generates an electromotive force (d-c voltage) directly proportional to rate at which the conductor is moving through the field. Each meter requires calibration and must run full at all times. The system accuracy is ± 1% of meter scale for velocity range of 0.9 to 9.1 m/s. Below this velocity, the system accuracy may fall to ± 2%.

(g) Ultrasonic Flow Meter

This is an obstruction-less flow measuring system that can be installed in pipelines carrying liquids. The two interrelated components comprise the ultrasonic flow metering system and the sensor containing ultrasonic transducers and transmitter package. The transducer receives and sends pulses. The pulses are transmitted against or along the direction of flow alternately. The pulse transit time is expressed in terms of frequencies. The average fluid velocity is proportional to the difference between these two frequencies.

12.7 FILTER FLOW CONTROL

During operation of rapid gravity filter, impurities brought up are deposited in the pores of filter bed, increasing the resistance against downward water movement. With the other factors unchanged, a drop in filtration rate would occur. A similar drop in filtration rate would take place when raw water level above filter bed goes down or the filtered water level downstream of the bed goes up, while the reverse movement would result in an increase of the rate of filtration. With regard to effluent quality, however, the filtration rate should be kept as constant as possible, while particular sudden fluctuations should be avoided. An abrupt increase in filtration rate might cause impurities from the raw water to breakthrough the filter bed, impairing effluent quality, while with negative heads a sudden reduction in the rate of filtration might release gas bubbles that have accumulated in the filter bed. When these gas bubbles travel upward, holes might be produced in the filter bed, through which the raw water can pass without proper treatment. A positive control of the rate of filtration is, therefore, necessary.

Rate control is obtained by inserting an additional loss of head in influent line (upstream control) or effluent line (downstream control) and adjusting this loss of head in such a way as to keep the supply of raw water or the abstraction of filtered water constant at the desired value. Since the rapid change in operating- conditions occur, constant supervision and having automatic control by mechanical, hydraulic, pneumatical or electrical means becomes essential.

Generally the flow controller is a double beat equilibrium valve controlled by a float placed in the controller chamber of filter. The flow control valve is designed and works on the principle of hydraulics. The filtered water from the filter discharges into an inspection box and then over a weir built in the wall of the inspection box into pure water channel at a lower level. The height of water over weir indicates the rate of flow and this rate setter is used for operating the outlet control valve which consists essentially of a double beat equilibrium valve controlled by a float placed in the control chamber built within inspection box but isolated from it. In the inspection box is fitted, a rate setter, which consists of a vertical tube, the bottom of which opens into the control chamber and into which is fitted another sliding tube, the top of later being in the form of circular weir.

The height of the circular weir is so adjusted that when the water in the inspection box flows at any particular level (which determines the rate of flow of filtrate) a portion of water spills over the circular weir into the trumpet pipe and trickles into the control chamber. In the later is provided a small submerged orifice through which there is a continuous discharge of water flowing into the drain and when there is a balance of flow between the water trickling in and out of the control chamber the level of the float in this chamber remains constant, the slightest difference in the rate of inflow and outflow will upset this balance and later the level of the float which will automatically adjust the opening of the control valve until this balance is restored. The trumpets pipe can be raised or lowered to give any desired flow and a calibrated scale is provided on the rate setter to set the filter to operate at required rate of filtration. This double beat valve is also controlled by a second float in the filter. This float closes down the control valve when the level of the water drops to about 15 cm above filtering surface where by preventing the filter being run dry. The controller is also provided with an automatic slow starting device.

12.7.1 Filter Flow Control Valve

The general arrangement of this type of outlet controller with associated accessories, is illustrated in Fig. 12.1 and 12.2.

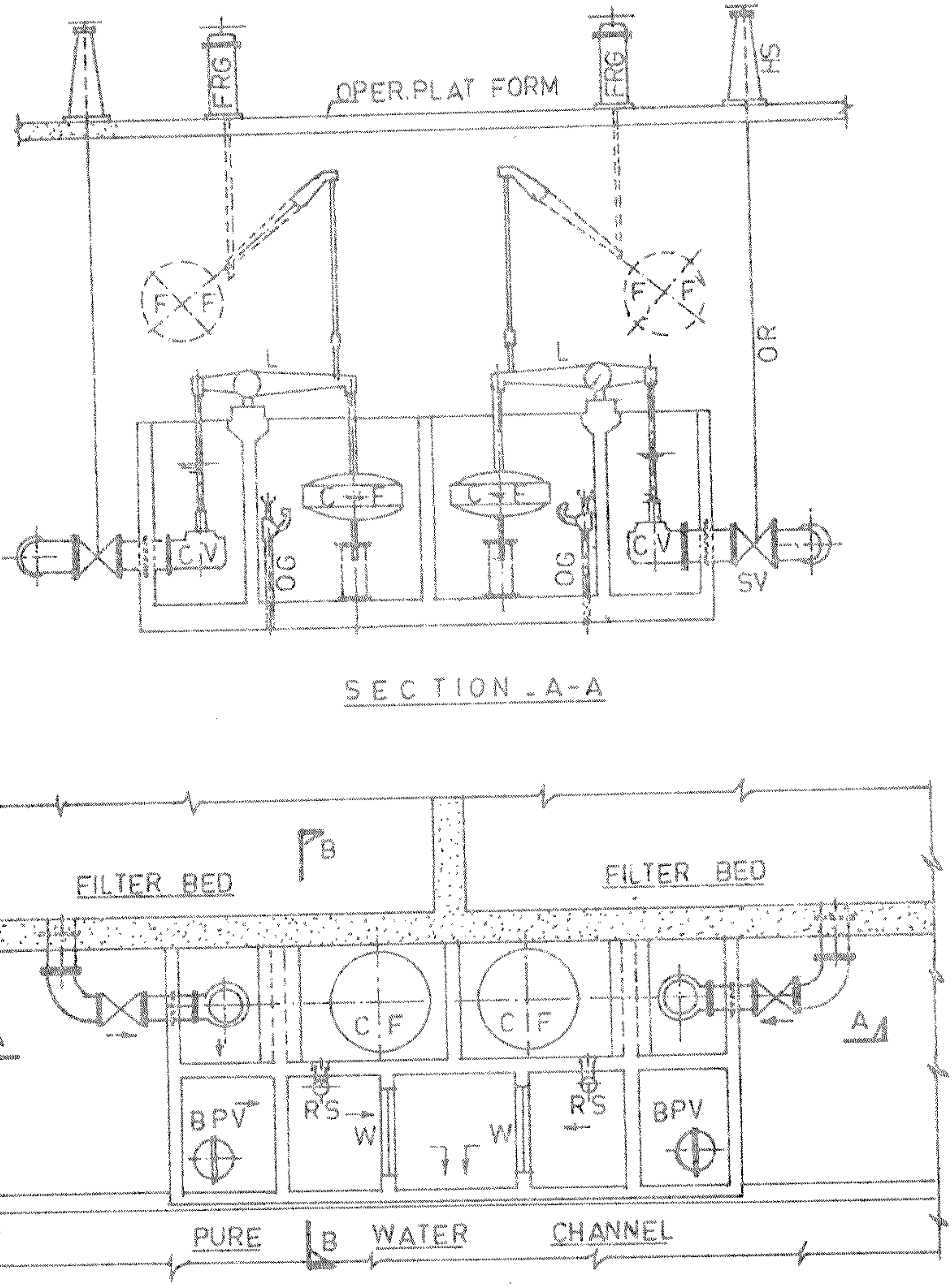
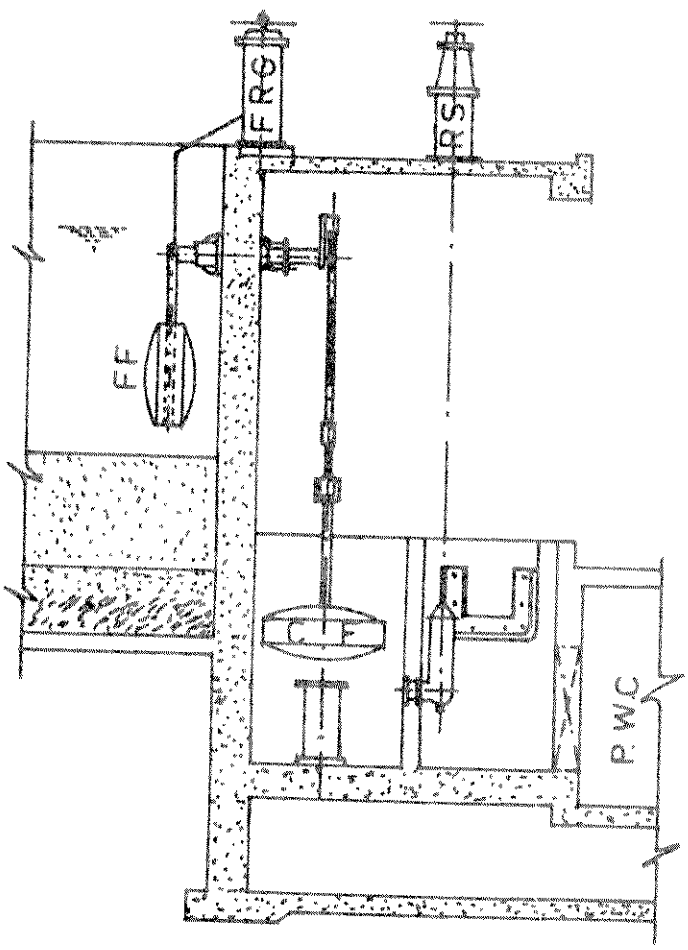


FIGURE 12.1 : PLAN OF OUTLET CONTROLLER CHAMBER
(NOTE FOR LEGEND REFER Fig. 12.2)



SECTION - B-B

LEGEND

CV......CONTROL VALVE
CF......CONTROLLER FLOAT
OG.....ORIFICE GEAR
F.F.....FILTER FLOAT
FRG..FLOAT RAISING GEAR
RS....RATE SETTER
BPV...BY PASS VALVE
W.......WEIR
L.......LEVER
SV.....SLUICE VALVE
OR....VALVE OPERATING ROD
HS.....HEAD STOCK
PWC.PURE WATER CHANNEL

FIGURE 12.2 : DETAIL OF FILTER CONTROLLER CHAMBER

The filter control valve is of CI construction with floats of GI, FRP, copper or any other corrosion resistant material.

The other type of controllers such as venturi, etc., work on pressure differential system which sends a signal to the controller. These differential pressures are reflected directly on the piston moving at a certain distance depending upon the difference between the pressures being exerted. The pressure is balanced by counter weights thus regulating the valve opening and closing. The controllers compare the actual flows with the set flow control points. According to the difference, the controller closes or opens the component, giving the discharge (butterfly valve, diaphragm, syphon).

The declining rate filter, however, does not require such control arrangement. However, to control the excess flow beyond the design capacity of any filter, a restrictor valve is introduced at the outlet so that filter is not allowed to operate at a filtration rate higher than assumed design values.

12.8 RATE OF FLOW OF CHEMICALS

For regulating alum flow or polyelectrolyte flow where used, the chemical solution is fed by gravity from solution tanks to a constant head box generally located near the dosing point. The constant head box (illustrated in Fig. 12.3.) is fitted with a PVC float operated stainless steel valve to keep constant level in dosing box. The rate of chemical flow is regulated by a stainless steel tapered needle valve over a stainless steel orifice in the constant head box. A scale gives directly the rate of flow of chemicals corresponding to opening of tapered needle valve.

For regulating lime solution being dosed, generally a V-nonch assembly with adjustable M.S shutter and a graduated scale is used. Regulated flow of lime solution as observed by head over V-notch indicated by graduated scale is allowed to flow by adjusting opening of M.S. shutter while the excess lime solution over flows back to the chemical tanks. (Fig. 12.4.)

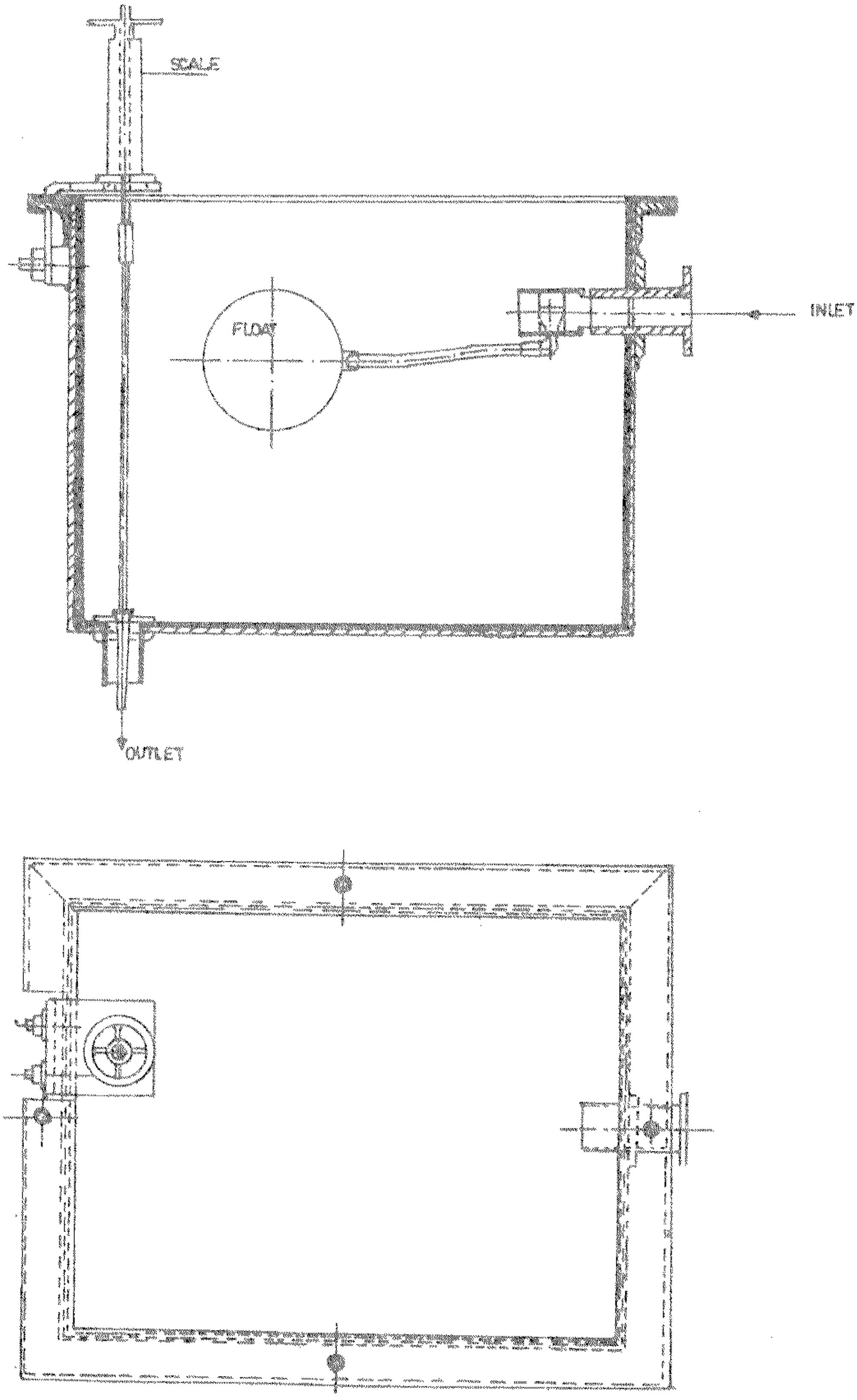


FIGURE 12.3 : M.S. RUBBER LINED CONSTANT HEAD BOX FOR ALUM DOSING

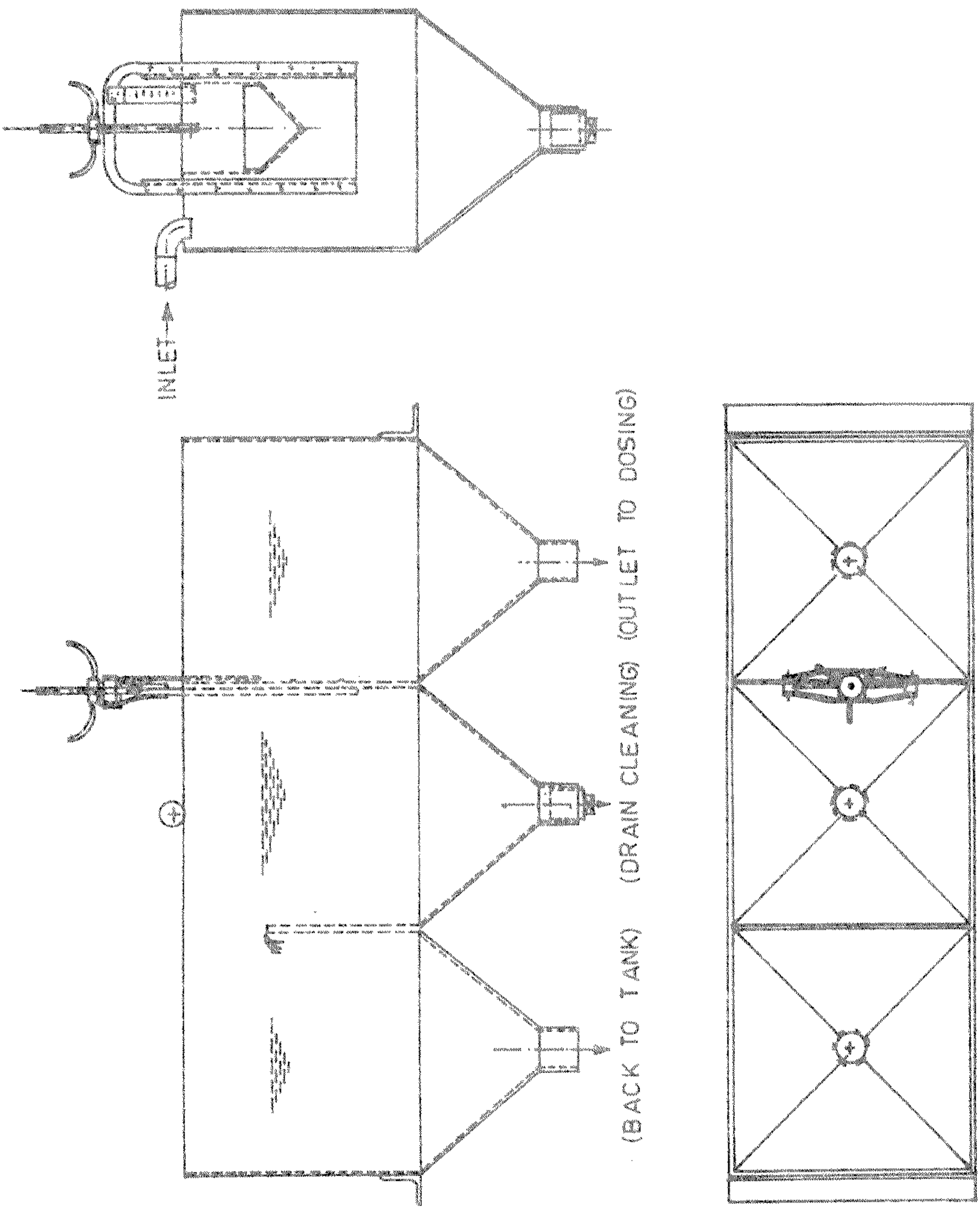


FIGURE 12.4 : LIME DOSING TANK

12.9 PRESSURE MEASUREMENT

Pressure is a parameter that is used extensively in testing and monitoring the performance of various types of pumping equipment, the monitoring of pressure gradients in pressure conduit and the regulation of pressure within required limits.

The most common types of pressure gauges are:

(1) Liquid: air and liquid: liquid diaphragm

(2) Bourden tube

(3) Strain guage

(4) Bellows.

The liquid: air diaphragm is a sensor unit using principle of balancing pressure across a diaphragm with a liquid on the side and air regulated by a nozzle-baffle system on the dry side. Due to change in liquid pressure the movement of diaphragm is balanced by build up of air pressure. Liquid system adopts a liquid instead of air.

The gauges should have minimum 100 mm size dial and should have range 1.5 to 2 times the normal operating pressure. The gauges are generally suitable for pressures up to 20.0 meters of water with accuracy of ±1% of maximum scale.

In the case of strain gauge, the sensor is used to measure dimensional change within or on the surface of a specimen when subjected to mechanical, thermal or combination of both inputs. The electrical type strain gauge is most frequently used and is based on measurement of capacitance, inductance or resistance change that is proportional to strain.

The Bellows element is a most conventional method of sensing pressure. It consists of a multiconvoluted bellows and its displacement by pressure change drives a mechanical linkage connected to indicator.

The Bourden tube works on a principle that a curved tube with a cross-sectional area that is not a circle will tend to uncurl as the area tries to become circular when subjected to pressure changes. The uncurling motion is calibrated to provide an indication of pressure. The pressure range for this type are from 0 to 7 and 0 to 350 kg/cm^2 with an accuracy of ±1% of full scale. This type is suitable where the liquid handled is noncorrosive type while for corrosive application, diaphragm type is preferable.

Wherever the pressure gauges are used in conjunction with reciprocating pumps pulsating dampener should be incorporated in the pressure gauge. All pressure gauges should have external zero setting mechanism and safety blow out mechanism. Pressure gauges installed in open should be of weather proof construction. Each and every pump and air blower should have pressure indication as an essential requirement.

12.10 WATER QUALITY

Water quality monitoring is essential for proper functioning of plant and to ensure desired quality of treated water. The water quality monitoring can be achieved in the plant laboratory by testing samples of raw and treated water at discrete intervals, using laboratory testing equipment. Reference may be made to Chapter 15 for details regarding recommended minimum laboratory tests and equipment.

12.11 OPTIONAL INSTRUMENTATION AND CONTROLS

12.11.1 LEVEL

(a) Raw Water Flow Control by level in clarified/filtered water tank

Where the flow to plant is controlled by the level in clarified/filtered water storage tank, a float operated electrically or pneumatically actuated inlet control valve may be used. The flow control of the inlet valve can be continuous or discrete using remote manual operation. In continuous control system, the level transmitter which transmits the level in the tank gives an input signal to a Pressure Internal Difference (PID) controller and the controlled output signal regulates the flow control valve on a continuous basis. In a discrete control system with remote manual operation both the raw water flow to plant and level of water in clarified/filtered water tank is observed on the control panel and the opening of the inlet control valve adjusted by remote manual inching operation from the control room. The push buttons, auto circuits, etc., are all mounted on the control panel. The raw water inlet control valve is also to be provided in both cases with a manual override.

(b) Level Annunciation and Auto Control Of Pumps

For ease of operation, it is advisable to provide high and low level annunciations for all the tanks at some centralised remote location where the control panel is housed. These alarms can be obtained from level switches similar to the one described at 12.5.1 (c). However, in chemical preparation tanks only low level annunciation serves its purpose. In tanks, where the draw-off of filling is by pumps, level switches can be used for auto starting/stopping of the pumps at high and low levels. Care should, however, be taken to have separate level switches for annunciation and for control of pumps.

(c) Remote Indication and Annunciation of Loss of Head Across Filters

Where the number of rapid gravity filters is large, it is sometimes preferable to have remote indication for loss of head across filters in individual filter consoles and alarm annunciation at high loss of head denoting need for backwash, for the filters at some centralised remote location. Differential pressure type electronic transmitters mounted in field near filters may be used for this purpose with pressure tapping from after the control valves and over sand media respectively.

Electronic transmitters should be suitable for high humidity atmosphere upto 95% RH and should give 4-20 m.a. signal. Remote indicator can be analog or digital type with facility for zero and span adjustment.

12.11.2 Flow

(a) Remote Indication of Raw Water Flow

Raw water flow indication at a remote location may also be provided. This will facilitate operation of inlet valve as also in data-logging. The remote flow indicator may be of analog or digital type. It is also preferable to have an intergrator to know the cumulative flow to the plant. This integrator should be hand reset type only and the reset facility should be provided in such a way that accidental resetting of counter is avoided.

(b) Remote Indication of Rate of Flow Through Filters

Remote indication of rate of flow of individual filters may also be provided. For the purpose, float operated electronic type two wire transmitter with 4-20 m.a. output may serve the purpose using the filter outlet weir as the basic flow element. A differential pressure transmitter with an orifice in the filter outlet pipeline acting as the basic flow element may also be used. The remote indicator can be analog or digital type. Integrator similar to one described in Clause (a) above may also be used to know cumulative flow through the filter.

(c) Wash Water Flow Indicator

Wash water flow to filters may be measured locally by installing a rotameter in the main wash water header line to filters. The rotameter is usually a metal cased bypass rotameter with stainless steel float, stainless steel orifice and carrier ring assembly. In cases where remote indication of wash water flow to filters is desired, a differential pressure transmitter using a stainless steel orifice in the wash main header as basic flow element, may be used with a digital or analog remote indicator placed at a convenient location for the operator.

Repeat indicators of wash water flow may also be installed in individual filter consoles where such a system is adopted. However, the same need not be kept 'ON' at all times. The indicator is to facilitate backwashing and as such may be switched 'ON' for that period only.

(d) Chemical Flow

For regulating flow of chemicals solution, positive displacement metering pumps with 0-100% capacity mechanical stroke adjustment by means of a micrometer dial screw on the pump may be used.

The stroke adjustment may be manual/ remote by means of an electrical stroke positioner on the control panel.

12.11.3 Pressure Switch Applications

In applications, where a minimum fluid pressure is required in a particular pipeline, a pressure switch may be incorporated for annunciation as well as auto trip of the connected

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equipment. For example, certain pumps requiring external water supply for cooling of the bearing should have a pressure switch on cooling water line to pumps.

12.11.4 Filter Console

Filter consoles for each individual filter can be provided when such an operational system is called for. The filter console table can be of FRP/M.S. sheet epoxy painted framed structure. All filter controls can be attended to by the operator from the individual filter console.

Open/close push buttons for filter inlet, outlet, wash water inlet, drain and air inlet valves are provided in the filter console along with their open/close indication. In such an operational arrangement all filter valves are to be pneumatically or electrically actuated. Control of air blowers for air scouring of filters are also incorporated in the filter console. If desired, wash water flow indicator, filter loss of head indicator and filter rate of flow indicator can also be incorporated in the filter console table.

It is also possible to have programmable logic based filter washing arrangement for the filters. The programmable controller should have required number of outputs each to be programmed independently and for pre-determined durations, to be decided at the time of commissioning.

12.11.5 Clarifier Desludging

A programmable logic based clarifier desludging arrangement may be provided to open the clarifier desludging valves at adjustable predetermined time intervals for an adjustable predetermined duration. In such a system of operation, the desludging valve will have to be electrically or pneumatically actuated. In case of pneumatic mode of operation, the solenoid valve used for the purpose should be of SS-316 or equivalent construction while the solenoid coil should be epoxy moulded, suitable for outdoor installation. The programmable controller may be located at a remote location preferably in the central control panel of the plant. Positive indications of valve operation by way of limit switches may also be provided near the programmable controller.

12 11.6 Water Quality

On-line instruments with annunciation for limit values may be provided for quality monitoring of the water treatment plant, for the following parameters.

(a) Turbidity

On-line turbidity meters working on the surface scatter principles may be provided for indication of raw water, clarified water and filtered water turbidities. Alarm annunciation can also be provided in case the turbidity of clarified water or filtered water is outside their respective acceptable values.

(b) pH

On-line pH sensors with preamplifier and two wire pH transmitters, if necessary, can be used for remote continuous pH indication. The pH transmitter should be housed in a weather-proof enclosure. Alarm annunciation can be provided in case pH of clarified/filtered water is outside acceptable limits.

(c) Residual Chlorine

On-line residual chlorine sensor and residual chlorine two wir transmitter can be used for continuous remote indication of free residual chlorine after chlorination. The two wire transmitter should be housed in a weather-proof enclosure.

Free residual chlorine can also be continuously indicated by an amperometric chlorine residual analyser housed near main control panel. Sampling pumps at field are required for amperometric measurement and indication.

In both types alarm annunciation can be provided in case residual chlorine in water is outside acceptable standards.

12.12 INSTRUMENT-CUM-CONTROL PANEL

To facilitate plant operation and monitoring, it is advisable to have a centrally located instrument-cum-control panel. This panel should have all the annunciations, status indication lamps, instruments, start/stop or open/close push buttons and logic wiring circuits. Chemical tank agitators, start/stop facility and status indication lamps may be on separate panel.

It is also advisable to have all logic circuit wiring in this control panel only so that Motor Control Centre (MCC) modules wiring can be standarised to advantage of draw-out features of MCC. Similarly, it is also advisable to route all control and instrumentation cables through this panel only. However, push button station cables, if so desired, may be taken directly to MCC.

For reasons of operators' safety, it is desirable to have control voltage not more than 100V, single phase, A.C.

The panel front sheet should not be less than 3 mm thick and single flap type doors with locking facility should be provided on back side. Panel height should in no case be more than 2400 mm and minimum operating height should not be less than 800 mm from floor level.

12.13 CONCLUSION

In the above chapter various methods of instrumentation and control system in water treatment plants have been discussed. As a general guideline the following should be considered while deciding the type of instrumentation & control required. Generally, for a plant of about 25 mld and below, simple and manually operated instrumentation should be preferred. This may include inlet flowmeters, level indicators for chemical tanks, overhead tanks, loss of head for filters, filter control equipment for filter, LOH glass tube graduated manometer for pressure measurement devices for pumps and blowers. For plant having capacity between 25 mld to 100 mld, semi-automatic equipment may be preferred.

However, valves may be manually or pneumatically operated. For a plant having more than 100 mld, it is advisable to go for electrically operated systems with instrumentation control panel on line quality measuring instruments with a remote indication. Flow measuring devices may be of ultrasonic type or electromagnetic type to have better accuracy. Tanks/sumps should be provided with automatic control for low and high level switches.

CHAPTER 13
OPERATION AND MAINTENANCE OF WATERWORKS

13.1 INTRODUCTION

Once the task of creating a water supply system is complete, the aspect which will have to be given the top most priority is the "operation and maintenance" of the system. Instances of poor operation and maintenance practices have on many occasions largely contributed to decreased utility, or even to an early failure, of newly constructed drinking water supply facilities. Thus the health and social benefits for which the facilities were designed have not been realised; capital investment have been wholly or partially lost; and scarce resources are expended on the premature replacement of equipment or for the rehabilitation of facilities before they have been in operation for the full span of their useful lives. Therefore proper operation and maintenance is the answer for deriving the benefit continually from the investments made.

Although each water works may have its own peculiar problems of operation and maintenance, there are many features of operation and maintenance which are common to all waterworks.

13.2 OPERATION AND MAINTENANCE

The maintenance of a water works may refer to up keeping the civil, mechanical and electrical components of a plant through normal repairs, so that they are able to function at designed capacity for their design period. It may further refer to such routine repairs as are necessary to prevent the components from malfunctioning.

The operation refers to the art of handling the plant and equipment optically so that the designed quantity and quality of water can be produced.

The operation of a water works refers to hourly and daily operation of certain component parts of the water works such as plants, equipments, valves, machinery etc., which are required to be attended to by an operator or his assistant. It is an important though routine work. Operators have to be trained properly before they are entrusted with the task of operation of specific plant, equipment, valves, machinery etc.

13.3 COMMON FEATURES OF OPERATION AND MAINTENANCE

In the operation and maintenance of a water works, there are certain common features to be considered by the authority controlling the water works. These are briefly stated below:

13.3.1 Availability of Detailed Plans, Drawings and Operation and Maintenance Manuals

When a water works is taken over for operation and maintenance, it must be ensured that atleast five to six sets of the detailed drawings, maps of each of the component of the water works along with all relevant 0 & M Manual are available with the operating authority. One of the sets may be preserved as a master set in apex office for reference. The other sets may be distributed to sub-offices in charge of relevant operation activity. All these sets must be corrected and updated whenever any additions/ alterations/ deletions are done to any of the structures and equipment.

13.3.2 Schedule of Daily Operations

For each of the activity where operators are employed, a detailed scheme and schedule of unit operations should be worked out and a copy of the same should be available with each operator. This schedule of unit operations may have to be altered to suit changes in raw-water quality, hours of availability of power, break-downs and up-set conditions etc.

13.3.3 Schedule of Inspection of Machinery

A regular schedule of inspection of machinery, equipment their lubrication and servicing programme must be prepared and circulated. Appropriate supervisory control should be exercised to see that these inspections, lubrications and servicing are being regularly carried out.

13.3.4 Records

For each piece of equipment and machinery a record register should be maintained in which all records of the equipment such as servicing, lubricating, replacement of parts, operating hours (including cumulative) and other important data is entered.

13.3.5 Records of Quality of Water

Complete records of bacteriological and chemical analysis of water from source to the consumers tap should be maintained and reviewed. Charts could also be prepared for the important characteristics of the water and any changes in these characteristics as compared to the standards must be taken note of.

13.3.6 Records of Key Activities of O & M

For planning future augmentations and improvements of a water works in operation, it is advisable to maintain certain key records such as daily and cumulative supply over the years, number of connections of various sizes given and cumulative number of connections each month, water treated and the supply billed.

13.3.7 Staff Position

Appropriate charts indicating the standard staff for each of the unit of operation and maintenance and the staff actually in position (by names if possible) shall be maintained at each office for review.