TECHNICAL SPECIFICATIONS FOR AURANGABAD PARALLEL PIPELINE WATER SUPPLY SCHEME

INDEX

ABBREVATIONS

Abbreviation	Description
AMC	Aurangabad Municipal Corporation
UIDSSMT	Urban Integrated Development for Small Scale and Medium Town
CPHEEO	Central Public Health Environmental Engineering Organization
PWD	Public Works Department
MJP	Maharashtra Jeevan Pradhikaran
MSEDCL	Maharashtra State Electricity Distribution Company Limited
CSR	Current Schedule of Rates
WS	Water Supply
CC	Cement Concrete
RCC	Reinforced Cement Concrete
PCC	Plain Cement Concrete
CM	Cement Mortar
U.C.R	Un-Coarsed Ruble
MBR	Master Balancing Reservoir
MLD	Million Liters per day
O&M	Operation & Maintenance
HP	Horse Power
M&R	Maintenance and Repair
WTP	Water Treatment Plant
GSR	Ground Service Reservoir
RL	Reduced Level
GL	Ground Level
FSL	Full Supply Level
LSL	Lowest Supply Level
HGL	Hydraulic Grade Level
GA	General Arrangement
MS	Mild Steel
OD	Outer Diameter
ID	Internal Diameter
GI	Galvanised Iron
RSJ	Rolled Steel Joist
NRV	Non Return Valve
SBC	Safe Bearing Capacity
GRP	Glass Reinforced Pipe
TBM	Temporary Bench Mark
LPS	Litre Per Second
RPM	Revoluation Per Minute
SWD	Side Water Depth

WORKING SURVEY

The Concessionaire shall himself carry out the Working Survey and line out of works as per approved drawings) and shall be responsible for accuracy of it. He shall employ qualified Engineer for this purpose. The Concessionaire shall provide free of charge all labour and material and instruments required for lining out, surveying, inspection as decided by the Engineer in Charge. Only one Bench Mark with definite value of R.L. will be shown to Concessionaire who shall have to provide for a network of temporary benchmarks all along the road for Pumping Main, Jackwell and Pump House at Jayakwadi dam, Approach bridge at Jayakwadi dam, WTP at Pharola, MBR at Nakshatrawadi.

The Concessionaire shall be responsible for the provision, accuracy and maintenance of temporary benchmarks. He shall be responsible for the correctness of the position, levels, dimension and alignments of all components of the work. Provisions of necessary instruments and labour in connection with suitable pointed bamboos or wooden stack shall be provided and firmly fixed at every 30 meters on both sides of trenches to indicate final as well as intermediate height. Any errors in position, levels, dimension and alignment, etc. shall be rectified, by Concessionaire at his own expenses. The Concessionaire shall carefully protect and preserve all bench marks, side rails, pegs and kilometer stones etc., marking out the centre lines of Pumping Main. Necessary approaches etc. shall be done and maintained by the Concessionaire as directed by the Engineer in charge of Aurangabad Municipal Corporation, Aurangabad or his representative.

The Concessionaire shall carry out working survey of the entire project such as Pumping Mains, Jackwell and Pump House at Jayakwadi dam, Approach bridge at Jayakwadi dam, WTP at Pharola, MBR at Nakshatrawadi etc. to ascertain the final acceptable levels and layout of the structure. This will form the basis for the final execution of work. The Concessionaire shall carefully preserve all survey as also setting out stakes, reference point’s bench marks, and monuments. Should any stakes, points or bench marks are removed or destroyed by any act of the Concessionaire or his employees, they may be reset by the Concessionaire. The Concessionaire has to generate L-section drawings at 30m intervals showing plan, HGL, GL and invert level of Pumping Mains with desired gradient as per ground profile. For head works, approach bridge, WTP and MBR block contour survey has to be carried out by the Concessionaire. Necessary GA drawings and L-Section drawings of the project components shall be prepared by Concessionaire and shall be got approved from AMC before commencement of structural designing and work proper.

HEADWORKS: INTAKE CHANNEL, JACKWELL & PUMP HOUSE (36m x 15m size) AT JAYAKWADI DAM.

1. The Head Works and raw Water Pump House is to be constructed in the submergence of Jayakwadi dam. The location of the pump house shall be fixed in consultation with the irrigation authorities and Engineer-In-Charge of AMC.

2. The ground levels and General layout should be verified by Concessionaire before commencement of the work and the same should be as approved by the AMC.

3. The concrete shall be necessarily RMC-Ready Mixed Concrete with M25/M30 grade concrete to be used for all RCC members as required by the IS provisions.

4. ToR steel of grade Fe-500 shall be used for all RCC members. The permissible stresses in steel shall be equivalent or more as stipulated in respective IS code.

5. All RCC designs and drawings are to be prepared by the Concessionaire and got approved from AMC.

6. External walls of the Jack well shall be in RCC M25/M30 of appropriate sizes and for pump house to be in brick masonry panel 230 mm thick along with RCC frame work.

7. 12.0 mm thick cement plaster with neeru finish to internal faces of brick walls.

8. 20 mm sand faced plaster in CM 1:3 to external faces.

9. Cement paint in two coats on external faces excluding primer coat shall be applied.

10. Oil bound distemper paint in two coats on internal faces excluding primer coat shall be applied.

11. Whitewash in three coats for ceiling shall be provided.

12. Kota stone flooring for both the floors of the pump house shall be provided.

13. Loads from Pumps, Motors, piping, valves and other accessories to be considered as per the manufacturers' data sheets. RCC members to be designed considering all types of loads.

14. Structure to be designed for earthquake as per latest IS codes.

15. Floor slab, sub floor slab, roof slab = Minimum 150 mm thick. The clear height between two floors shall be minimum 2.7m excluding the depth of roof beam.

16. Water proofing layer to be provided over roof slab with 10 years guarantee of water tightness.

17. All doors and rolling shutters shall be in MS except the main door which shall be in teak wood. The ventilators and windows shall be in aluminum frame with powder coating and fully glazed. Total area of openings shall be 25% and shall be got approved prior to the commencement of the work. It shall be adequate to have proper light and ventilation at all floor levels. Sizes of opening may be changed to suit architectural elevation.

18. Attractive architectural elevation and colour scheme shall be provided by Concessionaire.

19. Each beam supporting pumps should be designed considering point load from pumps and motors including impact factor.

20. Minimum width of inlet channel = 4 m. Length of RCC inlet channel = 15 m.

21. Walkways 1200 mm wide with GI pipe railing shall be provided on walls at Pump floor levels on all sides. MS ladders should be provided for access to these walkways.

22. 1.20 m wide RCC stair case with railing to be provided for access to bottom slab of jack well and to the roof slab of pump house with landings at suitable heights.

23. Cable trays of suitable size are to be provided. The size & layout of cable trays may have to be changed as per requirements of electrical installation.

24. RCC walls of inlet channel, bottom and Approach channel shall be finished smoothly with cement plaster.

25. All dewateringwill be Concessionaire's responsibility. Concessionaire may deploy electric pumps, diesel pumps and manual labour for this purpose.

26. All excavations required for construction of head works are included in scope of the work. Blasting is strictly prohibited.

27. PCC in leveling course is to be provided below all the column footings & base slabs with offset of 150mm on both sides. PCC shall be in M15 grade concrete.

28. Concessionaire shall carryout geotechnical investigation and shall conduct tests for determining safe bearing capacity of the foundation for each structure and the structure shall be designed accordingly.

29. After completion of work, the cofferdam shall be removed completely so that there is no obstruction to flow of water towards the approach channel and head works.

30. All RCC members shall be grouted with cement slurry to make them perfectly watertight.

31. All items which are not specifically mentioned above but which are required for satisfactory completion of the Jack well and Pump House are included in scope of the work.

32. The length and width of the pump house shall be designed considering the layout of the pumping machinery and electrical installations in pump house.

33. Continous corbel along the length of the pump house shall be provided at a height of at least 5.0 m from the floor, for mounting of rails for overhead crane.

34. A clear height of atleast 1.5 m above the crane shall be provided for maintenance purpose.

35. The pump's suction shall be suspended from the pump floor. Suitable size openings shall be provided for lowering of the pumps. RCC beams shall be provided for mounting of the pump. The beams shall be designed for dynamic load imposed by pump and motor. Panels and starters shall be mounted on the operating floor. Suitable cutouts shall be provided in the slab at the locations of panels and starters for entry of cable from below. Cutouts of adequate sizes shall be provided in operating floor slab for access to the valves by crane. Atleast two nos of RCC stair cases shall be provided for ascending / descending to operating floor from intermediate floor. A viewing gallery facing dam side and sit-out shall be provided on the operating floor. All the openings / cut outs, galleries etc shall be provided with GI pipe railings as per standard specifications and as directed by Engineer-In-Charge.

36. Structural Classification: The head works site is in Zone III as per IS 1893: 2002. The pump house structures are seismaically classified as “Codal” and hence shall be analysed and designed in accordance with the provisions of IS 1893:2002. Imporatnce factor shall be considered as 1.0. Environmental condition considered for sub-structure design is “Severe” as defined in Table 3 “Environmental Exposure conditions” of IS:456 and IS 3370.

37. Design Basis for Foundations:

a. The foundation raft shall rest on proper foundation strata after removing all loose and filled up and excavated material.

b. The bearing pressure exerted by the structure shall not exceed the allowable safe bearing capacity.

c. Settlements due to compression of the underlying sub grade shall be negligible.

d. The foundation design shall ensure competent performance in the transmission of all loads to the sub grade with appropriate safety margins. The local combinations to be considered in this respect shall cover all specified normal, severe and extreme loadings. In addition, the foundation design shall also ensure compliance with specified minimum factors of safety against overturning, sliding and floatation under worst load combinations.

The parameters of design of foundation shall be as follows:

Dry density of Backfill	:	1.9 Tons/ cu.m.
Saturated density of Backfill	:	2.0 Tons/ cu.m.
Submerged density of Backfill	:	1.1 Tons/ cu.m.
Bearing Capacity	:	20 Tons/ sq.m.

The bearing capacity mentioned above is maximum permissible and the same shall be verified by the Concessionaire by carrying out fresh soil investigations. If the bearing capacity is observed less than 20 Tons/ sq.m during testing, the same should be adopted to design the foundation.

RAMP & APPROACH BUND AT JAYAKWADI DAM.

1. Top width of the approach bund shall be minimum 9.00 mtr. With top RL of bund at RL 466.60 M.

2. The width of ramp of 9.00 m. with railing on one side and MS pipe 2000 mm dia on other side shall be provided from ground to approach bridge floor at RL 466.60 m.

3. The material to be used for approach bund embankment shall be selected material from excavation of jack well and approach channel.

4. The embankment shall have proper watering, rolling and compaction.

5. The dry stone pitching shall be provided for the bund embankment sides with proper interlocking.

SPECIFICATION FOR COFFER DAM

The coffer dam surrounding approach channel, approach bridge and jackwell and pump house will be constructed and maintained by Concessionaire from starting of excavation till completion of head works. The scope of work is inclusive of repairs or reconstruction if any due to damage etc. due to any eradication. The coffer dam bottom width shall be adequate with minimum required side slopes and adequate top width. The coffer dam seat shall be properly cleaned of grass and shrubs etc. The height of coffer dam shall be decided in accordance with site conditions such that maximum level before start of pumping shall be well below top of dam at least by 0.5m. It is responsibility of Concessionaire to maintain the coffer dam and redoing whenever required throughout the period of excavation and construction.

After completion of work, the Concessionaire shall dismantle the coffer dam after due permission of the AMC in such a manner that it will not obstruct storage of reservoir or any structure.

SPECIFICATION FOR DEWATERING FOR HEADWORKS

This item includes the entire dewatering operation from start of work till its completion in all respects.

The trenches shall be kept free of water during the entire construction and arrangements to dispose off the bailed out water shall be properly made by the Concessionaire. The job also includes removal of muddy-water, muddy paste, etc.

If anytime during excavation till its completion, the work site is filled with water or debris either due to untimely rains or due to underground seepage being struck during excavation, side slips or due to any cause whatsoever, the Concessionaire shall have to dewater and remove the debris, filled up material, etc. complete as directed by Engineer-In-Charge. Similarly if the coffer dam is constructed for water diversion and is broken, washed away due to any reason, the Concessionaire shall make it good immediately so that the construction work is not hampered.

If the work is continued for more than one working season, or beyond the stipulated time limit, due to any reason whatsoever, the Concessionaire has to do all the dewatering and removing and trench clearing operation till the completion of work. If any accident occurs during dewatering operations or due to coffer dam, etc. on account of any reason whatsoever, the Concessionaire shall be fully responsible for and shall have to shoulder all responsibility of compensation, etc.

In short, this item of dewatering covers the materials and labour for entire period of excavation from start till completion of work together with all eventualities mentioned above.

SPECIFICATIONS FOR APPROACH BRIDGE

GENERAL:

i) The structural design of the Approach Bridge shall be done by the Concessionaire and shall be got approved from approved College of Engineering or IIT as directed by Engineer-In-Charge.

ii) The construction shall be carried out as per standard specifications of PWD and other relevant codes and Indian Standards.

iii) Codes and Standards: Structural Design shall meet the criteria laid down in relevant Indian Standards listed below-

IS 456-2000	:	Codes of Practice for Plain and Reinforced Concrete.
IS 1893-2002	:	Code of Practice for Earthquake resistant Structures.
IS 875-1987 (Parts 1 to 3)	:	Code of Practice for Structural safety of buildings: Loading Standards (Parts 1 to 3)
IS 800-1984	:	Code of Practice General Construction in Steel
IS 11384-1985	:	Code of Practice for Design of Composite Structures.
IS 3370 (All Parts)	:	Code of Practice for Concrete structures for the storage of liquids (All Parts)
IS 5525-1969	:	Code of Practice forReinforcement Detailing.
IS 1080	:	Code of Practice for Design and Construction of shallow foundations.
IS 1904	:	Code of Practice for design and construction of foundations- general Requirements
IS 2950	:	Code of Practice for Design of Raft Foundations
IS 2185-Part I	:	Specification of Concrete Masonary units: Hollow and Solid Concrete Blocks.
SP:22	:	Explanatory handbook on codes for Earthquake Engineering.
SP:24	:	Explanatory Handbook for Code of Practice for plain and reinforced concrete.
SP 16-1980	:	Design Aids for reinforced concrete to IS 456.
SP 34-1987	:	Handbook on concrete reinforcement detailing.
IS 2974- 1992	:	Code of Practice for Design of machine Foundations.
IS 13920-1993	:	Code of Practice for ductile detailing of Reinforced concrete Structures subjected to seismic forces.

NOTE: The Concessionaire shall submit 6 sets of GA drawing and get the same approved from AMC before taking up the structural design and work proper.

Design Basis For Approach Bridge:

An approach bridge approximately 360m long and 9 m wide shall be provided. The bridge shall have 6.0 m clear carriageway and shall support 1 no. 2032 mm (OD) MS pipe line on one side and Guard rails as specified in Schedule on the other side. The pipelines and decking shall be supported on RCC columns and braces.

Design Parameter:

The bridge design shall be carried out based on following:

1) All reinforced concrete elements shall be designed as per IS 456-2000.

2) Bridge deck level shall be 466.60m and pipe invert level shall be 466.90 m. the pipe will be supported on pedestals constructed on deck slab.

3) Column foundation shall be minimum 1.5 m below the Average Ground Level.

4) Maximum unsupported span of 2032mm dia pipe line shall exceed 6 m.

5) The loads to be considered shall be as follows:

RCC	:	2.5 Tons / cu.m.
Soil	:	1.9 Tons / cu.m.

2032 mm dia pipeline : 4.0 Tons / m. when full. 0.80 Tons / m. when empty

6) Live loads- The deck slab shall be designed for Class B single lane loading as given in Clause 207.1.3 of IRC 6-2000.

7) Seismic loads shall be considered as per IS 1893:2002 for seismic zone III with Importance factor of 1.0.

   Safe bearing capacity of 20 Ton / Sq.m shall be considered at the foundation level. However the Concessionaire shall carry out necessary soil investigation to confirm the safe bearing capacity. If the bearing capacity is observed less than 20 Tons/ sq.m during testing, the same should be adopted to design the foundation.

8) Factor of safety against overturning – 1.5

9) Factor of safety against sliding – 1.5

DETAILED SPECIFICATIONS FOR EXCAVATION OF PIPE TRENCHES

1. GENERAL

Excavation in soft strata.

Excavation for trenches in soft strata which include all types of shingles, clay, soil, silt, sand and gravel, soft murum and any other materials which can best be removed with a shovel after loosing with a pickaxe and crow bar. The work shall in general be carried out as per std. specification no.Bd-A-1.

Excavation in hard murum and boulders.

Excavation under this item includes hard murum and boulders up to 0.1 cum and water bound macdam road. The work shall in general be carried out as per std. specification no.Bd-A-2.

Excavation for foundation trenches /pipe trenches etc. in soft rock & old cement road.

The excavation under this item include all the excavation for foundation, pipe trenches etc. in soft rock & old cement and lime masonry foundation & asphalt road. The work shall in general be carried out as per std. specification no.Bd-A-4.

Excavation for foundation trenches / pipe trenches etc. in hard rock.

The excavation under this item includes hard rock etc. & concrete road by chiseling, wedging, line drilling by mechanical means or by all means other than blasting including trimming and leveling the bed. The excavation shall be done by mechanical means either by air compressor, rock breaker & wedging by rock drilling in dry or wet condition. No blasting shall be allowed. Concessionaire should keep two air compressors in working condition at the site till the completion of excavation. The work shall in general be carried out as per std. specification no.Bd-A-6.

2. ADDITIONAL SPECIFICATIONS FOR EXCAVATION ITEM 1, 2, 3, & 4 above

The trenches shall be excavated to the grade and depth and on the line shown on the approved drawings or along the alignment as approved by the Engineer-In-Charge.

Before the trench excavation is commenced sight rails shall be erected at every 30 M and at change in direction point. The sight rails shall be got painted as directed and approved by the Engineer in charge before they are used. The vertical posts to which the sight rails are fixed shall be of square cut size wood of suitable size as approved by Engineer-In-Charge, and not of round bullies.

The sight rails position and levels shall be given by the Engineer in charge or his representative. The depth of excavation and the level of pipe invert shall be checked by the Engineer in charge on his representative by means by boning rods of appropriate length. The boning rods etc. shall be provided by the Concessionaires. Separate boning rod for excavation and for laying, and the required labour for this job shall be provided by the Concessionaire . The Concessionaire shall not tamper with the sight rails, levels given by the Engineer-In-Charge.

The excavation of the trench for a pipe shall be commenced at the down stream end and be continued up to the required gradient. The length of trench to be opened at one time shall be determined by the Engineer in charge, depending on its depth, width, nature of ground, road width, traffic etc.

The excavation shall be taken down to such depths as shown in approved layout drawings and / or as directed by Engineer-In-Charge. The bottom of the foundation shall be perfectly leveled before any pipe laying work is commenced.

Excavated material shall not be placed within 1.2 meters of the edge of the trench or half of the depth of the trench whichever is more.

In case of excavation in towns and inhabited places, it shall be strongly fenced and lighted during night by red lights with Concessionaire’s watchman. All precautionary and safety measures shall be

taken by the Concessionaire during excavation and construction.Material should not be dumped on road.

The Concessionaire shall provide shoring and strutting of approved size and type of normal conditions wherever necessary for excavation in soft materials.

The excavation carried out in excess of the required depths shall be made good to the required level by either concrete or masonry of required proportion by the Concessionaire as directed by the Engineer-In-Charge. The concessionaire shall remove the masonary concrete structure, stumps, roots of trees met with during excavation. He shall fill the hollows created due to removal of roots etc. or if existing originally shall be filled up by earth and shall be rammed and leveled properly as directed by Engineer-In-Charge.

In case of pipe trenches, the Engineer-In-Charge may reduce the width of trench wherever a hard strata is met with, if he feels adequate and just sufficient to lay the pipeline in order to reduce the hard quantity.

The bottom width of trench for suitable working shall be pipe dia + 300 mm on each size.

All existing gas pipes, water pipes, steam pipes, electric conduits, sewers, drains, fire cisterns and hydrants, telephone cables, railway's tracks and other structures which do not in the opinion of the Engineer –in -charge, required to be changed in location shall be carefully supported and protected from damage by the Concessionaire and in case of damage they shall be restored by him. Where pipe conduits or sewers are removed from the trench, leaving dead ends in the ground shall be carefully plugged or bulk head with brick or cement mortar by the concessionaire.

3. EARTHWORK GENERAL

The excavation in all kinds of soils will be carried out to the required dimension as per approved drawing and as directed by the Engineer-In-Charge, to the exact dimensions and formation level as per approved drawings, or as directed and to be verified form the sight rails to be fixed by the Concessionaire at the required intervals wherever necessary. The excavated materials shall be stacked at a distance as directed by the Engineer-In-Charge from the edge of the excavation and if directed, spread out to the slope. The shoring and strutting shall be provided at Concessionaire if excavation is done in deep cutting or in deceptive strata or where the Engineer-In-Charge desires for the safety of the surrounding structure. Guarding and lighting of the portions in deep cutting will be provided by the Concessionaire till the work is complete as a safeguard against accident. The work includes the removal of the balance excavated material after refilling of trenches and to place it in stacks at near by places or its entire removal and disposal beyond the site of work as directed by the Engineer-In-Charge. Ground will have to be cleared of all shrubs, plants and loose materials till natural ground is exposed.

Earthwork Excavation for Foundation

The foundation trenches shall be taken out to exact width of the lowest step of the footings as shown on the approved drawing or as directed by the Engineer-In-Charge.

In firm soil, the sides of a trench shall be kept vertical up to a depth of 2 meters from the bottom and for a greater depth over 2 meters from the bottom, the trench shall be widened by allowing steps of 45 cm on either side so as to give verticals side slopes of 0.25 horizontal to 1 vertical. Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or the sides slopes, as directed by the Engineer-In-Charge. It shall be the responsibility of the Concessionaire to take complete instructions in writing form the Engineer-In-Charge regarding the stepping, sloping or shoring to be done for excavation in trenches deeper than 2 meter.

The bed of the trenches shall be made level and firm by watering and ramming. Any soft or defective spots that are found shall be filled with concrete of the same proportion as the foundation concrete or as may be directed by the Engineer-In-Charge. If the excavation is done to dimensions greater than those shown on the approved drawings or those required by the Engineer-In-Charge,

the excess depth shall be made good by the Concessionaire and should be filled with concrete of the same proportion as the foundation concrete or as may be directed by the Engineer-In-Charge. The trenches shall be inspected and approved by the Engineer-In-Charge before concrete is placed.

Refilling Excavated Earth in Foundation for Plinth or Under Floor and within excavated trench of pipe line

Earth: The excavated stuff, as per the approval and as directed by the Engineer In Charge, from the available stuff, shall be used for the filling in plinth, excavated trances of pipe line, foundation etc. Earth used for filling shall be free from salts, organic or other foreign matter. All clods shall be broken or removed.

Filling sides of trenches: As soon as the work in foundation has been completed, the spaces around the foundations in trenches shall be cleared of the all debris, brick bats, mortar droppings etc. and filled with earth in layers not exceeding 15 cm. Each layer of 15 cm shall be amply watered, rammed and consolidated before the succeeding one is laid. The earth shall be first rammed with iron rammers where feasible and finally with the butt end or crow bars.

Plinth filling: The plinth shall be similarly filled with earth in layers not exceeding 15cm, amply watered and consolidated by ramming with iron rammers and finally with butt end or crow bars. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and consolidated, in order to avoid any settlement at a later stage. The finished level of the filling shall be kept to a slope intended to be given to the floor.

Earthwork excavation for pipes lines

Work included in excavation

Unless otherwise directed in the project plans or in the project specifications, all of the following items are included in the excavation.

Marking the ground surface for excavation and removing all surface obstructions including shrubs, jungle trees, etc. as necessary or as directed by the Engineer-In-Charge and providing and installing all shoring and strutting as necessary or as directed.

Pumping and bailing out water to keep trenches free of water during pipe laying and jointing and thereafter until joints mature.

Providing for uninterrupted surface water flow (drainage or storm water) during work in progress and providing for disposing off flows from storm drains to valleys or other disposal locations.

Protecting all pipes, conduits, culverts, tracks, utility poles, wire fences, buildings and other public and private property adjacent to or in the line of work.

Removing all shoring and strutting and ordered to be not left in place or not required by the project plans or specifications to remain in place.

Hauling away and disposal of excavated materials not necessary or else unsuitable for back filling purposes. The extra-excavated soil will have to be properly dressed in soil banks along with the trench as directed by the Engineer-In-Charge.

Back filling the excavated material as per standard specifications.

Restoring all property damaged or disturbed by these construction activities to as near as its original shape as possible.

Restoring the surface and forming of all roads, streets, alleys, walks, drives, casements, working spaces and rights of way to a condition as that prevailing prior to excavation, unless otherwise required by the project plans or project specifications.

The Concessionaire shall be responsible for the condition of all excavations made by him and shall properly and adequately protect the excavations from caving or sliding. All slides and caving shall be handled, removed or collected by the Concessionaire at whatever time and under whatever circumstances they may occur as directed by Engineer-In-Charge.

The Concessionaire shall provide sign boards at salient points in streets and keep men to guide the traffic. The Concessionaire shall adjust excavation for trenches in such lengths that the pipes can be laid within two to three days. If directed by the engineer in charge any obstacle, structures such as masonry, culverts, drains etc. coming in the way of the pipe line shall be removed and remade by the Concessionaire.

Change of Trench Location:
In case the Engineer-In-Charge orders that the location of trench be moved a reasonable distance form the one shown on the approved drawings, on account of the presence of an obstruction or from other cause or if a changed location is authorized at the Concessionaire's request, the Concessionaire shall not be entitled to extra compensation or to a claim for damage, provided the change is made before the excavation is begun. If however, such a change which is made on the orders of the Engineer-In-Charge involves the abandonment of excavation, then, that excavation with the necessary back fill has be to be carried out by the Concessionaire. In case that the trench is abandoned in favour of new location at the Concessionaire's request, abandoned excavation and back fill shall be at Concessionaire's expense. If any obstruction should lie within the trench in such manner that sheeting or bracing may be properly placed, or in order that the structure to be placed in trench may be properly built, such extra width of trench shall be excavated in the same manner as other trench excavation and back fill of the same shall be done by the Concessionaire.

Refilling of excavated Earth in Trenches of pipes
Earth: Earth used for filling shall be free from salts, organic or other foreign matter; all clods shall be broken or removed. Where the excavated material is mostly rock, the boulders shall be broken into pieces of not more than 25cm size in any direction, mixed with fine material consisting of decomposed rock, murum or earth as available so as to fill up the voids as far as possible and then the mixture used for filling. The excavated stuff shall be used as far as possible for the refilling. When the excavated material is not available then the material brought from outside shall be permitted, as per the directives of the Engineer in charge.

Filling Trenches: Refilling in trenches for pipes shall be commenced as soon as the pipe lines has been hydraulically tested and approved by Engineer-In-Charge.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 15 cm, amply watered, rammed and consolidated taking care that no damage is caused to the pipe below. Incase of excavation of trenches in rock, the filling up to a depth of 30 cm above the crown of pipe or barrel shall be done, with fine material such as earth, murum according to the availability at site, in the same manner as for excavation in soil. The remaining filling shall be done with rock filling of boulders of size not exceeding 25 cm, mixed with fine materials as available to fill the voids, watered, rammed and consolidated.

Road Crossing
Where the pipeline crosses the existing road, systematic filling shall be done. However, the earth shall be watered and mixed properly outside the trench before filling is started. The earth filling shall be done 0.3 m below bottom of the soling. The 5 cm depth below the soling shall be filled with mud-concrete thoroughly rammed and consolidated. Then soling and wearing coat shall be laid, watered rammed and consolidated and finished flush with the road surface. This shall be allowed to be consolidated further under traffic for about three days and thereafter topping of premix 25 cm to 40 cm shall be laid. The top of premix surface shall be kept above settlement under traffic.

Dewatering and Pumping During Excavation
If pumping or draining of water is required to be done at any time during excavation, the Concessionaire shall arrange for such draining by excavating channels, pumping or otherwise and

shall maintain these arrangements to the satisfaction of the Engineer-In-Charge for such a period as may be required. The discharge of the dewatering pumps shall be conveyed to drains and shall not be allowed to be spread in the vicinity of the work site.

Shoring to foundation during excavation

Open cuttings shall be suitably shored, sheeted and braced, if required by the Engineer-In-Charge or by site conditions or to meet local laws, for protecting life and property of adjoining work site.
Warped or deformed timber shall not be used. The shoring shall project at least 150 mm above ground level and shall extend to a suitable depth below the bottom.

Approach Bund:

All work for the the Approach bund shall be carried out in accordance with the standard specifications of PWD and as directed by the Engineer-In-Charge.

SPECIFICATIONS FOR CONCRETE WORK

1. Applicable Codes

Materials

i)	IS. 269	Specification for 33 grade ordinary Portland cement.
ii)	IS.455	Specification for Ordinary Portland slag cement.
iii)	IS.1489	Specification for Portland –Pozzolana cements (Part1 &2).
iv)	IS: 8112	Specification for 43 grade ordinary Portland cement.
v)	IS: 12269	Specification for 53 grade ordinary Portland cement.
vi)	IS: 12330	Specification for sulphate resisting Portland cement.
vii)	IS: 383	Specification for coarse and fine aggregates from natural Sources for concrete.
viii)	IS: 432	Specification for mild steel and medium (tensile steel bars and had-drawn steel) Wire for concrete reinforcement. (Part 1 and 2)
ix)	IS: 1786	Specification for high strength deformed steel bas and Wires for concrete reinforcement.
x)	IS: 4990	Specification for plywood for concrete shuttering work.

Material Testing

i)	IS.4031	Methods of physical tests for hydraulic cement (Part1 to 15)
ii)	IS.4032	Method of chemical analysis of hydraulic cement.
iii)	IS: 650	Specification for standard sand for testing of cement.
iv)	IS: 2430	Methods for sampling of aggregates for concrete.
v)	IS.2386	Methods of test for aggregates for concrete (Parts 1to 8)
vi)	IS: 3025	Methods of sampling and test (physical and chemical) for water used in industry.
vii)	IS: 6925	Methods of test for determination of water soluble chlorides in concrete admixtures.

Material storage

i)	IS:4082	Recommendations on stacking and storing of construction materials at site.

Concrete Mix Design

i)	IS: 10262	Recommended guidelines for concrete mix design.
ii)	Sp: 23 (S&T)	Handbook on Concrete Mixes

Concrete Testing

i)	IS.1199	Method of sampling and analysis of concrete.
ii)	IS: 516	Method of test for strength of concrete.
iii)	IS: 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
iv)	IS: 8142	Method of test for determining setting time of concrete by penetration resistance.
v)	IS: 9284	Method of test for abrasion resistance of concrete.
vi)	IS: 2770	Methods of testing bond in reinforced concrete.

Equipment

i)	IS:1791	Specification for batch type concrete mixers.
ii)	IS:2438	Specification for roller pan mixer.
iii)	IS:4925	Specification for concrete batching and mixing plant.
iv)	IS:5892	Specification for concrete transit mixer and agitator.
v)	IS:7242	Specification for concrete spreaders.
vi)	IS:2505	General Requirements for concrete vibrators: Immersion type.
vii)	IS:2506	General Requirements for screed board concrete vibrators.
viii)	IS:2514	Specification for concrete vibrating tables.

ix)	IS:3366	Specification for pan vibrators.
x)	IS:4656	Specification for form vibrators for concrete.
xi)	IS:11993	Code of practice for use of screed board concrete vibrators.
xii)	IS:7251	Specification for concrete finishers.
xiii)	IS:2722	Specification for portable swing weigh batchers for concrete (single and double bucket type).
xiv)	IS:2750	Specification for steel scaffoldings.

Codes for Practice

i)	IS:456	Code for practice for plain and reinforced concrete.
ii)	IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
iii)	IS:3370	Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
iv)	IS:3935	Code of practice for composite construction.
v)	IS:2204	Code of practice for construction of reinforced concrete shell roof.
vi)	IS:2210	Criteria for the design of reinforced concrete shell structures and folded plates.
vii)	IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
viii)	IS:5525	Recommendation for detailing of reinforcement in reinforced concrete works
ix)	IS:2751	Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
x)	IS:9417	Specification for welding cold worked bars for reinforced concrete construction.
xi)	IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
xii)	IS:3414	Code of practice for use of immersion vibrators for consolidating concrete.
xiii)	IS:4326	Code of practice for earthquake resistant design and construction of building.
xiv)	IS:4014	Code of practice for steel tubular scaffolding (Parts 1 & 2)
xv)	IS:2571	Code of practice for laying in situ cement concrete flooring.
xvi)	IS:7861	Code of practice for extreme weather concreting : Part 1 Recommended practice for hot weather concreting. Part 2 Recommended practices for cold weather concreting.
xvii)	IS:875	Code of Practice for design loads (other than earthquake) for building structures (Parts 1 to 5)
xviii)	IS:875	Code of Practice for bending and fixing of bars of concrete reinforcement.
xix)	IS:875	Code of Practice for design and construction of machine foundations (Parts 1 to 4)
xx)	IS:1893	Code of earthquake resistant design of structures.

Construction Safety

i)	IS:3696	Safety code for scaffolds and ladders. (Parts1 & 2)
ii)	IS:3696	Safety code for handling and storage of building materials.
iii)	IS:3696	Safety code for erection of concrete framed structures.

2. General

The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, Layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such inspection shall be arranged and the Engineer's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Concessionaire of any of his responsibilities. All materials, which do not conform to the Specification, shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes /

standards shall generally be used. Other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests.

3. Materials

Cement: Unless otherwise called for by Engineer-In-Charge, cement shall be Ordinary Portland cement of 43 grades conforming to latest IS code.

It shall be ensured that consistency of quality is maintained, there shall be no adverse interactions between the materials and the finish specified is not affected in any way.

Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer-In-Charge.

Cement which is not used within 60 days from its date of manufacture shall be tested at a labouratory approved by the Engineer-In-Charge and until the results of such tests are found satisfactory, it shall not be used in any work.

Aggregates (General)

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust / silt / organic impurities / deleterious materials and conform to IS: 383. Aggregate such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used. Aggregates shall be washed and screened before use where necessary or if directed by the Engineer-In-Charge.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. The maximum size of coarse aggregate shall be as stated on the approved drawings but in no case greater than1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed, Plums shall not constitute more than 20% by volume of the concrete.

Water: Water used for both mixing and curing shall conform to IS: 456-2000. Potable water are found generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used for concreting work.

Reinforcement: Steel for reinforcement shall be high yield strength deformed bars. The steel shall be of grade Fe 500 of SAIL, Vizag , Tata, Jindal, Essar only. No reinforcement steel from local manufacturers or re-rolling mills will be allowed.

Testing of Materials:

Manufacturer's Tests

For each batch of materials supplied manufacturer's Test Certificate shall be submitted for approval from Engineer-In-Charge.

Admixtures

Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS: 9103 and integral water proofing admixtures to IS: 2645. Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer-In-Charge. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their

interaction shall be checked and trail mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment.

Calcium Chloride shall not be used for accelerating setting of the cement for any concrete containing reinforcement or embedded steel parts. When Calcium Chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

Samples and Tests

All materials used for the works shall be tested before use. Manufacturer's test certificate shall be furnished for each batch of cement and when directed by the Engineer-In-Charge, samples shall also be tested by the Concessionaire in a laboratory approved by the Engineer-In-Charge. Sampling and testing shall be as per IS: 2386 under the supervision of the Engineer's representative.
Water to be used shall be tested to comply with requirements of IS: 456-2000 (OR ITS LATEST VERSION). The Concessionaire shall furnish manufacturer's test certificates and technical literature for any admixture proposed for use. If directed, the admixture shall be tested and shall be got approved by the Engineer-In-Charge.

Storage of Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with. The Concessionaire will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and Insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangements shall be approved by the Engineer-In-Charge. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected form leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

The Concessionaire shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground-water. Each type and size shall be stacked separately as directed by Engineer-In-Charge.

4. Concrete

General

Concrete grade shall be as designated on approved drawings. In concrete grade M15, M20, M25,M30 etc. the number represents the specified characteristic compressive strength of 150mm cube at 28 days, expressed in N/sq. mm as per IS:456-2000 (or its latest version). Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5, M10 and M15 shall be NOMINAL MIX CONCRETE where as all other grades, M20 and above, shall be DESIGN MIX CONCRETE and shall be produced from RMC (Ready Mix Concrete Unit if available).

Design Mix Concrete.

Mix Design & Testing: For Design Mix Concrete, the mix shall be designed according to any of the four methods given in SP:23 or relevant IS code to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS:456-2000. The design mix shall in addition be such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structured, the mix shall also result in water tight concrete. The Concessionaire shall

exercise great care while designing the concrete mix and executing the works to achieve the desired result. The minimum cement content for Design Mix Concrete shall be as per Table 5 of IS 456-2000.

The Concessionaire shall submit details of the source of all material and the proposed quantities of each ingredient per cubic meter of fully compacted concrete. The Concessionaire shall then make trial mixes for each class of concrete using the same Concessionaire's Equipment and the same materials as are proposed for the Permanent Works. The Concessionaire shall give 24 hours notice of such trials to enable the Employer's Representative to attend. For each trial mix, three separate and consecutive batches of concrete shall be made by the Concessionaire and the specimens shall be tested at 7 days and 28 days (9 specimens at 7 days and 9 specimens at 28 days). For 7 days test the acceptance criteria shall be 70% of the corresponding target mean strength.

The Concessionaire shall not commence concerting in the Permanent Works until details of trail mixes and test results for each class of concrete have been submitted to and approved by the Engineer-In-Charge.

A trial mix design will be approved by the Engineer-In-Charge with respect to strength if the average compressive strength of the nine specimens each at 7 days and 28 days, is more than the target mean strength appropriate to the grade of concrete.

Percolation test shall be conducted with trail mix in laboratory. **The Concessionaire shall not alter the approved mix proportions nor do the approved source of Supply of any the ingredients without having previously obtained the approval of the Engineer.**

During production, the Engineer may require mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.

It shall be the Concessionaire's sole responsibility to carry out the mix designs. He shall furnish to the Engineer at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength Requirements of the concrete ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456-2000.

A range of slumps which shall generally be used for various types of construction shall be as per IS 456-2000 or as directed by Engineer-In-Charge.

All concrete done for water retaining structures shall have a minimum slump value of 60 mm and maximum of 100 mm.

Batching & mixing of Concrete

It is expected that batching plants of suitable capacity and transit mixers for transportation of concrete and concrete pumps for placing concrete shall be used. However, the Concessionaire shall submit programme of concreting and allied works during the award of contract which will be reviewed accordingly. Proportions of aggregates and cement, as determined by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weight batches of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water– cement ratio specified as per approved mix design shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Concessionaire to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer-In-Charge. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS : 456-2000.

Nominal Mix Concrete

Mix Design & Testing

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However work tests shall be carried out as per IS 456-2000. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per IS 456-2000. However it will be the Concessionaire's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Batching & Mixing of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only, using whole bags of cement.

Formwork

Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc,. including ties, anchors, hangers, inserts, false work, wedges etc. The design and engineering of the form work as well as its construction shall be the responsibility of the Concessionaire. However, if so desired by the Engineer-In-Charge, the drawings and calculations for the design of the formwork shall be submitted to the Engineer-In-Charge for approval.

Formwork shall be designed to fulfill the following requirements:

a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

b) Made of suitable materials.

c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

d) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all load and dynamic effects arising from construction and compacting activities, wind and weather forces.

e) Capable of easily striking without shock, disturbance or damage to the concrete.

f) Soffit forms capable of imparting a camber if required.

g) Soffit forms and supports capable of being left in position if required.

h) Capable of being cleaned and / or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer-In-Charge. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust,

wire pieces dust etc., shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer-In-Charge. The Concessionaire shall equip himself with enough shuttering to allow for wastage so as to complete the job in time. Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed, in their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture. For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

All corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size, unless otherwise stated in approved drawings or elsewhere. Forms for substructure may be omitted when, in the opinion of the Engineer-In-Charge, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the Engineer-In-Charge, than that required as per approved drawing to compensate for irregularities in excavation. The Concessionaire shall provide adequate props carried down to a firm bearing without overloading any of the structure. The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m or as approved by the Engineer-In-Charge. The Concessionaire shall temporarily and securely fix items to be cast (embedment / inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Concessionaire’s responsibility.

The striking time for formwork shall be determined based on the following requirements.

a. Development of adequate concrete strength.
b. Permissible deflection at time of striking formwork.
c. Curing procedure employed – its efficiency and effectiveness;
d. Subsequent surface treatment to be done;
e. Prevention of thermal cracking at re-entrant angles;
f. Ambient temperatures; and
g. Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete). Under normal circumstances (generally where temperatures are above 20%C) forms may be struck after expiry of the time period given in IS: 456-2000 unless approved otherwise by the Engineer-In-Charge. It is the Concessionaire’s responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not excessive deformation and resist surface damage and any stress arising during the construction period

Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5 degree C. Local warming may be permitted if steel is kept below 0^0 C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the approved drawings / approved bending schedules or as directed by the Engineer-In-Charge.

Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Engineer-In-Charge.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Engineer-In-Charge prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends of the biding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Preparation prior to concrete placement.
Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements – formwork, equipment and proposed procedure, shall be approved by the Engineer-In-Charge. Concessionaire shall maintain separate Pour Card for each pour.

Transporting, Placing and compacting of Concrete.
Concrete shall be transported from mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water. In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be re-handled or caused to flow. For locations where direct placement is not possible and in narrow forms the Concessionaire shall provide suitable drops and “Elephant Trunks”. Concrete shall not be dropped from a height of more than 1.5m.

Concrete shall not be placed in flowing water. Concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.While placing concrete the Concessionaire shall proceed as specified below and also ensure the following:

a. Maintain continuity between construction joints and pre-determined abutments.

b. Without disturbance to forms or reinforcement.

c. Without disturbance to pipes, fixtures and the likes to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.,

d. Without dropping in a manner that could cause segregation or shock.

e. In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.

f. Do not place if the workability is such that full compaction cannot be achieved.

g. Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations withdraw the linings progressively as concrete is placed.

h. If placed directly on to hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

i. Ensure that there is no damage or displacement to sheet membranes.

j. Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer-In-Charge. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer-In-Charge. Concrete shall be protected against damage until final acceptance.

Mass Concrete Works
Sequence of pouring for mass concrete works shall be as approved by the Engineer-In-Charge. The Concessionaire shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

Curing
Curing and protection shall start immediately after the compaction of the concrete to protect it from:

1. Premature drying out, particularly by solar radiation and wind
2. Leaching out by rain and flowing water;
3. Rapid cooling during the first few days after placing;
4. High internal thermal gradients;
5. Low temperature or frost;
6. Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Engineer-In-Charge, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is approved to be used by the Engineer-In-Charge, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Engineer-In-Charge before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such a polyethylene, which shall be well sealed and fastened.

Construction Joints and Keys

Construction joints will be as approved by the Engineer-In-Charge. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer-In-Charge.

Dowels for concrete work, (not likely to be taken up in the near future), shall be coated with cement slurry and encased in lean concrete as indicated on the approved drawings or as approved by the Engineer-In-Charge.

As soon as the exposed concrete has sufficiently hardened, the surface of the joint shall be water jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed. Roughening of the surface by chipping or hacking will not generally be approved. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean. Thereafter all ponded water should be removed.

When, concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat for cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

Foundation Bedding

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer-In-Charge. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock shall be kept wet for 2 to 4 hours before concreting.

Finishes

General: The form work for concrete works shall be such as to give the finish as specified. The Concessionaire shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or mis-aligned forms, defective or poorly compacted concrete) will not be accepted. The Concessionaire shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

Unformed Surfaces: Finishes to unformed surfaces of concrete shall be classified as U1, U2, U3, 'spaded' or bonded concrete. Where the class of finish is not specified the concrete shall be finished to Class U1.

Class U1 finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface. Class U1 finish shall be a levelled and screed, uniform plain or ridged finish which (unless it is being converted to Class U2, U3, or bonded concrete) shall not be disturbed in any way after the initial set and during the period of curing, surplus concrete being struck off immediately after compaction.

Where a bonded concrete surface is specified, the laitance shall be removed from the Class U1 finished surface and the aggregate exposed while the concrete is still green.

A spaded finish shall be a surface free from voids and brought to a reasonably uniform appearance by the use of shovels as it is placed in the Works.

Class U2 finish shall be a wood float finish. Floating shall be done after the initial set of the concrete has taken place and the surface has hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 finish shall be a hard smooth steel-trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface. The surfaces shall be trowelled under firm pressure and left free from trowel marks.

The addition of dry cement, mortar or water shall not be permitted during any of the above operations.

Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc, shall be inspected by the Engineer-In-Charge who may permit patching of the defective areas or reject the concrete work. All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface. Rejected concrete shall be removed and replaced by the Concessionaire as directed by the Engineer-In-Charge.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Engineer-In-Charge.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar with approved bonding agent or by applying epoxy. The decision of the Engineer-In-Charge as to the method of repairs to be adopted shall be final and binding on the Concessionaire. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concreting shall be carried out as approved by the Engineer-In-Charge.
All the form bolt repairs and delayed repairs shall be carried out using a proportion of white cement in repair mix to the approval of the Engineer-In-Charge, so as to match the color of the surrounding area.

Hot weather Requirements

Concreting during hot weather shall be carried out as per IS: 7861 (Part I). Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40^{o}C at the time of placement of fresh concrete. Where directed by the Engineer-In-Charge, the Concessionaire shall spray non-wax based curing compound on unformed surfaces.

Liquid Retaining structures

The Concessionaire shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness. All such structures shall be hydro tested.

The Concessionaire shall make all arrangements for hydro-testing of structure such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account by the Concessionaire.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Engineer-In-Charge. All such rectification shall be done by the Concessionaire to the entire satisfaction of the Engineer-In-Charge.

Grouting

Standard Grout: Grout shall be provided as specified on the approved drawings. The proportion of Standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All Structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting water in all pockets shall be removed.

Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by Engineer-In-Charge. The grout proportions shall be limited as follows:

Use	Grout thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25 mm	One part Portland Cement to one part sand	0.44
b) Mix General	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53

Non-shrink grout: Non-shrink grout where required as instructed by the Engineer's Representative, shall be provided in strict accordance with the manufacturer's instructions / specifications on the approved drawings.

Inspection: All materials, workmanship and finished construction shall be subjected to continuous inspection and approval of Engineer-In-Charge. Materials rejected by Engineer-In-Charge shall be expressly removed from site and shall be replaced by Concessionaire immediately.

Clean-up: Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

Acceptance Criteria: Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

a) Properties of constituent materials;
b) Characteristic compressive strength;
c) Specified mix proportions;
d) Minimum cement content;
e) Maximum free-water / cement ratio;
f) Workability;
g) Temperature of fresh concrete;
h) Density of fully compacted concrete;
i) Cover to embedded steel;
j) Curing;
k) Tolerances in levels;
l) Durability;
m) Surface finishes;
n) Special requirements such as;
o) Water tightness
p) Resistance to aggressive chemicals
q) Resistance to freezing and thawing
r) Very high strength
s) Improved fire resistance
t) Wear resistance
u) Resistance to early thermal cracking

The Engineer's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Concessionaire.

Pre-formed Fillers and Joint Sealing compound

Materials: Pre-formed fillers for expansion / isolation joints shall be non-extruding and resilient type of bitumen impregnated fibers conforming to IS: 1838 (Part I).

Bitumen coat to concrete / masonry surfaces for fixing the pre-formed bitumen filler strip shall conform to IS: 702. Bitumen conforming to IS: 3384.

Sealants shall be of the following types:
Sealant Type A: Sealant Type A shall be a gun grade, non-slumping compound suitable for sealing horizontal, vertical and soffit joints in water retaining structures. It shall be a UK WFBS material approved for unrestricted use in contact with potable water to the full exposure condition of 1500 mm2/1, and shall not support bacterial growth. It shall be stable and shall have a low water absorption and good adhesion to concrete. Hardness (Shore A) : >12. Transverse Movement Accommodation : + -15%

Sealant Type B: Sealant type shall be a gun grade compound, suitable for sealing vertical movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete. Hardness (Shore A) : >12. Transverse Movement Accommodation : + -12

Sealant type C: Sealant type C shall be similar to Type B above. In addition it shall have been designed for sealing movement and construction joints in hydraulic and water retaining structures and shall be suitable for use in contact with potable water. Hardness (Shore A) : >20. Transverse Movement Accommodation : + -12.5%

Sealant type D: Sealant type D shall be a pourable compound suitable for sealing horizontal movement and construction joint on concrete structure. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete. Hardness (Shore A) : >9. Transverse Movement Accommodation : + -12.5%

Sealant type E: Sealant type E shall be a cold pourable compound complying with BS 5212, suitable for sealing movement and construction joint on concrete paved areas. It shall be resistant to fuels, oils and hydraulic fluids. It shall be tough, abrasion resistant and shall not decompose in strong sunlight. Hardness (Shore A) : >12. Transverse Movement Accommodation: + -12.5%. The hardness value specified in the above summaries is the Shore A Durometer value at 14 days at 25°C and 50% RH. the specified transverse movement values are based on joints having a width to depth ratio of 1.5:1.

The Concessionaire may use the above sealants or ones meeting equivalent or higher specifications.

Workmanship: The thickness of the pre-formed bitumen impregnated filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment. Concessionaire shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces / thickness of strips to make up the specified size shall not be permitted.

The concrete / masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the pre-formed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting / masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20kg/sq.m

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be hot with a coat of bitumen primer conforming to IS:3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs and prevent the pre-formed joint filler from dislodging. This

plate shall be welded to an edge angle of 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent filler welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

The Concessionaire shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the approved drawings or as agreed with the Engineer-In-Charge.

The Concessionaire shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

Joint sealing shall not be commenced without the approval of the Engineer-In-Charge. In reservoir joints the sealer shall be poured after completion of the water tightness test, to the satisfaction of the Engineer. All joint sealers shall be from an approved manufacturer. The Concessionaire shall apply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the Site and shall if requested supply to the Engineer-In-Charge sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer's instructions. De-bonding strip shall be used in conjunction with the sealers as indicated on the Drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to attach from the primer used to bond the sealer to the concrete. Polysulphide and polyurethane sealants shall not abut bitumen sealers. Surfaces to receive Polysulphide and polyurethane sealants shall be kept free from bituminous paints. All sealants shall be appropriate for the prevailing climatic conditions. Bituminous sealants shall comply with BS 2499 for Type A-1 Polysulphide sealants shall comply with IS 12118.

Concreting Records: A written record of the concrete works shall be made each day by the Concessionaire and kept available for inspection by the Engineer-In-Charge. The diary shall contain notes and records of:

a) The names of the Concessionaire's Engineer who are responsible for the different phases of the concrete work and also the names of their assistants.

b) The temperatures of air, water, cement, aggregates, together with the air humidity and type of weather.

c) Deliveries to the Site of concrete materials (quantity, brand of cement, grade of concrete, etc).

d) Inspections carried out, tests performed, etc. and their results.

e) Date and time of commencement and completion of different parts of the concrete works , erection and striking of forms.

f) Quantity of cement, fine and coarse aggregate and admixture used for each section of work and the number and kind of test samples taken on these ingredients and water.

DETAILED SPECIFICATIONS FOR M.S. PIPELINE

1. GENERAL:

Following specifications are in amplification OR in addition to the specifications for the respective item given in P.W.D. Hand Book Volume I and II (Latest Edition), Red Book of Government of Maharashtra and shall be strictly adhered to. Relevant IS and latest amendments thereon shall also be referred.

2. PROVIDING M.S. PIPES:

Pipes to be supplied under this contract shall conform to IS-3589-2001 Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter). The number of longitudinal and circumferential weld shall not exceed one for pipe of 6 m length. The length of each MS pipe shall not be less than 6 m.
In case Concessionaire proposes to supply pipes to the standards superior to the above standards the same shall be accepted.

a) Method of Manufacture

Electric resistance welded (ERW)

Applicable Standards (with latest editions)

BS 3601-1987 Steel pipes and tubes for pressure purposes, carbon steel, ordinary duties.
IS 3589-2001 specification for Steel Pipes for Water and Sewage (168.3 to 2540mm outside diameter)
IS 4711-2008 Methods of sampling of steel pipes, tube and fittings.
IS 1608-2005 Mechanical testing of metals - Tensile Testing
IS 5822-1994 Code of Practice for Laying of Electrically Welded Steel Pipes for Water Supply.

Testing and Acceptance Criteria

Visual Inspection

All pipes shall be free from defects such as cracks, surface flaws, laminations, etc. The ends shall be cleanly cut and reasonably square with axis of the pipe.
Dimensions and Tolerances
The dimensions such as O.D. and thickness shall conform to the requirement of order and applicable specifications. The tolerances are as under:

Outside Diameter: Pipe body : The tolerance shall be as under

OUTSIDE DIA. FOR ALL SIZES	TOLERANCES
FOR ERW & SAW PIPES	+0.75%

Thickness

Negative tolerance is not permitted.
(Ref: IS 4711-2008 Methods of sampling of steel pipes, tube and fittings).

Straightness

Finished pipe shall not deviate from straightness by more than 0.2% of the total length or 6mm which ever is lower.
Hydraulic Pressure Test
Each pipe shall be hydraulically tested at manufacture's works. The hydraulic test pressure is calculated from the formula.
P = (2ST/D)
Where,
P = Hydraulic Test pressure in MPa
S = Stress 60% of the specified minimum yield stress in MPa. The maximum test pressure to be limited to 5 Mpa wherever applicable.
T = Specified thickness of the tube in mm.
D = Specified outside diameter in mm.

Mechanical Test
Sampling
The procedure for sampling of pipes for various tests and criteria for conformity shall be as given in IS 4711-2008.

Tensile Test
Tensile test shall be carried out as per IS 1608-2005. The parent metal of pipe is subjected for measurement of ultimate tensile and elongation properties. Another sample is taken for testing of strength of the weld, the ultimate tensile of which should normally be more than or equal to ultimate tensile of parent metal. However, the minimum mechanical properties for pipes as per IS 3589-2001.

Flattening Test (for ERW pipes)
A ring not less than 40 mm length taken from one end of each selected pipe shall be flattened between two parallel plates. The test shall be taken by keeping the weld at 90^0 to the direction of the force. No opening shall occur by fracture in the weld unit until the distance between the plates is less than 66% of original O.D. of pipe and no cracks or breaks on the metal elsewhere than in the weld shall occur until the distance between the plate is less than 33% of original O.D. The approved pipes are stamped on one end for identification by inspecting authority.

Steel's Tensile Requirements:
Standard IS 3589-2001. Fe-410 MPa grade Steel
Ultimate Tensile Strength 410 MPa
Yield Stress 235 MPa

Design Requirements
Internal Pressure
Design Pressure taken should be maximum of the following:
a) 1.5 times maximum working pressure
b) Sum of maximum working pressure plus surge pressure.
However, the design pressure should not exceed 5 MPa as per IS 3589-2001 specifications.

Condition of Supply - The pipes shall be supplied with one shop coat of red oxide as per relevant IS internally and externally. The pipes shall be beveled internally or externally or both as per the decision of the Engineer-In-Charge.

M.S. SPECIALS
General: The main specials and appurtenances to be fabricated under this contract are as per list. The typical drawings for these are to be provided by the Concessionaire during execution. The Concessionaire shall give working drawing for the specials and appurtenances for fabrication thereof depending on the site conditions.

- One piece cut composite bends.
- Loose flange rings.
- Stiffener rings.
- Pressure and non-pressure type blank flanges.
- 'Y' Branches and tees.
- Tapers and wearing plates, dished manholes.
- All flanged and plain ended specials

Workmanship
Dished Manhole Cover: For fabrication of dished manhole covers, the Concessionaire shall use special dyes in the Hydraulic press to obtain the required shape. The plate shall be cold pressed and no heating shall be permitted.

Loose Flange Rings: Loose flange rings shall be cut from the plates of suitable thickness as

directed by the Engineer-In-Charge. In order to avoid the wastage, steel plates shall be cut in maximum 4 segments, to form a complete ring when welded together. Both holes of required size at the exact c/c distance in required pitch circle shall be drilled through the flange rings. They shall be mounted and tack welded on pipes / specials, etc.

Stiffener rings shall be cut from the M.S. channel of suitable size as required by the Engineer-In-Charge. In order to avoid wastage, these shall be cut in segments to form rings, when welded together. These shall be provided on site in segments and shall be welded on the pipes, as per instructions of Engineer-In-Charge.

Tapers: The tapers shall be fabricated in one or more pieces as may be necessary according to their length and sizes of plates available. These shall be stiffening rings fixed on them as per approved drawing during fabrication.

Special care to be taken during fabrication of composite bends, tees and 'Y' Branches.

The testing of these specials is not envisaged at the fabrication stage. These shall be subjected to test when the completed pipeline is tested hydraulically. In view of this, the Concessionaire, in his own interest, shall fabricate these specials with all the care, so that there is no failure of any welded joint during testing of the completed pipeline. If directed by Engineer-in-charge, the Concessionaire will have to manufacture M.S. bends from the available M.S. pipes by cutting and welding the pipe pieces as required, including painting of specials fabricated with red oxide paint and a covering coat of gray graphite paint.

Transporting M.S. Plates, Other Steel and Cut Sections and Waste Steel Materials: The Concessionaire shall exercise all necessary care to avoid damage to the material during loading, unloading and transit.

Progress Reports and Registers: The Concessionaire shall maintain a register of all finished materials giving dates of carrying out important operation such as testing, transport to site, etc. The Engineer-In-Charge shall check the register every week.

Extra Cutting Pipes, Plates, Sections: In course of work, the Concessionaire may be required to carry out work of gas cutting the plates, pipe sections of various thickness. The cutting work involved is covered in the scope of work. The cut shall be 'V' or square as directed by the Engineer-In-Charge. After cutting, the edges shall be made smooth (even by use of grinder pneumatic/electrical). During cutting, it shall be ensured that the shape of the material cut is not deformed.

STANDARD SPECIFICATIONS FOR SAND GUNITE

Specifications for item of cement gunite out-coating 40 to 50 mm thick in CM 1:3, proportions.

General: The pipeline that is to be laid underground shall be provided with cement gunite out-coating. The gunite shall be done in two coats and adequately cured at least fourteen days before the pipe is laid underground.

As far as possible, gunitting shall be done at gunitting yards where the pipes are stacked/ being stacked. Land, water, power supply, etc., required for gunitting at selected yard sites will be arranged by the Concessionaire. The gunitting yard shall be located near the actual site of work. The Concessionaire shall provide sufficient number of spiders inside the pipe to keep the pipes in circular shape and these spiders shall be retained inside till the mortar is set. Maintaining the exact circular shape of pipe is very important. The thickness of gunite shall never be less than 40 mm.

Reinforcement: The reinforcement shall be BRC Fabric No. 14, 75x300 mm size. MS reinforcement steel used shall be 10/12 gauge wires respectively having permissible stress of 1265 kg/cm^2 and shall conform to the relevant Indian Standard Specification.

The reinforcement shall be held around the pipe circumferentially to the pipe surface and shall be held secured, 25mm away from the pipe surface with the help of sufficient numbers of 1:1 cement mortar spacers and binding wire etc. Adjacent sheets of fabric shall be provided overlap. Care shall be exercised to ensure that minimum 25 mm cover is provided particularly at the lower half portion of the pipe also.

Materials: Cement, sand and water used for preparing cement mortar for gunitting shall conform to the standard specifications for these materials and for concrete works.

Mortar: The proportion of cement to sand in the mortar for gunitting shall be 1:3, by volume.

TRANSPORTING M.S.PIPE

The item includes arrangement for lifting and loading the pipe into truck transporting the pipes having length 6.0 to 12.0 m each from stack yard to the site of work by truck or whatever means including all loading involved in this operation, unloading the pipes by crane at the site of work, etc. including all materials, labour and equipments for this operation. The scope of work includes for making arrangements (as required) for conveying pipes for hillock/hilly portion, creek portion and river portion.

The concessionaire shall be responsible for damages that may occur during transportation or while loading and unloading, any pipes and the damaged pipe shall be repaired or replaced as directed by Engineer-In-Charge.

The guniting yard should be located at suitable locations along the alignment of the pipeline in consultation with the Engineer-In-Charge. In case of transportation of Gunited M.S. pipes, special care needs to be taken to avoid any damage to the Gunited portion of the pipe. If the guniting to the M.S. pipes is damaged during handling, loading, unloading or carting, the same will have to be rectified by Concessionaire as directed by Engineer-In-Charge.

SPECIFICATION FOR LOWERING, LAYING OF M.S. PIPELINE :

The Concessionaire shall clear that site of work of all grass, shrubs, trees, stumps, rubbish etc, before the start of the work and after every monsoon, till the defect liability period. The cleared grass, trees etc., shall be disposed off, by the Concessionaire as directed by the Engineer-In-Charge. The Concessionaire shall clear the site all rubbish, building materials, debris, excavated materials, etc. be cleaned and restore the site, in clean and tidy condition to the full satisfaction of the Engineer-In-Charge.

The pipeline being laid under this contract is below and above ground. For pipeline portion to be laid above ground the pipeline shall be supported on R.C.C. Chairs and saddles.

The supports shall be cast to the true alignments and / or levels as per approved drawing prepared while laying. The Engineer-In-Charge may make modifications in the alignment and / or levels at his discretion, depending on the site conditions. Before actual laying the line the Concessionaire should carry out the detailed working survey and plot it on the paper. He should mark the alignment considering the actual working operation as per RFP document / technical specification and it shall be got approved from the Engineer-In-Charge.

The Concessionaire shall use theodolite to fix the alignment and levels of the supports. **All working survey work for fixing the alignment and levels shall be done by the Concessionaire.** Concessionaire shall, therefore, have in his employment experienced Engineer for this work. The Concessionaire will have to arrange for site rails required for checking the excavation and pipe gradient. The chairs shall be cast in particular section serially so that laying of pipes can be started as soon as sufficient number of chairs are ready. Programme of casting of chairs shall be in accordance with the approved programme of laying of pipes lines. Pipe supports consisting of chair either on prepared formation or on plain c.c. pipes shall be laid as shown on the approved drawing, or as specified hereinafter and as directed by the Engineer-In-Charge. Suitable locations for the construction of thrust blocks and anchor blocks etc shall be done

in two stages, viz. firstly the portion below the invert of the pipe line shall be casted. The design of the thrust blocks anchor blocks, fixity blocks shall be done by the Concessionaire suitable to the site conditions and shall be submitted to the Engineer-In-Charge based on the detailed survey on the enlarged section. The designs shall be got approved from the competent authority before execution. Size of the blocks can be marked on the alignment and if there are any difficulties he can refer it to the Engineer-In-Charge. The distance between two successive fixity points shall generally not exceed 300 m. Expansion joint shall be provided midway between two fixity points in case of above ground pipe laying.

The Engineer-In-Charge shall decide the mode, number and the location of construction of fixity points and his decision shall be final and binding on the Concessionaire.

FIELD WELDING

Before aligning, assembling and welding, the pipe faces shall be cleaned by scraping with wire brushes or by any other method approved by the Engineer-In-Charge. Welding of pipes in field shall conform to Indian Standard Specification I.S.S. 816-1969 (Code of practice for use of metal arc welding for general construction in Mild Steel). In case of variance, specifications hereunder shall have precedence.

The Concessionaire shall keep record of the welding for each circumferential joint. It shall contain the name of the welder, operator and date of completion of such run of internal and external welding.

Gousing and Chipping: M.S. pipes of diameter larger than 1016 mm shall be welded with two numbers of runs from inside and a sealing run from outside. External sealing run shall be done only after internal welding is completed. Before starting the external welding the weld material in the joint shall be cleaned by chipping out loose scales. Gousing shall be done before rectification of any defective welding, wherever necessary and as directed by the Engineer-In-Charge. Gousing or chipping is included in the scope of welding.

Electrodes: Welding electrodes to be used for welding in this contract shall conform the Indian Standard Specification I.S.S. 814-1971 (Specifications for covered electrodes for metal arc welding of Mild Steel).

The Concessionaire shall use electrodes of Advani Oerlikon Ltd. or Premier or D&H welding electrodes, or Weldwell Speciality Pvt. Ltd depending on the thickness of the plates to be welded and the type of joint. The Concessionaire shall also use standard current and A.C. voltage required for the machine as per manufacturer's directions.

Types of Welded Joints: The circumferential joints of the pipes shall be butt welded with required number of runs externally and internally. All fillet welds shall have a throat thickness not less than 0.7 times the thickness of the pipe to be welded.

Welding Procedure: All parts of pipes, specials, etc. having any loose scale; slag, rust, paint and any other foreign material shall be removed with wire brush and left clean and dry.

All scales and slag shall be removed from each run of weld when that run is completed. Openings in the form of manholes shall be kept in the laid pipeline, at suitable distances, for easy access inside for cleaning, repairs etc. Such manholes, as far as possible, shall be provided on sides of the pipeline and cutting manholes at the crown shall be strictly avoided. Patch plates for plugging the above manholes shall be cut from a separate pipe of the same diameter. Edges of the patch plate shall be properly shaped and shall be inserted in the opening, leaving a gap of 3 to 4 mm and tacked. Welding of patch plate shall be done in segments in a proper sequence conforming to relevant Indian Standard Specifications.

Testing of Welded Joints: Welded joints shall be tested in accordance with procedure laid down in Indian Standard Specifications (I.S. 3600, Part1 and 2 – 1985 of procedure for Testing Fusion

welded joints and weld metals in steel).

At least one test specimen shall be taken out for testing from every fifty-field joints done. Test pieces shall be taken out from the places pointed out by the Engineer-In-Charge. These shall be machined and tested as early as possible. The shape of the test pieces removed for testing shall be such that it shall give the specimen of the required dimensions with the weld in the middle of the specimen and at the same time leave the holes in the pipe with rounded corner. This hole shall be patched with a plate of suitable size cut from a separate pipe of same diameter. It must ensure good butt weld. Facility of testing shall be identified in the recognized Govt. institute nearby as approved by Engineer-In-Charge.

Tensile Test: The test specimen taken perpendicularly across the weld shall be shaped in accordance with relevant Indian Standard Specification. The tension test specimen shall be machined. The protruding welded portion from inside shall be removed by machining before the specimen is tested.

If the specimen shows defective machining or develops flaws not associated with welding, it shall be discarded and another specimen substituted. The welded joint shall show strength not less than the minimum tensile strength for the plate, in accordance with relevant IS code.

Bend Test - Bend test specimen shall also be prepared in the same fashion as the tensile test specimen. The specimen shall stand being cold bended in 180^0 around a pin that has a diameter equal to 4 ½ times the plate thickness, without developing cracks. For this test, face representing inside of the pipe shall be placed next to the pin.

Tre-panned Plugs: Tre-panned plugs shall be taken out from any welded portion as pointed out by the Engineer-In-Charge. These plugs shall not show any defects in welding such as inclusion of slag, blow holes, cavities, etc. The plug shall be 12 mm in diameter and shall be taken out by means of suitable electrically operated tools. Such holes in the pipe shall either be filled back by inserting a steel stud and welding around or threading the hole and providing suitable G.I. plug. This test shall be done, as directed by the Engineer-In-Charge.

Procedure on Failure of Test Specimen: If the test specimen fails in either tensile or bend test or in both, two additional test specimen shall be taken out from the section and shall be tested for tensile and bend tests. If any one of them fails, extensive gousing and rewelding shall be done for the welded joints in that section to the full satisfaction of the Engineer-In-Charge. However, if both the samples give satisfactory results, the joint from which the original sample was taken and had failed shall be repaired to the satisfaction of the Engineer-In-Charge by gousing and welding etc. by the Concessionaire.

GAS CUTTING:

Gas cutting of M.S. pipes may require to be adopted on site for fabrication of kinks on site or for preparing distance pieces, straps, etc. and for cutting holes in pieces for man-holes, branches, scour valve, Air valves and other appurtenances and temporary manholes for cleaning, welding etc. After gas cutting, the edges shall be made smooth and even, so as to remove all inequalities. Ends of the pipe shall have 'V' edge and it shall be from outside.

INTERNAL MORTAR LINING

The entire pipe under consideration shall be factory lined and no In-Situ lining after laying of pipe will be permitted.

The lining shall be carried out as per IS- 11906:1986 Recommendations for cement mortar lining for cast iron mild steel and ductile-iron pipes and fittings for transportation of water.

STANDARDS
Wherever any reference is made to the above or any other standard specifications, it is understood that the latest revision there of shall take precedence over the above mentioned specifications or any other cited by the Concessionaire.

APPROVAL OF THE MATERIALS
The term 'materials' shall mean all materials, goods and articles of every kind whether raw, processed and manufactured which will be used by the Concessionaire on this work. All materials shall be fresh and of the kinds and qualities prescribed below and shall be of approved quality. Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damages or contamination. All materials furnished by the Concessionaire shall be subject to inspection and approval by the Engineer-In-Charge. The rejected material shall be immediately removed from the work site entirely by the Concessionaire.

The Concessionaire shall furnish all labour and other facilities for handling, testing and inspecting the materials to the Engineer-In-Charge.

The Engineer in Charge or his authorized representative may carry out tests on the materials brought by the Concessionaire before beginning and even during the progress of the work to verify that these conform to specifications. All sampling, packing, transporting and testing shall be done by the Concessionaire.

MATERIALS
Ordinary Portland Cement
Ordinary Portland cement used for mortar lining shall conform to I.S. 8112. The testing at laboratory at the discretion of the Engineer-In-Charge shall perform such tests as are deemed necessary and shall be carried out by the Concessionaire. Cement bags or bulk silos shall be tagged for identification at location of sampling. Tests will include tensile tests and weighing the cement supply to check for net weight received at site and used in the works.

On arrival at the site/ factory/ place of factory lining as applicable, cement shall be stored in weather proof silos designed for the purpose or in dry weather / water tight and properly ventilated structures with floors raised 15 to 20 cm., above ground level, 30 cm away from walls and with adequate provision to prevent absorption of moisture or flooding. All storage facilities shall be subject to approval by the Engineer-In-Charge and shall be such as to permit easy access for inspection and identification. Each consignment of cement shall be kept separately and the Concessionaire shall use the consignments in the order in which they are received. Not more than 15 bags shall be stacked vertically in one pile. Cement shall be stored in double locking arrangement so that cement transactions can be with the knowledge of supervisory staff. Daily account of cement shall be made available to inspecting authorities for store verification.

a) The Concessionaire shall provide from each consignment of cement delivered to the site such sample as the Engineer-In-Charge may required for testing. If the Engineer-In-Charge thinks it necessary, he may ask the Concessionaire to pass it through 16 mesh screen before use, and the Concessionaire shall do the needful. Any cement which is, in the opinion of the Engineer-In-Charge, lumpy of partially set shall be rejected and Concessionaire shall promptly remove such cement from the site.

b) The cement used for the work shall be fresh. Cement which has been stored on the site for more than sixty (60) days and cement which, in the opinion of the Engineer-In-Charge, is of a doubtful quality shall not be used in the works until it has been retested and test sheets showing that it complies in all respects with the relevant standard, have been delivered to the Engineer-In-Charge.

SAND: Sand shall consist of inert granular material. The grains shall be strong, durable and uncoated. The sand shall be well graded and shall pass BS No. 14 sieve with not more than five

percent passing BS No. 100 sieve. (Refer to ASTM 11 – specification for Wire Cloth Sieves for testing purposes)

Deleterious substances in Sand: Sand shall be clean and fresh from injurious amounts of dust, clay, lumps, shale, soft or flaky particles, mice, loam, oil, alkali and other deleterious substances. The total weight of such substances shall not exceed three percent of the combined weight of the substances and the sand that contains them. In additional, the limitations as specified in standard codes shall apply to specific substances.

Organic impurities: Sand shall not show a color value darker than the "reference standard color solution" prepared as required in STM C40, as last revised.

Substances: Field tests as approved by the Engineer shall be adopted for determining silt in the sand and determining organic impurities.

The field tests for ascertaining the percentage of clay lumps and impervious organic materials shall be carried out by the Concessionaires when ordered by the Engineer.

PLANT AND EQUIPMENT: The Concessionaire shall use plant and equipment which will be efficient, appropriate to secure satisfactory quality of work and maintain the required rate of progress which will ensure the completion of work within stipulated period.

If, at any time, in the opinion of the Engineer-In-Charge, such plants appear to be inefficient, in appropriates, insufficient in executing good quality work with required progress, the same shall be replaced, supplemented as directed by the Engineer-In-Charge.

It is an obligatory for Concessionaire to maintain required quality and rate of progress even of such instructions are not given by Engineer. The Concessionaire's equipment for cleaning, applying and traveling cement mortar in the pipe and for curing then cement mortar lining shall be so designed and manufactured and in such a condition as to permit the workers to follow the procedure and obtain the results as specified.

ADMIXTURES: To improve workability, density and strength in the mortar, admixture conforming to the latest edition of ASTM-C494 may be used at the option of the Concessionaire, subject to approval of the Engineer-In-Charge provided that the ratio of admixtures to Ordinary Portland cement does not exceed that used in the qualification tests of ASTM C-494. No admixtures shall be used that would have a deterious effect on potable water flowing in the pipe after the lining has been placed.

WORKMANSHIP: All work shall be performed in through and workman like manner by trained personnel under the supervision of experienced persons skilled in the application of cement mortar lining to pipe lines in place.

SPECIFICATION FOR CEMENT – MORTAR LINING IN FACTORY

COMPOSITION: Mortar for the lining shall be composed of cement, sand and water that have been well mixed and are of such consistency as to produce a dense, homogeneous lining, Unless otherwise specified by the Engineer-In-Charge, the mortar may also include admixtures.

PROPORTIONS: The approximate proportions of cement and sand in the mortar for the lining shall be 1 part of Ordinary Portland cement to 1:1 part of sand by volume. The exact proportions shall be determined by the characteristics of the sand used. Admixtures, if added, shall be used in strict compliance with the manufacturer's recommendations.

WATER CONTENT : The water content shall be the minimum quantity that produces a workable mixtures, with full allowance made for moisture collecting on the interior of the pipe surfaces, Slump tests should be carried out periodically on freshly mixed mortar immediately prior to the mortar being conveyed to the lining machine. The water cement ratio shall not exceed 0.35.

MIXING: Mortar shall be mixed by machine long enough to obtain maximum plasticity. The mortar shall be used before initial set.

FIELD TESTS: The following field tests shall be carried out by the Concessionaire for determining the quality of mortar.

Slump test and compressive strength of mortar: Slump test be made once in a day on the freshly mixed mortar immediately prior to the mortar being fed to the lining machine. The test should be made in accordance with IS-1199. After the slump test is carried out, a set of at least two standard test cylinders 50mm dia and 300mm length shall be made each day. The test cylinders shall be cured with the pipe at the same temperature and for the same total length of time. These cubes shall than be tested for 7 days and 28 days for finding out the crushing strength of mortar, such test shall be carried out twice a week or as Engineer may direct. The mortar test cylinders shall obtain a minimum compressive strength of 18MPa in 7 days and 31Mpa in 28days.
The Concessionaire shall by trial and error method design the mix of mortar by varying the different grades of sand and proportion, water content with the specified limits so as to give minimum compressive strength as stated above.

Sieve analysis shall be carried out twice every week to ensure that the sand conforms to the desired sieves analysis. Concessionaire shall provide required sieves as well as sieve analysis apparatus for taking tests.

Thickness Of Lining: The lining shall be uniform in thickness within the allowable tolerance, except at joints or deformations in the pipeline.

Cement mortar lining thickness shall be 9mm (for dia. up to 700mm) and 12 mm (for dia. above 700mm) or as directed by Engineer In Charge. The maximum tolerance for lining shall be +3 mm with no negative tolerance. The mortar lining work shall be by single application.

Preparation Of Pipe Surfaces: The interior surface of the pipe line shall be cleaned prior to placement of cement mortar lining. The pipe interior surface shall be free of oil, grease and accumulations of water. All loose mill scale, dirt, rust and construction debris shall be removed from the interior surface of the new steel pipeline. This may be accomplished by use of a stiff street broom in large pipe or a drag brush in small pipe. Shot or sand blasting is not required. Waste and rubbish material removed shall be disposed off as directed by the Engineer-In-Charge.

INSPECTION, GUARANTEES AND RESPONSIBILITY OF CONCESSIONAIRE:
The entire procedure of applying cement mortar lining shall be subject to continuous inspection by the Engineer-In-Charge, but such inspection shall not relieve the Concessionaire of the responsibility to furnish material and perform work in accordance with the specifications. All cement mortar lining not applied in accordance with specifications shall be subject to be rejected by the Engineer-In-Charge. Lining so rejected shall be removed and replaced by the Concessionaire.

All Places Accessible To Engineer: The Engineer shall have free access to all areas, places or facilities concerned with the furnishing of material or the performance of work.

Concessionaire To Assist Engineer: The Concessionaire shall furnish the Engineer-In-Charge reasonable assistance, in carrying out the inspection duties and specifically in obtaining information with respect to the character of material used and the progress and manner of the work.

Pipe Inspection Procedure: The Engineer-In-Charge shall inspect the pipe line following the application of the cement mortar lining to field joints to identify defective areas in the lining, to determine compliance with the specifications.

Pipe Inspection: A manual visual inspection of the lined pipe interior shall be made by the Engineer-In-Charge to determine the quality of the lining and to identify defective areas in the lining

for repair. For rendering layer thickness test, the Concessionaire may use magnetic blocks of 12 mm thick and attach to the pipe on diametrically opposite points inside the pipe line at locations as may be directed by the Engineer-In-Charge. These blocks shall be removed next day and the holes shall be closed next day by hand application after lining thickness is measured.

For lining thickness can also be measured by drilling holes in hardened mortar at diametrically opposite points by a depth gauge. Such holes shall then be closed by hand application of mortar. The Concessionaire may suggest any method for testing thickness of layer to the satisfaction of the Engineer-In-Charge.

Repairs Of Defective Lining: Defect in cement mortar lining include, but are not limited to, sand pocket, voids, over sanded area, excessively cracked. These shall be cut-out and replaced by hand or pneumatic placement to the same thickness as required for the mortar lining.

Protection Of Lining: Every precaution shall be taken to prevent damage to the lining. Should the lining be damaged due to the fault of the Concessionaire or otherwise, at any time prior to completion of the contract, such damage shall be repaired conforming to the specifications by the Concessionaire.

Guarantee And Performance Criteria: If on examination by the Engineer-In-Charge of the cement mortar lining work within a period of one year after final completion and acceptance of the contract work reveals evidence of defective materials or workmanship as defined in the specification, then the Engineer-In-Charge may order such remedies as set forth in the specification.

Performance Criteria – Surface Finish : The Hazen-Williams factor Chw (generally called as C Value / Coefficient as mentioned in CPHEEO Manual) shall be criteria for determining the acceptability of surface finish of cement mortar lining. For acceptable performance, guaranteed Chw shall not be less than 140

SPECIFICATIONS FOR FABRICATION OF EXPANSION JOINTS:

Steel plates and flats required for the manufacture of the Expansion joints shall be procured by the Concessionaire unless otherwise stated. The steel required for bolts, nuts, washers, etc. and packing material, etc. shall be procured by the Concessionaire.

The expansion joints shall be stacked in the fabrication yard under cover and on a raised platform till these are required on site.

Workmanship: Expansion joints shall be fabricated as required on site in line with the specifications. The Concessionaire must prepare shop drawings for the engineer's approval. All contact surfaces shall be properly machined and finished smooth to ensure smooth working of the joint. The expansion joints shall be assembled without under hammering or force in order to avoid any damages to any part thereof. The machined surfaces shall be greased before assembly. The expansion joints shall be perfect in all respects of manufacture and shall be painted with approved anticorrosive paint. The expansion joints shall be capable of withstanding the required test pressure and the packing material shall have high compressibility and properties to withstand deterioration by abrasion or water action. The packing material shall be of neoprene rubber which should be got approved from Engineer-In-Charge before being used for expansion joint.

Steel bolts and nuts used in the manufacture of the expansion joints shall conform with British standard specifications B.S.S. 190 or in the absence of which equivalent Indian Standard Specifications shall apply.

Dispatch To Site: At the time of dispatch to the site for erection, the expansion joints shall be in locked condition, assembled with steel rings without packing, using only four nuts and bolts. Remaining bolts washers and packing material including rubber rings shall be supplied by the Concessionaire separately along with Expansion joint. The machined surface of the expansion joint shall be greased before assembly. If any manufacturing defect is noticed for the expansion joint

after its erection at site, the Concessionaire shall carry out all necessary repairs at site or at his fabrication shop as directed by the Engineer-In-Charge. As regards the defect noticed and determined by the Engineer-In-Charge , his decision in this regard shall be final and binding on the Concessionaire.

Specification For Fixing Expansion Joint : Laying of pipes shall be stopped when the distance between the two faces of the pipe line laid from the successive fixity points towards the expansion joint is little more than the expansion joint plus one pipe. The expansion joint shall be aligned and welded at the pre-determined position to one face of the pipeline. The tapered position of the expansion joint shall be on the down stream of the pipeline. After welding of the expansion joint is completed, the pipe shall be aligned and welded to the expansion joint. There shall be a gap between this pipe and the face of the pipeline that has come from the other fixity point. This gap shall be measured when the temperature is 26.6^0C. (80^0F).

If this gap is sufficient enough, a distance piece shall be introduced and if this gap is less than 30 cm., a strap shall be provided. Gap shall be exactly measured at 26.6^0C (80^0F) and the distance piece of length equal to at the lower temperature the gap becomes wider and it shall be assembled and welded with one pipe face. When again at 26.6^0C the gap closes down, the free faces shall be tack welded and at the same time the locks of the expansion joint shall be broken.

After tack welding and breaking of the locks of the expansion joints is done, most important function to be performed shall be watching the behavior of the expansion joint. For this, the following procedure shall be adopted. Mercury cup shall be fixed to the pipe line near the expansion joint in advance to note the temperature of the pipe shell. Similarly, marking shall be made on the pipe to note the expansion / contraction taking place. As soon as the expansion joint locks are broken, the expansion / contraction takes place. Corresponding shell temperature shall be noted every hour for atleast 48 hours. During first two hours, watch also be kept on the fixity points for any damage due to non or improper functioning of the expansion joint. If it is observed that the expansion joint has got stuck up and does not take up expansion and contraction with the change in shell temperature, the tack welds of the last joint that was completed shall be broken and the expansion joint repaired. After it is repaired, the same procedure shall be followed again till satisfactory results are obtained.

SPECIFICATION FOR VALVES

SLUICE VALVE:

The sluice valve shall confirm to IS: 14846-2000 [Sluice Valve for Water Works Purposes (50 to 1200 mm Size)]. The material to be supplied under this sub-section shall include but not be limited to all necessary fittings including bolts, nuts, gaskets, backing rings, counter flanges, jointing material, strainers etc. as required.

Scope: This section covers the requirements for non rising stem type sluice valves. The valves will be used for water supply on line installations in upright positions, up to 45^0 C working temperature, with double flange and cap or hand wheel, for manual operation.

Nominal Pressure And Dimensions: The working pressure of the valves shall be 10 kg/cm^2 (1 Mpa) for PN1 valve and 16 kg/cm2 (1.6 Mpa) for PN1.6 valves.

The dimension and mass of the sluice valves shall be in accordance with IS: 14846 (latest edition).The flanges and their dimensions of drilling shall be in accordance with IS: 1538 (latest edition).

Material: The material for different components parts of sluice valve shall conform to relevant IS Code.

Coating: All sluice valves shall be coated by dipping in a bath of tar base composition as given in IS: 14846-2000. All components susceptible to corrosion attack shall be coated internally and externally. Protective coating shall always be applied to the individual components before they are assembled, following shot blasting to give good adhesion.

Marking, Testing And Inspection: The standard marking and packing of the valves shall be done as per IS: 14846-2000. The direction of rotation for OPEN, CLOSE position shall be marked on the hand wheel and on the bonnet of the valve. Testing of sluice valve shall be done for close end in accordance with IS: 14846-2000. All the valves shall be inspected for flaw detection test in accordance with IS: 14846-2000.

The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the Concessionaire of this responsibility.

AIR VALVES

The Kinetic Air valve shall confirm to IS: 14845-2000 [Resilient Seated Cast Iron Air Relief Valves for Water Works Purposes]

Scope and general design feature : This section covers the requirements of kinetic double ball air valves to be used for evacuation of accumulation of air in water mains under pressure, for the exhaust of air when such mains are being charged with water and for inlet of air when they are emptied of water. The design shall be such that higher the rate of flow the greater the resultant down thrust keeping the ball 'glued' to its seat until the last drop of air is expelled from the pipe system.

The valves shall have an integrated sluice valve. If required, they shall be installed on a flange welded on the MS pipe / special. The possible air velocity (inflow and outflow) must be at least 10 m/s. The working pressure of the air valves shall be 10 kg/cm^2 (1 Mpa) or 16 kg/cm2 (1.6 Mpa).

Construction Feature: The flow of air should be as unobstructed as possible. The low pressure orifice shall be in the same axis as the main discharge/incoming air flow and must have a diameter sufficiently large.

The cone angle in the low pressure (large orifice) chamber should be carefully calculated and there should be adequate height to allow for free movement of the vulcanite ball in the low chamber. The

annulus around the low pressure vulcanite covered ball is to be generously proportioned for discharge of air under various differential pressure.

The orifice shall be carefully profiled to allow the requisite flow of air under varying differential pressure. It shall be in moulded synthetic rubber such that even after extended contact the vulcanite covered ball does not stick to it when the line pressure becomes zero. In the high pressure chamber the orifice shall be in profiled in such a manner that the rubber covered ball is not damaged even after extended contact. There should be machined guide in the chamber which ensures that the ball travels vertically and makes contact with the nipple and seals off the orifice without fail.

Material: The material for different components parts of the air valve shall conform to relevant IS code. The body and seat of the valve shall withstand a working pressure of 16 kg/cm^2 for at least 15 minutes.

Butterfly Valves
Butterfly valves should be designed to be rigid and sturdy with a minimum loss of head across the valve.

Technical Specifications:
Manufacturing and testing standard:- IS 13095-1991Butterfly valves for general purposes Size Range:- 80 to 2500mm
Operation by:-

i) Hand lever (up to 150mm)
ii) Quarter turn Worm Gear Box (manual)
iii) Electrical Actuator with quarterturn worm.
iv) Hydraulic / Pneumatic operator.
v) End Connections: Wafer / Double flanged.
vi) Flanges drilled as per relevant IS codes.

Constructional Features:
Body:- Wafer / double flanged short / long valve body designed to withstand specified pressures.
Disc:- Streamlined single / double eccentrically mounted disc to ensure complete shut-off.
Body seat ring:- Accurately machined to close tolerances to match with body.
Shaft:- Stub type design sealing with combination of 'O' ring and 'U' cup seal to prevent leakage from drive end side.
Journal bearing:- Low friction self lubricated journal bearings for supporting shaft outside fluid flow.

VACCUM BREAKER CUM AIR CUSHION VALVE
Vacuum Breaker cum Air Cushion Valve should be designed to allow large quantities of air intake in the pipeline during column separation occurring after pump tripping or emptying of gravity lines, based on surge analysis data. Valve should also be designed to provide air cushioning effect after column separation & column reversal by compressing entrapped air & expelling it under controlled pressure so as to dissipate the energy of the returning water column. The valve is mounted on a Tee joint at location, where water column separation is likely to occur. The valve has spring loaded inlet & outlet ports of air. This valve is a tailor made valve & the sizes of the inlet & outlet ports are determined from the extent & severity of the water column separation at the given location.

CONSTRUCTIONAL DETAILS:
The inlet port is provided without any obstruction and controlled by a flap which will respond instantaneously to any pressure drop below atmospheric pressure inside and to take as much air as possible in within very short time. Suction area should not be lesser than 75% of the valve size for reliable performance.

In order to provide the cushioning effect, when water column is returning, it should be possible to regulate air outflow with the help of adjustable outlet port. Inlet & outlet ports should be provided with individual isolation valves. The air valve shall be Vacuum Breaker cum Air Cushion Valve as specified in Schedule 'B'. For above air valves, isolating Butterfly valve shall be provided. A tee of

pipe size and delivery size x air valve size shall be provided for fixing the air valve. This item includes the tee for fixing valve to the pipe, and also the isolating Buttterfly Valve, all material and labour for, fixing the whole assembly, jointing material nut bolts etc.

Outlet Port: Valve should also be designed to provide air cushioning effect after column separation & column reversibly compressing entrapped air & expelling it under controlled pressure so as to dissipate the energy of the returning water column. The outlet port is normally closed by float. In order to provide the cushioning effect, when water column is returning, the air outflow is regulated by reducing the outlet size in steps & finally controlling the outflow with the help of adjustable outlet.

Inlet Ports: Valve should be provided with two number inlet ports of equal size with SS Sealing disc & rust proof sealing body with individual isolation valves. The inlet port is provided without any obstruction so as to take as much air as possible in within very short time. Port should be such that no direct access to sealing mechanism from out side making it temper free.

Body: These valves should have T shaped body made up of MS IS 2062 with surface metallised & coated with Zinc rich primer & epoxy paint.

Springs: The valve should have spring (SS 304) loaded inlet & outlet ports of air designed to suit pipeline requirement.

Float Ball: The outlet port is normally closed by float made up of SS 304 ball. All sliding parts should be in SS 304 & bushes should be in Brass/GM. Sealing disc of inlet ports should be in SS 304 material & corresponding sealing body should be MS Hot deep galvanised. All other internal parts metalized & epoxy coated. Body of the valve should be metalized and epoxy coated. Nut-bolts should be hot deep galvanized. MS sheet cover should be provided for valve for security purpose. Suction area should not be lesser than 75% of the valve size for reliable performance.Inlet & outlet ports should be provided with individual isolation valves.

WORKING OF VACCUM BREAKER VALVES:
Condition 1 – During normal pumping, inlet port NRV of the valve is closed due to water pressure & outlet port is closed by ball float.
Condition 2 – During pipe filling, air from pipeline is required to be expelled. Outlet port remains open, when there is no water inside valve & air from pipeline is thrown out as water is filled in.
Condition 3 – After pump tripping, column separation/ vacuum generation takes place in the line. NRV mechanism at inlet port responds instantly to the pressure drop inside the valve and allows air suction instantly and in large quantity thereby protect the pipeline more reliably from damage due to vacuum generation inside the line.

Scope of supply –

1. Vaccum Breaker valve with corrosion protection coating.
2. Isolation Butterfly valve (wafer type) size equivalent to Nominal Size of valve- 1no. with SS disc
3. Double flanged tailpiece – 1no. & Single flanged tailpiece- 1no. with corrosion protection coating.
4. All nut bolts (Galvanised) & Gaskets
5. Valve cover with corrosion protection coating.

HYDRAULICALLY OPERATED ZERO VELOCITY VALVES
Hydraulically controlled water hammer control valves having linear tubular fabricated body with hydraulically controlled pressure dissipating mechanism and self align eccentric protective flap. An externally mounted consisting of single/ double or multi cylinder hydraulic control unit with fine-tuning facility with suitable mounting mechanism, arrangement should be mounted on external valve body.

CONSTRUCTION DETAILS: External body should be linear in nature fabricated out of M.S. sheet as per IS 2062. The main control flap of suitable thickness made of M.S. (IS-2062 or equivalent) should be connected to the hydraulic control unit with a shaft (En8 or equivalent) shaft should have bearings or bush type in Gunmetal or Brass only.

MAIN CONTROL FLAP AND CONTROL UNIT:

A. Main control unit should be consisting of single / double or multiple control units and should be connected by a shaft to the main flap.
B. The control unit should generate variable closure rates in different bends to suit specific changes in velocity and pressure conditions of a particular chainage.
C. This variable controlled closure of the main flap with the aid of the control unit or units should result in controlled decay of velocity or momentum.
D. Closing rate for the main flap in the last segment should be very slow, as determined by scientific analysis. Hydraulic contol unit must be capable of fine tuning closure pattern by for 5 deg. To facilitate complete synchronization with the actual piping conditions. This is done to accommodate actul field condition as compared to the theoretical values and to take care of variations in the field conditions.
E. The hydraulic controls inits must be external to the main valve body and assembled with the help of suitable mechanism. It must be possible to completely alter the closure patterns for any or all band by changing the control units (externally without stoppage of flow.)
F. The control unit must be replacable to enable a change with the flow in progress i.e. without affecting full flow passage through the pipeline. Gland packing should be avoided as it may affect controlled closure characteristic.

MATERIAL OF CONSTRUCTION:

a. Body, flap, Flanges & rise :- M.S. (IS 2062 or equivalent)
b. Rubber Parts :- Nitrile or Neoprene
c. Shafts and Hinge pins :- En 8 or equivalent
d. Bushes and Bearings :- Brass, Gunmetal or teflon

Acceptable Makes: Flownix Valves/ Delta Systems Pvt. Ltd/ Victor Engineers.

HYDRAULICALLY OPERATED NRV WITH CONTROL CHARACTERISTICS

Hydraulically controlled NRV with linear tubular fabricated body with hydraulically controlled pressure dissipating mechanism. Hydraulically controlled NRV should have variable closure rate in different closing bands predetermined by analysis to control any jerks due to sudden closure of disc. Control unit should be externally mounted to facilitate maintenance from outside, without removing valve from line. It should be possible to see working of valve externally.

For pumping system with multiple pumps running at a time and if a single pump fail during running, the water from other pumps tries to rush towards failed pump causing huge energy concentration near NRV. This can be avoided only by bypassing some water quantity by delaying closure on pump NRV. This valve is plain ended and should be welded in the line directly.

CONSTRUCTIONAL DETAILS:

Body Shell - External body should be liner tubular in nature fabricated out of M.S. Sheet as per IS 2062. Shell thickness should be kept suitable to valve rating.

Disc – Disc or main control flap should be of suitable thickness made of M.S. (IS – 2062 or equivalent) should be connected to the hydraulic control unit with a shaft

Shaft - Shaft should be made out of high tensile material En 8 or equivalent

Bushes - Shaft should have bearings or bush type in Gunmetal or Brass only.

Control Unit Specifications -

A. Main control unit should be consisting of multiple control units & should be connected by a shaft to the main flap.

B. The control unit should generate variable closure rates.
C. This variable controlled closure of the main flap with the aid of the control unit or units should result in controlled decay of velocity or momentum during reversal
D. Closing rate for the main flap in the last segment should be slow as determined by scientific analysis.
E. The hydraulic controls units must be external to the main valve body and assembled with the help of suitable mechanism. It must be possible to service/repair valve externally without removing the valve or stoppage of flow.

Valve should be provided with suitable Zinc rich Epoxy Coat and Polyuretin Coat for weather protection.

The NRV shall generally confirm to IS 5312-2004 [Swing Check Type Reflux (Non-Return] Valves for Water Works Purposes - Specification - Part 1 : Single-Door Pattern]

FIXING OF DIFFERENT TYPES OF VALVES

The required sluice valves, air valves, scour valves, etc. shall be supplied by the Concessionaire. The valves and materials supplied shall be flanged or plain ended as per requirement. The valves are to be carted to the site from supply place, lowered in the trenches or erected and jointed to the pipeline as directed with all jointing materials, such as rubber packing nuts and bolts, etc. and the labour , which included in the scope of work. The joints shall be normally flanged but in case of some difficult situation any Socket & Spigot lead joints is required to be done it shall be done by the Concessionaire. The required number of jointing for fixing these valves is included in the scope of work.

The Concessionaire shall provide the valves of reputed makes such as Kirloskar, IVC, or IVI. This item includes providing and fixing of valves at site of work including transportation, loading and unloading etc., all materials and labour required for fixing, including testing. The size of nuts, bolts and packing shall be as per IS specifications and suitable for the type of valves and as per the direction of Engineer-In-Charge . The location of the valves shall be as per the direction of Engineer-In-Charge.

So far as Kinetic Air valves are concerned, special care shall be taken for joints and the ebonite and / or vulcanite balls. These shall be kept immersed in water. These shall be used just before testing operation is to start. The scope for fixing of air valves includes the fixing of isolating valve below the Kinetic / vacuum breaker cum air cushion Air Valve.

SPECIFICATION FOR HYDRAULIC TESTING

After the work of laying pipeline is completed and before it is commissioned, the pipeline shall be tested in the field both for its strength and leakage in the following manner. **Whether stated specifically elsewhere or not, the testing in section of 2 km shall have to be completed within 3 months of laying and joining.** The proposal for the pipeline laid length to be divided into sections, shall be submitted by the Concessionaire / his site engineer and time of testing and availability of the field checking staff shall be got scheduled and got approved from the Engineer-In-Charge. The Concessionaire shall recheck pipe and valves for cleanliness and shall recheck operations of the valves. Blank flanges thereof shall normally stop off the open ends of the pipeline or sections or cap ends additionally secured where necessary by temporary struts and wedges. This blocking arrangement shall also be neatly drafted and detailed drawings shall be prepared and submitted for the approval of the competent authority. All anchor and thrust blocks must have been completed and all pipes must have been securely fastened. The Concessionaire shall clean out the whole pipe line and flush it with water, so as to remove the dust, dirt and any foreign matter lying in the pipeline.

Each valve section of the pipeline shall be subjected to hydraulic test in section. For this test, the pipe shall be slowly filled with clean water by opening cross connection with existing mains or otherwise by pumping water into the line (water and pumping arrangement is to be done by Concessionaire) as directed and all air shall be expelled from the pipe line through hydrants, air valves, and blow off, fixed on the pipe line. Once the pipe is full, the cross connection or pumping shall be closed. The pressure in the pipeline should then be raised in stages and built up and maintained by means of suitable approved pumps, to the specified test pressure based on the elevation of the lowest point on the line or section under test. The test pressure shall be got approved from the Engineer in charge in writing. The Site Engineers shall witness the test procedure and actual test pressures arrived at shall be Filmed / photographed.

The test pressure shall be not less than 1.5 times the maximum working pressure. Before starting the pressure test, the expansion joint shall be tightened. The test pressure shall be maintained for at least 24 hours. The drop in pressure shall not exceed 0.7 kg/cm^2 within a period of 2 hours after full test pressure is built up. Under this pressure no leak or sweating shall be visible at the welded joints. During the test, the pipe shall be struck with sharp blows with 1.5 kg. hammer. Water leak observed anywhere in the field joints, whether welded or bolted, the same shall be repaired entirely by the Concessionaire which shall include repairs to welding and re-gunitting, etc. The repaired joint shall be subjected to retest. No section shall be accepted unless it is perfectly watertight at the desired test pressure. The Concessionaire shall make all the arrangements for all labour, pumps, pressure gauge, equipment, etc. The gauges should be got tested and calibrated, as directed, by the Engineer-In-Charge. The Concessionaire shall arrange for labour required for operating air valves, scour valves, intercommunication with salient points, and protection of the site during testing etc.

The hydraulic testing of the water main will be carried out for entire length if directed by Engineer-in- charge. If any leakages are observed, even during defect liability period due to defective workmanship, the same shall be rectified immediately. Repairs on live water mains are to be carried out immediately to avoid wastage of water, and other problems such as disruption of water supply and traffic, etc. In view of this, any unplanned and irresponsible workmanship shall be viewed very seriously.

Generally the Concessionaire shall be required to test the pipeline sections of 2 Km using necessary equipment. However, if the Engineer-In-Charge directs, to test full pipe line lengths also required to be tested with regular pump. This is necessary to check the whole system testing. A low discharge high head submersible pump shall be fitted as directed by the Engineer in charge and full length can be filled and the end can be plugged. He should observe his comments on the behavior of pipeline and appurtenances and the concrete blocks etc. in writing. All the points shall have to be complied by the Concessionaire.

THRUST BLOCK, CHAIRS, ANCHOR BLOCKS, FIXITY BLOCKS:
The design for Chairs, Thrust Block, Anchor Blocks, Fixity Block etc shall be provided by the Concessionaire and shall be approved by Aurangabad Municipal Corporation, Aurangabad.

The Concessionaire shall locate the thrust blocks, anchor blocks etc. according to the survey he has done. He should get the designs approved for all such blocks from the Engineer in charge. M20 mix shall be used for construction of RCC chairs. The chairs shall be constructed as per the design approved by Engineer in charge and detailed drawing shall also be got approved from him. The distance between the chairs and height of the chairs shall be as per the approval of the Engineer in charge.

SPECIFICATIONS FOR PAINTING OF LETTERS:
Painting of letters shall be done in general as per specifications for painting of pipe line Item, regarding procedure and quality. The background paint shall be oil paint of approved shade and color. Similarly lettering the size, height, thickness, etc. shall be as per instructions issued by the Engineer-In-Charge.

SPECIFICATIONS FOR CLEANING AND PAINTING:
Above ground pipeline shall be cleaned and painted externally with one coat of red oxide and covering two coats of zinc based rich paint. Specifications for the red oxide and for zinc based rich paint are as given in relevant Indian Standard Specification.

Cleaning: External surfaces of pipes, specials shall be thoroughly cleaned by using scrapers, wire brushes to remove all rust mill, scale paint any other foreign material, to the satisfaction of the Engineer-In-Charge , to give a shining metallic surface. Surface so cleaned shall be washed with water simultaneously using wire brush. Care shall be taken to see that the metal cleaning solution is completely removed from the surface by washing.

Painting: Red oxide or iron paint and zinc based rich paint conforming relevant Indian Standard Specification shall be only used. The sample of the paints shall be tested by the Concessionaire as specified therein. The application of one coat of red oxide and covering two coats of zinc based rich paint shall be carried out to the full satisfaction of the Engineer-in-Charge and as per the manufacturer's instructions. Finished surface shall show a uniform application of paint. Painting may be done manually or by spray. The Concessionaire shall however, paint them on site after fixing is complete by initial one coat of red oxide and covering two coats of gray graphite.

SPECIFICATIONS FOR OIL PAINT

a. Grinding and Mixing: The paint shall be thoroughly ground and in such condition that stirring readily produces a smooth uniform mixture of such consistency that the paint works well under the brush. It shall be free from skin and gritty particles, the residue on 240 mesh B.S. Sieve not exceeding 1%.

b. Color capacity, finish and consistency: The paint film prepared in the manner described in Indian Standard Specification No. 101, 1964 (or latest revision) for paints, shall after drying for 48 hours, satisfy the requirements in color capacity and the finish.

c. Surface drying of color: The change in color of the dried paint film will be tested in the manner described in Clause No.12 of the Indian Standard Specification No. 101 for paints.

d. Water: The paint shall not contain more than 0.5 percent to 1 percent of water as determined in the manner described in Clause No. 14 of the Indian Standard Specification No. 101 for paints.

e. Flash point: The flash point shall not be below 900 F (350) unless it is not possible to have this

flash point, on account of the quality of controlled raw materials.

f. Drying Time: The paint when tested on a steel plate shall become sufficiently dry in between 4 and 12 hours and hard dry in not more than 24 hours and tack dry in not more than 48 hours as per I.S. 101

g. Resisting Properties: The paint shall remain liquid and retain its consistency at the ordinary atmosphere, temperature when packed in suitable container. After application and drying, the paint shall not show any surface cracks due to weathering action or expansion and contraction. The paint shall able to resist the action of acid and alkalis after application and shall keep properties for not less than one year.

h. Covering Capacity

i. The covering capacity for all types of paints shall not be more than 16-18 m2 per liters at 35 to 40 microns dry film thickness.

SPECIFICATIONS AND DESIGN CRITERIA FOR RCC GSR/MBR/SUMP, WITH CONCESSIONAIRES OWN DESIGN

Note: The specification and design criterion is prepared for GSR/MBR and SUMP. However the specification and design criterion must be used as per the scope of work and instruction of the engineer.

GENERAL

WATER RETAINING STRUCTURES SUCH AS GSR, MBR SUMP, ETC

i) The reservoirs will be a covered RCC container supported on RCC column with individual footing with intermediate braces, etc. or **GSR , MBR, Sump** either supported on ground or underground.
ii) Suitable number of MS ladders / spiral stair for **GSR , MBR, Sump** with landing at regular intervals for approach to the gallery and top slab of **GSR , MBR, Sump** shall be provided.
iii) RCC cantilever catwalk (gallery) 1.0 meter width with GI pipe railing shall be provided at floor level, preferably at junction of floor slab and vertical walls.
iv) Ventilators shall be provided in top slab of GSR/Sump.
v) Suitable number of CI Manhole frames and covers shall be provided and fixed in the roof of tank for access into the tank.
vi) Water level indicator assembly of approved type shall be provided and installed.
vii) Lightening arrestor as per IS specifications and conforming to I.E. Rules shall be provided and fixed.
viii) Vertical and horizontal piping of CI/DI/MS flanged pipes, CI/DI/MS specials of required sizes for inlet, outlet, overflow and bypass arrangements together with suitable sluice valves shall be provided.
ix) For washout one tee shall be fixed on the outlet pipe with one valve of suitable diameter.
x) Sluice valves of required size shall be fixed for inlet, outlet and washout. These valves shall be supplied by the Concessionaire conforming to relevant ISS and of makes approved by Engineer-In-Charge.
xi) Required no. of BB masonry/RCC chambers of suitable size with C.I. manhole frames and covers shall be provided and constructed at suitable locations for sluice valves/Butterfly Valves.
xii) Waterproof cement plaster of CM 1:2 proportion 20 mm thick shall be provided for inside surface of the tank including roof slab bottom.
xiii) Outside surface of tank, exposed face of columns, braces, beam, catwalk, bottom portion of slab and any exposed surface of the tank shall be provided with smooth finish and then three coats of approved shade of snowcem paint as per colour scheme approved by the Engineer-In-Charge shall be rendered.
xiv) Letters indicating capacity of tank, name of scheme and year of construction shall be either embossed or engraved on vertical wall of tank and shall be painted with suitable shade of oil paint in two coats.

HYDRAULIC TESTING:

On completion of work, hydraulic test or water tightness test shall be given as per standard specifications. The Concessionaire shall make required water arrangements for testing.

Since, this is water retaining structure; Concessionaire shall give a satisfactory hydraulic test of the tank. This test shall be considered water tightness test and accepted if the structure appears bone dry from outside after filling with water upto full supply level and the drop in water level is not more than 40 mm in 7 days. For this purpose the water filling arrangements is included in the scope of work and shall be made by the Concessionaire including water pumping arrangements, etc.

If during testing any damage occurs to the structure, it will be the responsibility of the Concessionaire to rectify until satisfactory water tightness test is given on completion of work.

The filling of the reservoir shall be carried out gradually at the rate not exceeding 30 cm rise in water level per hour and shall not exceed 2.0 meter in 24 hours and total period of 72 hours. Records of leakage starting at different level of water in the reservoir if any shall be kept. The reservoir once filled shall be allowed to remain filled for seven days before any readings drop in water level are recorded. The level of the water shall be recorded again at subsequent intervals of 24 hours over a period of seven days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the reservoir, which for all practical purposes shall not exceed 40 mm.

If the structure does not satisfy the condition of test and the daily drop in water level is increasing the period of test may be extended for a period of seven days and if the specified limit is then reached the structure may be considered as satisfactory.

If even after extending the period of test, the drop is more than permissible, the Concessionaire should empty the reservoir, rectify the defects in tank, by replastering whenever necessary, applying water proofing paint etc. and give the water-tightness test till the drop in level is within permissible limit.

WATER LEVEL INDICATOR ASSEMBLY

Mercury water level indicator with 15 mm dia, required GI pipes (medium duty), stop cocks (2 nos.), necessary fixtures suitable for staging height upto 15 M and water depth upto 5 M to represent depth of water in tank, etc. shall be provided and fixed by the Concessionaire as per direction of Engineer-In-Charge. The indicator should be fixed to exterior face of column at about 1.5 M above ground level at site or as per requirement of Engineer – in –charge.

1. **Lightening Arrestor:** Lightening arrestor conforming to IS and Indian Electricity Rules shall be provided. The lowermost portion of tape for 2 meters above ground level and 2 meters below ground level shall be enclosed by 50 mm GI pipe of medium class.

2. **Pipe Railing At Free End Of Catwalk:** Railing shall be of GI pipes medium class not less than 25 mm diameter in two rows and shall be fixed in position to RCC posts or MS angle posts of size 50 mm x 50 mm x 6 mm, 1.0 Meter in height, located at a maximum distance of 1.5 M C/C. The railing and the posts shall be provided with two coats of oil paint of approved shade.

3. **Aluminium Ladders:** One number of aluminium ladder shall be provided and fixed to give access into the tank through manhole in the roof slab. The ladder shall be of min.500mm width.

GENERAL NOTES

The design shall be got checked from the institute like Indian Institute of Technology near by in the area (IIT) or Govt. Engineering College/Govt Polytechnic. Remarks shall be complied by the Concessionaire as and when called for.

The Concessionaire shall submit the name, qualifications and experience of Design Engineer who has prepared detailed RCC calculations or who will prepare design and drawings of water retaining structures. The authorized representative of the designer will have to inspect and certify the works at foundation level and every brace level in presence of Engineer-In-Charge's authorized representative.

The design engineer has to prepare and submit a note on design methodology and construction and drawing in **five copies** through the Concessionaire.

The note should indicate, general description, and salient features of the design covering the following points:

a) Capacity
b) Shape and type as mentioned in the RFP Document.
c) Staging height of tank indicating various levels

d) Safe bearing capacity assumed in the design or safe bearing capacity of strata based **on actual investigation report of labouratory and type of foundation provided** with proper justification.
e) Maximum and minimum subsoil water level.
f) Site plan showing location of GSR / MBR / SUMP
g) Line diagram showing dimensional sectional elevation.
h) Design parameters proposed to be adopted for detail design.

This note on design will be subjected to thorough check by the Engineer-In-Charge of AMC.
The Concessionaire will have to submit five copies of the detailed design and drawing of the structure for approval to AMC.

The Design Engineer will be required to attend the office of Engineer-In-Charge for preliminary discussion for scrutiny remarks etc. whenever required with all reference data, books, IS specifications etc.

It will be binding on the Design Engineer of Concessionaire to clarify, modify, redesign and prepare drawings after compliance of scrutiny remarks by the Engineer-In-Charge or his representative such as Govt. Engineering college / Govt. Polytechnic/IIT within 15 days of communication of remarks. Even though design will be approved by Engineer-In-Charge, it will be the entire responsibility of the design engineer and the Concessionaire.

On approval of the design, Concessionaire shall supply **five sets** of design and drawing duly bound for use of the Engineer-In-Charge. The Concessionaire shall also furnish the Programme of execution for completion of work within the time limit stipulated in the RFP Document.

Even though the design and drawing submitted by the Concessionaire are approved by the Engineer-In-Charge, the Concessionaire will not be relieved of his contractual obligations to hand over the structure in sound condition and duly tested.

In case of any damage/failure either during construction / testing or after commissioning, whether due to faulty design or defective construction all repairs or reconstruction of the structure shall have to be carried out by the Concessionaire, entirely at his risk.

SPECIAL OBLIGATORY CONDITIONS OF DESIGN FOR WATER RETAINING STRUCTURE CRITERIA FOR THE DESIGN OF RCC GSR/MBR /SUMP
The structural design of water tank shall conform to the following standards, specifications and Codes of Practice of IS.

IS: 456-2000	Code of Practice for plain and reinforced concrete (latest edition)
IS: 875-1987	Code of Practice for structural safety of building, loading standards
IS: 3370	Codes of practice for concrete structures for storage of liquids Part I to IV(latest edition)
IS: 1893	Criteria for earthquake resistance design of structures (latest edition)

GENERAL
Capacity of the container of the tank shall be the volume of the water it can store between the designed full supply level and the lowest supply level.

i. Free Board is the indication of space provided above full supply level and shall be measured at a vertical distance above F.S.L up to soffit of beam supporting the roofs slab / dome. Free Board shall be minimum 30 cm below soffit of beam or slab, in case of domed roof, free board may be reduced up to 15 cm.
ii. The walls of container shall be designed for free board full condition.
iii. The tank foundation and other members of the structure shall also be designed for free board full condition.

iv. Parts of the tank in contact with stored water and enclosing water vapour above FSL shall be in concrete M25/ M30 as per approved design.

v. The Concessionaire is advised to verify actual strata before designing the structure and offer suitable design with full justification.

vi. Not with standing anything mentioned above if directed by the Engineer-In-Charge the Concessionaire shall carry out actual strata exploration as mentioned in Para 0.2 of IS 1892 - Latest version through a Govt. laboratory and adopt bearing capacity so arrived for the design.

vii. The factor of safety shall be adopted as per clause 6.1(a) of IS 6403 -1981 or Latest version.

viii. If the foundation consists of individual column footing minimum clear distance between centers of column shall be equal to twice the width of footing and clear distance between edges of footing shall be not less than width of footing.

ix. The foundation should be checked for negative pressure on soil due to combined direct and bending stresses. Negative pressure shall not be allowed on the foundation soil.

x. Classification of soil and characteristics of soil relevant to SBC shall be as per the soil investigation reports of Government institution / Government approved investigations.

xi. For the design of foundations of the solid raft type, the Plate Theory shall be adopted.

xii. In normal circumstances minimum 150 mm thick plain cement concrete with 150 mm projection all-round in grade M-15 with coarse aggregate as metal shall be provided as leveling course. Where injurious soils or aggressive water are anticipated the leveling course shall be of grade not weaker than M-20 and if necessary sulphate resisting or other special cement shall be used and the thickness of the leveling course shall be kept not less than 150 mm. The ground level within the foundation area of the structure shall be consolidated properly with a suitable slope to drain out rain water outside the foundation zone.

xiii. In the vicinity of mines, quarries and blasting sites or areas which may be subjected to blast or shock, the tanks shall be designed for dynamic forces adopted to shock.

xiv. Column may be assumed as fixed at the top of footing.

xv. Following shall be the minimum thickness of various member of the tank container:

xvi. Roof slab-120 mm, Bottom slab-200 mm, Roof dome-100 mm, Vertical wall of container-200 mm

LOADS

For all RCC and PCC components unit weight of concrete shall be taken as 25000 N / cum and 24000 N / cum respectively.

Water load and snow load shall be taken as per IS 875-1987 or Latest version.

Seismic forces shall be as per IS 1893-1984 or Latest version.

DESIGN

Shape of the structure shall be the most economical as directed by Engineer-In-Charge and shall be selected depending upon site conditions.

Design shall be based on the worst possible combination of various loads, moments, shears, resultant stresses in the tank for the following cases.

a) Tank Full
b) Tank Empty with Earth pressure if any from outside
c) Uplift pressure if any

Tank full means depth of water inside the container up to full height of the container including free board.

Design shall be based on accepted bases and methods of design as well as the provisions of IS 3370, IS 456, IS 1343 (Code of Practice for Pre-stressed concrete), IS 2210 (Latest edition of IS shall be referred).

Design of members (i.e. roof, walls, floor etc. of the container) shall be based on consideration of adequate resistance to cracking as well as adequate strength.

PERMISSIBLE STRESS IN CONCRETE FOR RESISTING TO CRACKING

a. For calculations relating to the resistance of members to cracking the permissible stresses in tension (direct and due to bending) and shear shall conform to the values specified in Table I of

IS 3370 (Part II). “The permissible tensile stresses due to bending apply to the face of the member in contract with the liquid”. In members with thickness less than 225 mm and in contact with the liquid on one side, these permissible stresses in bending apply also to the face remote from liquid.

b. For strength Calculations

For strength calculations, the permissible concrete stresses shall be in accordance with IS 456-2000. Where the calculated shear stress in concrete alone exceeds the permissible value reinforcement acting in conjunction with diagonal compression in the concrete shall be provided to take the whole of the shear. The maximum reinforcement shall conform relevant clauses of IS 456-2000.

PERMISSIBLE STRESSES IN STEEL

For strength calculations (concrete assumed to be cracked) the permissible stresses in reinforcement shall be as per table 2 of IS 3370 (Part II) (its latest revision). For Tor steel, the stress shall be as per IS 1786-1985 for cold worked steel high strength deformed bars for concrete reinforcement or its latest revision.

Modulus of elasticity of concrete Ec shall be taken as 5000 √fck where fck is the characteristic cube strength of concrete in N/sq. mm as per relevant clause of IS 456-2000.

Age Factor: Age factor for increase in strength shall not be considered for the design.

Units: Design should be in Metric units only.

DETAILING

a. Minimum Reinforcement for Water Retaining Members

The minimum reinforcement in walls, floors, roofs in each of two directions at right angles shall have an area of 0.3% of the concrete section in that direction for sections up to 100 mm thick. For sections of thickness greater than 100 mm and less than 450 mm the minimum reinforcement in each of the two directions shall be linearly reduced from 0.3% for 100 mm thick sections to 0.2% for 450 mm thick section. For section of thickness greater than 450 mm minimum reinforcement in each direction shall be kept at 0.2%. In concrete sections of thickness 225 mm or more, two layers of reinforcing steel shall be placed one over each face of the section to make up the minimum reinforcement specified in this clause.

b. The minimum reinforcement specified above may be decreased by 20% in case of high yield strength deformed bars conforming to IS 1786 (Latest version of ISS shall be followed).

c. Covers to Reinforcement

i. Minimum clear cover to reinforcement shall be as per IS 456 and 3370. (Latest version shall be referred).
ii. For members of structure in contact with water effective cover shall not be more than 60 mm. for bars subjected to bending stresses. For bars subjected to pure tension the effective cover shall not be more than 75 mm.

d. Spacing of Reinforcement

i. Spacing of reinforcement shall be as per IS 456-2000.
ii. Spacing of lateral ties for column shall satisfy the provisions of IS 456-2000.
iii. Reinforcing steel which accounts for resisting moments, tension etc, i.e. other than temperature and shrinkage steel, shall comprise of minimum 8 mm dia for ribbed baRs. For compressive members, the minimum dia of main reinforcement shall not be less than 12 mm dia.

Note:- In case of dispute regarding interpretation of any of the above clauses, the decision of the Engineer-In-Charge or his representative will be final and binding on the designer and Concessionaire.

PROGRAMME OF EXECUTION OF WORK

The Concessionaire shall furnish in duplicate to the Engineer-In-Charge within one month from the date of issue of work order a Programme indicating close progress of work to be achieved for completion within stipulated time limit. The Programme should be got approved from the competent authority. The progress schedule shall be in the form of bar charts, statement forms, daily out-turn of quantities. Should the Programme be found defective in any respect or impracticable the same shall be modified as required. Should the actual progress of work lag behind at any stage, revised Programme by accelerating the progress to be achieved shall be drawn up keeping the target of completing the scheme unaltered.

SPECIFICATION FOR TRENCHLESS METHODS FOR PIPELINE CONSTRUCTION

Scope of Work

Furnish all labour, materials and equipment and perform all the work necessary to design and construct pipelines crossing under paved roads using trench less methods, as specified herein and as per the approved drawings.

Construction shall be by using trench less techniques that are appropriate for the intended installation and which can be demonstrated to the satisfaction of the Engineer-In-Charge to meet the contents of these specifications.

Where a pipeline is to be constructed by micro tunneling, the Concessionaire shall confine his surface operations to working shafts and the area immediately adjacent to such shafts. Such working area shall be kept to the minimum practicable size for the proper construction of the works. The Concessionaire shall propose the location of all working shafts, having due regard to existing services, minimizing disruption to traffic and pedestrian movements and achieving the required system layouts, as shown on the approved drawings. Locations shall be approved by the Engineer-In-Charge prior to the commencement of construction.

The Concessionaire shall obtain approval of his method statement from concerned Authorities.

Design : The Concessionaire shall be responsible for the design of the casing pipes used for the trench less method including al joints, for the design of the thrust reception pits including support and thrust wall and for the design of the jacking system in general. His design will be reviewed by the Engineer-In-Charge but this will not relieve him of his responsibility for the adequacy of the design.

Submittals: In addition to the applicable requirements of this specification, the following shall be submitted by the Concessionaire and approved by the Engineer-In-Charge prior to commencement of any works.

1. Program of work with resource and equipment allocations.
2. Additional Soil Investigations.
3. Design Calculations for the non-destructive method:
   a) Casing pipes including jacking and friction forces in the axial direction and earth, traffic and surcharge loading in the vertical direction and the pipes resistance to these loads. Also, allowable deflections at joints to limit damage to the joint from eccentric loading under thrust and sealing limits.
   b) Thrust and reception pits to resist external soil and water pressures and stresses resulting from jacking machine. Drawings showing on plan and sections the method of supporting excavations and equipment layout shall be included. All calculations shall be certified / signed by a qualified design engineer of the concessionaire.
4. Materials Specifications and product data.
5. Method statements which shall include :
   a) List of equipment and resources
   b) Detailed step by step procedure describing how work will be carried out including clear definition of responsibilities and authority.
   c) Support of existing services and adjacent structures.
   d) Safety arrangements for compliance with safety requirements.

e) Arrangements for dealing with groundwater taking due regard to controlling the loss of material and preventing settlement around pit / pipe interface and tunnel face.
f) Dealing with different ground conditions.
g) Locking pipe in position during insertion of next pipe.
h) Sealing thrust and reception pits during existing and entering of pipe.
i) Control of over break.
j) Grout mix design and method of grouting.
k) Handling and fixing, of the inner pipe in the case of micro tunneling with larger diameter casing pipes.

Quality Assurance
The non – destructive method of pipeline installation shall be executed by firms having a record of at least three years of successful, trouble free execution of similar works.

Delivery Storage and Handling
All materials shall be properly protected so that no damage or deterioration shall occur during a prolonged delay.

Site Investigation
Soil conditions and ground conditions shall constitute the Concessionaire's risk. After award of the Contract, the Concessionaire shall be responsible for carrying out all geo-technical site investigations, including ground water level monitoring, which he considers necessary but as a minimum at the proposed access pit locations, and central median. The Concessionaire's site investigation program shall be submitted to the Engineer-In-Charge for review. The results of such investigations shall be submitted to the Engineer-In-Charge and shall include recommendations for pipe laying, excavation support and soil stabilization if required.

The Concessionaire shall be responsible for obtaining existing utility information and executing trail pits to locate and confirm services at pit locations etc. as required.

Health and Safety
The Concessionaire shall adopt safe working practices for tunneling in accordance with the appropriate standards. Only authorized personnel shall be allowed to work on site. The Concessionaire shall provide a Safety Officer, suitably experienced in tunneling operations and with adequate authority to control and implement safe working practices.

The Concessionaire shall make suitable arrangements for accommodating his personnel at the site including the following as a minimum:

1. Air- conditioned mobile office at the thrust pit with space, desk and chair for one inspector.
2. Telephone service.
3. Telecommunication between the control room and the work crews.
4. Cool Air-conditioning in summer for work crews engaged in operations at the thrust and the reception pits.
5. Approved gas detectors.
6. First aid kit.
7. One vehicle.
8. Emergency escape.

The excavated pits shall have a separate edge type ladder bay complete with ladder in addition to any other bay or bays required for the construction of the works. The pits shall be fenced off on all sides with close steel panels at least 1.8 m in height and equipped with safety warning lights. The panels (maximum space between 100 mm) shall be joined by steel rods supported on concrete blocks. Adequate lighting and ventilation shall be provided to the pits and electricity shall be supplied at no greater than 220 volts.

Skilled Operators and Supervision:

All operators in the employment of the Concessionaire shall be skilled and experienced In their respective trades and in particular shall be fully skilled in shaft sinking and tunneling. The operators who will perform the work shall have a minimum of 1 year experience in the performance of tunneling / micro tunneling subject to performance with 3 months probation.

Curriculum Vitae of key personnel and operators shall be submitted for approval. Interviews may be undertaken at the discretion of the Engineer-In-Charge.

Pipe Materials:

Pipe materials shall comply with the specifications. Micro tunnel pipes shall be designed to withstand the maximum axial thrust with a factor of safety of 4 based on the full effective area and the ultimate compressive strength of the pipe material. For reinforced concrete pipes the full effective area at the joint shall be used. Where GRP or similar materials pipes with concrete surround are proposed for micro tunneling, the concrete shall be regarded as sacrificial. The concrete surround shall be designed to withstand the maximum jacking force. The design shall also ensure that the GRP or similar material pipe is not subjected to any forces during installation.

Joints in pipes used in micro tunneling shall be designed to avoid projections which could obstruct the travel of the pipe and they shall be watertight under axial loading and at the permissible deflection of the pipes. Quality control tests at the factory should include subjecting the pipe joints, at a maximum permissible deflections, to an external hydrostatic pressure of 2 bars.

The Concessionaire's submittals shall describe the measures to be taken to avoid the development and transfer of grout shrinkage or expansion stresses to the pipe and to avoid any adverse chemical reaction between the pipe and concrete, grout or other materials, comprising the pipeline. The pipe manufacturer has to guarantee that this pipe and its material are suitable for its intended use.

Standard pipes shall be a minimum in length subject to the installation method used. Where required, pipes shall incorporate lubricant injection holes spaced equally around the circumstance. Concrete pipes with a liner shall only be permitted to have lubricant injection holes in the concrete. Lubrication holes shall be clear of joints and shall be plugged on completion of the work. The liner shall be made good and continuous. Pipes may incorporate lifting holes and fixing holes for securing temporary apparatus. All such holes shall be threaded to enable plugs to be screwed into the sockets to withstand any external water pressures.

Joints which shall be used conjunction with a resilient packing, shall be capable of accepting repeated annual deflections of up to 1degree without:

i) Damage of pipe or loss of structural strength.
ii) The ingress or egress of water or lubricant under the maximum operational or test pressures.
iii) The ingress of soil / groundwater onto the bearing surfaces.

The joint design for concrete pipes shall be such that the areas available for transmitting the maximum permitted thrust force will be sufficient to ensure that with an annular deflection of 1 inch and with resilient packing material in place the maximum pressure applied to the joint bearing surface will not exceed 23.5 N/mm^2 for drives up to 100 meters in length 21.0 N / mm^2 for drives in excess of 100 meters and up to 150 meters in length.

Unless independently authenticated test results acceptable to the Engineer-In-Charge are available, two consecutive axial loading tests incorporating a 1" angular deflection with the application of double the maximum permissible thrust force (or, if greater, of the greatest thrust force that the proposed thrust equipment can apply) shall have been successfully conducted without any visible crushing, cracking or spelling of the pipe being evident, before any pipes will be accepted for use. The tests shall be extended to record the loading at which any visible signs of failure become evident and shall be carried out in an approved manner to simulate actual working conditions. Pipes which have been submitted to the proof load test will not be permitted in the works.

Where the Concessionaire elects to construct certain sections within larger diameter pipes and grout the annular space, the external pipe may be of steel with full circumferential weld. The steel pipe and the grout shall be regarded as sacrificial and the inner pipe shall be designed as a stand alone pipe, capable of withstanding installation and grouting forces and soil, traffic and groundwater loads subject to the method.

Joint packing: The material used for joint packing shall have under dry conditions when subjected to the maximum permitted bearing pressure.

i) A restoration after 1 hour of at least 65%of the original thickness, and
ii) A compression of at least 50% of the original thickness.

Independently authenticated test results to demonstrate that the packing complies with the Specification shall be submitted and shall include a graph of the stress / strain relationship over the range of conditions which will be encountered during the works.

The material used for packing shall withstand all imposed loading applied during the installation of all pipes for each completed length without showing signs of deterioration of distress. The packing material is to be cut to dimensions that ensure the full bearing width of the joint is protected. The initial thickness of the packing shall be such that the final joint gaps achieved upon completion of the pipeline are a nominal 8 mm in width.

Packing shall not be fixed over the full face of the pipe but stopped approximately 1cm from free edges. The joint gap shall have tolerance of between 6mm and 15 mm depending on jacking forces. Outside gaps in the joints between pipes shall be sealed.

Lubricant: Lubricant shall always be used while micro-tunneling. The material used for lubrication shall be a polymer or bentonite based slurry approved by the Engineer-In-Charge. It shall be stored and mixed in a manner recommended by the supplier and tested prior to use. Lubricants injection overpressure shall be avoided. It shall be sufficient to fill the annular overbore voids around the outside of the pipe to avoid collapse and upward migration of the void prior to permanent grouting.

The Concessionaire shall obtain a certificate from the manufacturer of the bentonite powder showing the properties of each consignment delivered to the Site. The certificate shall be made available to the Engineer-In-Charge on request. The properties to be given by the manufacturer are the apparent viscosity range (in Pascal seconds) and the gel strength range (in Pascal's) for solids in water.

Bentonite shall be mixed thoroughly with clean fresh water to make slurry 24 hours before its usage. The temperature of this water used in mixing the bentonite suspension, and of the suspension when supplied to the drilling machine, shall be not lower than 5degree C.

Where saline or chemically contaminated groundwater exists, special precautions shall be taken to modify the bentonite suspension or pre hydrate the bentonite in fresh water so as to render it suitable in all respects for the intended purpose.

Control tests shall be carried out on the bentonite suspension, using suitable apparatus. The density of freshly mixed bentonite suspension shall be measured daily as a check on the quality of the suspension being formed. The measuring device shall be calibrated to read to within 0.005 g/ml. Tests to determine density, viscosity, shear strength and pH value shall be applied to bentonite supplied to the pipe bore. For average soil conditions the results shall generally be within the ranges as mentioned in the following Table:

Property to measured be	Range of results at 20^0 C	Test method
Density	Less than 1.10 g/ml	Mud density balance
Viscosity	30 – 90s Or less than 0.020 Pa-s	Marsh cone method Fan Viscometer *
Shear Strength (10 minute gel strength)	1.4 – 10 Pa or 4-40 Pa	Shear meter Fan Viscometer
pH	9.5-12	pH indicator paper Stripes electrical pH meter

* Where the Fan viscometer is specified, the fluid sample should be screened by number 52 sieves before testing.

The frequency of testing bentonite slurry and the method and procedure of sampling shall be proposed by the Concessionaire for approval before the commencement of work. The frequency may subsequently be varied as required, depending on the consistency of the results obtained, subject to approval.

The tests shall be carried out until a consistent working pattern has been established, account being taken of the mixing process, any blending of freshly mixed bentonite suspension and previously used bentonite suspension. When the results show consistent behavior, the tests for shear strength and pH value may be discontinued, and tests to determine density and viscosity shall be carried out as agreed with the Engineer-In-Charge. In the event of a change in the established working pattern, tests for shear strength and pH value shall be reintroduced for a period if required.

Joint Sealant: The joint sealant shall be an electrometric ring complying with BS 2492:1990

Grout: As Slurry replacement, the grout shall consist of Ordinary Portland cement and water as determined by geo technical data and directed by the Engineer-In-Charge. It's normal strength shall be at least 20 N/mm². Admixtures shall be used only if tests have shown to the satisfaction of the Engineer-In-Charge that their use improves the properties of the grout. i.e. by increasing workability or slightly expanding the grout.

As Annular Space Filling, a low strength, non shrink shall be protected from the possible adverse physical or chemical – effect of grout, Compressible material shall be wrapped around pipe. The internal pipe shall be filled with water to avoid floatation forces, hydration temperatures and to resist forces during grouting. A 5 mm high free vented standpipe should be used. A free venting standpipe of not less than 100 mm dia shall be installed on the grout injection feed to restrict grouting pressures to a maximum of 1 bar.

Thrust and Reception Pits: The dimensions of thrusts and reception pits shall be limited to the minimum required to construct the works.

Thrust and reception pits shall be constructed within a sheet pile cofferdam or caisson if the ground conditions dictate. The pit bottom be sealed with concrete. Entry and exit sealing rings shall be provided. The Concessionaire shall determine the excavated dimensions of the drive and reception shafts as required to suit the site conditions. Minimum shaft dimensions shall be used at all locations where utilities, roads or trees exist adjacent to the required shaft locations.

Excavations shall be supported according to type of pit as specified below:
Type 'A' Thrust and reception pits in all types of soils except rock, with high groundwater table and with the excavation secure by precast reinforced concrete caisson The caisson bottom shall be sealed with a concrete plug which shall be placed underwater and designed to resist water uplift as well as forces from the jacking equipment to be installed in the pit. All the joints between caisson

rings shall be sealed with the joint sealant and the caisson grouted from outside in order to make in water tight. A reinforced concrete wall shall be provided in the thrust pit to resist the jacking force. A properly braced concrete wall shall be provided in the thrust and reception pits in order to install the entry and the exit rings.

Type 'B' Same as Type 'A' but the excavation is secured by inter-locked steel sheet piles. The sheet piles shall be braced by suitable steel framing welded to the sheet piles. No strut shall be used for bracing. The first set of bracing shall be at 0.5 m from the ground surface.
Type 'C' Same as 'A' but in dry conditions.
Type 'D' Same as type 'B' but in dry conditions.
Type 'E' Same as Type 'A' except that the pit is partially in soil and partially in rock. The portion in soil is secured by caisson as in Type 'A' where as the portion in the rock can be unsupported. Special precautions shall be taken to seal the interface between the caisson and the rock so that it is water and soil tights.
Type 'F' Same ass type 'E' except that excavation in soil is secured by sheet piles instead of a caisson.
Type 'G' Same as Type 'E' but in dry conditions.
Type 'H' Same as Type 'F' but in dry conditions.
Type 'I' The thrust and reception pits are in rock in an area of high groundwater table. The excavation can be unsupported. A reinforced concrete will shall be provided in the thrust pit to resist the jacking force. Properly braced concrete walls shall be provided in the thrust and reception pits in order to install the entry and exit rings.
Type 'J' Same as Type 'I' except in dry conditions.

The pits shall be completely dry prior to commencing and throughout tunneling works. Dealing with groundwater where required shall be conducted in a slow manner. Standby facilities shall be provided.

The thrust wall shall be perpendicular to the proposed line of thrust. The thrust wall shall be sufficient to accept repeatedly the maximum permitted thrust force without undue movement. It will not be permissible to thrust directly off any permanent part of any shaft, chamber or pumping station unless this is specifically designed to withstand the thrust reaction. Thrust wall shall not be joined to the jacking rig base concrete.

Where it is proposed to use a tail tunnel as the reaction surface the maximum permitted thrust force shall not exceed the lesser of the following:

i) The maximum permissible thrust force.
   a) 50% of the sum of the maximum forces at the rigs used to construct the tail tunnel, or
   b) If the over break to the tail tunnel has been grouted up, 100% of the sum of the maximum forces recorded at the rigs used to construct the tail tunnel.

Any tail tunnel which has been used as a reaction surface shall pass the specified water tightness test at a time not less than 14 days after the load has been removed.

The design of the thrust wall and any other associated Temporary works shall be such as to prevent damage to any part of the permanent works or any immediately adjacent service or structure.

Any void between the soil face used to provide a reaction to the thrust force and the thrust wall shall be filled completely with grout.

The Concessionaire shall take any measures necessary to prevent damage or deterioration of the soil reaction face during the construction of the Temporary and Permanent works from whatever possible cause, such as ingress of water, softening, corrosive soil or loss of fines from the granular soil.

Pipe installation within Sleeves: Pipe sections shall be placed and joined individually within the sleeve or mounted on guide rails or trolleys in such a manner as to transmit the pulling / pushing forces through the carriage and not through the pipe.

Micro tunneling: Unless otherwise agreed, the method to be employed for micro tunneling shall be mechanical earth, pressure counter balance tunneling system incorporating a polymer or bentonite based slurry system. The use of water alone shall not be permitted.

The horizontal drive rate shall be maintained equal to the excavation rate throughout the operation. During all stages of the setting up, micro-tunneling operation and dismantling both subsidence and heave shall be prevented. The micro-tunneling system shall be manufactured and operated having regards to the provisions of BS 5228: Parts 1 & 2 and BS 6164.

The slurry system shall have a dual purpose of removing excavated soil and balancing groundwater and face pressures. The slurry / excavated soil mixture shall be properly removed from the excavation, and removed from the site to a suitable location. Stock pilling on site shall be avoided. Pressure gauges shall be provided in the control room to measure the slurry and suction pressures. Face support shall be provided by full earth pressure balance.

The tunneling machine shall be steerable, incorporating hydraulic rams to move the articulated head. A laser beam transmitted from the jacking shaft to a target mounted in the tunneling machine shall achieve the line and level.The design of the tunneling machine shall ensure no rotation or rolling during installation. The tunneling operation shall be run continuously between thrust and reception pits. During short stoppages needed for pipe jointing, the slurry pressures / face pressures shall be maintained.

Tailings removal and cutting face shall not be operated when the pipe thrust is not being carried out. A remote control tunneling machine shall be used. It shall include a closed circuit television camera which transmits a picture of the laser beam on the target together with other machine information (such as jacking force, face pressure, length, roll, pitch, steering attitude, temperature, valves open or closed) to a microprocessor console on the surface from where the system is operated.

The tunneling machine shall be capable of operating under groundwater conditions as necessary, the hydrostatic balance shall be not less than 3 m head of water.

Line and Level: A laser guidance system shall be used for the control of tunnel alignment. The laser shall be mounted independently of the thrust wall or machine jacking rig or anything else that may move during jacking. The shield / tunnel machine shall be fitted with calibrated laser target, robustly constructed and rigidly secured to the shield / tunnel machine.

Manual checking of the line and level shall carried out by conventional theodolite and level techniques. The setting of the laser and target and the alignment of the tunnel relative to the laser beam shall be accurate and checked constantly. The lateral deviation of any part of the pipeline should not be more than +50mm from the detailed in the Contract.

The level of any part of the pipeline should not deviate by more than +20mm from the approved detailed drawing. The maximum lapping between the edges of adjacent pipes shall not be more than +5mm. If the deviation exceeds the specified tolerance, work shall cease immediately and the Engineer-In-Charge informed forthwith. The Concessionaire shall submit proposals to rectify the deviation and work shall only recommence on the written instruction of the Engineer-In-Charge.
Unless otherwise approved by the Engineer-In-Charge, all pipe jacking and tunneling shall be carried out in an uphill direction.

Thrust System: The rig shall distribute the thrust to the pipes via a thrust ring and packing. The jacks shall apply the thrust to the thrust ring by means of a symmetrical distribution. Inter-jack stations shall be used where frictional resistance or other causes would otherwise result in unacceptable thrust forces.

If used, spacer blocks shall be true and free from any distortions. All thrust rings shall be true and free from any distortions and sufficiently stiff so as to transfer the load from the jack uniformly to the

packing. Other than at the shield, each group of jacks shall be interconnected to ensure that an evenly distributed load is applied to the thrust ring. Each jack shall incorporate a load cell.

At the rig and at intermediate stations automatic thrust recording equipment monitoring load cells incorporated in each jack is to be provided together with a pressure metering device. Other continuous records including cutter torque, rate of progress, slurry progress, pitch, roll, slurry, flow, earth face pressure etc. shall be provided.

Copies of these records clearly stating the units measured shall be submitted daily to the Engineer-In-Charge. The thrust force shall not exceed the maximum permissible thrust force as determined by the Concessionaire, based on calculations submitted by the Concessionaire and approved by the Engineer-In-Charge and on consideration of the behavior of the pipe joint at the maximum permitted angular deflection of 0.5 inch with the maximum permissible bearing stress in conjunction with the stress / strain relationship obtained from the packing compression tests.

Lubrication Holes: Where lubrication holes are required, these shall be threaded to enable plugs to be screwed into the socket and withstand the external pressure. No-return valves shall be fitted where opening a hole would permit ground loss. Lubrication hole shall be plugged watertight on completion; lining or coating shall be made good. The pressure of the lubricant shall be maintained until it is replaced by grout.

Grouting: Upon completion of a section, if grouting is required or specified, the grout shall be pumped through all lubrication holes. The pressure and quantity of grout injected shall be calculated by the Concessionaire and approved by the Engineer. Grouting shall commence at the lower holes and shall be carried out systematically working from one end of the pipe jack to the other. Where injection holes can be opened without loss of ground, grout shall be pumped through the lower injection holes until it emerges from the upper holes.

Grouting progress shall be continuously monitored to ensure not over pressurization.

Records

The Concessionaire shall maintain and submit to the Engineer after each shift a log which records:

- Identification number of pipes installed during shift and name of operator and strata encountered.
- Position and orientation of the lead ten pipes.
- Forces used on both main and inter-jack rams during driving of each pipe.
- Line and level.
- Roll of pipe jacking shield.
- Maximum rate of advance.
- Thrust from ground on face of machine
- Volume of lubricant used, location of injection and pressure at point of injection.
- Gas readings at the excavating face (oxygen, methane and hydrogen sulphide)
- Volumes of material removed.
- Volumes of grout used, the points of injection and pressure at the points of injection.
- Cutter torque
- Slurry flow and pressure.
- Supply pressure
- Pitch of TBM
- Gas readings in thrust pit.
- Level records of around surface or road pavement.
- Accident and stoppage, if any, with full explanation.

Testing: Upon completion of the permanent construction of the tunnel, an infiltration test shall be conducted to verify that the joints are water tight. The infiltration test shall be carried out after dewatering has stopped and the groundwater has attained normal levels. In the case of lined concrete pipes the leakage tests shall be carried out after installation and before the liners of the

successive pipes as joined and sealed. After joining and sealing of the liners, there shall be no evidence of a build-up of groundwater pressure at the joints of the concrete pipe. Man-entry pipelines shall be visually inspected only. Any leaks will be repaired / stopped.

Infiltration or pipe deflection is not permitted in sections of pipelines underneath roads, paved areas and services. In the event of the Works failing the test, for whatever reason, the Concessionaire at his own responsibility, take such remedial action as is necessary, subject to the Engineer-In-Charge's approval of any methods proposed. The Works shall than be re-tested until such time as the Works pass the test.

Monitoring Ground Surface Movement

The Concessionaire shall continuously monitor the ground surface, adjacent structures, and buried utilities and shall control activities such a s excavation, tunneling and dewatering to prevent movement and / or damage to existing structures.

Settlement shall be held to within the following limits:

1. Ground or roadway surface above the pipe center line : 5mm
2. Front face of adjacent structures : 3mm

Settlement points shall be installed and monitored prior to any excavation associated with the pipeline to be constructed by micro-tunneling.

The Concessionaire shall determine the optimum location for settlement point to monitor existing structures to approval of the Engineer.

The Concessionaire shall provide settlement points on the road surface and within existing structures. Settlement points along the road surface shall be located along the pipe Centre line and on lines parallel to the Centre line at 2 metres and 4 metres away from the pipe Centre line on each side. The distance between settlement points along the same line shall be 5 metres. Settlement points on existing structures shall be located approximately 0.5 metres above the ground surface. Location of settlement points in the vicinity of the shafts will be agreed with or at the direction of the Engineer-In-Charge.

The Concessionaire shall monitor all settlement points with reference to benchmarks located outside the area of influence of the works. Monitoring shall demonstrate repeatedly to 3mm.

The Concessionaire shall obtain the elevations of settlement points as described below:

1. For settlement points within 20 meters of the heading, after each advance of 5 m.
2. For settlement points greater than 20 metres but less than 100 meters away from the heading, daily.

The settlement point elevations shall be reported to the Engineer within 24 hours during the course of construction of the pipeline and related shafts.

Should settlement occur greater than the specified limits, at any location affected by the works, the Engineer may require modification of the method or sequence of the work or a shutdown of the work to make appropriate changes in the construction operation. Changes required to keep settlement within the specified acceptable limits shall be made solely at the Concessionaire's expense. **Upon completion of the pipeline, the Concessionaire shall continue to monitor the settlement point elevations regularly during the maintenance period and report to the Engineer on a monthly basis.** If the specified limits are exceeded then the Concessionaire should report immediately and submit a proposal to rectify the road surface and prevent further settlement.

RAW WATER PUMPING MACHINERY AT JAYAKWADI DAM HEAD WORKS

General Description of works

The scheme is planned to meet the total demand of 192 MLD water for Aurangabad Municipal Corporation area. The Raw water from Jayakwadi Dam is to be lifted through 2000 mm O.D. M.S. pipeline, 27000 m long rising main. Under present scheme, 6 nos. of V.T. pump sets and allied mechanical and electrical equipments are to be procured and installed. Out of which 4 no. shall be working and 2 nos. shall be stand by.

1	**Data of the scheme :**		
1.1	Daily Demand of water	183.63	ML
1.2	Hours of pumping considering loss due to tripping & other interruptions	23	Hrs./ day
1.3	Total Flow	192	MLD
1.4	Water Level in the jack well by R.L.		
a	Ground Level at Pumping Station	463.77	m
b	Maximum Water Level (M.W.L.)	463.90	M
c	Maximum Draw down Level (M.D.D.L.)	455.52	m
d	Lowest Water Level (L.W.L.)	440.00	m
f	F.S.L. of Aeration fountain at WTP	516.50	m
1.5	**Rising Main**		
a	Length	27000	m
b	Dia. Inside	2000	mm M.S.
c	Thickness of plate	16.00	mm
d	Thickness of C.M. lining	12.00	mm
e	Clear internal Dia.	1976	mm
1.6	Number of Pumps	6	Nos.
a	**Duty pumps**	**4**	**Nos.**
b	Standby pumps	2	Nos.
1.7	Quality of water	Max.Turbidity suspended solids.	500 NTU
1.8	Max. Ambient Temp.	45^0 C	

Electricity and Water:

The Concessionaire shall arrange for electricity and water supply at site, from available facilities at his own responsibility.

Power Supply: It is intended to provide 33 KV express feeder from MSEDCL. It is proposed to provide 2 nos. of **33 KV/3.3 KV, 3000 kVA** Power transformers with VCB's for raw water pumps and 2 nos. of **33 KV/0.433 KV, 100 kVA** auxiliary transformers for allied equipments.

System and supply characteristics at the site are as under:

33 KV supply, 50 Hz. 3 wire, 3 phase, Fault level - 750 MVA
Anticipated voltage and frequency variations are as under:
Voltage variation ±10 %
Frequency variation ±3 %
Combined voltage and frequency variation ±10 %
The Concessionaire shall communicate the total electrical load required during successful operation of pumping machinery.

Scope of contract:

i) The scope of contract include designing, providing, erecting, testing, commissioning and operation & maintenance during concession period of the vertical turbine pump sets with all allied mechanical and electrical works as per layout and specifications below.

ii) ii) The total work is of turnkey nature.
iii) The job includes loading, unloading, transportation, delivery at site, storing with due care, erection with required civil works, performance test, operation, maintenance etc. complete.
iv) The matters omitted and not specified in the document , but which may be inferred to be obviously necessary for intended service shall be deemed to have been included in the contract and shall be obligatory and this point shall be carefully noted by the Concessionaire.

Obligatory Conditions: It is obligatory for the Concessionaire to examine the pump supporting arrangement of civil structure and suitability of submergence in the jack well and submit the following information:

i) Weight of pump including bowl assembly, column pipes, discharge head, motor stool, thrust bearing etc.
ii) Weight of VSS motor.
iii) Maximum dynamic load imposed on the pump supporting structure with justification and reference to I.S.
iv) Characteristic curves of the bowl assembly and pump showing relationship between discharge and head, power required and efficiency (bowl performance curves and pump performance curves shall be drawn on same graph and shown in separate legends for easy identification. Head losses in strainer, suction bell mouth, column pipes, and discharge head, and power losses in line shaft and thrust bearing shall be considered for characteristic curves of pump.
v) Pump (not bowl) performance curve for solo and parallel operation from 2 nos. to 4 nos. showing relationship between discharge and head superimposed on system head curves for getting an idea of immediate and ultimate stage discharge.
vi) Point load on corbel due to crane and heaviest equipment handled with full justification.

Test Certificate and Manuals:

The successful Concessionaire shall submit test certificates for various components as called for in the specifications. If necessary and required by the Engineer-In-Charge, certificates for materials of construction of equipments shall be furnished.

The successful Concessionaire shall also submit Instruction manuals in duplicate covering operation, maintenance and repairs of all equipments including wiring diagrams and charts in duplicates for periodical maintenance of equipments.

Acceptable makes:

1.	Pumps	Kirloskar / Mather and Platt / Jyoti / FBM/Worthington/ Flowmore
2.	Valves	Kirloskar / IVI / IVC
3.	Vacuum Circuit Breaker	Jyoti / GEC / Crompton / Siemens / BHEL
4.	Cranes	Hercules / WMI
5.	Transformer	Kirloskar / Crompton / NGEF / Bharat Bijli / Western Vivekanand / Trans Delta
6.	H.T. Panel	Jyoti / GEC / Control & Switchgear
7.	VSS motors	Kirloskar / Jyoti / NGEF / Crompton / Marathon
8.	H.T. Capacitors	Prabodhan / Madhav / Khatau
9.	Cables	Finolex / ICC / Asian / Gloster / Tropadur
10.	Valve actuator	Beacon Rotork / Auma

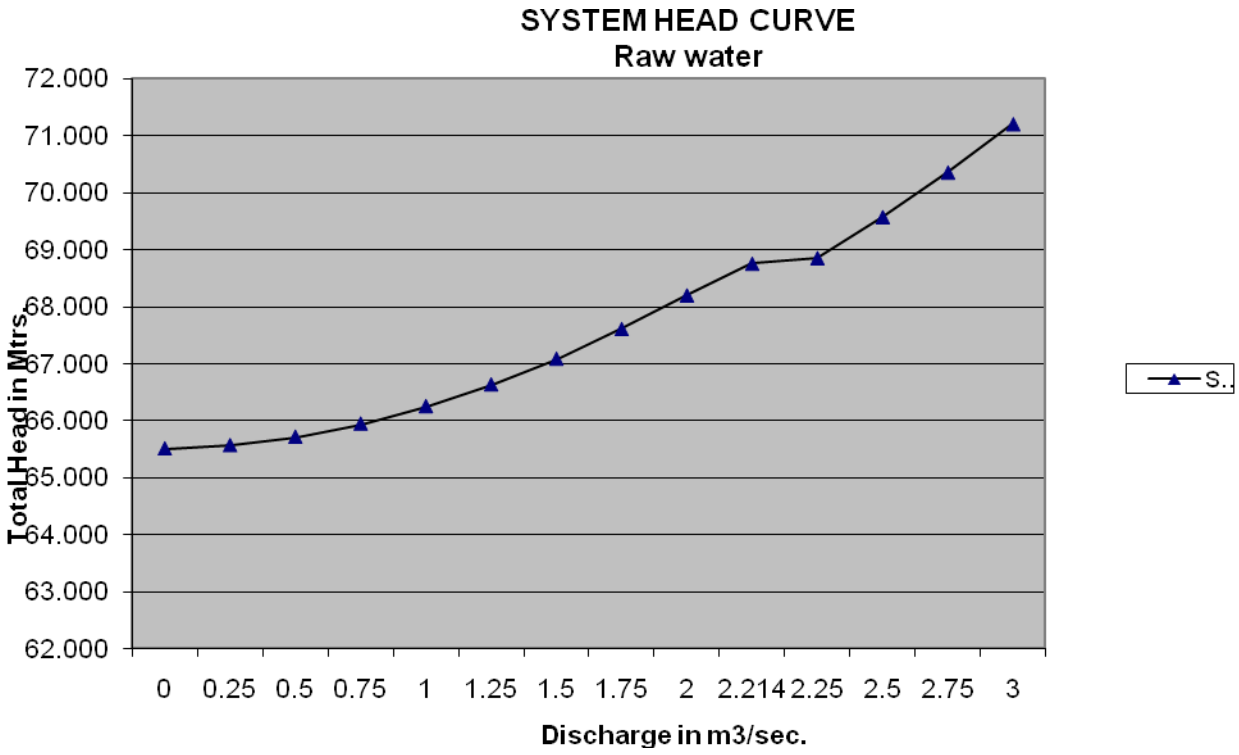
DETAILED SPECIFICATIONS FOR ELECTRO-MECHANICAL WORKS FOR RAW WATER PUMPING MACHINERY

V.T.PUMPS: Each V.T. pump (Water lubricated) shall be of approved make and suitable for following duty conditions and operating conditions.

1.	**Discharge**	**554.44 lps i.e. 555 lps**
2.	**Head**	**73 m**
3.	Head Range	55 m to 81 m
4.	Shut off Head	more than 100 m
5.	RPM of pump	980 RPM
6.	No. of stages	Not more than 2
7.	Efficiency	Minimum 84%
8.	No. of pump sets	**6 Nos. (4 Nos. working + 2 Nos. stand by)**

The total head referred above is inclusive of all losses in the pipeline from discharge flange of the pump to WTP. Inlet losses in column pipe and discharge head for individual pump shall be assessed by the Concessionaire and included in the design head of bowl assembly.

Characteristic Curves: System head curve for the system is furnished. The Concessionaire shall furnish characteristic curves of bowl assembly and also pump after deducting column losses etc. The Concessionaire shall furnish along with his bid, the characteristic curves so prepared superimposed on system head curves for single and multi pump operation. The pumps shall have stable characteristics over the entire range of working head. The pump shall be suitable for starting against closed sluice valve i.e. shut off condition. The efficiency curve shall be reasonably flatter between head range 52 m to 76 m.



Codes and Standards: The design, manufacture and performance of the V.T. pumps shall comply with all currently applicable regulations and safety codes in the locality area where the equipment will be installed. The equipment shall also conform to the latest applicable Indian Standards. In particular the equipment shall conform to the latest revisions of the following:
IS 1710 -Vertical turbine pump for clear cold, fresh water.
IS 5120 - Technical requirements for roto-dynamic special purpose pumps.

Where the above standards are in conflict with the stipulation of this specification, the specification supersedes them.

Design Requirement: The equipment shall be capable of developing the required total head at rated capacity for continuous operation. The total head discharge curve shall be continuously rising towards the shut off with highest shut off point. Pumps shall be identical and shall be suitable for parallel operation with equal load division. Impellers shall preferably be of non over- loading type. Pumps shall run smooth without undue noise and vibrations. The magnitude of peak to peak vibration at slip will be limited to 100 microns at the bearing housing. Pumps shall be vertical turbine type with required number of stages not exceeding the requirement given above and suitable for the service conditions stipulated.

Bowl Assembly: The pump bowls shall be flanged with machined matching of faces. The joints, suction bell mouth to bowl assembly, to column pipes and to discharge head i.e. all joints shall be flange joints. The bowls shall be capable of withstanding a hydrostatic pressure equal to twice the duty head or 1.5 times shut off head which ever is greater.

Suction Bell mouth & Strainer: The cast iron / M.S. bell mouth, not less than 900 mm dia. shall be fitted to the suction case to limit the velocity. The suction strainer shall be of S.S. Net opening area in strainer shall not be less than 3 times the entrance area of bell mouth. The shape and curvature of the bell mouth shall be designed to streamline the flow of bowl suction. The thickness of bell mouth shall not be less than 10mm.

Impeller: The impellers shall be dynamically balanced so as not to cause any vibrations during operation. The impellers shall be closed type and shall be made in one piece and securely fixed to the stainless steel shaft, to assure accurate adjustment of each impeller. The water passage will be finished smooth by hand. Balancing holes for reducing hydraulic thrust shall not be provided.

Wearing Rings: Wearing rings shall be renewable type. These shall be held in place by screwing against rotation, press fit or locked with pins, flanged and screwed. Wearing rings shall be provided on both casing and impeller. Hardness of wearing rings shall be less by at least 50 BHN than the impeller.

Shaft: The shaft shall be of stainless steel and furnished to the close tolerance at the impeller / bearing fixing sizes. The design of the shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above / below the operating speed.

The shaft shall be properly balanced so as not to cause any vibrations during operation. The pump shaft bearings i.e. bush bearings would be Finostos, water lubricated. Extra long bearing shall be provided for suction and discharge bowls.

Column Pipe Assembly: Column pipes shall be of M.S. Fabricated heavy weight, flanged type, each in 1.5 m length or less so that after complete erection of the pump the bottom of strainer shall be at 1.5 m above the bottom of jack well and length of strainer shall be adjusted accordingly. The total length of column assembly, bowl assembly, bell mouth and strainer shall not be less than 14 m for each pump.

The column assembly length (including column pipes, bowl, assembly, bell mouth and strainer) shall be adjusted considering the pump floor level. A matching piece shall be provided if required. The stiffeners shall be provided to all pipe flanges. The discharge head and column pipe diameters shall be same. The discharge head shall incorporate full diameter elbow.

Line Shaft: The shafts shall be of solid circular section, prepared from stainless steel, machined and ground thoroughly and coupled with muff couplings. The shaft sections shall be provided with non-corrosive and abrasion resisting wearing surfaces particularly at the location of each guide bearing. Length of line shaft shall not be more than 1.5 m. each.

Line Shaft Bearing: These shall be designed to be water lubricated by the pump self water and shall be placed in bearing holders located in position at the joint of columns. Line shaft bearing shall be of Finostos designed for efficient lubrication. Composite design of line shaft and bearing centres shall ensure that the entire rotating assembly is brought from stand-still to full speed without any vibrations and shaft deflection and to ensure that first critical speed is not within 80% to 120% of full speed.

Discharge Head & Motor Stool: The discharge head shall be fabricated from M.S. and shall incorporate mounting flange for motor stool for solid shaft motor, stuffing box with renewable gland packing and tapping for pressure gauge mounting etc. The discharge head shall be of robust construction and shall be designed to support entire load of pump assembly, water column and motor etc. and shall withstand all static, dynamic and torsional loads, hydraulic thrust imposed during operation from shut off to stipulated operating conditions and thrust due to change in direction of flow, without any vibrations. Discharge head with sole pads will not be accepted. The discharge head shall be installed on sole plate with ISMB frame and entire load of motor and pump shall be on the lower floor as given below:

Pump floor level 466.60 m RL
Panel floor level 470.00 m RL

Drain arrangement for gland leakage water shall be provided at bottom of discharge head with G.I. pipe. The base of the discharge head shall not be less than 1200 mm x 1200 mm. The power shall be transmitted from motor to vertical shafting through a flexible coupling. Both halves of the coupling shall be machined all over, securely keyed to their respective shafts. The pins shall be of stainless steel. The arrangement of two halves shall be suitable to check alignment and parallelism. A self aligning thrust bearing shall be housed in the head gear adequately designed to accommodate entire weight of rotating parts and hydraulic thrust and shall be suitable for reserve rotation up to at least 150% normal forward speed. Bearing shall be designed for 30,000 hours life. The bearing shall be of oil lubricated type and shall be provided with oil level gauge and suitably positioned temperature probes. Two sets of adjustable contacts shall be provided one for an alarm and other for tripping the raw water pump motor. This shall be connected to 3.3 KV main panel so that digital temperature can be read out with alarm and tripping.

Motor stool shall be provided for mounting the electric motor. The motor stool shall accommodate the pump thrust bearing and pump motor coupling. The motor stool shall be robust construction and of fabricated mild steel and adequately sized with opening to work on the flexible coupling.

The pump shall be provided with non reversible rachet or similar mechanism to prevent them from rotation in reverse direction. Pressure gauge for each pump and manifold pipe shall be provided. Pressure gauge shall be 150 mm dial, 0-15 kg/cm^2 and least count shall be 0.05 kg/cm^2. Each pressure gauge shall be fitted with restrictor nozzle of brass and G.I. Pipe and U tube. Pressure gauge on common manifold shall also be provided. All pressure gauges shall be installed in pump house on wall with necessary G.I. pipe connections from manifold to pump house. The pressure gauges shall be installed at suitable height so that the reading can be taken accurately.

Sole Plate: The M.S. sole plate arrangement shall be provided under the discharge head for precise horizontal and vertical alignment. Thickness of sole plate shall not be less than 40 mm. It shall be independent of base plate integral with the discharge head. The contact surfaces of the sole plate arrangement as under shall be machined for precise leveling and shall ensure vibration free operation of the pump.

i) Base frame and sole plate
ii) Sole plate and discharge head

All joints between machined contact surfaces shall be with nut bolts/ tapped studs/ bolts. All contact surfaces shall be blue-matched to ensure proper contact to the extent of 60% of contact area after necessary site finish if required. The opening in the sole-plate/frame shall be of adequate size to pass the bowl assembly etc. very easily. M.S. base frame shall be anchored on the main RSJs or supporting RCC beams ensuring complete rigidity. Entire structural fabrication and foundation arrangement shall be designed and submitted for approval.

Air Release Arrangement: An air cock of 50 mm dia and same size GI pipes, bend shall be fixed to the discharge head. The G.I. pipes shall be suspended vertically in the well with adequate length to release air.

Water Lubrication Tank and Other Accessories: In order to lubricate line shaft bearing of the pump, lubrication arrangement comprising the following shall be provided. Lubrication tanks 2 Nos. interconnected with each other and common for all pumps fabricated from sheet metal of thickness not less than 5 mm and of capacity not less than 1 m^3. The tank shall be cylindrical and shall be installed on panel mounting floor with at least 6 concrete saddles or as directed during execution by Engineer-In-Charge.

Each lubrication tank shall be equipped with the following:

a) W L sight gauge
b) Overflow lead to sump
c) Drain valve lead to sump
d) G.I. pipe connection with isolating valve and non- return valve to each pump column assembly for lubrication. The valve shall be located near the tank. The size of individual pipe and valve to pump shall be 40 mm diameter.
e) Inlet connection with solenoid operated valve and suitable removable strainer by suitable tapping from common header.
f) Float valve in the tank for control of overflow.
g) Any other item necessarily required for proper functioning.

All accessories required for proper and safe operation, dismantling and erection and pump shall be supplied with heavy duty clamps for column and line shafts, one pair for each pump.

Material of Construction:

a) Discharge and suction case, Bowls	:	C.I. I.S. 210 Gr. FG 200
b) Discharge head, Bell mouth and motor stool	:	M.S. Fabricated
c) Impeller : Bronze to I.S. 318 GR II	:	
d) Impeller shaft	:	SS 410
e) Column pipes	:	ERW heavy duty
f) Shaft Sleeve	:	SS 410
g) Line shaft	:	SS 410
h) Nut bolt and washer	:	SS 410
i) Wearing ring	:	I.S. 318-LT B2
j) Line shaft bearing	:	FINOSTOS
Minimum Sizes:	:	
a) Column pipe diameter	:	600 mm
b) Thickness of column pipe and Bell mouth	:	10 mm
c) Impeller and line shaft dia	:	90 mm or nearest commercial size
d) Bell mouth diameter	:	900 mm
e) Thickness of sole plate	:	40 mm

Testing: All the pumps shall be subject to factory tests in presence of Engineer-In-Charge or his representative and third party appointed for the purpose.

The Concessionaire shall arrange all required test equipment duly calibrated for field performance test, which shall be witnessed by Engineer-In-Charge.

FACTORY TEST:
The test shall include review of raw materials' test certificates and quality control procedure.

1) Hydrostatic Test: Following items shall best tested at hydrostatic pressure equal to twice duty head or 1.5 times shut off head of bowl assembly which ever is higher as per IS 5120.

i) Bowl assembly

ii) Discharge head
iii) 20% quantity of column pipes.

2) Performance Test: The test shall generally be carried out as per IS 9137. The test shall be carried out at full speed and full load at manufacturer's work. The test shall be carried out to cover following 10 points:

i) 1 Duty point
ii) 4 points above duty point
iii) 4 points below duty point
iv) 1 Shut off head

Power consumption at all above points shall be recorded.
Zero reading confirmation for V notch measurements shall be done.

The test shall be carried out only by the job motor which will be supplied under this contract. The test at reduced speed and reduced load will not be accepted.

3) Strip Inspection: Three no. of pump sets, after completion of its performance test and as selected by the Engineer or Inspector at random will be offered for strip inspection and dimensional checking. The manufacturer/ contactor shall submit all required dimensional drawings for strip inspection. Minimum points as under shall be checked.

i) Condition of all components particularly bushes, bearings and wearing rings to examine undue rubbing, wear etc.
ii) Hardness of Finostos bearing
iii) Dynamic balancing of (a) Impellers (b) Flexible coupling
iv) Clearance between
    a) Wearing rings
    b) Impeller shaft and bearings
    c) Impeller shaft and key
    d) Shaft and flexible coupling
    e) Key and keyway on shaft

MATERIAL TEST CERTIFICATE:
Material Test Certificate of the various pump components shall be furnished by Concessionaire.

FIELD PERFORMANCE TEST: The test shall be carried out as per IS: 9137 code of acceptance test of pump Class-C, in general and as started below in particular. The purpose of the field test is not to ensure whether pump performs as regards parameters i.e. H, Q & power etc. within acceptance limit as per IS: 9137. The purpose is to ensure that the pump performance is generally acceptable or otherwise. Final acceptance shall be as per following criteria.

a) Verification of guarantee of H & Q specified in clause 9.4.1 of IS: 9137 shall be based on following liberalize tolerances.
X_H ± 0.06 Xqv ± 0.09

b) As regards P-Q characteristic for acceptance it shall be checked whether motor is not getting overloaded within the specified head range.

c) Volumetric measurement shall be taken on basis of rise in level in MBR. In addition flow meter to be provided by Concessionaire.

d) The head shall be measured with calibrated pressure gauge of accuracy 1% or better .At least 3 pressure gauges shall be got calibrated from two different institutions with prior approval of the Engineer- in-charge. The calibration shall be point to point and not mere for percentage error.

The gauge shall be fitted at suitable place from the discharge nozzle. It may be noted that pressure gauge shall be installed at least 2 times diameter away from discharge nozzle and

delivery valve be placed at least four times diameter away from discharge nozzle. Such conditions shall be simulated at site condition and no allowance for this deficiency shall be considered. The decision of Engineer-in- charge shall be final.

e) The input power to motor shall be measured with 2 Nos. Class 0.5 accuracy single phase watt meters with suitable CTs and test lids and PTs provided in Panel. The watt meters, CTs and PTs shall be got calibrated point to point and not mere for percentage error.

f) The speed shall be measured by at least 2 Nos. non contact tachometers with digital display calibrated from two different institutions approved by the Engineer-In-Charge.

g) The field test shall be taken with entire head range in such a manner that it would cover at least 6 points (i.e. 1 duty point, 2 above duty point, 2 below duty point and shut off). The guarantee for head and discharge shall deem to be fulfilled as per clause.

The field performance test at site is absolutely essential as above (a) to (g) and the manufacturer shall also be asked to attend the same.

SLUICE VALVES 600 mm

General: The Sluice valve of **600 mm** diameter shall be of approved make and shall be provided in the delivery pipe of each pump. The sluice valves of cast iron body suitable for the PN 1.6 rating shall be provided and shall conform to IS: 14846:2000. The sluice valves shall be double flanged, water works pattern, inside screw, non-rising spindle type and shall be fitted with double faced gunmetal taper wedge made in one piece and having two machined facing rings securely fixed into machined recesses in the wedge. The guides and the lugs shall be provided to guide the wedge through its full travel and the lugs and guides shall be lined with bronze. The bronze liners provided on guides and lugs shall be secured by counter-sunk screws or rivets of nonferrous metals. The clearances (radial and axial) between the lugs and guides shall not exceed 2.5 mm. All valves shall be provided with individual electrical actuators on delivery side of each pump.

The valve positions shall be as shown on approved drawing. The valves shall be installed on pump floor as directed by Engineer-In-Charge.

Valve Actuators: Each sluice valve shall be provided with an electric actuator of approved make Elect. Actuator shall be suitable for operation on 415V, 3 phase 50 Hz electric supply. The motors shall be squirrel cage type with insulation conforming to IS: 2613 Class B. The actuator shall be suitable for opening and closing against duty head considering shut off. At least 50% safety margin over normal operating conditions shall be provided in motor rating for unseating the valve. A thermal cutout device shall be provided to enable starting from any valve position. A local push button/ rotary switch and LOCAL/OFF/REMOTE selector switch shall be provided with clear marking for switch position, in addition to separate ON-OFF device on L.T. Panel as described as detailed specification. The terminal box shall be a separate unit bolted to gear case and provided with double ‘O’ ring sealing arrangement to prevent moisture from entering the actuator even if terminal box is removed.

Drive bushing shall be provided for accommodating the valve spindle. The bushing shall be detachable type. Pair of limit switches shall be incorporated in the actuator to provide remote position and interlock signals. Similarly a torque switch for closing and a position switch for opening shall be provided. Necessary mechanism to prevent torque trip while unseating shall be provided. A hand wheel shall be provided for emergency manual operation of the valve with interlocking to prevent motor operation while the valve is being operated manually.

Arrangement for greasing and drain plug shall be provided in the actuator. The drive shall incorporate a backlash hammer blow feature. Thrust bearing of ball or roller type shall be provided with oil or grease lubrication.

A reduction gear box shall be provided between actuator and valve. The torque rating of the reduction gear box shall be at least 2.0 times maximum torque required for opening and closing of the valves. The reduction gear box shall be oil lubricated.

The entire unit i.e. valves actuators, reduction gear box along with valve and accessories shall be supplied by valve manufacturers only. The valves and valve actuators combined shall be tested at valve manufacturer's works for operation against requisite duty. The design calculation of torque and HP of actuator motor shall be got approved from Engineer-in- charge.

SLUICE VALVE 200 MM DIA:
A sluice valve of **200 mm** dia shall be of approved make and shall be provided in the common manifold pipe for scouring arrangement. The sluice valve of cast iron body shall be suitable for PN1.6 rating. The valve shall conform to I.S.-14846-2000.

Testing: All sluice valves and actuators shall be tested at manufacturer's works as per relevant IS in presence of third party testing agency approved by department, and Engineer-In-Charge or his representative and the scope of inspection is as given below.
For sluice valves
a) Review of raw material test certificate and quality control procedure.
b) Body and seat test.
c) Test with operation of actuator and reduction gear box fully assembled with valve opening and closing with synchronizing.
d) Checking wear travel.

FOR VALVE ACTUATORS:
a) Review of raw material test certificate and quality control procedure
b) High voltage test
c) Insulation Resistance test
d) Routine and operation test
e) Checking wiring diagram and circuit
f) Operation with limit switches

HYDRAULICALLY CONTROLLED NRV 600 MM
General: Hydraulically controlled NRV, **600 mm** diameter shall be provided with linear tubular fabricated body with hydraulically controlled pressure dissipating mechanism. Hydraulically controlled NRV should have variable closure rate in different closing bands predetermined by analysis to control any jerks due to sudden closure of disc. Control unit should be externally mounted to facilitate maintenance from outside, without removing valve from line. It should be possible to observe working of valve externally.

CONSTRUCTIONAL DETAILS:
Body Shell - External body should be linear tubular in nature fabricated out of M.S. Sheet as per IS 2062. Shell thickness should be kept suitable to valve rating.

Disc – Disc or main control flap should be of suitable thickness made of M.S. (IS – 2062 or equivalent) should be connected to the hydraulic control unit with a shaft.

Shaft - Shaft should be made out of high tensile material En 8 or equivalent.

Bushes - Shaft should have bearings or bush type in Gunmetal or Brass only.

Control Unit Specifications:
A. Main control unit should be consisting of multiple control units & should be connected by a shaft to the main flap.
B. The control unit should generate variable closure rates.
C. This variable controlled closure of the main flap with the aid of the control unit or units should result in controlled decay of velocity or momentum during reversal.

D. Closing rate of the main flap in the last segment should be slow as determined by scientific analysis .Hydraulic control unit must be capable of fine tuning the closure pattern by for 5 deg to facilitate complete synchronization with the actual piping conditions.
E. The hydraulic controls units shall be external to the main valve body and assembled with the help of suitable mechanism. It must be possible to service/ repair valve externally without removing the valve or stoppage of flow.

NRVs should have duel closing characteristics as per above specifications. NRVs should be completely leak-tight and back flow should be allowed only through external bypass of 80mm size with isolating sluice valve of PN 1.6 rating.

BUTTERFLY VALVE 600 mm

600 mm dia Butterfly valves shall be of short wall body pattern, with both ends flanged. The valve shall conform to IS 13095 suitable for PN 1.6 rating. The valve shall be of approved make only.
The manual actuator with suitable hand wheel shall be provided to operate the valve. The shaft shall be horizontal. The valve seat on the disc shall be of synthetic rubber and renewable without dismantling the valve. All fasteners shall be of stainless steel, the valve body, disc and disc cover shall conform to grade FG-260 of IS 210. Suitable hand wheel for operation of valve shall be seamless with open and closed marking.

Testing: All the valves shall be tested at manufactures works as per relevant IS in presence of third party agency approved by department and Engineer-in charge or his representative.
The scope of inspection is as given below:

a) Review of materials test certificates and quality control procedure.
b) Seat and body hydro-test for test pressure as per IS.

KINETIC AIR VALVE 200 mm.

Two Nos. kinetic Air Valves of **200 mm.** dia shall be of approved make and shall be provided and installed on common manifold outside pump house as shown in the layout drawing. The kinetic air valves, conforming to IS 14845 shall be of two orifice type, the small orifice releasing air from the pipe under normal working condition while the large orifice shall admit or release air when the pipe is being emptied or filled. The air valves shall be designed to operate satisfactorily at a normal working pressure of 10 kg/cm2. Kinetic air valve body shall be tested to 16 kg/cm2. Each air valve shall be provided with an isolating sluice valve of 200 mm dia which shall generally comply with specifications given above except for electrical operation. The isolating valves shall be provided with seamless cast iron hand wheels for manual operation.

TESTING: All valves shall be tested at manufacturer's works in the presence of third party inspection agency approved by department and Engineer-in- charge or his representative. The scope of inspection is as given below:

a) Review of raw materials test certificate and quality control procedure.
b) Hydraulic pressure as per relevant IS. (body Test)
c) Operation test for functioning of small orifice and large orifice.

M.S. Pipe Work: M.S. pipe work shall be fabricated from steel plates conforming to IS: 226. The fabrication of pipes shall generally conform to IS: 3589. The 1976 mm. (I.D.) dia and 600mm dia (I.D.) M.S. pipe and specials shall be fabricated out of 10mm thick plate as per approved drawing.
Layout drawings for pipes, specials and valves shall be got approved from department prior to erection. All the specials and pipes shall be painted with two coats of anticorrosive paint. Dished end shall be provided at the end of common manifold and thickness of dished end shall not be less than 16 mm.

Air release arrangement: An arrangement shall be made for release of air coming from the column pipes of pumps. A bend of 50 mm dia shall be provided after discharge head for air release arrangement.

Flanges: The flanges for pipes and specials shall be designed to with stand 25 kg/cm^2 pressure. Matching faces of the flanges shall be properly machined. The flanges shall conform to IS: 1538. The flanges shall be of minimum 20 mm thickness.

The jointing shall be rubber of proven hardness, suitable for forming water tight joint and shall be of flat section 3 mm thick.

Painting: For all M.S. pipes and specials supplied by the Concessionaire, the internal and external surfaces of the pipe work and specials shall be painted with one coat of epoxy primer and two coats of epoxy paint approved by the Engineer-In-Charge.

Testing: The Concessionaire shall give satisfactory testing of the pipe work at hydrostatic pressure of 15 kg/cm2 in presence of Engineer-In-Charge.

R.C.C. WORK

The detailed specifications shall be as per relevant IS codes which are applicable for RCC works as per prevailing practice of MJP, PWD etc. in the state of Maharashtra. In addition to that the following information is mentioned as guide lines for the said item.

Suitable and adequate numbers of concrete saddles for pipe work and valves shall be provided. The Concessionaire shall also provide all steel packing plates required for erection of the plant as directed by the Engineer-In-Charge. Necessary concrete block shall be provided below all sluice valves, reflux valves, delivery pipe, and manifold. The size of concrete block shall be provided as directed at the time of execution. The thrust blocks are also included in the scope of this contract under this item. All concrete work shall be cast-in M-25 grade concrete.

DISMANTLING JOINT, 600 mm:

A dismantling joint of 600 mm size shall be provided in delivery pipeline of each pump. The dismantling joint shall be placed between pump and non – return valve and shall be fabricated from M.S. plates designed to withstand for 25 kg/cm2. However, plate thickness for barrels shall not be less than 10mm. The design of the joint shall ensure that no forces are transmitted to the pump foundation, and the flanges of dismantling joints are held rigid during normal working. For dismantling, it should be possible to slide flanges at one end by at least 20 mm to enable dismantling and refitting. General arrangement drawing shall be got approved from the Engineer-In-Charge before actual fabrication of the joint.

E.O.T. CRANE, 10 MT:

A **10 MT** safe working capacity and tested to 1.25 times working capacity, **E**lectrically **O**perated double girder overhead **T**ravelling crane of approved make with all accessories shall be provided. The functional requirement of the crane shall be as under:

i) To lift complete weight of the pump or motor from any point, in the pump house. The operation shall be electrical; lift of hoist chain should be 10 mtrs minimum,
ii) To travel longitudinally along entire length of the pump house including loading/ unloading bays. Operation shall be electrical. Longitudinal travel shall be 36 m.
iii) To travel laterally across entire nominal pump bay span. Operation shall be electrical. Lateral travel shall be 15 m.

This item includes:

i) Continuous RCC corbel beams along entire length of pump house shall be provided by pump house civil Concessionaire and only 50 x 50 m square bars or rail section of 90 lb/yard shall have to be installed in the scope of this item with necessary anchoring & flush plates.
ii) Bridge girder mounted on track wheels and end carriages
    a) Motorized mechanisms for all three motions (Hoist speed limited to 4 m/min)
    b) Hoist suitable for 10 mtrs Lift
    c) Trolley and hoist
    d) Push button operated pendant
    e) Control gears and switch gears including earthing.

The crane shall generally conform to I.S. 3177 and I.S. 807.

Bridge Rails And Supporting RSJ: The bridge girder shall be designed to carry load as given above at any position during travel. The wheels of end carriage shall be machined and shall have flanges on common shaft, extending full span for longitudinal travel and shall be with reduction gear box. The rails/square bas shall be secured on supporting R.C.C. beam with all required fasteners. End stops to prevent over travel shall be provided.

Traveling Trolley And Hoist: The traveling trolley shall have single flanged wheels and shall be mounted on lower flange of the bridge girder. Suitable stops shall be provided to prevent over travel of trolley.
The hoist shall be mounted below traveling trolley. The hoist shall incorporate swivel hook with ball and roller bearing.

Reduction Gear Boxes: The reduction gear boxes shall be of robust construction and for arduous duty. They shall be fully enclosed with oil level marking for minimum and maximum levels. The bearings shall be ball and roller type and taper roller bearings shall be provided where thrust loads are to be sustained.

Brakes And Clutches: Automatic electro-mechanical brake system shall be provided for hoisting motion. The hoisting motion shall stop automatically at upper and lower limits. Electro-magnetic clutch or similar safety device shall be provided on all power transmission system to disengage the motor in case of over loading and obstruction.

Motors: The electric motors shall be totally enclosed, fan cooled with enclosure conforming to IP 54 or superior. They shall be squirrel cage induction motors working on 230 V/415V A.C. supply with class 'F' insulation. The motors shall preferably be foot mounted and shall be designed for S 5 duty as per I.S. 325. The motor for hoist shall be designed for min. 1.6 times safe load.

Switchgear, Control Gear And Electrical Works: A Panel fabricated from mild steel sheets of 2.0 mm thickness and down shop leads shall be provided to meet the functional requirement of crane.
The essential features shall be as under:

1) Reception and distribution of power for Electric motorized operation.
2) Control gears for start and stop of the motors with reversing motion.
3) 3.Operation of hoisting motion including reversing motion by means of suspended mobile pendant set for operation from pump floor level.
4) Limit switches for automatic stop of hoisting motion.
5) Earthing arrangement.
6) L.T. cable as required.
7) Holder and bulb fixture should be provided on trolley, so as to travel with trolley for required illumination at work site.

Material Of Construction: Material of construction for components shall be as stipulated below or superior.

i) Structural steel-conforming to IS 808.
ii) End carriage-steel conforming to IS 2060.
iii) Track and trolley wheels- carbon steel conforming to IS 1030.
iv) Hooks- steel to I.S. 1875/ forged steel conforming to IS 1875.

Testing: The crane shall be tested at manufacturer's works in presence of third party approved by department and Engineer-In-Charge or his representative. The scope of testing is as follows:-

a) Review of raw materials test certificates and quality control procedure.
b) The crane shall be tested 1.25 times working capacity for all 3 motions for operation, deflection and load test. Site conditions shall be simulated for deflection test.

22 KV SUB-STATION POLE STRUCTURE AND CIVIL WORK.
The substation drawing and general layout of substation equipments shall be prepared and got approved from the Electrical Inspector.

Pole Structure: Required quantity of RSJ 200 x 100 mm pole structure and bus etc. shall be provided and extended to provide bays for reception and isolation of incoming feeder, formation of bus and extension of bays for transformers. The item includes required number of channel sections to accommodate AB switches, outdoor CTs, PTs, insulators and bus. Stays for incomer poles shall be provided. All poles shall have adequate foundation.

Lightening Arrestor: Two sets of lightening arrestors each comprising 3 No shall be provided on pole structure at suitable locations in feeder switch yard and transformer switch yard. The final location shall be as approved during detail Engineering and as approved by Electrical inspector. The arrestor shall be of 33 kV station class.
It shall have anti-contamination feature and pressure relief device with current limiting gaps generally conforming to IS: 3070 Part – I. Test certificate in duplicate from the manufacturer shall be furnished.

Air Break Switches And Isolators: AB switches and isolators as shown in the approved single line diagram shall be provided. All transformers shall be provided with individual AB switches in addition to a AB switch for incoming VCB. The insulators shall be post type suitable for 33 kV system and conforming to IS: 2544. Each switch shall be rated to 200 Amps continuous current, and short time current of 50 kA. The AB switches shall be mounted on cross channels on pole structure. The isolators shall be mounted on concrete pedestal or pedestals fabricated from angles, channels etc. The AB switches shall be triple pole, manually operated off load type, double break and suitable for mounting in vertical position. The isolator shall be 3 poles, revolving type suitable for horizontal mounting. Both AB switches and isolators shall be gang operated. Each pole of the switch shall be rated for 200 Amp. The switch shall be complete with down rod lever, G.I. pipe operating handle erected on extended square shaft and supported by external bush bearing, coupling pipe, padlocking arrangement and other components for the assembly. The contacts shall be of suitable copper alloy only.

The porcelain insulators for air break switches shall be of double post type using 2 Nos. of 22 kV post insulators. The insulators shall comply with the specifications separately mentioned elsewhere in respect of electrical and mechanical characteristics.

Horn Gap Fuses: 33 kV Horn gap fuse shall offer protection against short circuit and suitable for use in conjunction with 33 kV system saving fault level of 750 MVA. The fuse shall be designed for horizontal mounting 2 Nos. x 33 kV post insulators. The set shall comprise of 3 numbers. In all 5 nos. of horn gap fuses sets shall be provided.
The complete fuse shall meet impulse voltage in accordance with BS: 2692 or IS: 3106. The same shall withstand power frequency wet withstanding voltage in accordance with IS: 1818.
The fuse equipment shall be mounted on pedestals as specified for isolator.

Conductors And Insulators: The bus bars, bus-taps, interconnector jumpers shall be copper conductor rated to carry 200 Amp continuous current, without exceeding temperature rise of 70^0C over ambient temperature and to carry 50 kA fault current for 1 second without exceeding temperature limit of 200^0C. The bus bars spacing and supports shall be designed to keep deflection within limit. The terminations and interconnections shall be with mechanical bolted type clamps, ensuring reliable permanent and good electrical connections. Wherever appropriate and required, the base conductors shall be covered with alkathene pipes or other insulating pipes/ tubes.
Required no of disc and post pin insulators shall be provided. The insulators shall conform to IS: 731 and IS: 2544 applicable for system voltage of 33 kV rating.
Test as per relevant IS shall be carried out, test certificate shall be furnished in duplicate.

Substation Civil Work: The Concessionaire shall design and construct sub-station plot of size as required and approved by the Electrical Inspector including excavation, filling, leveling etc. The

substation plot shall be leveled to a level of 0.3 m above ground level with approved earth work including watering, mechanical compaction to required density. The work includes earth excavation, transportation and disposal at all lifts and leads. The entire sub-station plot area shall be covered by graded stone metal of size 25 mm.

The fencing shall be galvanized chain link of mesh size 50 mm x 50 mm made of 10 SWG GI wire. The fencing mesh wire shall be welded on ISA 75 galvanized angle frame of 2.45m height spaced at a distance of 1.2 m. The section of the frame shall be fitted with flat iron support of size 25 x 6 mm on top, bottom and midway and chain link jali of 3.26 mm dia or 10 SWG G.I. hard wire mesh of 50 x 50 mm to the angle iron at every distance of 30 cm by iron studs complete duly painted with one coat of red oxide and two coats of aluminum paint.

Fencing Gates: 4 no of double leaf hinged doors each 150 cm in width and 185 cm in height using 40 mm GI B grade ISI mark pipe shall be provided at 4 corners of the sub-station area. The channel iron of size 150 x 75 mm by 2.5 m long shall be provided and erected at both sides of the gate.
The total fencing shall be painted with one coat of red oxide and two coats of silver paint.
Minimum 25 nos. of GI fire buckets (with round bottom) of 9 lt capacity and filled with dry sand shall be kept in sub-station on M.S. stand.

D.C.P. type fire extinguisher cartridge type with G.M.cap 150 gm CO^2 gas cartridge powder brackets conforming to IS 2171-1985 and erected with necessary stands with 10 kg cartridge capacity - 10 nos. shall be provided.
6 nos. of 33 kV rubber hand gloves shall be provided for operation of A.B. switches.
Printed instruction chart for treating persons suffering from electric shocks shall also be supplied by the Concessionaire.

POTENTIAL TRANSFORMERS:
The outdoor type potential transformer for measurement shall be single phase, double wound oil filled type suitable for 33 kV effectively earthed system and generally conforming to I.S.3156. They shall be mounted on pole structure on incoming feeder. Oil level indicators shall be provided at suitable location.
The rating of the potential transformer shall be as under:
i)Voltage Ratio 33 kV / 110 V
ii) Rated highest voltage36 kV
iii) 1 minute power frequency withstand voltage (kV) 50 KV
v) Class of accuracy Class 1.0
vi) Rated burden 50 kV
Test certificate in duplicate from manufacturer shall be submitted.

CURRENT TRANSFORMERS:
The outdoor type current transformer for protection shall be single phase, oil filled type suitable for 33 kV effectively earthed system and generally conforming to I.S.2705. Oil level indicator shall be provided at suitable location.
The rating of the current transformer shall be as under:
I. Rated voltage33 kV
II. Short time current for 1 sec. (kA - RMS) 13.1
III. Peak current (kA) 50
IV. 1 minute power frequency withstand voltage (kV) 50
V. 1.2 / 50 M.S. impulse withstand voltage (kV) 125
VI. Ratio400 / 1-1A
VII. Class of accuracy 10 P 10
VIII. Rated burden 15 VA
CT's to be installed on galvanized iron associated structure of VCB or separate pedestal.
Test certificate in duplicate from manufacturer shall be submitted.

33 kV OUTDOOR VCB:

3 nos. of Outdoor vacuum circuit breakers, 1 for Incomer feeder and 2 no of 3000 kVA Power transformers shall be provided. 2 No of Off load AB switches of adequate capacity shall be provided for 100 kVA auxiliary transformers. The breakers shall be triple pole manually and electrically operated.

The minimum rating of the circuit breaker shall be as under:

I. Rated voltage36kV
II. Rated current630 Amps.
III. Fault level750 MVA
IV. Symmetrical breaking current25 KA
V. Opening time 0.2 sec max.
VI. Making current (Peak) 50 KA
VII. Impulse withstand capacity for 1 sec. 170 KV
VIII. 1 minute power frequency withstand voltage (RMS) 70 KV

Indication:

i) Local ON / OFF indication.
ii) Remote ON / OFF indication.
iii) Spring charged / discharged indication.

TESTS:

i) Routine test in presence of third party Engineer. Review of Type test with certificate shall be furnished.
ii) All VCB's with associated relays shall be tested at site for operating under normal and fault conditions.

Installation: All VCB's shall be installed as shown in the drawing. The Concessionaire shall cast cement concrete foundation with cable duct required considering permissible bending radius.

POWER TRANSFORMER:

General: Power transformer **33 / 3.3 kV, 3000 kVA** shall be copper wound oil immersed, naturally cooled and suitable for outdoor/ indoor installation and shall conform to IS: 2026. The unit shall be plinth mounted in the switch-yard, duly ensuring minimum ground clearance as per I. E. Rule and side margins of 500 mm at least on two sides of the plinth are provided to enable the maintenance staff to carryout maintenance.

Construction: The tank shall be fabricated from high grade steel sheet of thickness 6 mm for transformer. The construction shall be such to prevent collection of water on any part of the tank. It shall be mounted on skids. It shall have adequate number of lifting lugs, so located that adequate working clearance is available while lifting between slings and any fittings or accessory on the transformer. It shall also have 4 Nos. of jacking pads for lifting with jacks.

The winding shall be of electrolytic grade copper conductors and shall confirm to group Dy- 11. The star point shall be brought out through tank and suitably terminated with separate base terminal with stud in weather proof porcelain bushing for solid neutral earthing. The insulating paper and other insulating material shall be suitable for high oil temperature without any effect on physical and chemical properties. The winding shall be treated for shrinkage before assembling in the core. The winding shall be designed to eliminate hot spot and braced to withstand dynamic stresses due to fault, without any damage.

The core shall be constructed from cold rolled, grain oriented steel laminations insulated from each other by means of suitable heat resistant oil proof coating. The arrangement shall afford lifting of the cores and winding bodily from the tank without disturbing the cable boxes on HT or LT sides.

The high voltage winding shall be provided with on load tap changer with 17 position steps tapings from +5% and - 15% in steps of 1.25%. The tap changer shall be automatic with Automatic Voltage Regulator (**AVR**) control. The tap position indicator shall be provided and shall give positive and unambiguous tap position. The radiators shall be either plate type or of tubular construction complete with bronze collared air release plugs, isolating valves and drain plugs.

The conservator shall be complete with fill cap, drain plug and dehydrating breather. The design of breather shall prevent contact between external atmosphere and dehydrating agent. Conservator shall be provided with magnetic oil level gauge with low level alarm contacts on one face and plain prismatic level gauge on the other face.

Buccholz relay shall be provided to detect internal fault in 3000 kVA transformers. The relay shall comprise of alarm and trip elements and should be wired to relay and control panel.

The Concessionaire shall design the plinth for transformer and get it approved from AMC authority and construct the same well in time to unload transformer on plinth after delivery from manufacturer. Primary side connection shall be through overhead bare conductor and secondary side connections to transformers shall be through cables. Air insulated cable box with disconnecting chamber shall be provided on secondary side and shall be suitable to accommodate number of cable terminations and consistent with no. of cable runs. The cable boxes shall be fully weatherproof conforming to IP-55 protection and equipped with canopy to avoid ingress of rain water through joints. An inspection cover shall be provided on cable box and disconnecting chamber for access to terminals.

RATINGS: The design ratings of the power transformer shall be as under:

1.	Capacity	3000 KVA
2.	Overload rating	As per IS 2026
3.	Primary voltage	33 KV
4.	Transformer ratio	33 KV/ 3.3 KV
5.	Tapping	+ 5% to – 15% in steps of 1.25%
6.	Vector group	Dyn-11
7.	Primary connection	Delta
8.	Secondary connection	Star
9.	Impedance	6.25%
10.	Design ambient temperature	50^0 C
11.	Top oil temp rise(by thermometer)	50^0 C
12.	HV & LV winding (by resistance)	55^0 C
13.	Insulation level	One min PF withstand voltage i) Primary winding70 kV rms ii) Secondary winding20 kV rms
14.	Noise level	As per NEMA TR-1 standard
15.	Tap changing method	On load

Fittings: Fittings as under shall be provided with power transformer;

a.On load tap changer with automatic voltage regulator.
b.Conservator with all accessories and magnetic level gauge alarm and trip contacts.
c.Explosion vent with diaphragm.
d.Air relief vent.
e.Buccholz relay, with alarm and trip contacts.
f.Inspection covers on tank cover.
g.Oil sampling valve
h.Oil drain valve
i.Filtering connection
j.2 grounding terminals on tank
k.Lifting lugs for transformer
l.Pulling eyes
m.Lifting lugs or eyes for cores and windings
n.Rollers
o.Dial type oil temperature indicator with alarm and trip contacts.
p.Resistance type winding temperature indicator with alarm and trip contacts.
q.Winding diagram and rating plate.
r.Weather proof control cabinet/ **Marshalling box** for all control cables/wiring.

All transformers shall be tested at manufacturer's works for routine and performance tests as per relevant I.S. / MSEDCL latest norms for no load and load loss restrictions. The inspection shall be carried out at manufacturer's works in presence of third party inspection authority and MSEDCL authority if necessary. Test certificate shall be submitted after testing.

AUXILLARY TRANSFORMER:

100 kVA power transformers with voltage ratio of **33 kV / 0.433 kV** generally conforming to IS 2026 with specifications as above for Power transformer of 3000 kVA except the changes as under shall be provided to meet power requirement for valve actuators, lighting, ventilation etc. The changes in specifications are:

i. Buccholz relay is not necessary.
ii. Impedance shall be as per I.S.
iii. Sheet thickness shall not be less than 5 mm
iv. Phase to phase and phase to earth clearances shall be maintained.
v. Tap changer shall be off-load, with out AVR.

Both transformers shall be tested at manufacturer's works for routine and performance tests as per relevant I.S. / MSEDCL latest norms for no load and load loss restrictions. The inspection shall be carried out at manufacturer's works in presence of third party inspection authority and MSEDCL authority if necessary. Test certificate shall be submitted after testing.

RELAY METERING AND SCANNER PANEL FOR 33 kV SYSTEM:

Total 3 Nos. outdoor 33 KV Vacuum circuit breakers are to be installed, out of these 1 VCB is for incoming feeder and 2 VCBs are for 3000 kVA transformers. A combined panel of Relay metering and scanner for transformers is to be designed and provided as per detailed specifications.
Protection relays shall be provided to open the circuits in the event of fault. The relays shall conform to specifications in subsequent sub- clauses.

The relays, instruments and indications specified below shall be housed in common relay and metering panel located in the pump house. The CTs and PTs installed on pole structure shall be connected for protection and metering. The control voltage shall be tapped from rectifier unit in VCB.

PROTECTION RELAY:

A separate protection relay for each VCB for over current, short circuit, and earth fault protection shall be provided. The relay shall be triple pole, 5 A rating having, two over current elements with 50% to 200% range and one earth fault element with 20% to 80% with inverse definite minimum time lag (IDMTL) characteristic with instantaneous high set relay for 200% to 800%. All relays shall be in one standard case and mounted flush on panel. The relay shall be suitable for operation on 110V DC with range of 70% - 110% of rated voltage. The relays shall be provided with plug setting on coil and time multiplier to reset tripping time.

The relay shall conform to IS: 3231 in general. The relays shall be of rectangular shape with tight dust covers removable from the front. It shall have external reset positive action indicator. The auxiliary relays shall be series or shunt connected and shall be non draw out type. The main relay shall be draw out type. It shall not trip the circuit when de-energised.
Facilities as under shall be provided.

i. Test facilities with loose test plug.
ii. Provision for easy isolation of trip circuits of each relay

METERS

3 No. 96 mm voltmeters having 0-36 kV range and equipped with 4 position selector switch, indicating voltage on incoming two feeders shall be provided.

SCANNERS

Scanners shall be provided to indicate the following in respect of each of 2 transformers of 3000 kVA

i) Winding temperature
ii) Oil temperature.

PANEL

The Panel shall house the protection relays, all vital controls, indications, fault annunciation and metering instruments. The Panel shall be totally enclosed, dust and vermin proof with degree of protection no less than IP 54. The panel shall be fabricated from steel sheet of 2 mm thickness reinforced with steel section and shall be floor mounted on base channel of ISMC of 75 mm at least 50 mm above floor. The panel shall be mounted on box channel of ISMC of 50 mm. The height of panel shall be equal to height of 3.3 kV panel. Panel with proper finish of spray painted.
The relays, controls and meters etc. mounted flush on the front side of the panel. Doors shall be provided at the rear.

The panel shall incorporate following components,

i) 3 Nos. over current plus earth fault IDMTL relays with instantaneous high set relay. The range shall be 50 to 200% for over current and 20 to 80% for earth fault suitable for operation on 110 V DC with 70- 110% of rated voltage and high set instantaneous element adjustable between 200 -800% shall be incorporated.
ii) 2 Nos. remote control switches, for closing opening of VCBs.
iii) Illuminated windows (for each VCB)
- Circuit breaker on
- Circuit breaker Off
- Spring charged
- Spring discharged
- Trip circuit healthy
- Trip circuit faulty
- Relay energized
- Relay de-energised
- 2 spare windows duly wired

iv) Audio visual non-trip alarm annunciation (for 3000 KVA transformer)
- Transformer oil level low for transformer
- Transformer Buccholz relay annunciation
- Transformer winding temperature high

v) Audio visual trip alarm annunciation (for each relay)
- Two spare windows duly wired
- Over current relay operated
- Earth fault relay operated
- Transformer oil temperature high
- Transformer Buccholz relay operated

vi) Digital scanners (3 Nos. which includes one spare) for oil and winding temperature for transformers.
vii) Under voltage relay

Grouped alarm annunciation shall be provided to indicate operation of the relays, and hooter shall be located at top of the panel. Audible alarm accept push button, test push button, reset push button and push button for on demand trip circuit healthy position shall be provided for each relay.

Inspection and Testing

1) The panel shall be offered for tests / inspection to Third Party Engineer as under
- H.V. simulation test
- Complete panel after assembling.

2) The relays on Incoming VCBs shall be got tested from MSEDCL or other agency acceptable to the department before commissioning the system.

3.3 kV INDOOR MOTOR CONTROL PANEL

GENERAL: A panel comprising **3.3 kV** switch gear and control gears shall be designed for:

i) Reception of power from 3000 kVA -2 nos. transformers.
ii) Distribution of power to raw water pump motors.
iii) Protection of the panel and motors from short circuit, earth fault, over current, under voltage, stalling and single phasing.
iv) Indication for voltage, current and operating conditions of breakers, relays, motors.
v) Annunciation.
vi) Auto trip.
vii) Interlocking between incomers and bus coupler.

Components: The components shall be as per approved single line diagram and as specified below:

a. 2 Nos. 630A, 3.3 kV VCB for reception of power from 2 transformers.
b. 1 Nos. 630 A VCB for bus coupling.
c. 6 Nos. Vacuum Contactor for motor starting and control with HRC fuses for back up protection, 1 spare, 2 for transformers' capacitors, total 9 panels.
d. Air insulated aluminum bus bars designed for 100 MVA fault level and rated to carry 800 Amp continuous current.

3.3 KV Incoming Breakers

General: The breakers shall be Vacuum Circuit breaker draw out type suitable for indoor installation. It shall be housed in metal clad enclosure. The enclosure shall be totally enclosed, dust and vermin proof. The panel shall incorporate control protection and annunciation instruments / features and detailed subsequently.

Construction: The breaker shall be 3 poles operated through a common shaft, draw out type and provided with automatic closing shutters. It shall have separate compartments for breakers, bus bars, CT PT meters cable box.

The breaker shall have constructional features as under:-

I. The contacts of suitable proven material and shape to break 17.49 kA current.
II. 230V AC motor with gang operated spring charging mechanism indication of spring state, position limit switches and all other accessories suitable for any number of closing and opening operation, so long as power is available to the motor and at least one closing and opening operation, in case of power failure.
III. Crank for manual charging of spring.
IV. Required NO +NC contacts with minimum 2 NOS + 2 NCs spare contacts.
V. Closing coils rated for 110V DC and suitable for operation on 70 -110% of rated voltage.
VI. Trip coil rated for 110V DC and suitable for operation on 70-110% of rated voltage.
VII. Operating mechanism housed in weather proof enclosure at accessible height.
VIII. Mechanical ON-OFF release.
IX. Operation counter.

Rating

Minimum rating of the breaker shall be as under:

a) Rated voltage 3.3 kV
b) Rated current 630 A
c) Symmetrical breaking current (RMS) 26.20 kA
d) Fault level 150 MVA
e) Short time rating 26.20 kA for 1 second
f) Peak making capacity 55.10 kA
g) 1 minute power frequency withstand voltage 10 kV

Accessories

The breakers shall incorporate following accessories:

1. 3 Nos. CTs of ratio 400/1-1 A with 20 kA burden and of class 10 P 10 for protection and class I for metering.
2. 1 No. 3 phase PT 3300 V/110-110 VA burden with fuse and test block.
3. 1 No. TP IDMTL relay having two over current elements with 50%, 200% range and one earth fault element with 20% to 80% range suitable for operation on 110 V DC with range of 70-110% of rated voltage. A high set instantaneous element adjustable from 200% to 800% shall be incorporated.
4. 1 No. 0 – 600 A ammeter with selector switch.
5. 1 No. 0 – 4 kV voltmeter with selector switch
6. 4 Nos. indicating lamps for ON, OFF, TRIP and TRIP CIRCUIT HEALTHY
7. 1 No. instantaneous under voltage relay resettable from 20% to 80% of rated voltage. The relay shall be associated with time delay relay
8. Cable termination from power cable and glands for control cable.
9. Arrangement for rectifier to obtain 110V DC from PT for control circuits.

3.3 KV Bus Coupler: The bus coupler breaker shall be generally conforming to specification for incoming breaker, with all accessories as in sub – clause for incoming VCB except cable terminations, CTs and PTs.

Motor Duty Vacuum Contactor: Vacuum contactor shall be provided for direct-on-line starting, control and protection of the motor. Each of the 9 Panels (6 for motors and 2 for transformer capacitor and 1 spare) shall conform to the following.

3.3 kV Vacuum Contactor Panel: 3.3 kV switch gear for motors shall comprises of isolating switch, motor duty HRC fuses and vacuum contactors housed in a meter clad, dust, moisture and vermin proof enclosure. Basic enclosure shall be metal clad having 4 distinct compartments each separately earthed- breaker compartment, relay and instrument chamber, bus bar compartment, CT/PT & cable chamber. All doors shall be gasketted using high life cross linked polyutherene gaskets. The vacuum contactor panel shall be complete with control, protection and annunciation instruments/ equipments. The arrangement of 3.3 kV vacuum contactor panel shall be as shown in the approved single line diagram.

Construction: Vacuum contactor panel shall be built in single tier construction with a provision of isolation and motor duty HRC fuses of suitable capacity. Vertical section of the panel shall contain CTs, PTs bus bars etc. The isolators shall be off load type. The contact movement shall be through balance contact spring so as to provide consistency in operation at minimum contact pressure. The vacuum interrupter bottles shall be of ceramic material, having high degree of tensile compression and binding strength. The ceramic material shall also have high conductivity, softening point and breakdown voltage. The contact shall be made from special alloy or shall be filled with antisurge alloy. Vacuum contactors shall be mechanically interlocked with isolating switches to prevent the opening of isolator when the contactor is on.

Operational Control: The vacuum contactor shall be employed for direct on line starting of the pump motor. The operating coils of the vacuum contactor shall be rated for 110 V DC supply without the need for resistors. The opening and closing speeds shall be obtained with minimum contact bounce by suitably balancing the spring pressure. The arcing period shall not exceed half cycle. Current shall be chopped at very low value so that resulting over voltage shall be well within the limits. Necessary arrangement / device shall be provided to keep over voltage / surge during making and breaking within limit. Required auxiliary contacts shall be fitted in the contactors with spare NO and NC contacts. The arrangement of bus bars, instrument transformers, cable compartments, wiring and terminal blocks etc. shall be generally as described for 3.3 kV circuit breakers.

Each Vacuum contactor panel shall comprise of following equipments/ instruments,

I.	1 No	3.3 kV 400 Amps draw out vacuum contactor suitable for AC 3 duty
II.	3 Nos	200 Amp motor duty HRC fuses, for back up protection
III.	3 Nos	CTs of ratio 100/1-1 Amp for metering class 1.0 and 10 P for protection having

20 VA burden, and 3 Nos. PTs having suitable burden for under voltage relay and rectifier

IV. 1 No Motor protection relays having instantaneous short circuit, single phasing, over load, locked rotor and earth fault protection element

V. 1 No High speed tripping relay with hand reset contacts

VI. 4 Nos Indicating lamps for 'ON','OFF" and 'TRIP' indication of the contactor

VII. 1 No Ammeter range 0-200 A with suppressed scale for CT ratio of 200/5A along with 3 position ammeter to read each phase

VIII. 2 Nos Indicating lamps for motor space heater 'ON & OFF'

IX. Required Nos. of cable glands for control cables 2.5 sq. mm and XLPE armoured cable of 3 core 50 sq.mm. 3.3 kV grade

X. Indication for sluice valve 'close' operating' and 'full open' shall be provided with

XI. ON and OFF push button for operating valve actuator, with interlocking and time delay arrangement

I. 10 Point temperature scanner on each vacuum contactor for indication and alarm in conjunction with 3 wire platinum RTD (100 ohms or so) embedded in stator winding suitable sensing unit in both bearings of motor

II. Scanning of oil temperature and level of pump's thrust bearings

Panel Construction: The 9 panel, 3.3 kV control gear (VCB and Vacuum contactor) housed in totally enclosed sheet metal clad, vermin and dust proof cubicles, suitable for floor mounting and of equal height. The panel shall incorporate the following,

a) Triple pole single bus bars housed in enclosed compartment in horizontal formation.
b) Enclosed vertical bus bars serving the 3.3 kV motors.
c) Identical separate compartment for all panels for breakers contactors, instruments, bus bars, CT, PT cable termination relays and annunciation and HT fuses for capacitor connection.
d) Inter panel barriers in the bus bars chambers shall be of epoxy.
e) Interlocking: CB shall be inserted in open position. It shall not be possible to withdraw CB in closed position. CB shall operate only in one of the 3 positions i.e. service, test and isolated. The CB will not close in any of the intermediate position.
f) A copper earth bus of size 50 X 10 mm shall be continuously run at the bottom of panel. Earth bus shall be capable to carry short circuit current for 1 sec.

The panel shall be fabricated from M.S. sheet 2 mm thick, hinged door shall be provided at the front and rear with car type handles. Mechanical interlock, shall be provided to prevent opening of the front door in 'ON' position or alternative arrangement shall be provided to trip the supply it he event of opening of the front door. Cable entries and exists shall be from bottom. Distance between cable gland plate and terminal lug shall be greater than 700 mm. The indicating and operating devices shall be preferably at uniform levels and shall not be above 1600 mm from floor level.
The panel frame work shall have minimum ISMC 100 base channel.

Bus Bars: The bus bars shall be of minimum rectangular section to operate at rated current continuously. All joints shall be silver plated. The bus bars shall be covered with heat resistant PVC sleeves with colour code. Cable joint shall be epoxy shrouded. The bus bars shall be supported on durable non-hygroscope supports rigidly fixed to frame work.
The terminal blocks shall be one piece molded and screwed type. At least one spare terminal block shall be provided in each panel. Control cables shall be neatly run over PVC cable trays and shall be terminated in compression type terminated blocks. Identification Codes as approved by the Engineer shall be used for cable terminations.

CT AND PT: The CT and PT for metering and protection shall be epoxy resin cast. Short time rating of the CT shall be 17.49 A for 1 second. The PT shall be connected on both primary and secondary sides through current limiting type fuses. The PT shall be mounted on with withdrawal truck.

Testing: The H.T. panel shall be tested at manufacturer's work in presence of Engineer In charge or his representative. The scope of inspection is as follows:-

i.Review of raw materials test certificate and quality control procedure.
ii.High voltage test.
iii.Routine test as per IS.
iv.Checking of phase and earth clearance of bus bars.
v.Checking of wiring diagram and contact circuit an operation of panel.
vi.Insulation Resistance Test.
vii.Fault simulation for testing protection relays except short circuit and earth fault.

3.3 kV VSS MOTORS:

General: The Concessionaire shall provide 3.3 kV squirrel cage motors of approved make for driving raw water pumps. The motors shall conform to I.S. 325. The Concessionaire shall have to supply winding data of motor duly signed by manufacturer.

The motor shall be suitable for voltage variations for ±10%, frequency variation of ±5% and combined variation of ±10% and speed 1000 RPM (Synchronous). The Torque speed and current-speed characteristic of the motors shall be suitable to accelerate the driven equipment to full speed without exceeding the limit of starting current at 6 times full load current.

Design:

I. The rated power of the motor shall be at least 10% above the maximum power required over entire head range of pump. However, output rating of motor shall not be less than **550 kW.**

II. The starting time and locked rotor withstand time under hot condition shall have suitable discrimination for proper selection of protection relay.

III. The locked rotor withstand time under hot condition and at 110% rated voltage shall be more by at least 3 second than the starting time with driven equipment coupled and at 85% rated voltage.

The motors shall be suitable for restricted operation at following conditions,

I. Accelerating the driven equipment from stand still to full speed within duration of 1 minute or less at 65% of rated voltage.
II. Operation on load at 75% of rated voltage for 5 minutes.
III. Two starts in quick succession from cold condition.
IV. One hot restart at maximum steady state temperature over ambient temperature of 48 deg. C.
V. Three starts per hours equally spaced over the duration after attaining thermal equilibrium.

The class of insulation of the motor shall be minimum F class. However, temperature rise of the motor when operating at extreme conditions of voltage and frequency variation shall not exceed 80 deg. C by thermometer and 90 deg. C by resistance over an ambient temperature of 45 deg. C at site.

Construction: The motor shall be foot mounted, vertical solid shaft. The rotor shall be statistically and dynamically balanced. Critical speed shall not be in the range of 80% to 120% of the motor speed.

The motors shall be screen protected, drip proof construction with degree of enclosure protection conforming to IP-23 or superior and having heavy duty friction bearings, grease lubricated type.

The cable box shall be phase segregated and with degree of protection conforming to IP 54. The terminal box shall be suitable for termination of power cable as per size in cable schedule. The fault withstand capacity of the cable box shall not be less than the fault level as specified.

Motor should be star connected with 3 line & 3 neutral terminals separately brought out to respective terminal boxes.

Motor should have separate phase segregated neutral terminal box suitable for connecting fully rated power cable to FCMA/ HFSR Soft Starter.

Accessories:
Accessories as under shall be provided,
1. Shaft mounted cooling fan of cast iron / aluminum or mild steel and dynamically balanced.
2. Space heater, operating on 1 phase 240 V 50 Hz supply incorporating necessary interlocking to ensure that space heat is 'Off when motor is running and 'on' when motor is idle with separate terminal box conforming to IP 54 protection on motor frame.
3. Resistance temperature detector, for detecting temperature of winding with terminals brought to separate terminal box for high temperature alarm and higher temperature trip, and indication on scanner in vacuum Concessionaire panel.
4. Bearing temperature detector for both bearing and wired to scanner in vacuum contactor panel.

Testing: All the motors shall be tested in presence of third party agency approved by the department and Engineer-in –charge or his representative at manufacturer's works. The tested motor shall be used for performance test of pumps at manufacturer's works. The scope of testing is as follows:
a) Review of raw materials test certificates and quality control procedure.
b) All the motors shall be offered for routine test and one motor shall be offered for type test at full load. The vibration level should be within permissible limit (IS: 12075) and noise level shall be 80 db/or less for which certificate shall be submitted.

3.3 kV H.T.CAPACITOR PANEL:
The pump motors shall be provided with suitable capacitors for improving power factor to 0.95 lagging at normal duty condition. However, KVAR selected shall not exceed the magnetizing KVAR of the motor; even if corrected P.F is less than 0.95 lagging, calculations for the same shall be submitted. The capacitors shall be suitable for operation at rated voltage and shall be connected in respective power circuit of the motor.
The capacitor bank shall be complete with structure, connections, discharge resistors etc. The capacitor shall be low loss, all polypropylene vacuum impregnated with PXE oil complete with internal discharge resistance The capacitors shall conform IS 13925 Part-1.The capacitor rating shall be subject to prior approval on furnishing letter from motor manufacturer stating the magnetizing KVAR and uncorrected PF at rated power required by the pump-motor. The capacitor panel shall be provided with terminal cover & 3 nos. 63 Amps 3.3 kV HRC fuses duly mounted on epoxy insulators & cable termination box to terminate H.T. cable.
Each panel shall incorporate CBCT, 2% series reactor and Load break switch.
6 capacitor panels are to be provided and connected to power circuit of 3.3 kV Vacuum contactor of 3.3 kV motor gear panel through suitably rated HRC Fuse. Each capacitor shall be totally enclosed type and provided with suitable rating CTs and pedestal mounting ammeter with selector switch to measure amperage of each capacitor individually. 2 capacitor panels are to be provided and connected to bus of each transformer for correcting power factor in no load condition. The capacitors should be tested at manufacturer's works for routine test in presence of third party Inspector.

415 V L.T. SWITCH GEAR AND CONTROL PANEL:
General: A panel comprising 415 V switch gears and control gears shall be suitable designed for the functions as under:-
i) Reception of power from 100 kVA transformers -2 No
ii) Distribution of power for crane, other auxiliary equipments and ancillary installation, actuators, lighting etc.
Components: The switch gears and control gears shall be as per single line diagram and as specified below:
1) 200 A MCCB for reception of power from 100 kVA transformers- 2 no
2) 1 set 200 A TPN Bus- Bars
3) 6 Nos. DOL starters for valve actuators suitable for forward & reverse operation with indications, connected and wired with interlocking with motor control breaker for sequential start and stop.
4) 1 No. DOL starter (forward & reverse) spare for actuator.
5) 16 Nos. 32 A triple pole MCBs for LT capacitors and spare.

6) 2 Nos. 63 A triple pole MCBs for lighting indoor, outdoor and 2 No spare.
7) 10 Nos. 16 A MCB for different loads.
8) 4 Nos. 25 A Double pole MCBs for space heaters of pump motors with interlocking system.
9) 2 Nos. 0 to 500 V voltmeters with selector switches shall be provided for incomer.
10) 2 Nos. 0 to 200 Amp ammeters shall be provided with selector switch with suitable CT (size 144 x 144 mm sq.)
11) 3 Nos. pilot lamps with fuses- 6 sets
12) Suitable LT capacitor Banks.

Indicators:

i) Space heaters for pump motors
ON - RED
OFF - GREEN

ii) Sluice valve for raw water pumps
ON - RED
OFF - GREEN
OPERATING - WHITE

Protection relays: Protection relays and meters shall be provided as specified in the specifications of individual components.

Construction

The constructional features, inspection of the panel shall generally conform to the specification for 3.3 kV panel with exception of the following:

i)The bus bars shall be triple pole and neutral rated to carry 200 A continuous current.
ii)The panel shall be designed to withstand fault level of 35 MVA.
iii)The base channel shall be minimum ISMC 75.
iv)Power cables shall be 1.1 kV grade PVC insulated copper cable of size not less than 4 sq.mm sizes.
v)Control cables shall be 650 V grade PVC insulated copper cable of size 2.5 sq. mm or above.
vi)Ground bus shall be minimum 25 x 4 mm copper.
vii)C.T. shall be rated for 36 kA fault current.

The panel height shall be exactly same as that of 3.3 kV panel. The panel shall be painted with powder coated paint of approved colour.

Molded Case Circuit Breaker: The MCCB shall be quick make and break and trip free contact having the rating to suit the load condition on it. The ON/OFF position shall be clearly indicated. MCCB having 200Amp capacity shall be with suitable thermal relay and magnetic relay. Breaking capacity shall be 25 kA. MCCB shall be provided with shunt trip coil suitable for 230V and shall have tripping push button arrangement. The under voltage relay shall also be provided in 200 amp MCCB with earth fault relay.

DOL Starter: The starters for valve actuators shall be air break type operated with start, reverse and stop push buttons mounted on front on the panel. It shall incorporate bimetallic thermal or magnetic over current relay, reversing contactors with necessary features for valve actuator duty. The starter shall have interlocking arrangement with motor breaker to ensure closure of the valve before motor is switched on with time delay arrangement. Suitable selector switch shall be provided on starter for selection of auto/ interlocking with breaker or manual. It shall incorporate control feature consistent with torque and limit switches in actuator with necessary wiring.

Indicating Lamps: All indicating lamps shall be of low wattage with series resistance. The lens shall be polycarbonate, oil, dust- proof unbreakable and of suitable colour. The arrangement shall permit removal of lenses and bulbs from front. All lamps shall be protected with individual fuses.

Meters: The ammeters and voltmeters shall be dust and weather proof with plastic window and of accuracy class as per I.S. 1248. They shall be flush mounted on panel. Size of the meter shall be 150 mm square.

Mat: Electrical grade rubber mat ISI mark 12 mm thick 1000 mm wide extending over full length of each panel shall be provided.

Testing: The L.T. panel shall be tested at manufacturer's work in presence of Engineer In charge or his representative. The scope of inspection is as follows:-

a) Review of raw materials test certificate and quality control procedure.
b) High voltage test
c) Routine test as per IS
d) Checking of phase and earth clearance of bus bars
e) Checking of wiring diagram and contact circuit an operation of panel.
f) Insulation Resistance Test
g) Fault simulation for testing protection relays except short circuit and earth fault.

APPROVED MAKES:

MCB: L & T /ABB/ Crompton /Siemens/ Hawell
METER: AE/ IMP/ NECCO/ NSDA/ Rishabh/ DIP
DOL Starters: L & T/ Siemens/ Crompton/ Bharatiya/ Kirloskar/ Telemechanique/ other reputed make approved by Engineer In charge.

CABLES

3.3 kV power cable shall be aluminum conductor XLPE armoured cable. The cable shall be of size rated to carry full load current at 0.85 P.F. continuously or to withstand short circuit current of 15 kA for 1 second duration, whichever is greater but shall not be less than the size specified in subsequent clause.

1.1 KV POWER CABLES:

Power cable used in 415 V systems shall be 1.1 kV grade 3.5 cores or 3 core as applicable alluminium conductor XLPE insulated PVC sheathed galvanized flat steel armoured type conforming to IS: 7098.
Cables shall be of sizes rated to carry full load current continuous at 0.85 PF or to withstand short circuit current of 35 kA for 1 second duration which ever is greater, but shall not be less than size specified in subsequent clause.

Control cable for d.c. Supply, circuit breaker, relays, indication, annunciation and protection: 650/1100V grade cable of adequate number of cores, of suitable size, copper conductor, PVC sheathed, armoured shall be provided as required and approved by the Engineer. All above cable for purpose of work are designated as 'Control Cables' and include all required cables not specifically stipulated.

Complete wiring diagram showing terminal block number, ferrule number and unit, with earthing point shall be submitted for prior approval before execution.

Cable Schedule: The sizes for the cables stated in the schedule are the minimum acceptable size.The Concessionaire may offer alternative sizes subject to approval from Engineer-In-Charge

Sr. No.	From	To	Grade	Cores x Run	Size Sq.mm
1	Incoming Supply	Metering Unit	33 kV	3 Core x single run	120
2	Transformer 3.3 kV	3.3 kV control panel	3.3 kV XLPE	3 Core x 2 runs	300
3	Motor control panel	3.3 kV motor	3.3 kV XLPE	3 Core x single run	70
4	Transformer 415 V	L.T. Panel	1.1 kV	3.5Core x single run	120
5	L.T. Panel	Crane	1.1kV	3 core	25
6	L.T. Panel	Actuators & Lighting	1.1 kV	3 core	16 & 4

Cabling Method: Cables shall be laid in trenches and ducts in ground and while passing through wall on trays in and out of the pump house. Every cable shall be neatly run vertically, horizontally or

parallel to adjacent walls, beams or columns. At both ends for termination, the cable shall approach from 1 common direction and are individually terminated in an orderly and symmetrical fashion.
The cables shall be terminated in mechanical glands which shall be suitable to provide adequate support by locking on the armour for additional earth continuity. Suitable compression type cable lugs shall be used for cable terminations.

The point of entry, exit of the cables from the building shall be sealed from outside with an approved asbestos compound followed by about 40 mm thick bituminous compound or a weak mortar, care shall be taken not to damage sheathing of cable due to hot bituminous compound while sealing.
Cable route markers of approved design shall be installed at the following position:
i) Entry and exit points of under ground duct / trench.
ii) Exits from the building.
iii) At every 5 m distance of straight run.
iv) Any other position necessary to trace route.

A metallic plastic tag bearing cable reference number indicated in cable schedule at ever 5 m run or part therefore and at both ends shall be provided for ease of identification and route tracing. The schedule shall be prepared by the Concessionaire and submitted for approval.

The cable routing and laying shall be such that sharp bends and links are avoided. The radius at bends for PVC insulted cables shall not be less than 15 D where D is overall diameter of the cable. Laying and termination of 3.3 kV grade cable shall be as per manufacturer's instructions. Such instructions shall be furnished to the Engineer-In-Charge. Loops/ extra length shall be provided in each cable run located suitably. The loop/ extra length shall be adequate for two straight through joints as and when such need arises.

Cable Trenches: The 1.1 kV grade cable from sub-station to L.T. panel shall be laid in cable trench. The depth of the trench shall be at least 500 mm measured from finished ground level. Before laying, bottom of the trench shall be cleared of broken stones, loose pieces etc. and the bottom shall be finished, firm and smooth contoured.

First 75 mm sand layer shall be placed to form bedding for cable. Cable shall be gently pulled and rested on bedding for cable. Cable shall be gently pulled and rested on bedding to avoid any tension during back filling and subsequent settlement.
After laying of cables, further 75 mm fine sand shall be provided to cover cables, which shall further be covered by precast, concrete tiles of adequate width to overlap the cable by at least 50 mm each on both sides. The trench then shall be backfilled and finished to ground level with top soil. The trenches inside transformer substation shall be filled by sand. Separate trenches shall be provided for L.T. and H.T. cables.

Cable Ducts: Cables from 3000 kVA Transformers to 3.3 kV Panel shall be laid in cable ducts. The duct shall be constructed in RCC 800 mm deep and 400 mm wide. ISA 40 shall be inserted at 400 mm center to center to support a 200 height above bottom and clamp the cable. The cables shall be laid in trefoil formation. The cables shall be clamped at 1200 mm interval.
Pre-cast covers shall be provided over the trench.

Cable Trays: The cable trays shall be used for indoor installation of cables and outdoor vertical runs on the building. The trays shall be of mild steel pre- fabricated and perforated. The sheets shall be of thickness not less than 2.0 mm shall be complete with approved, Tees fixing and shall be hot dip galvanized. Bends and tees shall also be pre- fabricated with inside radius not less than 300 mm or above (in case of large cables) and galvanized. All cuts on site shall be treated with cold galvanizing process. Support brackets shall be provided at maximum of 1200 mm centers. Cable trays from panel to motors shall be supported from underside of floor slab.

Cable shall be fixed on the trays at an interval of 1500 mm with suitably designed cable clamps. The cables/ shall be supported at each 250 mm span particular care shall be exercised in laying

cable on vertically rising trays by providing adequate cable fixing at short intervals to ensure that cable is not under any strain, load is properly transmitted to clamp and cable is securely fixed.
Separate cable tray shall be used for power and control cables and also the cables operating on different voltages.

Test: Routine tests in respect of 6.6 kV cable shall be carried out at manufacturer's work and test certificate in duplicate shall be furnished.

CABLE TERMINATION KITS:
Termination method on pole structure, VCB, Vacuum contactor, motor for 3.3 kV cables shall be as recommended by the manufacturer, with cable termination kit / compound etc. and any structural work required.
The termination kits required for various cables as under:

I. Providing and erecting Out door type termination kits for 33 kV XLPE 3 core cable from MSEDCL incoming feeder to sub-station - 2 nos.
II. Providing and erecting Out door type termination kits for 3.3 kV XLPE 3 core cable from transformers to H.T. panel - 6 nos.
III. Providing and erecting Indoor door type termination kits for 3.3 kV XLPE 3 core cable for motors and capacitors - 26 nos.

EARTHING:
General: The earthing arrangement for sub – station switch yard and indoor equipment shall be designed in conformity with the I.E. rules 1956 and IS: 3043 and Rules/ Regulations/ Instructions of statutory authorities, as applicable for the class of work under the contract. The arrangement specifications and quantity/ size stipulated hereunder are minimum requirements. It shall however be the responsibility of the Concessionaire to design and provide the earthing arrangement as stated above. The earthing arrangement shall be got approved from the Electrical Inspector.
All earth electrodes shall be of 50 mm G.I. pipe, 3 .0 length with a trough and cover. The electrodes shall not be stipulated at a distance less than 1.5 m from building fencing structure and equipment foundations. The earth pits shall confirm to the provisions in IS and shall be constructed in M-150 concrete. Required quantity of salt and charcoal shall be provided. Each earth pit shall have funnel arrangement for watering, minimum requirements of earth pits/ electrodes are as under:
Earthing for 33 kV System:

1. Pole structure	2 Nos.
2. Lightening arrestor	3 Nos.
3. Outdoor VCB body	14 Nos. (2 No. each)
4. Transformer body	16 Nos.
5. Transformer neutral	16 Nos.
6. GOD/D.O.	6 No.
7. Current Transformer	6 Nos.
8. Potential Transformer	3 Nos.

Total	**66 Nos.**

This quantity is tentative. Earthings as required shall be provided by the Concessionaire. Each earth electrode shall have disconnecting link to disconnect and measure resistance of earth electrode. RCC Chamber shall be provided with C.I. cover to each earth pit. RCC chambers top shall be flushing to metal spreading level in switch yard.

A ring bus shall be formed in the pole yard and transformer yard to which individual earth electrode shall be connected. Earth leads from equipment, structure etc. shall be connected separately to the ring bus. Both ring buses shall be interconnected with two parallel earth leads at two opposite points on each ring bus.

Extension of earth connection: Earth connections shall be given to metal frame work of A.B. switches, operating handles, lightening handles, lightening arrestors, insulators, transformer neutral

and body cable box and glands, VCB body and frame work, pole structure and fencing. Each unit shall have two separate and distinct each connections of adequate size.

Earth Leads: Minimum size of earth leads for earthing of equipment shall be as under:
Lightening arrestor, A.B. Switches, steel structure, Transformer body, cable box, gland fencing, Transformer neutral: 50 x 6 mm Galvanized M.S. flat.
The earth leads run to the structure shall be severely bolted or clamped. Neutral earth leads shall run on separate support without touching body of the transformer. The run and arrangement of earth lead shall be neat and I parallel and at right angles formation with reference to general layout of the switchyard and equipment. The bend in flat shall be gradual to prevent mechanical damage and 90 deg. C multiple bends if required in earth leads shall be located below ground level.
Inter connections of the earth continuity conductor and main / branch earth leads shall be bolted ensuring reliable, permanent and good electrical connection and further brazed. Earth leads shall be protected against mechanical damage and corrosion particularly at the point of connection.

Earthing For 3.3 kV and 415 V System:
The earthing shall be generally as specified above and as detailed below:
a) Minimum 18 earth pits for 3.3 kV system
b) Minimum 6 Nos. earth pits for equipments and panel for 415V system
c) There shall be separate and independent earthing system for 3.3 kV and 415V system and isolated from each other.
d) Earth electrodes for 3.3 kV and 415V system shall be 50 mm dia G.I. and of 3 m long
e) Separate ring bus shall be formed for each system to which individual earth electrode of the system shall be connected. Earth leads from equipment shall be connected separately to the ring bus.
f)Two earth leads from each equipment shall be connected to ring bus independently.
h) A disconnecting link shall be provided at each pit for disconnection and measurement of earth electrode resistance.

SWITCH YARD & PUMPHOUSE LIGHTING:
Switch yard lighting shall be provided, erected and tested with 25 Nos. street light fitting fixtures of HPSV lamp suitable for 150 watt with lamp pole fixture and bunch of suitable copper wire on steel tubular poles (4.5 x 3.65 x 3.25 mm dia.) of (5+1.75+1.75 m long) total 8.5 m long complete with suitable pole cap. Pole base plate, required terminal box, G.I. pipe for cable run vertically to pole terminal box and RCC plinth foundation complete. Poles are to be painted by two coats of red oxide and two coats of silver paint. Location of poles in switch yard will be decided by Engineer-In-Charge. Suitable size cable to be provided for above lighting and power connection to be take from near by switch room with required switch fuse unit.
The cable shall be laid underground as per standard specifications. Poles shall be connected by extra leads to nearby earth bus in an engineering manner.

Pump house lighting (Internal & External): For pump house, office, store and switch room illumination and ventilation work following minimum number of fixtures are to be provided.

1. HPSV lamp high bay fitting 400 watts	20 Nos.
2. 2 x 40 Watts industrial tube light fittings	200 Nos.
3. Ceiling fan 24” with regulator	12 Nos.
4. Exhaust Fans heavy duty 450mm, 1400 RPM	24 Nos.
5. Pedestal type air circulator (24”) 600 mm sweep (GEC/ Almonard)	12 Nos.
6. Point wiring throughout the pump house area	100 Points
7. Independent point wiring plug	25 Point

Point wiring shall be in M.S. conduit and copper wire only.
Power supply is to be taken from nearer L.T. panel in separate miniature circuit breaker panel. Required number of power plugs (not less than 18) shall be provided. Complete lighting drawing shall be got approved from the deptt before starting the work. Industrial tube light fitting shall be controlled from one control point, necessary single pole breaker and bunch of 4 run copper wire should be arranged.

Complete load should be equally distributed on each phase and maximum number of circuits should be provided as per I.E. rules.
The work of providing wall races for exhaust fan fitting and providing G.I, sheet fabricated cowl/ louvers is included in this work.
The above mentioned fixtures are to be suitably arranged for lighting and ventilation purpose of main pump house, office room, store room an 3.3 KV master control room.

H.T.METERING CUBICLE:
This item includes supplying, erecting, testing and commissioning of H.T. metering cubicle MSEDCL approved, fabricated with 14 SWG M.S. sheet with supporting angle & channel , painted with powder coating or epoxy paint shade light gray, copper bus bar size 25x6 mm, electronic security lock and Godrej make mechanical lock with counter meter for measuring no. of times the opening of doors top side covers interlock with meter door ,epoxy coated 3 nos. CT having ratio between 5/5 to 200/5 A, burdon10VA, class0.5 suitable for provided trivectometer and provision for incoming and outgoing cables. The unit shall be tested at manufacturer's works witnessed by MSEDCL's authority with test certificate etc.
The proper earthing arrangement with 7 nos. of independent 25 x 3 mm copper strip shall be provided. The unit shall be erected on the cement concrete foundation. The 230 V A.C. supply shall be made available near metering for inspection of meter as well as for testing, calibration etc.

TEST & TRIAL
SITE TESTING AND COMMISSIONING
1.**STANDARDS:** The testing and commissioning covered by this specification shall, unless otherwise stated, comply with the requirement of the latest editions of applicable Indian Standards and currently applicable regulations. The manufacturer's recommendation for testing and commissioning shall be followed.

2.**GENERAL:** The following physical tests shall be carried out on all the equipments.
a)Check for physical damage.
b)Check name plates as per specification.
c)Check adequacy in tightness of nuts, bolts, clamps, and other connecting terminals.
d)Check leakage of oil or air if any, oil level, air pressure wherever applicable.
e)Check earth connectors.
f)Check cleanliness and glaze of insulator and bushing surfaces.
g)Check proper lubrication provided for moving parts.
h)Any other checks, specified in the relevant code of installation and manufacturer's drawings / catalogues.

3.The test to be carried out on various equipments shall be as follows:
Insulation Resistance Test
The insulation resistance test shall be carried out on the following equipments:
EHV installationby 5000 V megger
HV installation above 1 KVby 2500 V megger
Power circuit of voltage up to 1 KVby 1000 V megger
AC and DC auxiliary circuitsby 500 V megger

4. The results of all the above tests shall be submitted to the purchaser.

5. The purchaser may ask for some additional tests to be carried out which in his opinion are necessary to determine that the works comply with the specifications, manufacturer's recommendations or IS standards. The Concessionaire shall also carry out such additional tests. Test and trial of pumping machinery shall be given by Concessionaire after satisfactory commissioning of machinery. The Concessionaire shall carry out operation and maintenance of sub-station, pump house and the works involved in the scope of this RFP document and technical specifications. The intention of carrying out operation and maintenance through Concessionaire is to operate the pumps as per the requirement of the department, impart training to the deptt. staff

in a systematic manner so that the starting and stopping of pumps is done methodically, the records are maintained, checks, routine maintenance which shall be as under.

6. Operation of all pumps, motors, valves and sub station and supply water as per the requirement of deptt.

7. To maintain all records i.e. logbook, for operation and maintenance.

8. To monitor all parameters such as pressure temperature, sub–station equipments and for all other systems specified in the RFP document.

9. To carry out routine checks water level, operation of equipments, noise, vibrations and shall maintain all corresponding records.

10. Carrying out preventive maintenance during above period such as lubrication, greasing, gland, cooling abnormal heating of panel, motor etc checking of loose connections of cables, and keep the installation neat and clean dust free.

11. To give training to the operators or to the agency envisaged by the Deptt for smooth O & M.

12. The Concessionaire shall provide log books and all records as directed by the deptt. and shall hand over to the deptt. And safety precautions for emergency situations such as power failure, tripping restarting, abnormal leakages in pump house short circuits sparking fire etc.

13. The Concessionaire shall provide sundry material of good quality of recommended grease, oil for lubrication, cotton waste gland, packing, rubber packing etc. as required. Normally the water would be supplied regularly after stabilizing the system with full trial and testing and the requirement would be generated in stages.

PURE WATER PUMPING MACHINERY AT WTP SUMP

General Description of works

The scheme is planned to meet the total demand of 192 MLD water for Aurangabad Municipal Corporation area. The pure water from Pharola WTP is to be lifted through 2000 mm M.S. pipeline, 12160 m long rising main. Under present scheme 6 nos. of V.T. pump sets and allied mechanical and electrical equipments are to be provided and installed. Out of which 4 no. shall be working and 2 nos. shall be stand by.

Data of the scheme:

1.	Daily demand of water	178.12 Ml
2.	Hours of pumping	23 hrs per day
3.	Total flow	186 Mld
4.	LSL in sump	508.00 m RL
5.	GL at pump house	513.21 m RL
6.	FSL of MBR at Naxatrawadi	632.00 m RL
7.	Rising main	
	i) Length	12160 m
	ii) Outside diameter	2040 mm
	iii) Thickness of plate	20 mm
	iv) Material	MS
	v) Internal lining thickness	12 mm
	vi) Inside bore diameter	1976 mm
8.	Number of pumps	
	i) Working	4
	ii) Stand By	2

Electricity and Water: The Concessionaire shall arrange for electricity and water supply at site, from available facilities.

Power Supply: It is intended to provide 33 KV express feeder from MSEDCL. It is proposed to provide 2 nos. of **33 KV/ 6.6 KV, 5000 kVA** Power transformers with VCB's for pure water pumps and 2 nos. of **33 KV/ 0.433 KV, 400 kVA** auxiliary transformers for allied equipments and WTP.
System and supply characteristics at the site are as under:
33 KV supply, 50 Hz. 3 wire, 3 phase, Fault level - 750 MVA.
Anticipated voltage and frequency variations are as under,
Voltage variation ±10 %
Frequency variation ±3 %
Combined voltage and frequency variation ±10 %
The Concessionaire shall communicate the total electrical load required during successful operation of pumping machinery.

SCOPE OF WORK:

I. The scope of work includes designing, providing, erecting, commissioning, testing and operation & maintenance during guarantee period of the vertical turbine pump sets with all allied mechanical and electrical equipments as per layout and specifications below.
II. The total work is of turnkey nature.
III. The job includes loading, unloading, transportation, delivery at site, storing with due care, erection with required civil works, performance test, operation, maintenance etc.
IV. The matters omitted and not specified in the document, but which may be inferred to be obviously necessary for intended service shall be deemed to have been included in the contract and shall be obligatory and this point shall be carefully noted by the Concessionaire.

Obligatory Conditions: It is obligatory for the Concessionaire to examine the pump supporting arrangement of civil structure and suitability of submergence in sump and submit the following information:

I. Weight of pump including bowl assembly, column pipes, discharge head, motor stool, thrust bearing etc.
II. Weight of VSS motor.
III. Maximum dynamic load imposed on the pump supporting structure with justification and reference to I.S.
IV. Characteristic curves of the bowl assembly and pump showing relationship between discharge and head, power required and efficiency (bowl performance curves and pump performance curves) shall be drawn on same graph and shown in separate legends for easy identification. Head losses in strainer, suction bell mouth, column pipes, and discharge head, and power losses in line shaft and thrust bearing shall be considered for characteristic curves of pump.
V. Pump (not bowl) performance curve for solo and parallel operation from 2 nos. to 4 nos. showing relationship between discharge and head superimposed on system head curves for getting an idea of immediate and ultimate stage discharge. Bid is liable for rejection if the obligatory documentation is not submitted.
VI. Point load on corbel due to crane and heaviest equipment handled with full justification.

TEST CERTIFICATE AND MANUALS: The successful Concessionaire shall submit test certificates for various components as called for in the specifications. If necessary and required by the Engineer, certificates for materials of construction of equipments shall be furnished.

The successful Concessionaire shall also submit Instruction manuals in duplicate covering operation, maintenance and repairs of all equipments including wiring diagrams and charts in duplicates for periodical maintenance of equipments.

DETAILED SPECIFICATIONS FOR ELECTRO-MECHANICAL WORKS FOR PURE WATER PUMPING MACHINERY

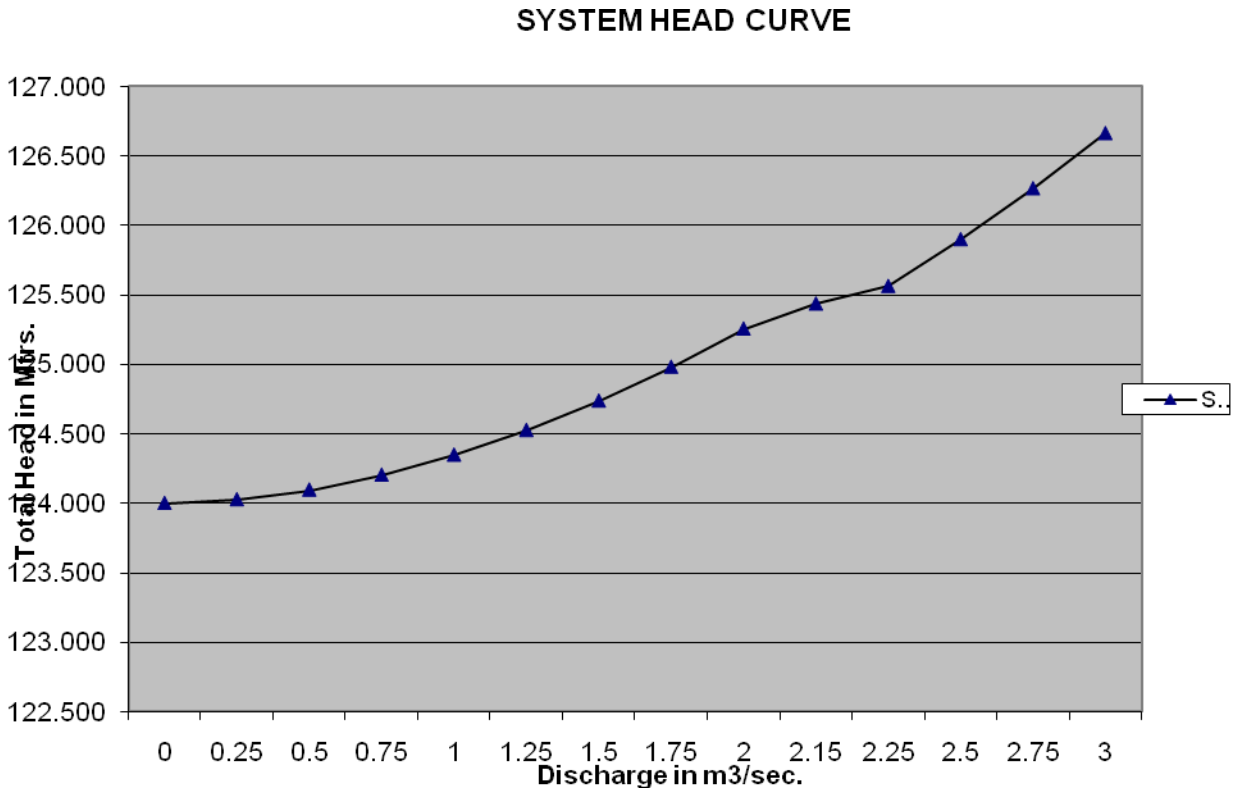
V.T.PUMPS

Each V.T. pump (Water lubricated) shall be of approved make and suitable for following duty conditions and operating conditions.

1.	**Discharge**	**537.8 lps i.e 538 lps**
2.	**Head**	**127 m**
3.	Head Range	94 m to 140 m
4.	Shut of Head	more than 170 m
5.	RPM of pump	980 RPM
6.	No. of stages	Not more than 4
7.	Efficiency	Minimum 84%
8.	No. of pump sets	**6 Nos. (4 Nos. working + 2 Nos. stand by)**

The total head referred above is inclusive of all losses in the pipeline from discharge flange of the pump to MBR. The Inlet losses in column pipes and discharge head for individual pump shall be assessed by the Concessionaire and included in the design head of bowl assembly.

CHARACTERISTIC CURVES: System head curve for the system is furnished. The Concessionaire shall furnish characteristic curves of bowl assembly and also pump after deducting column losses etc. The Concessionaire shall furnish along with his bid the characteristic curves so prepared superimposed on system head curves for single and multi pump operation. The pumps shall have stable characteristics over the entire range of working head. The pump shall be suitable for starting against closed sluice valve i.e. shut off condition. The efficiency curve shall be reasonably flatter between head range 94 m to 139 m.



Codes And Standards: The design, manufacture and performance of the V.T. pumps shall comply with all currently applicable regulations and safety codes in the locality area where the equipment

will be installed. The equipment shall also conform to the latest applicable Indian Standards. In particular the equipment shall conform to the latest revisions of the following:
IS 1710 - Vertical turbine pump for clear cold, fresh water
IS 5120 - Technical requirements for Roto-dynamic special purpose pumps
Where the above standards are in conflict with the stipulation of this specification, the specification supersedes them.

Design Requirement: The equipment shall be capable of developing the required total head at rated capacity for continuous operation. The total head discharge curve shall be continuously rising towards the shut off with highest shut off point. Pumps shall be identical and shall be suitable for parallel operation with equal load division. Impellers shall preferably be of non over- loading type. Pumps shall run smooth without undue noise and vibrations. The magnitude of peak to peak vibration at slip will be limited to 100 microns at the bearing housing. Pumps shall be vertical turbine type with required number of stages not exceeding the requirement given above and suitable for the service condition stipulated.

Bowl Assembly: The pump bowls shall be flanged with machined matching of faces. The joints, suction bell mouth to bowl assembly, to column pipes and to discharge head shall be flange joints. The bowls shall be capable of withstanding a hydrostatic pressure equal to twice the duty head or 1.5 times shut off head which ever is greater.

Suction Bell Mouth & Strainer: The cast iron / M.S. bell mouth, not less than 900 mm dia. shall be fitted to the suction case to limit the velocity. The suction strainer shall be of S.S. Net opening area in strainer shall not be less than 3 times the entrance area of bell mouth. The shape and curvature of the bell mouth shall be designed to streamline the flow of bowl suction. The thickness of bell mouth shall not be less than 10mm.

Impeller: The impellers shall be dynamically balanced so as not to cause any vibrations during operation. The impellers shall be closed type and shall be made in one piece and securely fixed to the stainless steel shaft, to assure accurate adjustment of each impeller. The water passage will be finished smooth by hand. Balancing holes for reducing hydraulic thrust shall not be provided.

Wearing Rings: Wearing rings shall be renewable type. These shall be held in place by screwing against rotation, press fit or locked with pins, flanged and screwed. Wearing rings shall be provided on both casing and impeller. Hardness of wearing rings shall be less by at least 50 BHN than the impeller.

Shaft: The shaft shall be of stainless steel and furnished to the close tolerance at the impeller / bearing fixing sizes. The design of the shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above / below the operating speed.The shaft shall be properly balanced so as not to cause any vibrations during operation.
The pump shaft bearings i.e. bush bearings would be Finostos, water lubricated. Extra long bearing shall be provided for suction and discharge bowls.

Column Pipe Assembly: Column pipes shall be of M.S. fabricated, heavy weight, flanged type, each in 1.5 m length or less so that after complete erection of the pump the bottom of strainer shall be at 0.5 m above the bottom of sump and length of strainer shall be adjusted accordingly. The total length of column assembly, bowl assembly, bell mouth and strainer shall not be less than 6 m for each pump. The column assembly length (including column pipes, bowl, assembly, bell mouth and strainer) shall be adjusted considering the pump floor level. A matching piece shall be provided if required. The stiffeners shall be provided to all pipe flanges. The discharge head and column pipe diameters shall be same. The discharge head shall incorporate full diameter elbow.

Line Shaft: The shafts shall be of solid circular section, prepared from stainless steel, machined and ground thoroughly and coupled with muff couplings. The shaft sections shall be provided with non-corrosive and abrasion resisting wearing surfaces particularly at the location of each guide bearing. Length of line shaft shall not be more than 1.5 m. each.

Line Shaft Bearing: These shall be designed to be water lubricated by the pump self water and shall be placed in bearing holders located in position at the joint of columns. Line shaft bearing shall be of Finostos designed for efficient lubrication. Composite design of line shaft and bearing centres shall ensure that the entire rotating assembly is brought from stand-still to full speed without any vibrations and shaft deflection and to ensure that first critical speed is not within 80% to 120% of full speed.

Discharge Head & Motor Stool: The discharge head shall be fabricated from M.S. and shall incorporate mounting flange for motor stool for solid shaft motor, stuffing box with renewable gland packing and tapping for pressure gauge mounting etc. The discharge head shall be of robust construction and shall be designed to support entire load of pump assembly, water column and motor etc. and shall withstand all static, dynamic and torsional loads, hydraulic thrust imposed during operation from shut off to stipulated operating conditions and thrust due to change in direction of flow, without any vibrations. Discharge head with sole pads will not be accepted. The discharge head shall be installed on sole plate with ISMB frame and entire load of motor and pump shall be on the lower floor as given below:

Pump floor level 513.00 m RL
Panel floor level 516.40 m RL

Drain arrangement for gland leakage water shall be provided at bottom of discharge head with G.I. pipe. The base of the discharge head shall not be less than 1200 mm x 1200 mm. The power shall be transmitted from motor to vertical shafting through a flexible coupling. Both halves of the coupling shall be machined all over, securely keyed to their respective shafts. The pins shall be of stainless steel. The arrangement of two halves shall be suitable to check alignment and parallelism. A self aligning thrust bearing shall be housed in the head gear adequately designed to accommodate entire weight of rotating parts and hydraulic thrust and shall be suitable for reserve rotation up to at least 150% normal forward speed. Bearing shall be designed for 30,000 hours life. The bearing shall be of oil lubricated type and shall be provided with oil level gauge and suitably positioned temperature probes.

Two sets of adjustable contacts shall be provided one for an alarm and other for tripping the raw water pump motor. This shall be connected to 6.6 KV main panel so that digital temperature can be read out with alarm and tripping.

Motor stool shall be provided for mounting the electric motor. The motor stool shall accommodate the pump thrust bearing and pump motor coupling. The motor stool shall be robust construction and of fabricated mild steel and adequately sized with opening to work on the flexible coupling.

The pump shall be provided with non reversible ratchet or similar mechanism to prevent them from rotation in reverse direction. Pressure gauge for each pump and manifold pipe shall be provided. Pressure gauge shall be 150 mm dial, 0-21 kg/cm^2 and least count shall be 0.05 kg/cm^2. Each pressure gauge shall be fitted with restrictor nozzle of brass and G.I. Pipe and U tube. Pressure gauge on common manifold shall also be provided. All pressure gauges shall be installed in pump house on wall with necessary G.I. pipe connections from manifold to pump house. The pressure gauges shall be installed at suitable height so that the reading can be taken accurately.

Sole Plate: The M.S. sole plate arrangement shall be provided under the discharge head for precise horizontal and vertical alignment. Thickness of sole plate shall not be less than 50 mm. It shall be independent of base plate integral with the discharge head. The contact surfaces of the sole plate arrangement as under shall be machined for precise leveling and shall ensure vibration free operation of the pump.

i) Base frame and sole plate.
ii) Sole plate and discharge head.

All joints between machined contact surfaces shall be with nut bolts/ tapped studs/ bolts. All contact surfaces shall be blue-matched to ensure proper contact to the extent of 60% of contact area after necessary site finish if required. The opening in the sole-plate/frame shall be of adequate size to

pass the bowl assembly etc. very easily. M.S. base frame shall be anchored on the main RSJs or RCC beams ensuring complete rigidity. Entire structural fabrication and foundation arrangement shall be designed and submitted for approval.

Air Release Arrangement: An air cock of 50 mm dia and same size GI pipes, bend shall be fixed to the discharge head. The G.I. pipes shall be suspended vertically in the well with adequate length to release air.

Material Of Construction:

a) Discharge and suction case, Bowls : Cast steel
b) Discharge head, Bell mouth and motor stool : M.S. Fabricated
c) Impeller : Bronze to I.S. 318 GR II
d) Impeller shaft : SS 410
e) Column pipes : ERW heavy duty
f) Shaft Sleeve : SS 410
g) Line shaft : SS 410
h) Nut bolt and washer : SS 410
i) Wearing ring : I.S. 318-LT B2
j) Line shaft bearing : FINOSTOS

Minimum Sizes:

a) Column pipe diameter : 600 mm
b) Thickness of column pipe and Bell mouth : 10 mm
c) Impeller and line shaft dia : 110 mm or nearest commercial size
d) Bell mouth diameter : 900 mm
e) Thickness of sole plate : 50 mm

Testing: All the pumps shall be subject to factory tests in presence of Engineer-In-Charge or his representative and third party appointed for the purpose.

The Concessionaire shall arrange all required test equipment duly calibrated for field performance test, which shall be witnessed by AMC authorities.

A) FACTORY TEST: The test shall include review of raw materials' test certificates and quality control procedure.

1) Hydrostatic Test: Following items shall best tested at hydrostatic pressure equal to twice duty head or 1.5 times shut off head of bowl assembly which ever is higher as per IS 5120.

i) Bowl assembly
ii) Discharge head
iii) 20% quantity of column pipes.

2) Performance Test: The test shall generally be carried out as per IS 9137. The test shall be carried out at full speed and full load at manufacturer's work. The test shall be carried out to cover following 10 points:

i) 1 Duty point
ii) 4 points above duty point
iii) 4 points below duty point
iv) 1 Shut off head

Power consumption at all above points shall be recorded. Zero reading confirmation for V notch measurements shall be done.
The test shall be carried out only by the job motor which will be supplied under this contract. The test at reduced speed and reduced load will not be accepted.

3) Strip Inspection: Three no. of pump sets, after completion of its performance test and as selected by the Engineer or Inspector at random will be offered for strip inspection and dimensional checking. The manufacturer/ Concessionaire shall submit all required dimensional drawings for strip inspection. Minimum points as under shall be checked.

1. Condition of all components particularly bushes, bearings and wearing rings to examine undue rubbing, wear etc.
2. Hardness of Finostos bearing
3. Dynamic balancing of (a) Impellers (b) Flexible coupling
4. Clearance between
   a) Wearing rings
   b) Impeller shaft and bearings
   c) Impeller shaft and key
   d) Shaft and flexible coupling
   e) Key and keyway on shaft.

MATERIAL TEST CERTIFICATE:
Material Test Certificate of the various pump components shall be furnished by Concessionaire.

FIELD PERFORMANCE TEST: The test shall be carried out as per IS: 9137 code of acceptance test of pump Class-C, in general and as started below in particular. The purpose of the field test is not to ensure whether pump performs as regards parameters i.e. H, Q & power etc. within acceptance limit as per IS: 9137. The purpose is to ensure that the pump performance is generally acceptable or otherwise. Final acceptance shall be as per following criteria.

h) Verification of guarantee of H & Q specified in clause 9.4.1 of IS: 9137 shall be based on following liberalize tolerances.
X_H ± 0.06 Xqv ± 0.09

i) As regards P-Q characteristic for acceptance it shall be checked whether motor is not getting overloaded within the specified head range.

j) Volumetric measurement shall be taken on basis of rise in level in MBR. In addition flow meter to be provided by Concessionaire.

k) The head shall be measured with calibrated pressure gauge of accuracy 1% or better .At least 3 pressure gauges shall be got calibrated from two different institutions with prior approval of the Engineer- in-charge. The calibration shall be point to point and not mere for percentage error.

The gauge shall be fitted at suitable place from the discharge nozzle. It may be noted that pressure gauge shall be installed at least 2 times diameter away from discharge nozzle and delivery valve be placed at least four times diameter away from discharge nozzle. Such conditions shall be simulated at site condition and no allowance for this deficiency shall be considered. The decision of Engineer-in- charge shall be final.

l) The input power to motor shall be measured with 2 Nos. Class 0.5 accuracy single phase watt meters with suitable CTs and test lids and PTs provided in Panel. The watt meters, CTs and PTs shall be got calibrated point to point and not mere for percentage error.

m) The speed shall be measured by at least 2 Nos. non contact tachometers with digital display calibrated from two different institutions approved by the Engineer-In-Charge.

n) The field test shall be taken with entire head range in such a manner that it would cover at least 6 points (i.e. 1 duty point, 2 above duty point, 2 below duty point and shut off). The guarantee for head and discharge shall deem to be fulfilled as per clause.

The field performance test at site is absolutely essential as above (a) to (g) and the manufacturer shall also be asked to attend the same.

SLUICE VALVES 600 mm

GENERAL: The Sluice valve of **600 mm** diameter shall be of approved make and shall be provided in the delivery pipe of each pump. The sluice valves of cast iron body suitable for the PN 1.6 rating shall be provided and shall conform to IS: 14846:2000. The sluice valves shall be double flanged, water works pattern, inside screw, non-rising spindle type and shall be fitted with double faced gunmetal taper wedge made in one piece and having two machined facing rings securely fixed into machined recesses in the wedge. The guides and the lugs shall be provided to guide the wedge through its full travel and the lugs and guides shall be lined with bronze. The bronze liners provided on guides and lugs shall be secured by counter-sunk screws or rivets of nonferrous metals. The clearances (radial and axial) between the lugs and guides shall not exceed 2.5 mm. All valves shall be provided with individual electrical actuators on delivery side of each pump.
The valve positions are tentatively indicated. The valves shall be installed on delivery floor.

Valve Actuators: Each sluice valve shall be provided with an electric actuator of approved make. Elect. Actuator shall be suitable for operation on 415V, 3 phase 50 Hz electric supply. The motors shall be squirrel cage type with insulation conforming to IS: 2613 Class B. The actuator shall be suitable for opening and closing against duty head considering shut off. At least 50% safety margin over normal operating conditions shall be provided in motor rating for unseating the valve. A thermal cutout device shall be provided to enable starting from any valve position. A local push button/ rotary switch and LOCAL/OFF/REMOTE selector switch shall be provided with clear marking for switch position, in addition to separate ON-OFF device on L.T. Panel. The terminal box shall be a separate unit bolted to gear case and provided with double 'O' ring sealing arrangement to prevent moisture from entering the actuator even if terminal box is removed.

Drive bushing shall be provided for accommodating the valve spindle. The bushing shall be detachable type. Pair of limit switches shall be incorporated in the actuator to provide remote position and interlock signals. Similarly a torque switch for closing and a position switch for opening shall be provided. Necessary mechanism to prevent torque trip while unseating shall be provided. A hand wheel shall be provided for emergency manual operation of the valve with interlocking to prevent motor operation while the valve is being operated manually.

Arrangement for greasing and drain plug shall be provided in the actuator. The drive shall incorporate a backlash hammer blow feature. Thrust bearing of ball or roller type shall be provided with oil or grease lubrication.

A reduction gear box shall be provided between actuator and valve. The torque rating of the reduction gear box shall be at least 2.0 times maximum torque required for opening and closing of the valves. The reduction gear box shall be oil lubricated.
The entire unit i.e. valves actuators, reduction gear box along with valve and accessories shall be supplied by valve manufacturers only. The valves and valve actuators combined shall be tested at valve manufacturer's works for operation against requisite duty.
The design calculation of torque and HP of actuator motor shall be got approved from Engineer-in-charge.

Sluice Valve 200 Mm Dia: A sluice valve of **200 mm** dia shall be of approved make and shall be provided in the common manifold pipe for scouring arrangement. The sluice valve of cast iron body shall be suitable for PN1.6 rating. The valve shall conform to I.S.-14846-2000.

Testing: All sluice valves and actuators shall be tested at manufacturer's works as per relevant IS in presence of third party testing agency approved by department, and Engineer-In-Charge or his representative and the scope of inspection is as given below.
For sluice valves:

a) Review of raw material test certificate and quality control procedure.
b) Body and seat test.
c) Test with operation of actuator and reduction gear box fully assembled with valve opening and closing with synchronizing.
d) Checking wear travel.

For valve actuators:

a) review of raw material test certificate and quality control procedure
b) High voltage test
c) Insulation Resistance test
d) Routine and operation test
e) Checking wiring diagram and circuit
f) Operation with limit switches,

HYDRAULICALLY CONTROLLED NRV 600 MM

General: Hydraulically controlled NRV, **600 mm** diameter shall be provided with tubular fabricated body with hydraulically controlled pressure dissipating mechanism. Hydraulically controlled NRV should have variable closure rate in different closing bands predetermined by analysis to control any jerks due to sudden closure of disc. Control unit should be externally mounted to facilitate maintenance from outside, without removing valve from line. It should be possible to observe working of valve externally.

CONSTRUCTIONAL DETAILS -

Body Shell - External body should be tubular in nature fabricated out of M.S. Sheet as per IS 2062. Shell thickness should be kept suitable to valve rating.

Disc – Disc or main control flap should be of suitable thickness made of M.S. (IS – 2062 or equivalent) should be connected to the hydraulic control unit with a shaft.

Shaft - Shaft should be made out of high tensile material En 8 or equivalent

Bushes - Shaft should have bearings or bush type in Gunmetal or Brass only.

Control Unit Specifications -

A. Main control unit should be consisting of multiple control units & should be connected by a shaft to the main flap.
B. The control unit should generate variable closure rates.
C. This variable controlled closure of the main flap with the aid of the control unit or units should result in controlled decay of velocity or momentum during reversal.
D. Closing rate for the main flap in the last segment should be slow as determined by scientific analysis .Hydraulic control unit shall be capable of fine tuning the closure pattern by for 5 deg to facilitate complete synchronization with the actual piping conditions.
E. The hydraulic controls units shall be external to the main valve body and assembled with the help of suitable mechanism. It shall be possible to service/ repair valve externally without removing the valve or stoppage of flow.

NRVs should have duel closing characteristics as per above specifications. NRVs shall be completely leak-tight and back flow should be allowed only through external bypass of 80 mm size with isolation sluice/ butterfly valve of PN 1.6 rating.

BUTTERFLY VALVE 600 mm.

600 mm dia Butterfly valves shall be of short wall body pattern, with both ends flanged. The valve shall conform to IS 13095 suitable for PN 1.6 rating. The valve shall be of approved make only.

The manual actuator with suitable hand wheel shall be provided to operate the valve. The shaft shall be horizontal. The valve seat on the disc shall be of synthetic rubber and renewable without dismantling the valve. All fasteners shall be of stainless steel, the valve body, disc and disc cover shall conform to grade FG-260 of IS 210. Suitable hand wheel for operation of valve shall be seamless with open and closed marking.

Testing: All the valves shall be tested at manufactures works as per relevant IS in presence of third party agency approved by department and Engineer-in charge or his representative.

The scope of inspection is as given below:

i) Review of materials test certificates and quality control procedure.
ii) Seat and body hydro-test for test pressure as per IS.

KINETIC AIR VALVE 200 mm.

Two Nos. kinetic Air Valves of **200 mm.** dia shall be of approved make and shall be provided and installed on common manifold outside the pump house as shown in the approved drawing. The kinetic air valves, conforming to IS 14845 shall be of two orifice type, the small orifice releasing air from the pipe under normal working condition while the large orifice shall admit or release air when the pipe is being emptied or filled. The air valves shall be designed to operate satisfactorily at a normal working pressure of 16 kg/cm2. Kinetic air valve body shall be tested to 24 kg/cm2. Each air valve shall be provided with an isolating sluice valve of 200 mm dia which shall generally comply with specifications given above except for electrical operation. The isolating valves shall be provided with seamless cast iron hand wheels for manual operation.

Testing: All valves shall be tested at manufacturer's works in the presence of third party inspection agency approved by department and Engineer-in- charge or his representative. The scope of inspection is as given below:

1. Review of raw materials test certificate and quality control procedure.
2. Hydraulic pressure as per relevant IS. (body Test)
3. Operation test for functioning of small orifice and large orifice.

IM.S. PIPE WORK:

M.S. pipe work shall be fabricated from steel plates conforming to IS: 226. The fabrication of pipes shall generally conform to IS: 3589. The 19766 mm. (I.D.) dia and 600 mm dia (I.D.) dia M.S. pipe and specials shall be fabricated out of 10mm thick plate as per approved drawing.

Layout drawings for pipes, specials and valves shall be got approved from department prior to erection. All the specials and pipes shall be painted with two coast of anticorrosive paint. Dished end shall be provided at the end of common manifold and thickness of dished end shall not be less than 20 mm.

Air release arrangement: An arrangement shall be made for release of air coming from the column pipes of pumps. A bend of 50 mm dia shall be provided after discharge head for air release arrangement.

Flanges

The flanges for pipes and specials shall be designed to with stand 25 kg/cm^2 pressure. Matching faces of the flanges shall be properly machined. The flanges shall conform to IS: 1538. The flanges shall be of minimum 20 mm thickness. The jointing shall be rubber of proven hardness, suitable for forming water tight joint and shall be of flat section 3 mm thick.

Painting: For all M.S. pipes and specials supplied by the Concessionaire, the internal and external surfaces of the pipe work and specials shall be painted with one coat of epoxy primer and two coats of epoxy paint approved by the Engineer-In-Charge.

Testing: The Concessionaire shall give satisfactory testing of the pipe work at hydrostatic pressure of 16 kg/cm2 in presence of Engineer-In-Charge.

R.C.C. WORK

The detailed specifications shall be as per relevant IS codes which are applicable for RCC works as per prevailing practice of MJP, PWD etc. in the state of Maharashtra. In addition to that the following information is mentioned as guide lines for the said item.

Suitable and adequate numbers of concrete saddles for pipe work and valves shall be provided. The Concessionaire shall also provide all steel packing plates required for erection of the plant as directed by the Engineer-In-Charge. Necessary concrete block shall be provided below all sluice va1ves, reflux valves, delivery pipe, and manifold. The size of concrete block shall be provided as directed at the time of execution. The thrust blocks are also included in the scope of work. All concrete work shall be cast-in M-25 grade concrete.

DISMANTLING JOINT, 600 mm:
A dismantling joint of 600 mm size shall be provided in delivery pipeline of each pump. The dismantling joint shall be placed between pump and non–return valve and shall be fabricated from M.S. plates designed to withstand for 25 kg/cm2. However, plate thickness for barrels shall not be less than 10 mm. The design of the joint shall ensure that no forces are transmitted to the pump foundation, and the flanges of dismantling joints are held rigid during normal working. For dismantling, it should be possible to slide flanges at one end by at least 20 mm to enable dismantling and refitting. General arrangement drawing shall be got approved from the Engineer-In-Charge before actual fabrication of the joint.

E.O.T. CRANE, 15 MT:
A **15 MT** safe working capacity and tested to 1.25 times working capacity, electrically operated double girder overhead traveling crane of approved make with all accessories shall be provided. The functional requirement of the crane shall be as under:

i) To lift complete weight of the pump or motor from any point, in the pump house. The operation shall be electrical; lift of hoist chain should be 10 mtrs minimum,
ii) To travel longitudinally along entire length of the pump house including loading/ unloading bays. Operation shall be electrical. Longitudinal travel shall be 36 m.
iii) To travel laterally across entire nominal pump bay span. Operation shall be electrical. Lateral travel shall be 15 m.

This item includes:

i) Continuous RCC corbel beams along entire length of pump house shall be provided by pump house civil Concessionaire and only 50 x 50 m square bars or rail section of 90 lb/yard shall have to be installed in the scope of this item with necessary anchoring & flush plates.
ii) Bridge girder mounted on track wheels and end carriages
    1. Motorized mechanisms for all three motions (Hoist speed limited to 4 m/min)
    2. Hoist suitable for 10 mtrs Lift
    3. Trolley and hoist
    4. Push button operated pendant
    5. Control gears and switch gears including earthing.

The crane shall generally conform to I.S. 3177 and I.S. 807.

Bridge rails and supporting RSJ: The bridge girder shall be designed to carry load as given above at any position during travel. The wheels of end carriage shall be machined and shall have flanges on common shaft, extending full span for longitudinal travel and shall be with reduction gear box. The rails/square bas shall be secured on supporting R.C.C. beam with all required fasteners. End stops to prevent over travel shall be provided.

Traveling Trolley and Hoist: The traveling trolley shall have single flanged wheels and shall be mounted on lower flange of the bridge girder. Suitable stops shall be provided to prevent over travel of trolley. The hoist shall be mounted below traveling trolley. The hoist shall incorporate swivel hook with ball and roller bearing.

Reduction Gear Boxes: The reduction gear boxes shall be of robust construction and for arduous duty. They shall be fully enclosed with oil level marking for minimum and maximum levels. The bearings shall be ball and roller type and taper roller bearings shall be provided where thrust loads are to be sustained.

Brakes and Clutches: Automatic electro-mechanical brake system shall be provided for hoisting motion. The hoisting motion shall stop automatically at upper and lower limits. Electro-magnetic clutch or similar safety device shall be provided on all power transmission system to disengage the motor in case of over loading and obstruction.

Motors: The electric motors shall be totally enclosed, fan cooled with enclosure conforming to IP 54 or superior. They shall be squirrel cage induction motors working on 230 V/415V A.C. supply with

class ‘F’ insulation. The motors shall preferably be foot mounted and shall be designed for S 5 duty as per I.S. 325. The motor for hoist shall be designed for min. 1.6 times safe load.

Switchgear, Control Gear and Electrical Works: A Panel fabricated from mild steel sheets of 2.0 mm thickness and down shop leads shall be provided to meet the functional requirement of crane. The essential features shall be as under:
1.Reception and distribution of power for Electric motorized operation.
2.Control gears for start and stop of the motors with reversing motion.
3.Operation of hoisting motion including reversing motion by means of suspended mobile pendant set for operation from pump floor level.
4.Limit switches for automatic stop of hoisting motion.
5.Earthing arrangement.
6.L.T. cable as required.
7.Holder and bulb fixture should be provided on trolley, so as to travel with trolley for required illumination at work site.

Material of Construction: Material of construction for components shall be as stipulated below or superior.

1. Structural steel-conforming to IS 808.
2. End carriage-steel conforming to IS 2060.
3. Track and trolley wheels- carbon steel conforming to IS 1030.
4. Hooks- steel to I.S. 1875/ forged steel conforming to IS 1875.

Testing: The crane shall be tested at manufacturer’s works in presence of third party approved by department and Engineer-In-Charge or his representative. The scope of testing is as follows:-

a.Review of raw materials test certificates and quality control procedure.
b.The crane shall be tested 1.25 times working capacity for all 3 motions for operation, deflection and load test. Site conditions shall be simulated for deflection test.

33 KV SUB-STATION POLE STRUCTURE AND CIVIL WORK.

Pole Structure: About 8 no of RSJ 200 x 100 mm pole structure and bus etc. shall be provided and extended to provide bays for reception and isolation of incoming feeder, formation of bus and extension of bays for transformers. The item includes required number of channel sections to accommodate AB switches, outdoor CTs, PTs, insulators and bus. Stays for incomer poles shall be provided. All poles shall have adequate foundation.

Lightening Arrestor : Two sets of lightening arrestors each comprising 3 No shall be provided on pole structure at suitable locations in feeder switch yard and transformer switch yard. The final location shall be as approved during detail Engineering and as approved by Electrical inspector. The arrestor shall be of 33 kV station class.
It shall have anti-contamination feature and pressure relief device with current limiting gaps generally conforming to IS: 3070 Part – I.
Test certificate in duplicate from the manufacturer shall be furnished.

Air Break Switches and Isolators: AB switches and isolators as shown in the single line diagram shall be provided. The insulators shall be post type suitable for 33 kV system and conforming to IS: 2544. Each switch shall be rated to 200 Amps continuous current, and short time current of 50 kA. The AB switches shall be mounted on cross channels on pole structure. The isolators shall be mounted on concrete pedestal or pedestals fabricated from angles, channels etc. The AB switches shall be triple pole, manually operated off load type, double break and suitable for mounting in vertical position. The isolator shall be 3 poles, revolving type suitable for horizontal mounting. Both AB switches and isolators shall be gang operated. Each pole of the switch shall be rated for 200 Amp. The switch shall be complete with down rod lever, G.I. pipe operating handle erected on extended square shaft and supported by external bush bearing, coupling pipe, padlocking arrangement and other components for the assembly. The contacts shall be of suitable copper alloy only.

The porcelain insulators for air break switches shall be of double post type using 2 Nos. of 33 kV post insulators. The insulators shall comply with the specifications separately mentioned elsewhere in respect of electrical and mechanical characteristics.

Horn Gap Fuses: 33 kV Horn gap fuse shall offer protection against short circuit and suitable for use in conjunction with 33 kV system saving fault level of 750 MVA. The fuse shall be designed for horizontal mounting 2 Nos. x 33 kV post insulators. The set shall comprise of 3 numbers.
The complete fuse shall meet impulse voltage in accordance with BS: 2692 or IS: 3106. The same shall withstand power frequency wet withstanding voltage in accordance with IS: 1818.
The fuse equipment shall be mounted on pedestals as specified for isolator.

Conductors and Insulators: The bus bars, bus-taps, interconnector jumpers shall be copper conductor rated to carry 200 Amp continuous current, without exceeding temperature rise of 70^0C over ambient temperature and to carry 50 kA fault current for 1 second without exceeding temperature limit of 200^0C. The bus bars spacing and supports shall be designed to keep deflection within limit. The terminations and interconnections shall be with mechanical bolted type clamps, ensuring reliable permanent and good electrical connections. Wherever appropriate and required, the base conductors shall be covered with alkathene pipes or other insulating pipes/ tubes.
Required no of disc and post pin insulators shall be provided. The insulators shall conform to IS: 731 and IS: 2544 applicable for system voltage of 33 kV rating. Test as per relevant IS shall be carried out, test certificate shall be furnished in duplicate.

Substation Civil Work: The Concessionaire shall design and construct sub-station plot of size 30 x 60 m or as required and approved by the Electrical Inspector including excavation, filling, leveling etc. The substation plot shall be leveled to a level of 0.3 m above ground level with approved earth work including watering, mechanical compaction to required density. The entire sub-station plot area shall be covered by graded stone metal of size 25 mm.
The fencing shall be galvanized chain link of mesh size 50 mm x 50 mm made of 10 SWG GI wire. The fencing mesh wire shall be welded on ISA 75 galvanized angle frame of 2.45m height spaced at a distance of 1.2 m. The section of the frame shall be fitted with flat iron support of size 25 x 6 mm on top, bottom and midway and chain link jali of 3.26 mm dia or 10 SWG G.I. hard wire mesh of 50 x 50 mm to the angle iron at every distance of 30 cm by iron studs complete duly painted with one coat of red oxide and two coat of aluminum paint.
A VCB room of adequate size and as approved by the Electrical Inspector shall be constructed as per civil engineering practice. Installation of VCB is included in the scope of work.

Fencing Gates: 4 no of double leaf hinged doors each 150 cm in width and 185 cm in height using 40 mm GI B grade ISI mark pipe shall be provided at 4 corners of the sub-station area. The channel iron of size 150 x 75 mm by 2.5 m long shall be provided and erected at both sides of the gate.
The total fencing shall be painted with one coat of red oxide and two coat of silver paint.
Minimum 25 nos. of GI fire buckets with round bottom of 9 lt capacity and filled with dry sand shall be kept in sub-station on M.S. stand.
D.C.P. type fire extinguisher cartridge type with G.M.cap 150 gm CO^2 gas cartridge powder brackets conforming to IS 2171-1985 and erected with necessary stands with 10 kg cartridge capacity - 10 nos. shall be provided.
6 nos. of 33 kV rubber hand gloves shall be provided for operation of A.B. switches.
Printed instruction chart for treating persons suffering from electric shocks shall also be supplied by the Concessionaire.

33 kV INDOOR VCB PANEL:
3 nos. of Indoor vacuum circuit breakers, 1 no for Incomer feeder and 2 no of 5000 kVA Power transformers shall be provided. Off load break switches of adequate capacity shall be provided for 400 kVA auxiliary transformers and capacitor panels for main transformers. The breakers shall be suitable for indoor application; triple pole manually and electrically operated and shall be installed in a panel. The VCB panel shall be provided with all protective relays.

Rating: The minimum rating of the circuit breaker shall be as under:

I. Rated voltage33 kV
II. Rated current800 Amps.
III. Fault level750 MVA
IV. Symmetrical breaking 25 KA
V. Opening time 0.2 sec max.
VI. Making current (Peak) 35 KA
VII. Withstand capacity for 1 sec. 25 KA
VIII. 1 minute dry power frequency withstand voltage (RMS) 50 KV

Indication:

i) Local ON / OFF indication.
ii) Remote ON / OFF indication.
iii) Spring charged / discharged indication.

Protection Relay: A separate protection relay for each VCB for over current, short circuit, and earth fault protection shall be provided. The relay shall be triple pole, 5 A rating having, two over current elements with 50% to 200% range and one earth fault element with 20% to 80% with inverse definite minimum time lag characteristic and instantaneous high set relay for 200% to 800%. All relays shall be in one standard case and mounted flush on panel. The relay shall be suitable for operation on 110V DC with range of 70% - 110% of rated voltage. The relays shall be provided with plug setting on coil and time multiplier to reset tripping time.

The relay shall conform to IS: 323 in general and IS: 3231 in particular. The relays shall be of rectangular shape with tight dust covers removable from the front. It shall have external reset positive action indicator. The auxiliary relays shall be series or shunt connected and shall be series or shunt connected and shall be non draw out type. The main relay shall be draw-out type. It shall not trip the circuit when de-energized.

Facilities as under shall be provided.

i. Test facilities with loose test plug.
ii. Provision for easy isolation of trip circuits of each relay for testing and maintenance.

Meters: 2 No. 96/144 mm voltmeter having 0-36 kV range and equipped with 4 position selector switch, indicating voltage on incoming two feeders.

Scanners: Scanners shall be provided to indicate the following in respect of each of the transformers of 5000 kVA

i) Winding temperature
ii) Oil temperature.

Panel: The Panel shall house the protection relays, all vital controls, indications, fault annunciation and metering instruments. The Panel shall be totally enclosed, dust and vermin proof with degree of protection no less than IP 54. The panel shall be fabricated from steel sheet of 2 mm thickness reinforced with steel section and shall be floor mounted on base channel of ISMC of 75 mm at least 50 mm above floor. The panel shall be mounted on box channel of ISMC of 50 mm.

The relays controls and meters etc. shall be mounted flush on the front side of the panel. Doors shall be provided at the front and rear.

The panel shall incorporate following components.

- 2 Nos. over current plus earth fault IDMTL relays with instantaneous high set relay. The range shall be 50 to 200% for over current and 20 to 80% for earth fault suitable for operation on 110 V DC with 70- 110% of rated voltage of high set instantaneous element adjustable between 200 -800% shall be incorporated.
- 2 Nos. remote control switches, for closing and opening of VCBs.
- Illuminated windows (for each VCB)
- Circuit breaker on
- Circuit breaker off
- Spring charged

- Spring discharged
- Trip circuit healthy
- Trip circuit faulty
- Relay energized
- Relay de-energized
- 2 spare windows duly wired
- Audio visual non-trip alarm annunciation (for 5000 KVA transformer)
    - Transformer oil level low
    - Transformer Buccholz relay annunciation
    - Transformer winding temperature high
- Audio visual trip alarm annunciation (for each relay)
    - Two spare windows duly wired
    - Over current relay operated
    - Earth fault relay operated
    - Transformer oil temperature high
    - Transformer Buccholz relay operated
- Digital scanners (3 Nos. which includes one spare) for oil and winding temperature
- Under voltage relay: Grouped alarm annunciation shall be provided to indicate operation of the relays, and hooter shall be located at top of the panel. Audible alarm, accept push button, test push button, reset push button and push button for on demand trip circuit healthy position shall be provided for each relay.

Inspection and Testing: The panel shall be offered for tests / inspection to Third Party Engineer as under:
i) H.V. simulation test ii) Complete panel after assembling.

The relays on 2 Incoming VCBs shall be got tested from MSEDCL or other agency acceptable to the department before commissioning the system.

TESTS:
i) Routine test in presence of third party Engineer. Review of Type test with certificate shall be furnished.
ii) All VCB's with associated relays shall be tested at site for operating under normal and fault conditions.

INSTALLATION: All VCB's shall be installed as shown in the drawing. The Concessionaire shall cast cement concrete foundation with cable duct required considering permissible bending radius.

POWER TRANSFORMER
GENERAL: Power transformer **33 KV / 6.6 kV, 5000 kVA** shall be copper wound, oil immersed, naturally cooled and suitable for outdoor/ indoor installation and shall conform to IS: 2026. The unit shall be plinth mounted in the switch-yard, duly ensuring minimum ground clearance as per I. E. Rule and side margins of 500 mm at least on two sides of the plinth are provided to enable the maintenance staff to carryout maintenance.

CONSTRUCTION: The tank shall be fabricated from high grade steel sheet of thickness 6 mm for transformer. The construction shall be such to prevent collection of water on any part of the tank. It shall be mounted on skids. It shall have adequate number of lifting lugs, so located that adequate working clearance is available while lifting between slings and any fittings or accessory on the transformer. It shall also have 4 Nos. of jacking pads for lifting with jacks.
The winding shall be of electrolytic grade copper conductors and shall confirm to group Dyn- 11. The star point shall be brought out through tank and suitably terminated with separate base terminal with stud in weather proof porcelain bushing for solid neutral earthing. The insulating paper and other insulating material shall be suitable for high oil temperature without any effect on physical and chemical properties. The winding shall be treated for shrinkage before assembling in the core. The

winding shall be designed to eliminate hot spot and braced to withstand dynamic stresses due to fault, without any damage.
The core shall be constructed from cold rolled, grain oriented steel laminations insulated from each other by means of suitable heat resistant oil proof coating. The arrangement shall afford lifting of the cores and winding bodily from the tank without disturbing the cable boxes on HT or LT sides.
The high voltage winding shall be provided with on load tap changer with 17 position steps tapings from +5% and - 15% in steps of 1.25%. The tap changer shall be automatic with Automatic Voltage Regulator (AVR) control. The tap position indicator shall be provided and shall give positive and unambiguous tap position. The radiators shall be either plate type or of tubular construction complete with bronze collared air release plugs, isolating valves and drain plugs.
The conservator shall be complete with fill cap, drain plug and dehydrating breather. The design of breather shall prevent contact between external atmosphere and dehydrating agent. Conservator shall be provided with magnetic oil level gauge with low level alarm contacts on one face and plain prismatic level gauge on the other face.
Buccholz relay shall be provided to detect internal fault in 5000 kVA transformers. The relay shall comprise of alarm and trip elements and should be wired to VCB panel.
The Concessionaire shall design the plinth for transformer and get it approved from AMC authority and construct the same well in time to unload transformer on plinth after delivery from manufacturer.
The primary and secondary side connections to transformers shall be through cables. Air insulated cable boxes with disconnecting chambers shall be provided on both sides and shall be suitable to accommodate number of cable terminations and consistent with no. of cable runs. The cable boxes shall be fully weatherproof conforming to IP-55 protection and equipped with canopy to avoid ingress of rain water through joints. An inspection cover shall be provided on cable box and disconnecting chamber for access to terminals.

Ratings: The design ratings of the power transformer shall be as under:

I. Capacity **5000 KVA**
II. Overload rating As per IS: 2026
III. Max. HV voltage 33 KV
IV. Transformer ratio **33 kV/ 6.6 kV**
V. Tapping + 5 % to -15% in steps of 1.25%
VI. Vector group Dyn – 11
VII. Primary connection Delta
VIII. Secondary connection Star
IX. Impedance 6.25 %
X. Oil temperature rise measured by thermometer 50^0 c above ambient
XI. Winding temperature 55^0 C above ambient
XII. 1 minute power frequency withstand voltage For HV side - 35 kV
For LV side - 10 kV
XIII. Noise level 80 db or less
XIV. Tap changing method On load tap changer with AVR

FITTINGS: Fittings as under shall be provided with power transformer:

a. On load tap changer with automatic voltage regulator.
b. Conservator with all accessories and magnetic level gauge alarm and trip contacts.
c. Explosion vent with diaphragm.
d. Air relief vent.
e. Buccholz relay, with alarm and trip contacts.
f. Inspection covers on tank cover.
g. Oil sampling valve
h. Oil drain valve
i. Filtering connection
j. 2 grounding terminals on tank.
k. Lifting lugs for transformer
l. Pulling eyes
m. Lifting lugs or eyes for cores and windings.
n. Rollers

o.Dial type oil temperature indicator with alarm and trip contacts.
p.Resistance type winding temperature indicator with alarm and trip contacts.
q.Winding diagram and rating plate.
r.Weather proof control cabinet/ Marshalling box for all control cables/wiring.

All transformers shall be tested at manufacturer's works for routine and performance tests as per relevant I.S. / MSEDCL latest norms for no load and load loss restrictions. The inspection shall be carried out at manufacturer's works in presence of third party inspection authority and MSEDCL authority if necessary. Test certificate shall be submitted after testing.

AUXILLARY TRANSFORMER

400 kVA power transformers with voltage ratio of **33 kV / 0.433 kV** generally conforming to IS 2026 with specifications as above for Power transformer of 5000 kVA except the changes as under shall be provided to meet power requirement for valve actuators, lighting, ventilation etc. The changes in specifications are:

i.Impedance shall be as per I.S.
ii.Sheet thickness shall not be less than 5 mm
iii.Phase to phase and phase to earth clearances shall be maintained.
iv.Tap changer shall be off-load, with out AVR

Both transformers shall be tested at manufacturer's works for routine and performance tests as per relevant I.S. / MSEDCL latest norms for no load and load loss restrictions. The inspection shall be carried out at manufacturer's works in presence of third party inspection authority and MSEDCL authority if necessary. Test certificate shall be submitted after testing.

6.6 kV INDOOR MOTOR CONTROL PANEL

General: A panel comprising **6.6 kV** switch gear and control gears shall be designed for:

I.Reception of power from 5000 kVA -2 nos. transformers.
II.Distribution of power to pure water pump motors.
III.Protection of the motors from short circuit, earth fault, over current, under voltage, stalling and single phasing.
IV.Indication for voltage, current and operating conditions of breakers, relays, motors.
V.Annunciation.
VI.Auto trip.
VII.Interlocking between incomers and bus coupler.

Components: The components shall be as per single line diagram and as specified below:

i) 2 Nos. 630A, 6.6 kV VCB for reception of power from 2 transformers.
ii) 1 Nos. 630 A VCB for bus coupling with adopter panel.
iii) 7 Nos. 630 A Vacuum contactor panels for motor starting and control including 1 spare unit,
iv) 2 Nos. Load break switches for transformers' capacitors total 12 panels.
v) Air insulated aluminum bus bars designed for 100 MVA fault level and rated to carry 800 Amp continuous current.

6.6 KV Incoming VCB panel- 2 no.

General: The breakers shall be Vacuum Circuit breaker draw out type suitable for indoor installation. It shall be housed in metal clad enclosure. The enclosure shall be totally enclosed, dust and vermin proof. The panel shall incorporate control protection and annunciation instruments / features and detailed subsequently.

Construction: The breaker shall be 3 poles operated through a common shaft, draw out type and provided with automatic closing shutters. It shall have separate compartments for breakers, bus bars, CTPT meters cable box.

The breaker shall have constructional features as under:-

1. The contacts of suitable proven material and shape to break 17.49 kA current.
2. 230V AC motor with gang operated spring charging mechanism indication of spring state, position limit switches and all other accessories suitable for any number of closing

and opening operation, so long as power is available to the motor and at least one closing and opening operation, in case of power failure.

3. Crank for manual charging of spring.
4. Required NO +NC contacts with minimum 2 Nos. + 2 NCs spare contacts.
5. Closing coils rated for 110V DC and suitable for operation on 70 -110% of rated voltage.
6. Trip coil rated for 110V DC and suitable for operation on 70-110% of rated voltage.
7. Operating mechanism housed in weather proof enclosure at accessible height.
8. Mechanical ON-OFF release.
9. Operation counter.

Rating: Minimum rating of the breaker shall be as under:

a) Rated voltage6.6 kV
b) Rated current630 A
c) Symmetrical breaking current (RMS) 26.20 kA
d) Fault level 150 MVA
e) Short time rating 26.20 kA for 1 second
f) Peak making capacity 55.10 kA
g) 1 minute power frequency withstand voltage 10 kV

Accessories: The breakers shall incorporate following accessories

1.3 Nos. CTs of ratio 400/1-1 A with 20 kA burden and of class 10 P for protection and class 1 for metering.
2.1 set 3 phase PT 6.6 kV/110-110 V, 50 VA burden with fuse and test block.
3.1 No. TP IDMTL relay having two over current elements with 50%, 200% range and one earth fault element with 20% to 80% range suitable for operation on 110 V DC with range of 70-110% of rated voltage. A high set instantaneous element adjustable from 200% to 800% shall be incorporated.
4.1 No. 0 – 600 A ammeter with selector switch.
5.1 No. 0 – 7 kV voltmeter with selector switch
6.8 Nos. indicating lamps for ON/OFF/TRIP/TRIP CIRCUIT HEALTHY/SPRING CHARGED etc.
7.1 No. instantaneous under voltage relay resettable from 20% to 80% of rated voltage. The relay shall be associated with time delay relay.
8.Trip relay
9.Trip circuit supervision relay
10.Multi function meter
11.Switches for breaker control, local remote selection
12. Cable termination from power cable and glands for control cable.
13. DC power pack to obtain 110V DC from PT for control circuits.

6.6 KV Bus Coupler VCB Panel- 1no.: The bus coupler vacuum circuit breaker panel shall be generally conforming to specification for incoming VCB panel, with all accessories as in sub – clause for incoming VCB panel except cable terminations, CTs and PTs and relays.

6.6 kV Vacuum Contactor Panel- 7 no.: 6.6 kV switch gear for motors shall comprises of isolating switch, motor duty HRC fuses and vacuum contactors housed in a meter clad, dust, moisture and vermin proof enclosure. The vacuum contactor panel shall be complete with control, protection and annunciation instruments/ equipments.

Construction: Vacuum contactor panel shall be built in single tier construction with a provision of isolation and motor duty HRC fuses of suitable capacity. Vertical section of the panel shall contain CTs, PTs bus bars etc. The isolators shall be off load type. The contact movement shall be through balance contact spring so as to provide consistency in operation at minimum contact pressure. The vacuum interrupter bottles shall be of ceramic material, having high degree of tensile compression and binding strength. The ceramic material shall also have high conductivity, softening point and breakdown voltage. The contact shall be made from special alloy or shall be filled with antisurge alloy. Vacuum contactors shall be mechanically interlocked with isolating switches to prevent the opening of isolator when the contactor is on.

Operational Control: The vacuum contactor shall be employed for direct on line starting of the pump motor. The operating coils of the vacuum contactor shall be rated for 110 V DC supply without the need for resistors. The opening and closing speeds shall be obtained with minimum contact bounce by suitably balancing the spring pressure. The arcing period shall not exceed half cycle. Current shall be chopped at very low value so that resulting over voltage shall be well within the limits. Necessary arrangement / device shall be provided to keep over voltage / surge during making and breaking within limit. Required auxiliary contacts shall be fitted in the contactors with spare NO and NC contacts. The arrangement of bus bars, instrument transformers, cable compartments, wiring and terminal blocks etc. shall be generally as described for 6.6 kV circuit breakers.

Each Vacuum contactor panel shall comprise of following equipments/ instruments,

i) 6.6 kV 400 Amps vacuum contactor, draw out type suitable for AC 3 duty- 1 no
ii) 200 Amp motor duty HRC fuses, for back up protection.
iii) 3 Nos.CTs of ratio 100/1-1 Amp for metering class 1.0 and 10 P for protection having 20 VA burden, and 1 Nos. PT having suitable burden for under voltage relay.
iv) DC power pack, charge type- 1 no.
v) Motor protection relay having instantaneous short circuit, single phasing, over load, locked rotor and earth fault protection element- 1 no.
vi) High speed tripping relay with hand reset contacts.
vii) 5 Nos. Indicating lamps for 'ON','OFF" and 'TRIP' indication of the contactor.
viii) 1 No. Ammeter range 0-200 A with selector switch.
ix) 2 Nos. Indicating lamps for motor space heater 'ON & OFF'
x) Required Nos. of cable glands for control cables 2.5 sq. mm and XLPE armoured cable of 3 core 50 sq.mm. 3.3 kV grade.
xi) Valve actuator switch.
xii) Indication for sluice valve 'close', 'operating' and 'full open' shall be provided.
xiii) ON and OFF push button for operating valve actuator, with interlocking and time delay arrangement.
xiv) 10 Point temperature scanner on each vacuum contactor for indication and alarm in conjunction with 3 wire platinum RTD (100 ohms or so) embedded in stator winding of motor and bearing temperature detection.
xv) Scanner for pump's thrust bearing temperature.

Panel Construction: The 10 panel, 6.6 kV control gear (VCB and Vacuum contactor) housed in totally enclosed sheet metal clad, vermin and dust proof cubicles, suitable for floor mounting and of equal height. The panel shall incorporate the following:

a) Triple pole single bus bars housed in enclosed compartment in horizontal formation.
b) Enclosed vertical bus bars serving the 6.6 kV motors and capacitors.
c) Identical separate compartment for all panels for breakers, contactors, instruments, bus bars CT, PT, cable termination, relays, annunciation and HT fuses for capacitor connection.
d) Inter panel barriers in the bus bars chambers shall be of epoxy.

The panel shall be fabricated from M.S. sheet 2 mm thick, hinged door shall be provided at the front and rear with car type handles. Mechanical interlock, shall be provided to prevent opening of the front door in 'ON' position or alternative arrangement shall be provided to trip the supply it he event of opening of the front door. Cable entries and exits shall be from bottom. The indicating and operating devices shall be preferably at uniform levels and shall not be above 1600 mm from floor level.

Bus Bars: The bus bars shall be of minimum rectangular section to operate at rated current continuously. All joints shall be silver plated. The bus bars shall be covered with heat resistant PVC sleeves with colour code. Cable joint shall be epoxy shrouded. The bus bars shall be supported on durable non-hygroscope supports rigidly fixed to frame work. The terminal blocks shall be one piece molded and screwed type. At least one spare terminal block shall be provided in each panel.

Control cables shall be neatly run over PVC cable trays and shall be terminated in compression type terminated blocks. Identification Codes as approved by the Engineer shall be used for cable terminations.

CT AND PT: The CT and PT for metering and protection shall be epoxy resin cast. Short time rating of the CT shall be 17.49 A for 1 second. The PT shall be connected on both primary and secondary sides through current limiting type fuses. The PT shall be mounted on withdrawal truck.

TESTING: The H.T. panel shall be tested at manufacturer's work in presence of third party inspector. The scope of inspection is as follows:-

a) Review of raw materials test certificate and quality control procedure.
b) High voltage test
c) Routine test as per IS
d) Checking of phase and earth clearance of bus bars
e) Checking of wiring diagram and contact circuit an operation of panel.
f) Insulation Resistance Test
g) Fault simulation for testing protection relays except short circuit and earth fault.

6.6 kV VSS MOTORS:

General: The Concessionaire shall provide 6.6 kV squirrel cage motors of approved make for driving pure water pumps. The motors shall conform to I.S. 325. The Concessionaire shall have to supply winding data of motor duly signed by manufacturer.

The motor shall be suitable for voltage variations for ±10%, frequency variation of ±5% and combined variation of ±10% and speed 1000 RPM (Synchronous). The Torque speed and current-speed characteristic of the motors shall be suitable to accelerate the driven equipment to full speed without exceeding the limit of starting current at 6 times full load current.

DESIGN:

I. The rated power of the motor shall be at least 10% above the maximum power required over entire head range of pump. However, output rating of motor shall not be less than **900 kW.**

II. The starting time and locked rotor withstand time under hot condition shall have suitable discrimination for proper selection of protection relay.

III. The locked rotor withstand time under hot condition and at 110% rated voltage shall be more by at least 3 second than the starting time with driven equipment coupled and at 85% rated voltage.

The motors shall be suitable for restricted operation at following conditions,

i) Accelerating the driven equipment from stand still to full speed within duration of 1 minute or less at 65% of rated voltage.
ii) Operation on load at 75% of rated voltage for 5 minutes.
iii) Two starts in quick succession from cold condition.
iv) One hot restart at maximum steady state temperature over ambient temperature of 48 deg. C.
v) Three starts per hours equally spaced over the duration after attaining thermal equilibrium.

The class of insulation of the motor shall be minimum F class. However, temperature rise of the motor when operating at extreme conditions of voltage and frequency variation shall not exceed 80 deg. C by thermometer and 90 deg. C by resistance over an ambient temperature of 45 deg. C at site.

Construction: The motor shall be foot mounted, vertical solid shaft. The rotor shall be statistically and dynamically balanced. Critical speed shall not be in the range of 80% to 120% of the motor speed.

The motors shall be screen protected, drip proof construction with degree of enclosure protection conforming to IP-23 or superior and having heavy duty friction bearings, grease lubricated type.

The cable box shall be phase segregated and with degree of protection conforming to IP 54. The terminal box shall be suitable for termination of power cable as per size in cable schedule. The fault withstand capacity of the cable box shall not be less than the fault level as specified. Motor should be star connected with 3 line & 3 neutral terminals separately brought out to respective terminal boxes. Motor should have separate phase segregated neutral terminal box suitable for connecting fully rated power cable to FCMA/ HFSR Soft Starter.

Accessories: Accessories as under shall be provided,

1. Shaft mounted cooling fan of cast iron / aluminum or mild steel and dynamically balanced.
2. Space heater, operating on 1 phase 240 V 50 Hz supply incorporating necessary interlocking to ensure that space heat is 'Off' when motor is running and 'on' when motor is idle with separate terminal box conforming to IP 54 protection on motor frame.
3. Resistance temperature detector, for detecting temperature of winding with terminals brought to separate terminal box for high temperature alarm and higher temperature trip, and indication on scanner in vacuum contactor panel.
4. Bearing temperature detector for both bearing and wired to scanner in vacuum contactor panel.

Testing: All the motors shall be tested in presence of third party agency approved by the department and Engineer-in –charge or his representative at manufacturer's works. The typed tested motor shall be used for performance test of pumps at manufacturer's works. The scope of testing is as follows:

I. Review of raw materials test certificates and quality control procedure.
II. All the motors shall be offered for routine test and one motor shall be offered for type test at full load. The vibration level should be within permissible limit (IS: 12075) and noise level shall be 80 db/or less for which certificate shall be submitted.

6.6 kV H.T.CAPACITOR PANEL:

The pump motors shall be provided with suitable capacitors for improving power factor to 0.98 lagging at normal duty condition. However, KVAR selected shall not exceed the magnetizing KVAR of the motor; even if corrected P.F is less than 0.95 lagging, calculations for the same shall be submitted. The capacitors shall be suitable for operation at rated voltage and shall be connected in respective power circuit of the motor.

The capacitor bank shall be complete with structure, connections, discharge resistors etc. The capacitor shall be low loss, all polypropylene vacuum impregnated with PXE oil complete with internal discharge resistance as per IS13925 Part-1.The capacitor rating shall be subject to prior approval on furnishing letter from motor manufacturer stating magnetizing KVAR and uncorrected PF at rated power required by the pump-motor with terminal cover & 3 nos. 6.6 kV HRC fuses duly mounted on epoxy insulators & cable termination box to terminate H.T. cable.

The capacitor panel shall include CBCT, 2% series reactor and Load break switch.

Total 6 capacitor panels are to be provided and connected to power circuit of 6.6 kV Vacuum contactor panels of 6.6 kV motor through suitably rated HRC Fuse.

The panel shall consist of following:

- Load break switch
- HT fuses of suitable rating
- E/F relay to sense unbalance
- Capacitor bank
- Al bus bars and wiring
- Indicator lamps
- Aux contactors
- CBCT
- 2% series reactor

415 V L.T. SWITCH GEAR AND CONTROL PANEL

GENERAL: A panel comprising 415V switch gears and control gears shall be suitable designed for the functions as under:

I. Reception of power from 400 kVA transformers -2 No
II. Distribution of power for crane, other auxiliary equipments and ancillary installation, actuators, lighting etc.

Components: The switch gears and control gears shall be as per single line diagram and as specified below:

1)630A MCCB for reception of power from 400 kVA transformer

2)1 set 800 A TPN Bus- Bars

3)6 Nos. DOL starters for valve actuators suitable for forward & reverse operation with indications and connected and wired with interlocking with motor control breaker for sequential start and stop.
4)1 No. DOL starter (forward & reverse) spare for actuator
5)16 Nos. 32 A triple pole MCBs for capacitors, H.T. Panel and spare.
6)2 Nos. 63 A triple pole MCBs for lighting indoor, outdoor and 2 No spare.
7)10 Nos. 16 A MCB for different loads.
8) 4 Nos. 25 A double pole MCBs for space heaters of pump motors with interlocking system.
9)2 Nos. 0 to 500 V voltmeters with selector switches shall be provided for incomer.
10) 2 Nos. 0 to 200 Amp ammeters shall be provided with selector switch with suitable CT (size 144 x 144 mm sq.)
11)3 Nos. pilot lamps with fuses- 6 sets
12) Suitable LT capacitor Banks.

INDICATORS:

I.Space heaters for pump motors
ON - RED
OFF - GREEN

II.Sluice valve for raw water pumps
ON - RED
OFF - GREEN
OPERATING - WHITE

Protection Relays: Protection relays/ release and meters shall be provided as specified in the specifications of individual components.

Construction: The constructional features, inspection of the panel shall generally conform to the specification for 6.6 kV panel with exception of the following:
i)The bus bars shall be triple pole and neutral rated to carry 800 A continuous current.
ii)The panel shall be designed to withstand fault level of 35 MVA.
iii)The base channel shall be minimum ISMC 75.
iv)Power cables shall be 1.1 kV grade PVC insulated copper cable of size not less than 4 sq.mm sizes.
v)Control cables shall be 650 V grade PVC insulated copper cable of size 2.5 sq. mm or above.
vi)Ground bus shall be minimum 25 x 4 mm copper.
vii)C.T. shall be rated for 36 kA fault current.
The panel height shall be exactly same as that of 6.6 kV panel. The panel shall be painted with powder coated paint of approved colour.

Molded Case Circuit Breaker: The MCCB shall be quick make and break and trip free contact having the rating to suit the load condition on it. The ON/OFF position shall be clearly indicated and 'on' indication lamps shall be provided. MCCB shall be provided with suitable thermal relay or magnetic relay. Breaking capacity shall be 50 kA. MCCB shall be provided with shunt trip coil suitable for 230V and shall have tripping push button arrangement. The under voltage relay shall also be provided in the MCCB with earth fault relay. Each MCCB shall be provided with stop push button.

Starter: The starters for valve actuators shall be air break type operated with start, reverse and stop push buttons mounted on front on the panel. It shall incorporate bimetallic thermal over current relay, reversing contactors and necessary features for valve actuator duty. The starter shall have interlocking arrangement with motor breaker to ensure closure of the valve before motor is switched on with time delay arrangement. Suitable selector switch shall be provided on starter for selection of auto/ interlocking with breaker or manual. It shall incorporate control feature consistent with torque and limit switches in actuator with necessary wiring.

Indicating Lamps: All indicating lamps shall be of low wattage with series resistance. The lens shall be polycarbonate, oil, dust- proof unbreakable and of suitable colour. The arrangement shall permit removal of lenses and bulbs from front. All lamps shall be protected with individual fuses circuit.

Meters: The ammeters and voltmeters shall be dust and weather proof with plastic window and of accuracy class as per I.S. 1248. They shall be flush mounted on panel. Size of the meter shall be 150 mm square.

MAT: Electrical grade rubber mat ISI mark 12 mm thick 1000 mm wide extending over full length of each panel shall be provided.

Testing: The L.T. panel shall be tested at manufacturer's work in presence of Engineer In charge or his representative. The scope of inspection is as follows:-

a) Review of raw materials test certificate and quality control procedure.
b) High voltage test
c) Routine test as per IS
d) Checking of phase and earth clearance of bus bars
e) Checking of wiring diagram and contact circuit an operation of panel.
f) Insulation Resistance Test
g) Fault simulation for testing protection relays except short circuit and earth fault.

APPROVED MAKES:

MCB : L & T /ABB/ Crompton /Siemens/ Hawell
METER : AE/ IMP/ NECCO/ NSDA/ Rishabh/ DIP
DOL Starters :L&T / Siemens / Crompton / Bharatiya / Kirloska r/ Telemechanique / other reputed make approved by Engineer In charge.

CABLES:

6.6 kV power cable shall be aluminum conductor XLPE, armoured cable and of 6.6 kV grade. The cable shall be of size rated to carry full load current at 0.85 P.F. continuously or two withstand short circuit current of 15 kA for 1 second duration, whichever is greater but shall not be less than the size specified in subsequent clause. The cables shall conform to IS 7098.

1.1 KV Power Cables: Power cable used in 415 V system shall be 1.1 kV grade 3.5 cores or 3 core as applicable alluminium conductor, XLPE insulated, PVC sheathed, galvanized flat steel armoured type conforming to IS: 7098. Cables shall be of sizes rated to carry full load current continuous at 0.85 PF or to withstand short circuit current of 35 kA for 1 second duration which ever is greater, but shall not be less than size specified in subsequent clause.

Control Cable for D.C. supply, circuit breaker, relays, indication, annunciation and protection

650/1100V grade cable of adequate number of cores, of suitable size, copper conductor, PVC sheathed, armoured shall be provided as required and approved by the Engineer. All above cable for purpose of work are designated as 'Control Cables' and include all required cables not specifically stipulated. Number of cores in the cable as under shall be spare.

a) Up to 6 core Nil
b) 7 core to 10 Core 1 No.
c) 11 core to 30 core 2 Nos.
d) Above 20 core 3 Nos.

Complete wiring diagram showing terminal block number, ferrule number and unit, with earthing point shall be submitted for prior approval before execution.

Cable Schedule: The sizes for the cables stated in the schedule are the minimum acceptable size.The Concessionaire may offer alternative sizes subject to approval from Engineer-In-Charge

Sr. No	From	To	Grade	Cores	Size Sq.mm
1	Incoming Supply	Metering Unit	33 kV	3 Core	120
2	Transformer 6.6 kV	6.6 kV control panel	6.6 kV	3 Core	240
3	Motor control panel	6.6 kV motor	6.6 kV	3Core	70
4	Transformer 415 V	L.T. Panel	1.1 kV	3.5 Core	300
5	L.T. Panel	Crane	1.1kV	3 core	25
6.	L.T. Panel	Actuators & Lighting	1.1 kV	3 core	16 & 4

Cabling Method: Cables shall be laid in trenches and ducts in ground and while passing through wall on trays in and out of the pump house. Every cable shall be neatly run vertically, horizontally or parallel to adjacent walls, beams or columns.
The cables shall be terminated in mechanical glands which shall be suitable to provide adequate support by locking on the armour for additional earth continuity. Suitable compression type cable lugs shall be used for cable terminations.
The point of entry, exit of the cables from the building shall be sealed from outside with an approved asbestos compound followed by about 40 mm thick bituminous compound or a weak mortar, care shall be taken not to damage sheathing of cable due to hot bituminous compound while sealing.
Cable route markers of approved design shall be installed at the following position.

i. Entry and exit points of underground duct / trench.
ii. Exits from the building.
iii. At every 5 m distance of straight run.
iv. Any other position necessary to trace route.

A metallic plastic tag bearing cable reference number indicated in cable schedule at ever 5 m run or part therefore and at both ends shall be provided for ease of identification and route tracing. The schedule shall be prepared by the Concessionaire and submitted for approval.
The cable routing and laying shall be such that sharp bends and links are avoided. The radius at bends for PVC insulted cables shall not be less than 15 D where D is overall diameter of the cable. Laying and termination of 6.6 kV grade cable shall be as per manufacturer's instructions. Such instructions shall be furnished to the Engineer-In-Charge. Loops/ extra length shall be provided in each cable run located suitably. The loop/ extra length shall be adequate for two straight through joints as and when such need arises.

Cable Trenches: The 1.1 kV grade cable from sub-station to L.T. panel shall be laid in cable trench. The depth of the trench shall be at least 500 mm measured from finished ground level. Before laying, bottom of the trench shall be cleared of broken stones, loose pieces etc. and the bottom shall be finished, firm and smooth contoured.
First 75 mm sand layer shall be placed to form bedding for cable. Cable shall be gently pulled and rested on bedding to avoid any tension during back filling and subsequent settlement.
After laying of cables, further 75 mm fine sand shall be provided to cover cables, which shall further be covered by precast, concrete tiles of adequate width to overlap the cable by at least 50 mm each on both sides. The trench then shall be backfilled and finished to ground level with top soil. The trenches inside transformer substation shall be filled by sand. Separate trenches shall be provided for L.T. and H.T. cables.

Cable Duct: Cables from 5000 kVA Transformers to 6.6 kV Panel shall be laid in cable ducts. The duct shall be constructed in RCC 800 mm deep and 400 mm wide. ISA 40 shall be inserted at 400 mm center to center to support a 200 height above bottom and clamp the cable. The cables shall be laid in trefoil formation. The cables shall be clamped at 1200 mm interval.
Pre-cast covers shall be provided over the trench.

Cable Trays: The cable trays shall be used for indoor installation of cables and outdoor vertical runs on the building. The trays shall be of mild steel pre- fabricated and perforated. The sheets shall be of thickness not less than 2.0 mm shall be hot dip galvanized. Bends and tees shall also be pre-fabricated with inside radius not less than 300 mm or above (in case of large cables) and galvanized. All cuts on site shall be treated with cold galvanizing process. Support brackets shall be provided at maximum of 1200 mm centers. Cable trays from panel to motors shall be supported from underside of floor slab.
Cable shall be fixed on the trays at an interval of 1500 mm with suitably designed cable clamps. The cables/ shall be supported at each 250 mm span particular care shall be exercised in laying cable on vertically rising trays by providing adequate cable fixing at short intervals to ensure that cable is not under any strain, load is properly transmitted to clamp and cable is securely fixed.
Separate cable tray shall be used for power and control cables and also the cables operating on different voltages.

Test: Routine tests in respect of 6.6 kV cable shall be carried out at manufacturer's work and test certificate in duplicate shall be furnished.

CABLE TERMINATION KITS:
Termination method on pole structure, VCB, Vacuum contactor, motor for 6.6 kV cables shall be as recommended by the manufacturer, with cable termination kit / compound etc. and any structural work required.

EARTHING
General: The earthing arrangement for substation switch yard and indoor equipment shall be designed in conformity with the I.E. rules 1956 and IS: 3043 and Rules/ Regulations/ Instructions of statutory authorities, as applicable for the class of work under the contract. The arrangement, specifications and quantity/ size stipulated hereunder are minimum requirements. It shall however be the responsibility of the Concessionaire to design and provide the earthing arrangement as stated above. The earthing arrangement shall be got approved from Electrical Inspector.
The earth pits shall conform to the provisions in IS and shall be constructed in M-150 concrete. Required quantity of salt and charcoal shall be provided. Each earth pit shall have funnel arrangement for watering, minimum requirements of earth pits/ electrodes are as under:

Earthing for 33 kV System:

1.Pole structure	2 Nos.
2.Lightening arrestor	2 Nos.
3.Indoor VCB panel, 33 KV	2 Nos.
4.Transformer body	16 Nos.
5.Transformer neutral	16 Nos.
6.GOD/D.O.	6 No.
7.CTPT	2 No.

Each earth electrode shall have disconnecting link to disconnect and measure resistance of earth electrode. RCC Chamber shall be provided with C.I. cover to each earth pit. RCC chambers top shall be flushing to metal spreading level in switch yard.
A ring bus shall be formed in the pole yard and transformer yard to which individual earth electrode shall be connected. Earth leads from equipment; structure etc. shall be connected separately to the ring bus. Both ring buses shall be interconnected with two parallel earth leads at two opposite points on each ring bus.

Extension Of Earth Connection: Earth connections shall be given to metal frame work of A.B. switches, operating handles, lightening arrestors, insulators, transformer neutral and body cable box and glands, VCB body and frame work, pole structure and fencing. Each unit shall have two separate and distinct each connections of adequate size.

Earth Leads: Minimum size of earth leads for earthing of equipment shall be as under:
Lightening arrestor, A.B. Switches, steel structure, Transformer body, cable box, gland fencing, Transformer neutral: 50 x 6 mm Galvanized M.S. flat.
The earth leads run to the structure shall be severely bolted or clamped. Neutral earth leads shall run on separate support without touching body of the transformer. The run and arrangement of earth lead shall be neat and parallel and at right angles formation with reference to general layout of the switchyard and equipment. The bend in flat shall be gradual to prevent mechanical damage and 90^0. Multiple bends if required in earth leads shall be located below ground level.
Inter connections of the earth continuity conductor and main / branch earth leads shall be bolted ensuring reliable, permanent and good electrical connection. Earth leads shall be protected against mechanical damage and corrosion particularly at the point of connection.

EARTHING FOR 6.6 KV AND 415 V SYSTEM: The earthing shall be generally as specified above and as detailed below:

1.Minimum 18 earth pits for 6.6 kV system
2.Minimum 6 Nos. earth pits for equipments and panel for 415V system

3.There shall be separate and independent earthing system for 6.6 kV and 415V system and isolated from each other.
4.Earth electrodes for 6.6 kV and 415V system shall be 50 mm dia G.I. and of 3 m long.
5.Separate ring bus shall be formed for each system to which individual earth electrode of the system shall be connected. Earth leads from equipment shall be connected separately to the ring bus.
6.Two earth leads from each equipment shall be connected to ring bus independently.
7.A disconnecting link shall be provided at each pit for disconnection and measuring earth electrode resistance.

SWITCH YARD & PUMPHOUSE LIGHTING:

Switch yard lighting to be provided, erected and tested with street light fitting fixtures of HPSV lamp suitable for 150 watt with lamp pole fixture and bunch of suitable copper wire on steel tubular poles (4.5 x 3.65 x 3.25 mm dia.) of (5+1.75+1.75 m long) total 8.5 m long complete with suitable pole cap. Pole base plate, required terminal box, G.I. pipe for cable run vertically to pole terminal box and RCC plinth foundation complete. Poles are to be painted by two coats of red oxide and two coats of silver paint.

Location of poles in switch yard will be decided by Engineer-In-Charge. Suitable size cable to be provided for above lighting and power connection to be take from near by switch room with required switch fuse unit. The cable shall be laid underground as per standard specifications. Poles shall be connected by extra leads to nearby earth bus in an engineering manner.

Pump house lighting (Internal & External)

For pump house, office, store and switch room illumination and ventilation work following minimum number of fixtures are to be provided.

1. HPSV lamp high bay fitting 400 watts	20 Nos.
2. 2 x 40 Watts industrial tube light fittings	200 Nos.
3. Ceiling fan 24” with regulator	12 No
4. Exhaust Fans heavy duty 450mm, 1400 RPM	24 Nos.
6. Pedestal type air circulator (24”) 600 mm sweep (GEC/Almonard)	12 Nos.
6. Point wiring throughout the pump house area	100 Points
7. Independent point wiring plug	25 Point

Point wiring shall be in M.S. conduit and copper wire only.

Power supply is to be taken from nearer L.T. panel in separate miniature circuit breaker panel. Required number of power plugs (not less than 18) shall be provided. Complete lighting drawing shall be got approved from the Deptt before starting the work. Industrial tube light fitting shall be controlled from one control point, necessary single pole breaker and bunch of 4 run copper wire should be arranged. Complete load should be equally distributed on each phase and maximum number of circuits should be provided as per I.E. rules.

The work of providing wall races for exhaust fan fitting and providing G.I, sheet fabricated cowl/ louvers is included in this work.

The above mentioned fixtures are to be suitably arranged for lighting and ventilation purpose of main pump house, office room, store room and 6.6 KV master control room.

H.T.METERING CUBICLE:

This item includes supplying, erecting, testing and commissioning of H.T. metering cubicle MSEDCL approved, fabricated with 14 SWG M.S. sheet with supporting angle & channel , painted with powder coating or epoxy paint shade light gray, copper bus bar size 25x6 mm, electronic security lock and Godrej make mechanical lock with counter meter for measuring no. of times the opening of doors top side covers interlock with meter door ,epoxy coated 3 nos. CT having ratio between 5/5 to 200/5 A, burden 10VA, class0.5 suitable for provided trivectometer and provision for incoming and outgoing cables. The unit shall be tested at manufacturer's works witnessed by MSEDCL's authority with test certificate etc.

The proper earthing arrangement with 7 nos. of independent 25 x 3 mm copper strip shall be provided. The unit shall be erected on the cement concrete foundation. The 230 V AC supply shall be made available near metering for inspection of meter as well as for testing, calibration etc.

FCMA SOFT STARTERS:

1. The High Voltage Soft Starter for HT induction motor will be based on Flux Compensated Magnetic Amplifier principle and shall be installed on the Neutral side of HT induction Motor.
2. The Flux Compensated Magnetic Amplifier (FCMA) Soft Starter shall be suitable for operation on 6.6 KV at 3 Ph, 50 Hz A.C. supply and suitable for connection to the phase segregated Neutral Terminal Box of the HT induction motor.
3. The Soft Starter shall be rated equivalent to the HT induction motor rated power and shall be capable of operating satisfactorily with the HT induction motor under the specified starting conditions of the induction motor. The Soft Starter rating offered shall not be less than the 900 KW.
4. The Soft Starter shall reduce the starting current of the HT induction motor at least to 80% of the direct on line starting current of the motor. The Soft Starter shall have a facility to further reduce the current, if the motor & load torque speed curves permit so. The Soft Starter shall control the starting torque in such a manner so as to effect smooth starting of the HT induction motor drive. The Soft Starter shall be provided with suitably rated ammeter to indicate the motor current during starting.
5. The Flux Compensated Magnetic Amplifier (FCMA) shall work on the principle of unsaturated core in the working zone and shall not lead to generation of harmonics. The Soft Starter shall have Silicon steel core. The windings of the Soft Starters shall be with insulation class H maximum, temperature of winding shall be limited to that of class B. The FCMA unit shall be Air Cooled and dust & vermin proof. The FCMA Soft Starters shall be suitable for indoor mounting.
6. The Soft Starter shall be so rated as to allow at least two consecutive starts from cold or four hot starts per hour.
7. The Soft Starter shall be designed for supply voltage variation of ± 6% and frequency variation of +/- 3%.
8. The Soft Starter shall be suitable for working at control supply voltage on 110V DC.
9. The FCMA Soft Starter shall be housed in a sheet steel enclosure of thickness not less than 2 mm and painted with corrosion resistive paint such as Epoxy or Polyurethane. The degree of protection shall be IP-24 or equivalent.
10. FCMA Soft Starter unit shall have anti condensation heater, complete with switch and thermostat. The heater shall have interlocking in such a way that it is switched 'OFF' when motor is in run mode.
11. FCMA Soft Starter shall not contain any active electronic components.
12. FCMA Soft Starter shall have a built in facility for run mode bypass so that the incoming voltage to the HT induction motor is equal to the supply voltage.

TESTING: Routine Test

Physical inspection for dimensional check.

1. Control circuit operation check .
2. High voltage test.
3. Insulation resistance test before & after high voltage test.
4. Temperature rise test for bypass device at rated HT induction motor current for 1 hour.

Site Test

1. Insulation resistance check.
2. Control circuit test.
3. Test to demonstrate achievement of starting current as per specifications and as finalised during detail engineering.

Guarantee of Performance: The equipment shall be almost maintenance free and shall not produce any harmonics. The Concessionaire shall give guarantee of performance of at least 1 year from the date of commissioning.

HT Switchgear connections:

1. 1 No. potential free No contact of the motor circuit breaker shall be wired to the control terminals for interlocking with Soft Starters.
2. The circuit breaker closing circuit shall accept a potential free contact from the Soft Starter to ensure that the motor is started only when Soft Starter is in “Start” mode.
3. The circuit breaker trip circuit shall accept a potential free contact from the Soft Starter to trip the motor in case the Soft Starter gives a trip command.

APFC PANEL: It should be designed to control the power factor of 0.99 and shall never be less than 0.95.

TEST & TRIAL

SITE TESTING AND COMMISSIONING

STANDARDS: The testing and commissioning covered by this specification shall, unless otherwise stated, comply with the requirement of the latest editions of applicable Indian Standards and currently applicable regulations. The manufacturer’s recommendation for testing and commissioning shall be followed.

GENERAL: The following physical tests shall be carried out on all the equipments.

a)Check for physical damage.
b)Check name plates as per specification.
c)Check adequacy in tightness of nuts, bolts, clamps, and other connecting terminals.
d)Check leakage of oil or air if any, oil level, air pressure wherever applicable.
e)Check earth connectors.
f)Check cleanliness and glaze of insulator and bushing surfaces.
g)Check proper lubrication provided for moving parts.
h)Any other checks, specified in the relevant code of installation and manufacturer’s drawings / catalogues.

The test to be carried out on various equipments shall be as follows:

Insulation Resistance Test

The insulation resistance test shall be carried out on the following equipments:
EHV installationby 5000 V megger
HV installation above 1 KVby 2500 V megger
Power circuit of voltage up to 1 KVby 1000 V megger
AC and DC auxiliary circuitsby 500 V megger
14.The results of all the above tests shall be submitted to the purchaser.
15.The purchaser may ask for some additional tests to be carried out which in his opinion are necessary to determine that the works comply with the specifications, manufacturer’s recommendations or IS standards. The Concessionaire shall also carry out such additional tests.
Test and trial of pumping machinery shall be given by Concessionaire after satisfactory commissioning of machinery. The Concessionaire shall carry out operation and maintenance of sub-station, pump house and the works involved in the scope of this project.
The intention of carrying out operation and maintenance through Concessionaire is to operate the pumps as per the requirement of the department, impart training to the deptt. staff in a systematic manner so that the starting and stopping of pumps is done methodically, the records are maintained, checks, routine maintenance which shall be as under.
1) Operation of all pumps, motors, valves and sub station and supply water as per the requirement of deptt.
2) To maintain all records i.e. logbook, for operation and maintenance.
3) To monitor all parameters such as pressure temperature, sub–station equipments and for all other systems specified in the RFP document and technical specification.
4) To carry out routine checks water level, operation of equipments, noise, vibrations and shall maintain all corresponding records.

5) Carrying out preventive maintenance during above period such as lubrication, greasing, gland, cooling abnormal heating of panel, motor etc checking of loose connections of cables, and keep the installation neat and clean dust free.
6) To give training to the operators or to the agency envisaged by the Deptt for smooth O & M.
7) The Concessionaire shall provide log books and all records as directed by the deptt. and shall hand over to the deptt. And safety precautions for emergency situations such as power failure, tripping restarting, abnormal leakages in pump house short circuits sparking fire etc.
The Concessionaire shall provide sundry material of good quality of recommended grease, oil for lubrication, cotton waste gland, packing, rubber packing etc. as required. Normally the water would be supplied regularly after stabilizing the system with full trial and testing and the requirement would be generated in stages.

SPECIFICATIONS FOR 192 MLD WTP AT PHAROLA

1. Programme of Work

The Concessionaire shall furnish to the Engineer-In-Charge within one month from the date of order to start the work, a programme indicating progress to be achieved for completion as per contract agreement. The progress schedule shall be in the form of bar charts, statement forms, daily out-turn of quantities. Should the programme be found defective in any respect or impracticable the same shall be modified as required. Should the actual progress of work lag behind at any stage, revised programme by accelerating the progress to be achieved shall be drawn up, keeping the target of completion unchanged.

Normally, a period of about 1 to 1 ½ month will be required for scrutiny of and getting approval of the competent authority to the design and detailed drawings from the date of receipt from the Concessionaire. The Concessionaire shall be fully responsible for the delay that would be caused in scrutiny of and giving approval to the design and drawings due their being incomplete, shabby and half hazard manner without any illustrative dimensioned sketches in design and due to non-submission of reference book carrying out scrutiny as mentioned above by the Department and due to improper design and drawings submitted by the Concessionaire.

2. Satisfactory Completion of Various Items

The sub-works included in the scope of work are job works. The various items of the sub-works are to fit in perfectly in the whole plant physically, hydraulically and architecturally so as to form effective, working parts of the whole system as per specifications. Each sub-work will be considered as complete when it is completed as per specifications and put into commission as per standard as a successful component part of the whole plant. The Concessionaire will have to use on site best quality of material approved by the Engineer-In-Charge and no claim shall be entertained in case desired quality of material is required to be bought from the longer distance.

3 Checking Quality of Work

The Concessionaire shall, at any time during continuance of the contract, offer sample of work done or, if necessary, pull down a reasonable part of the work enough for such inspection and testing as the Engineer-In-Charge may direct and the Concessionaire shall make good the same to the satisfaction of the Engineer-In-Charge.

Sampling and testing of routine concrete work and other civil work, items shall be done in accordance with N.B.C. practice and I.S.S. to the satisfaction of the Engineer-In-Charge.

4 Inspection

The Concessionaire shall give not less than seven days notice in writing to the Engineer-In-Charge about the work which is proposed to be covered or placed beyond the reach of inspection and verification of sizes for doing the same. If any work is covered without such written notice, the same shall be uncovered by the Concessionaire and in default thereof the same shall be made good by the Concessionaire as directed by Engineer-In-Charge.

5 Disposal of the Excavated Materials: All materials obtained from any excavation as required to be carried out under this contract will be the property of AURANGABAD MUNICIPAL CORPORATION and the Concessionaire shall not have any claim on it. The excavated stuff if approved by the AURANGABAD MUNICIPAL CORPORATION can be used by the Concessionaire for the construction of this work. The surplus excavated materials remaining after the use of other items shall be transported outside within a lead of 5 Kms. and disposed off as directed by the Engineer-In-Charge.

6 Acceptance by Designers / Consultants / Equipment Suppliers

Concessionaire while submitting the bid shall furnish name/names of the process designers/consultants for the hydraulic and process design of the plant as also the names of the structural designers along with their qualifications, experience in the field, addresses and written consent letters from the designers for agreeing to design the treatment plant.

Consent letters from the process designers / consultants should indicate the works of such type of capacity not less than 100 MLD water treatment plant at one place designed by them and satisfactorily commissioned with documentary evidence of having done so and reference certificates from the authorities for designing and satisfactorily commissioning of such filtration plants, etc.
The Concessionaires should indicate also the names of the manufacturers and erectors of mechanical equipment for water treatment plant of capacity of a least 100MLD at one place together with their consent letter of having agreed to supply, erect or supervise erection with satisfactory commissioning.

7 Responsibility of Concessionaire for design, drawing and work

Even though, the design and drawings are approved by the Competent authority of the AMC, the Concessionaire shall be fully responsible for the technical and arithmetical correctness and soundness of the design and drawings and for the safety of the works executed on the basis of such approved design and drawings and for the damages and failure etc. of the works so constructed whether due to bad workmanship or faulty. Repairs or reconstruction to such damages or failure of the work shall have to be done by the Concessionaire.

9 Design and Construction of RCC works

RCC design shall be based on IS code of practice and following are the relevant ISS for safe permissible stresses and other details. A detailed design criterion is enclosed separately.

a)	IS 456 – 2000	:	IS Code of Practice for PCC and RCC IIInd Revision)
b)	IS 875 – 1987 (Part I – V)	:	IS Code of Practice for Design Loads for Building and Structure.
c)	IS 3370 – 1965 (Part I to IV)	:	IS Code of Practice for Concrete Structure for the Storage of Liquids.
d)	IS 1893 – 2002	:	Criteria for Earthquake Resistant design of structure.

1. The Basic design requirement, criteria and dimensions mentioned hereafter shall be strictly adhered to.
2. The intending Concessionaire should acquaint himself thoroughly with site conditions as well as the needs of Aurangabad Municipal Corporation, before designing the structure.
3. The above Indian standards current on the date of bid shall be applicable to the design of structure. Items not specifically covered by the Indian Standard Code of Practice reference shall be made to relevant standard specifications. If none of the standards have provision on any item relating to design, the decision of the Engineer-In-Charge of concerned AURANGABAD MUNICIPAL CORPORATION, in such matter shall be final and binding on the Concessionaire.
4. The minimum depth of foundation for individual footing should not be less than 2.00 M. In case of raft foundation, it should not be less than 3.50 M.
5. Free Board: Minimum free board required from soffit of beam/slab should not be less than 30 cms. The tank foundation and other member shall be designed for free board full condition.
6. Age factor: Age factor should not be considered for design.
7. For structure having more than 6 columns internal braces are obligatory. One set of brace should be provided at ground level and is obligatory.
8. Thickness of container member shall be checked for non-cracking check.

GENERAL SPECIFICATIONS

1 Specifications of Work: The work shall be carried out as per practice and procedures laid down in National Building Code of Practice and relevant I.S.S. updated for respective items and CPHEEO Manual on Water Supply published by Government of India and / or as directed by the Engineer-In-Charge.

2 General Descriptions and Location of Site: The Proposed water treatment plant is to be constructed at Pharola in the premises of existing water treatment plant. The Concessionaire will have to excavate the site to requirement as per approved layout.

3 Source of Raw Water Supply: The source of raw water is Jayakwadi Dam Dist. Aurangabad.

4 Quality of Raw Water: As regards the requirements and the scope of the water treatment plant the Concessionaire should carry out sample tests independently to verify the quality of water to design the plant.

5 Motive Power: The Concessionaire shall communicate the total electrical load required for successful operation of the water treatment plant offered, within one month from the date of getting the work order. This electric load shall include load for inside and outside light points etc. attached to the building/structures properly. The electric supply required by the Concessionaire for the purpose of execution and erection of machinery and equipment shall be arranged by him.

6 Proposed Works and Scope of Work: The proposed water treatment plant consists of the following sub-works together with allied items complete in all respects so as to be effective and successful parts of the water treatment plant as a whole.

a) One aeration fountain (cascade type) and a raw water channel with measuring venturi flume to deal with a flow of 192 MLD (8000 m^3/hour).
b) Flash mixer of adequate detention period, not less than sixty seconds for each unit with mechanical equipment to deal with a flow of 192 MLD (8000 m^3/hour).
c) A Clariflocculator of 2.5 hours detention capacity with mechanical equipment to deal with a flow of 192 MLD (8000 m^3/hour).
d) Rapid sand gravity filters to deal with a flow of 192 MLD (8000 m^3/hour) complete with porch, entrance hall, air blower room, office, laboratory, two toilet units, etc.
e) Mechanical equipments required for the operation of the treatment works as specified in the items and specifications.
f) One overhead wash water tank of suitable capacity to wash minimum two filter beds at a time.
g) Provide suitable number of air blowers with motors for treatment plant with 100% standby.
h) Bypass arrangements for each unit.
i) Two vacuum type chlorinators – one for pre-chlorination and one for post-chlorination with 100% standby.
j) Alum, and TCL solution tanks, chemical house and stores.
k) Emergency disinfections arrangement of TCL solution tanks.
l) Electrical installations for all units for power and lighting including yard lighting on industrial pattern.
m) Waste water and sludge collection and disposal.
n) Laboratory equipment, chemicals, glassware and miscellaneous items.
o) Independent sanitary blocks on ground floor of filter house.
p) Pure water sump of capacity of 1 hr storage with pure water pump house above sump.
q) Dressing and leveling of site and internal asphalt roads.
r) Pumping machinery for wash water for treatment plant with 100% stand-by.

7 Basic Data: The proposed water treatment plant shall have normal supplying capacity of 192 MLD. Other obligatory conditions for hydraulic design shall be observed.

8 Foundation Conditions and Prescribed Bearing Capacity:

a) The Concessionaire shall verify the bearing capacity by taking actual trial pits on site and refilling them afterwards, at points required by him. The foundation levels shall be decided by the Concessionaire for the various works proposed.

b) All structures shall rest on hard foundation.

c) Filling required to be done to get foundation leveled for receiving bed concrete shall be done in cement concrete M-100 grade. Bedding course of M-200 grade not less than 15 cm. thick shall be provided for foundations of all structures including brick wall foundation.

d) If the work is to be done on hill portion, the Concessionaire shall have to take proper care of retaining the slopes of excavation and if required he shall construct guide/retaining walls, so as not to endanger the structure or part of the structure due to movement of materials of excavation on slopes or of cut part of excavation.

9 Sub-soil Water

The Concessionaire should investigate the possibility of meeting the sub-soil water and design the structure accordingly. The scope of work is inclusive of bailing out of sub-soil water, seepage, rain, gutter or any type of water to any extent during excavation and construction etc. till completion of the whole work.

10 Layout and Statement to be submitted with the Bid

a)Layout

A tentative layout of the treatment plant should be submitted. The layout should only indicate the positions of the different units of the treatment plant of total capacity of 192 MLD.

The layout of whole water treatment plant shall be fairly compact, easily accessible and functionally co-related and having architectural appearance and aesthetic treatment to be approved by AURANGABAD MUNICIPAL CORPORATION.

b)Other Statements and Drawings

Lip of aeration fountain - RL 516.500 M
FSL of pure water sump- RL512.000 M
LSL of pure water sump- RL 505.000M

The Concessionaire shall prepare and submit his own drawings for approval as under:

i) Statement showing the detention periods adopted and calculations of capacities and sizes of various proposed units of the works.
ii) Contoured layout plan showing clearly all the sub works.
iii) Elevation – both front and rear side of the sub work as per general and architectural requirements.
iv) Relevant sections – both front and rear side of the sub work as per general and architectural requirements.
v) Plans at various levels to clarify the drawings given.
vi) Flow diagram showing levels of water in various structures and the levels of the structures themselves showing the details of the various units.
vii) Drawing showing general electrification of the plant as a whole.

11 Detailed Structural and Hydraulic Design Calculations, Layout, Flow Diagram and Detailed Working Drawings and Record Drawings.

i) After the work order is issued, the Concessionaire shall submit the general layout drawing, flow diagram of all the sub works of the plant.
ii) After getting approval to the above, the Concessionaire shall prepare and submit capacity calculations, structural, RCC and hydraulic design calculations of the water treatment plant in six copies to the Engineer in charge within 30 days from the date of getting approval to the layout plan and flow diagram.
iii) The hydraulic designs for various units shall be done as per the requirements specified.
iv) The structural design shall be based on standard recognized reference books and shall be as per standard Engineering Code of Practice and as per current ISS and it shall indicate the reference of the standard reference books adopted, giving page number, etc. for method of design adopted and formula's that are followed for easy and quick

checking of the design. The said reference books shall also be made available for reference and checking whenever called for. The design calculations shall be elaborate and step-by-step without any omissions and with illustrative dimensional sketches wherever required for clarification and easy checking.

The structural designs will have to be got checked from Govt. engineering college. The scrutiny charges for the same will be the responsibility of the Concessionaire.

v) Any modifications, alternations in levels, design calculations and detailed drawings to be carried out as a result of compliance of scrutiny remarks of competent authority shall be carried out and submitted afresh by the Concessionaire, if called upon by the concerned authorities.

vi) The actual execution of work shall be started by the Concessionaire only after receipt of approval to the design calculations and detailed working drawing, from the competent authority.

vii) If any provisions in the design and construction are found to be inadequate or faulty, necessary modifications shall have to be carried out at any stage upto the completion of work.

viii) After completion of the work in all respects, the Concessionaire shall submit five sets of completion record drawings, of all the works as constructed with the stamps **'RECORD DRAWING'.**

12 Desired Performance of the Water Treatment Plant

The filtered water shall conform to the following requirements.

a) Physical Quality and Requirement

i) The filtrate should be clear with the turbidity less than 1 unit on J.T.U. Scale.

ii) The filtrate should be free from colour with maximum unit of 3 on platinum cobalt scale.

iii) The turbidity of the settled water from the clariflocculator shall not be more than 10 units on J.T.U. scale and preferably less than 10 J.T.U (Jackson Turbidity Unit).

iv) The filter runs should not be less than 36 hours.

v) The wash water consumption should not exceed 2% of the quantity filtered as counted on the average of the year's working.

vi) The duration of wash should not normally exceed 10 minutes. The water on the bed at the close of wash should have turbidity not exceeding 10 units on J.T.U. scale.

vii) At the commencement of filter run after wash, the initial loss should not be more than 15 cm.

viii) **Taste and Odour:** There should be nothing objectionable or disagreeable as regards taste and odour, upto a temperature of 45^0C (atmospheric).

b)Quality of Filtered Water

The Quality Standards for potable water after treatment shall be as per CPHEEO manual.

The Concessionaire shall undertake the necessary sampling and testing so as to prove that the filtered water conforms to the above requirements. After consultation with the Concessionaire, the sample procedure shall be as directed by the Engineer – in –charge prior to the commencement of the commissioning of the plant.

13 Water tightness Test for Structures

All the hydraulic structures (water containers such as pre-treatment units, filter-box, wash water tank, chemical tanks, channels etc.) will have to be tested for water tightness by filling them with water upto their designed full supply level. Similarly the pipelines will have to be tested hydraulically. Masonry or RCC structures such as pre-treatment works, filter box, wash water tank, chemical tanks and channels will be considered as water tight only when the reduction in the water level from FSL is not more than 6 mm in 48 hours. The sides of underground structures should not be refilled till the satisfactory hydraulic test is given. In case of structures above ground, the outside surfaces of the structures must be bone-dry with water upto FSL inside. The hydraulic tests shall be given at the end of completion of each item and structures kept full of water upto the time of commissioning, in order to avoid hair cracks if kept empty for a long time.

As regards the pipelines the tests shall be performed for the working pressure of water head equivalent to 1.5 times the prescribed working pressure for the pipes used.
The Concessionaire will have to give all these hydraulic tests by making his own arrangements for water supply and filling and disposing of water. All materials, test pumps, caps, etc shall be responsibility of the Concessionaire. Concessionaire shall rectify the defects noticed and carry out the test again and repeat the testing operation till successful result is obtained and accepted by the Engineer – in –charge.

14 Commissioning and Trial Run
After completion of various sub-work in all respects the whole plant shall be run on trial basis by the Concessionaire.

15 Mechanical Equipment
All the mechanical equipment required for efficient working of the plant shall be provided of robust and durable type conforming to relevant ISS specified for the constituent material and construction. This includes the labour skilled and unskilled, tools, lifting tackle, valves, controlling devices, prime movers, etc.

The valves upto 300-mm. dia shall be manually operated without spur gear arrangements. The valves of sizes above 300 mm dia and upto 700 mm dia shall be manually operated but with spur gear arrangements. The valves of sizes 800 mm dia and above shall be operated with electric actuator of Beacon-Rotork / Emtok make only with suitable arrangements of manual operation in the case of emergency. The reduction gearbox shall also be a Beacon-Rotork / Emtork make. The torque selection calculations, design of the actuator, gear box (spur / worm) shall be got approved from the Engineer – in –charge. All the CI headstocks / wheel of sluice valves etc. shall be smooth finished, so that on painting they present a smooth appearance. They should be painted with synthetic enamel paint of approved quality.

16 Storing of Chlorine gas Tonners / Containers
The general arrangements shall conform to latest bylaws for Gas Storage by the Central Government. The Concessionaire will have to use the cylinders during the trial run period; and operation and maintenance period. He should follow the complete procedure for obtaining the regular license for using the Chlorine gas Tonners from the Competent Authority of the Central Government, under the relevant laws. The license will be subsequently transferred in the name of the AURANGABAD MUNICIPAL CORPORATION. The general arrangements shall be got approved from the AMC. Four gas Tonners of capacity 900 kg each shall be supplied by the Concessionaire for the plant.

17 Spare Parts
The Concessionaire shall supply before commencement of trial run, the list of spares and vendor list for spare parts required to ensure smooth operation of the plant continuously. The name of the vendor supplying the spare parts with trade number and probable annual average delivery period should also be mentioned in the list of spare parts.

18 Specific Requirements to be provided for in the Design of structures
All members of the structures in contact with water shall be in RCC grade M-250 or higher grade. In case of vertical walls or water-retaining structures the portions of wall above FSL and slab covering or incubating water shall also be of the same grade as that of the portion below it. The minimum thickness of such members shall not be less than 15 cm. This is not applicable for small channel walls, roofs which should satisfy design requirements.

I. Wherever partition walls are provided in water retaining structures, these shall be designed for the conditions with one compartment as full while, adjacent one as empty, wherever such condition is applicable.
II. The side walls of water-retaining structures shall be designed for the worst conditions such as:
    a)Tank full conditions without earth filling from outside.
    b)Tank empty conditions with submerged earth pressure from outside.

c)There shall be no counter-forts coming inside the structures.

Unit-wise obligatory Details for Hydraulic Design

I)	**Aeration Fountain (Cascade Type)**	
a)	Capacity	192 MLD or 8000 cum/hr.
b)	Area to be provided (excluding area of central inlet shaft)	Plan area not less than 0.625 square metre per MLD
c)	Minimum number of cascades	4 – 6
d)	Minimum drop Minimum rise of step	0.8 to 1.0 M 20 cm
e)	Collecting channel	Peripheral to the aeration fountain (free fall from last step to channel shall be 20 m)
f)	Free board	Not less than 30 cms
g)	Velocity	1 m/sec to 1.25 m/sec (Max)
h)	Inlet of fountain	2000 mm dia MS 16 mm thick encased in RCC shaft
i)	RL of lip of aeration fountain	516.5 M
j)	Peripheral walkway	1.20 M wide (min) connected to other component
k)	Structure	RCC
II)	**Parshall Flume / Ventury Flume**	
a)	Capacity	192 MLD or 8000 cum/hr.
b)	Velocity in channel	Not more than 0.6 M/sec.
c)	Loss of head	0.75 M (Max.)
d)	Free board	0.3 M (Min.)
e)	Access	1.2 M wide (Min.) gallery concerned to other components.
f)	Structure	RCC in M 25
g)	Measuring device pedestal type Gauge	Simple flow meter with dial type indicator for measuring the flow of raw water for min. 100 cum/hr and max 10,000 cum/hr accurate shall be provided and fixed. Float chamber can be controlled by inlet, outlet valve arrangement.
III)	**Distribution Chamber: - A distribution Chamber shall be provided before flash mixer. Suitable outlet valve shall be provided**	
IV	**Flash Mixer**	
a)	Type	RCC in M 25 circular
b)	Detention period	Not less than 60 sec.
c)	Outlets in separate RCC chambers with proper discharge regulating arrangements.	Four Nos. One for each Clariflocculator designed to carry 48 MLD discharge with maximum velocity of 1.5 M/sec. for normal flow, the velocity should be minimum 0.8 M/sec.
d)	RPM of blade	100 to 150
e)	Free board	0.50 M for normal flow
f)	Value of G to be achieved	G = 300 sec^{-1}
g)	Prime mover	As per Design calculations
h)	Loss of head	0.4 m (Max.)
i)	Side water depth	3.5 m (Max.)
j)	Shaft and blade	Stainless steel
k)	Access	1.2 m wide (Min.) peripheral walkway connected with other component.
l)	MS covers for motors	6 mm thick MS sheet cover for motors.
V)	**Clariflocculator**	

a)	No. of units and type	4 Nos. radial flow of 48 MLD each MLD.
b)	i) Rated flow	2000 cum/hr per Clariflocculator.
	ii) Detention period	
	i)Flocculator	30 minutes.
	ii)Clarifier	2.5 hours detention time minimum excluding sludge storage capacity.
	Note: Capacity below clear side water depth of Clariflocculator shall not be considered.	
c)	Side water depth	3.50 M minimum.
	Free board	Not less than 0.50 M.
d)	Floor slope	1:12 slope shall be provided towards central pocket only.
e)	Inlet shaft	RCC of adequate capacity, with velocity between 0.8 m to 1.2 m range.
f)	Surface loading	30 cum/sqm / day. For normal flow rate and not more than 40 cum/sqm/day with 20% over loading
g)	Weir loading	Not more than 300 cum/M/day with 20% overloading
h)	Type of weir	Peripheral launder and MS right angled V-notches to give clear over-fall in the launder.
i)	Velocity at the weir	Not more than 0.3 M/sec.
j)	Prime mover	
	i) For blades	As per design
	ii) For bridge	As per design
	The detailed design calculation of prime mover, i.e. torque, duty, etc. shall be furnished for approval.	
k)	Launder	RCC in M 25 outside the tank.
i)	Velocity of flow in Flocculator inlet pipe	0.8 M to 1.2 M per sec.
m)	Range of velocity gradient 'G'	10 to 75 sec^{-1}
	Agitator assembly for Clariflocculator	4 nos. of paddle agitator for each Flocculator.
n)	Velocity in launder	Not more than 1 M/sec. maximum (even when considered 20% overloading.) Difference in clarifier FSL and launder FSL should be 30 cms.
o)	Type of clarifier bridge	Full diameter of Flocculator and half diameter of clarifier
p)	Diameter of CI drain pipe	Minimum 300 mm dia or as per design.
q)	Sludge removal	Mechanized unit with continuous removal of sludge under pressure.
r)	Bleeding pipe with telescopic valve arrangement shall be provided in a separate RCC chamber.	The operation of bleeding pipe shall be done from top of clariflier
s)	Access	1.2 M wide (min.) peripheral walkway connected to other components.
t)	Sludge scrapper	Mechanical sludge scrapper conforming to IS 10313 / 1982.

The Clariflocculator units should be located such that it will be able to take the settled water from these Clariflocculators to the inlet of raw water channel of filters of 192 MLD capacity. The separating wall between clarifier and Flocculator should be in RCC M 25 only. Brick wall will not be accepted.

VI) Filters

a)	Design flow	192 MLD or 8000 cum/hr.

b)	No. of beds and type	16 nos. of rapid sand gravity
c)	Depth of filter sand	0.6 to 0.75 m.
d)	Minimum depth of gravel	0.45 m.
e)	Rate of filtration	5,000 litres / sqm / hr.
f)	Overloading to be guaranteed	20% of above rate
g)	Area of filter house	Sufficient for closed filters with pipe gallery and platform minimum 5.5 m width with front foyer of 3.0 m width.
h)	Free board	Not less than 0.50 M
i)	Rate of back wash of water	600 litres / sqm / minute.
	Duration of back wash	10 minutes.
j)	Minimum free fall from outlet weir to pure water channel	30 cm
k)	Velocity in the pure water channel	1 to 1.5 M/sec with 20% overloading capacity.
l)	Under drain system	Conventional PVC 10kg / square cm pipe of designed dia., with CI header tees.
m)	Lateral travel of wash water upto the edge of wash water gutter	Maximum 1.40 M
n)	Constant water level above sand surface	Minimum 1.30 M
o)	Uniformity coefficient of sand	1.3 to 1.7
p)	Effective size of sand	0.45 mm to 0.70 mm.
q)	Specific gravity	2.55 to 2.65
r)	Inlet C. I. sluice gate/ valve for each filter bed	As per design,
s)	All outlet sluice valve dia for each filter bed	As per design,
t)	Drain valve of each filter bed	As per design,
u)	Minimum control valves for each filter unit	Filter inlet – 1 no. Filtered water outlet – 1 no. Air inlet – 1 no. Wash water inlet – 1 no. Wash water outlet – 1 no.
v)	Loss of head	Maximum 1.8 to 2.0 M
VII)	Air Blower	
a)	No. of units	2 nos.(1 W+ 1 S)
b)	Rate of air supply	Capable of delivering minimum 600 LPM per sqm of free air, of filter area at 0.4 kg/sqcm at the under drains.
c)	Duration of supply	5 minutes minimum.
d)	Working pressure	0.35 – 0.4 kg / cm^2
d)	Dia of piping	As per design but Minimum 80 mm dia CI pipes
f)	Standby	100%
	Note: Design calculations for blower prime mover to be submitted by the Concessionaire.	

VIII)	**Chemical House and Chemical Stores**	
a)	Structure	RCC framed with brick panels in two storeys.
b)	i) Carpet area of chemical house	As per design
	ii) Carpet area of chemical store	As per design
c)	Alum solution	As per design
d)	TCI solution tank	As per design
e)	Lime solution tank	As per design
f)	Laboratory and rest room	As per design

IX)	**Wash Water Tank**	
a)	Construction	RCC
b)	Capacity	As per design (suitable to supply wash water two filter units at a time where the units are 4 or more plus 10% for other uses)
X)	**Wash Water Pumps for Water Tank**	
a)	Type	Electrically driven, centrifugal
b)	HP	As per design,
c)	Discharge	As per design to fulfill the wash water requirement in 1 Hr
d)	Total head	As per design
e)	No. of pump	2 nos. (1 working and 1 standby)
f)	Pipe and valves	C.I. as per requirement
XI)	**Chlorinators (As per IS 10533 / 1983)**	
a)	No. of units	4 nos.
b)	Dose	Pre-chlorination 3 ppm Post chlorination 2 ppm
c)	Rated discharge	192 MLD.
d)	Type	Vaccum feed type
e)	Injector	Booster pumps, suitable for working and standby.
f)	Standby	100%
XII)	**TCI Dosing Installation (Emergency Disinfections)**	
a)	No. of units	2 nos. to suit 3 ppm dosing.
b)	Total rated capacity	192 MLD for all tanks
c)	Capacity of tank	To suit 3 ppm dosing.
d)	Drive for mixing	By electric power
XIII)	**Bypassing Arrangements**	As per detailed specifications
XIV)	**Drainage Arrangements**	Up to boundary limits of the plot with RCC NP3 pipes of min. 400 mm dia.
XV)	**Electric Installations**	As per detailed specifications.
XVI)	**Laboratory Equipments**	As per detailed specifications.
XVII)	**Sanitary Blocks**	As per detailed specifications.
XVIII)	**Pure Water Sump**	
a)	Capacity	1 hour i.e. 8000 m^3
b)	Type	RCC M 25
XIX)	**Pure Water Pump House**	
a)	Floor area	Suitable to accommodate pumps, panel board and other electrical and mechanical installations.
b)	Location	Above the treated water sump.
c)	Height	6.5 m minimum.
d)	Construction	RCC M 25 framed structure with brick paneling.

DETAILED SPECIFICATIONS

General

These specifications as laid down hereinafter are in amplification of the requirements already specified in preceding pages of this RFP document and further fully complementary to it. The elaborate specifications for electrical works are given separately in addition to the following. Additional specifications for mechanical work and civil work are separately given.

AERATION FOUNTAIN (CASCADE TYPE)

A)Design and Construction

This shall be of cascade type and designed for a ultimate stage flow of 192 MLD. Risers and treads of the cascades shall be of minimum 20 cm and 50 cm respectively. The peripheral launder shall receive water under clear overfall condition. To avoid splashing, sufficient height shall be provided to the launder above FSL. The cascades shall be finished with granite set in cement concrete, giving aesthetic appearance. The lip of aeration fountain should be at RL 516 M. Fountain lip opening shall be provided with MS jali made of flats of size 75 mm x 6 mm with maximum opening of 75 mm. The jali should be curved in shape of segment of sphere with central rise of 0.40 M. The jali can be detachable. It should be painted with an epoxy anticorrosive paint. Smooth lip spillage shall be achieved.

B)Accessories

1.2 M wide walkway and 25 mm dia double row GI pipe railing with CI stanchions of min. 1 M height at the outer periphery as per the specification of mechanical engineering works shall be provided surrounding the fountain.

C)Mechanical Equipment

The central inlet to the fountain shall be R.C.C. pipe of required dia with bell mouth at its top, increased to suitable diameter. From the duck foot bend M.S. pipeline 2000 mm dia. 16 mm thick extending upto 15.00 M distance measured from center of duck foot bend, shall be provided by the Concessionaire with required specials as per site conditions.

MEASURING FLUME, STILLING CHAMBER, FLOW MEASURING EQUIPMENT ETC.

A) Design

The flume shall be designed as an open channel type for a flow of 192 MLD (8000 m3 / hr) with free board of not less than 30 cm. The measuring flume shall have a baffle wall, stilling chamber and a side chamber for float. The item shall include construction of entire length of channel starting from the launder of aeration fountain to the receiving point at flash mixer. ISS: 6059 and ISS 9117 of latest edition shall be followed.

B) Accessories

On one side walkway of 1.20 M width with 25-mm. GI pipe railing in double row at the outer edge and as per specifications for mechanical engineering works shall be provided.

C) Electrical & Mechanical Equipment

Simple flow meters with dial type indicator shall be provided and installed near the flume. To measure minimum flow of 100 cum / hour and maximum flow of 10000 cum / hr as per ISS 6756, 6236 and 2032 of latest edition.

In order to reduce head loss, the measuring device shall be on parshall flume principle. It shall have, however, to be assured that the channel does not head up due to churning of water in the flash mixer. There should be clear over fall from channel and aeration fountain channel shall be provided with a drain pipe with valve for purpose of washing. At this time, channel shall be provided with penstock gate in MS to separate out from flash mixer.

Flash Mixer

A) Design and Construction

The flash mixer of 192 MLD (8000 cum/hr) shall be constructed RCC finished with cement plaster 1:3 mix at the water face. The unit shall be provided with RCC slab partly covering the tank for locating the driving unit of the agitator and for approach to the same. The FSL of flash mixer shall be 0.2 M below the sill of channel. The maximum detention time to flash mixer shall be 60 second with side water depth of maximum 3.5 M. It should have arrangement to receive the measured and chlorinated raw water, dose aluminium sulphate solution and immediately and violently dispersed the solution throughout the bulk of water in a flash-mixing chamber. The hydraulic design should be such that the accuracy of the flume is not affected by the hydraulic behavior of the section. The design should provide flash mixing chamber with submerged mixers, shaft driven from overhead motors and gear box each designed to impart turbulent energy into water at an anticipated rating of 2.5 KW (minimum). Aluminium sulphate shall be dosed immediately adjacent to the flash mixing device.

B) Accessories

The walkway of 1.20 M width shall be provided with 25 mm. dia GI pipe railing in double row as specified in general mechanical engineering works specification attached.

C) Electrical and Mechanical Equipments

This will consist of the following:

i. Frame agitators with stainless steel blades and stainless steel vertical shaft mounted on bearing of sufficient strength to prevent vibrations.
ii. Electrical motor of suitable horse power, starter and reduction gear (Not less than 3 HP).
iii. Suitable size outlets with proper controlling arrangements of flow.
iv. Water tight penstock on the inlet.
v. Protective covers of MS sheets duly painted for motor.
vi. CI / MS pipelines between flash mixer and clariflocculators shall be provided with a control valves and suitable chambers.
vii. Flash mixer draining arrangements shall be provided with a suitable sluice valve and chamber.

Clariflocculator

A)Design

The item includes construction of 4 Nos of RCC radial flow clariflocculator units each having 48 MLD capacity with central flocculation chamber of 30 minutes detention period and outer annual clarifier of 2.5 hours (minimum) detention period, overflow rate not exceeding 30 M^3 / M^2 / day for 8000 cum/hr excluding sufficient for sludge storage shall be provided, however, capacity below S.W.D shall not be considered. Peripheral launder to clariflocculator shall be provided to take clarified water to the launder. Suitable number of right angled alluminium 'V' notches of 6 mm thick be provided on launder wall. The shape, depth and size of inlet and outlet of clariflocculator shall be designed that the gentle overturning motion given to the water in the flocculating zone shall bring about complete agglomeration of floc to the maximum raw water turbidity. In short (a) Turbidity not more than 20 JTU. (b) Suspended solids not more than 10 mg / l. (c) Total Al not more than 0.30 mg/l for water leaving the clariflocculator shall be achieved, wherever pre-chlorination unit is provided a residual chlorine of 0.2 mg/l for water leaving the clariflocculator shall be maintained.

B)Construction

The outer clariflocculator wall shall be in RCC of thickness not less than 20 cm. The bottom slab shall be in RCC minimum thickness of 20 cm. It shall have a slope of 1 in 12 from outer periphery towards the centre. The flocculator wall shall be 15 cm. thick in RCC with cement plaster on both sides. The central inlet to the flocculator chamber shall be RCC, shaft of adequate diameter with suitable slot opening at the top. This includes providing, laying, lowering and jointing CI / MS pipes of suitable diameter from flash mixer outlet to central inlet shaft of the flocculation chamber. The portion of CI / MS pipe below the floor of the clariflocculator will be encased in CC (M – 250) with

adequate cover of 20 cm. from all sides. The flocculator wall shall rest on RCC ring beam and column of suitable section and height so that water from flocculator will pass on to clarifier radially, below the flocculator wall.
The sludge pipe from the central sludge pocket upto chamber of nearest drainage system shall be of CI / MS pipe of appropriate class, flanged type. The pipes will be encased in CC M-250 upto 20 cm cover to all sides for length below the floor of the clariflocculator. The diameter shall be not less than 300 mm. It should be possible to remove the entire sludge accumulated at the centre of the pit of the clariflocculator by gravity alone to the last drop when it is to be emptied for repairs or so. It also includes sluice valve of equal dia to that of pipe line with extended spindle and wheel. A telescopic bleeding arrangement shall be provided separately and drained in the sludge chamber.
There shall be RCC circular launder outside the edge of vertical wall and extending over to the whole periphery around the weir and launder shall be connected at suitable points to inlet chamber or pipe of the filter unit. The launder shall be designed to take full flow in clariflocculator and size should be such that minimum clear free fall in the launder shall be maintained. The launder should not be provided inside the clarifier for using either sides as weir. From launder of clarifier, clarified water channel of 48 MLD capacity will lead to filter inlet.

C)Accessories
The clarifier will have 1.2 M wide peripheral walkway all round with GI pipe railing 25 cm. dia in two rows at the inner / outer circumference as per general specifications for mechanical engineering works.

D)Mechanical and Electrical Equipments
This includes providing and erecting standard mechanical equipment with required electrical wiring, switches etc. complete. In flocculation chamber, flocculator paddles made of MS section of suitable size and MS flats fixed to central stainless steel shaft of suitable dia (not less than 50 mm and as per IS 7208/1974) should be provided. The flocculator blade shall be of MS plate. The stainless steel central shaft shall be provided with guide bearings to the bottom suitable for underwater use. Even in the case of Dor-Oliver type flocculator mechanism offered by the Concessionaire, the paddles shall be in MS and guide shaft, if used, shall be in stainless steel. The paddle area of flocculator shall be 10 to 25% if tank sectional area in the plane of shaft and the paddle tip velocity should be 0.3 to 0.4 m/sec. the distance between the paddle tips should be of maximum one meter. The flocculator driving mechanism shall comprise of 400/440 volts, 3 Phase A.C. motor of suitable Mechanical Section H.P. (minimum 3 H.P) with approved make starter connected by worm reduction gear of suitable ratio through pinion and bevel wheel drive. Bevel shaft shall be connected to flocculator shaft through rigid couplings. The warm reduction gears shall be suitable for 24 hrs. continuous operation. The design calculations justifying the selection of gears, material of constructions, lubrication, torque requirements verses torque suitability of gear box, etc. shall be submitted for approval. The equipment for clarifier shall consist of a lattice girder bridge. The bridge will be of entire diametric length of flocculator and half the clarifier and with trolley rails resting on the clarifier wall as well as flocculator wall. The bridge path shall consist of a 1.5 m meter wide walkway made of welded and bolted RSJ section of suitable size and fitted with MS grill of removable angle frames and using 20 mm x 6 mm. flats with maximum opening equal to 50 mm. two nos. scraper arms with scraper blades of suitable size covering the entire diameter of the clarifier being suspended from the top of bridge should be provided. The driving mechanism for the bridge shall consist of 400/440 volts. A.C. motor of suitable H.P (not less than 5 H.P) with starter of approved make jointed through coupling to worm reduction gear transmitted by chain drive imparting slow motion to the driving mild steel wheel, moving on rails. The bearings shall be housed in high grade C.I housing with G.M bush for rigidity. Special current collector for transmission of electric power from outside to the different units of bridge shall be provided. The clarifier bridge mechanical equipment should be given two coats of anticorrosive epoxy paint. The panel shall be suitable for outdoor installation and switch fuse units of approved make shall only be assembled. The panel drawing should be got approved prior to fabrication and brought to the site only after inspection by the Engineer – in –charge.
Minimum Performance
Turbidity not greater than 10 JTU.
S.S not greater than 10 mg/lit.

Total Al not greater than 0.3 mg/l.

Filter House and Rapid Gravity Sand Filters

A. Design

The filter units shall be closed with control bay in a filter house. The location of filter house shall not be on pure water sump. There shall be minimum 2 nos. of filter beds which can be operated independently. Together, they will deal with a flow 192 MLD capable of filtering at the rate of 5,000 ltr /m^2/hr. The system should be designed such that it should be possible to overload the filter by 20% without affecting the quality of filtered water. It is proposed to backwash the filter with air wash at the rate of 35 to 45 m^3/m^2/hr of filter bed area at 0.35 kg/cm^2 / 0.4 kg/cm^2 pressure at the under drains and followed by wash water at the rate of 600 litres /sqm /minute of the filter bed area for a duration of 10 minutes. It shall be ensured that the lip level of wash water trough is kept minimum 60 cm above the surface of sand to accommodate expansion of sand bed.

A. 1.20 M wide walkway all round the filter beds with three row of GI pipe railing of 25 mm dia as specified in the general specifications for mechanical engineering works.
B. Space for housing air blowers and panel board in a separate filter annex room with adequate working space.
C. An office room.
D. Pressure reducing arrangement to reduce pressure of water supplied from wash water tank for back washing the filter beds if necessary.
E. Each unit shall be complete in all respects with inlet valves, wash water inlet valves, wash water outlet valves, etc.
F. The lintel height for all building structures shall be minimum 2.4 m from the finished floor.

The filter inlet and outlet channels shall be designed for 20% hydraulic overloading with free board of minimum 50 cm.

B. Filter Media

This shall consist of properly washed quartz sand of effective size between 0.45 mm to 0.70 mm with a uniformity coefficient between 1.3 to 1.7. The gravel media shall be as per standard specifications of rapid gravity filters. The filter bed shall consist of 0.60 to 0.75 M of sand supported on 0.45 M gravel. The filter sand shall be granular, hard, durable, well-washed and screened. It shall be free from clay, dust, shale, loam, organic impurities, vegetation and other impurities and shall not contain more than 10% micaceous matter. The sand crushed and powered and immersed in concentrated hydrochloric acid shall not loose more than 1.5% of weight calculated as $CaCO_3$ and not more than 2% weight shall be lost in case of sand crushed / powered after burning. The friability weight after milling for 15 minutes (750 strokes) shall be less than 10% and for 30 minutes (1500 strokes) shall be less than 20%. The gravel shall be hard, durable and shall not disintegrate under the action of water. The smallest and largest size shall be 3 mm and 50 mm respectively. The Concessionaire shall specify the size and thickness of each layer of filter media (gravels and sand).

C. Construction

The filter house and filter annex building shall be of RCC framed structure. Filter house will comprise of closed control bay and filter beds. Ground floor filter annex shall be double storeyed comprising of inter-annex hall with porch at main control door, air blower room, panel board installation, general administrative block, 1.5 m wide staircase from annex room to operating floor of filter house shall be provided.

Two Nos. RCC staircases 1.2 m wide shall be provided for going from filter operating platform to inspection gallery. These staircases shall be provided with GI pipe hand railing as per specifications mentioned for mechanical engineering work. The steps of staircase shall be provided with CC chequered tiles.

Dimensions of the brick walls, external and internal, should be appropriate for the function of wall to serve and shall not be less than 23 cm. For brick masonry there shall be sponge finished cement plaster in CM 1:3 mix from outside and inside face of the wall shall be plastered in CM 1:3 mix and smooth finished with neeru. The thickness of plaster shall be 12 mm for brick masonry.

The inside face of inspection chamber and filtered water outlet channel connecting portion shall be provided with 6 mm. thick first class quality white glazed tiles, with white glazed corner, etc. set in

white cement. The chamber shall be provided with suitable bulk head fittings for illumination. Inspection chambers shall be provided with MS angle framed both sides MS mesh protected transparent cover. The inspection box and filtered water outlet channel shall be in RCC slab finished with marble mosaic tiles, of approved colour, shade and size. There should be four openings of 90 x 60 cm. heavy duty CI manhole frame and cover, the width of the passage (walkway) around and in between the two adjacent filter beds shall be 1.20 M minimum. Walkway around and filter units shall be provided with 25 mm. dia double row GI pipe hand railing as specified in the general specifications for mechanical engineering works. Railing shall also be provided along the pipe gallery. The clear height shall be 2.7 m. minimum above filter operating platform level to roof slab bottom. The roof and the ceiling etc. shall be finished as specified in the general specification for civil engineering works. The minimum difference in the operating floor and the walkway level on top of P.W channel shall be 2.7 M. The lintel levels for all the building structures shall not be less than 2.45 m.

The position of inspection box, RCC staircase, location of air blowers etc. should be so chosen as to offer very neat and tidy appearance to the filter house.

The ground floor of filter annex should accommodate air blowers, entrance hall with entrance counter, ten chairs, etc. A decorative partly glazed and partly paneled large size door should be provided.

D. Mechanical Equipments

i. Piping

Under this arrangement inlet piping, with regulating arrangement of approved type, outlet pipe with central valves, filter back wash piping waste water discharging piping with valves and air pipe from the blowers upto the under-drainage system with suitable control valves and air releases with necessary piping, extended spindle penstock and operating C.I hand wheel etc. as required shall be provided. All valves should be capable of being operated from operating floor.

All pipes shall be CI 'LA' class with flanged joints. This also includes the required number of specials to negotiate bends and interconnections, etc. The complete piping for back wash of water shall be provided suitable to wash two filter beds at a time.

ii. Under – drainage system

This shall be provided with PVC pressure pipe class 10 with plain ended CI tees to be laid over RCC flooring. The under drainage system shall be designed for the washing rate which shall not exceed 600 litres / M^2 / minute. The under drainage system shall consist of manifolds and laterals as per design of the Concessionaire to satisfy the obligatory requirement.

The ratio of the area of the manifold to the total area of laterals drawing into the manifold shall be 1.5 to 2. Wash water gutter (laterals and main) shall be properly designed so that while functioning, it facilitates complete bed washing. There is no loss of filter material. Wash water travel shall not exceed 1.20 M transversely. Height of lip of the gutter shall be designed taking into consideration the bed expansion during back wash. Duration of wash should not exceed 10 minutes in any case. The quantity of back wash water used shall not exceed on an average 2% of total quantity of filtered water as counted on the average of year's working. The piping shall be sufficiently fixed to RCC floor to prevent its getting detached from the floor. The under drain system shall be capable of taking an overload of 20%.

The under drain system should be capable of taking an overload of 20% as stipulated above. So also the filter outlet control system should also be capable of taking an occasional overload of 20% of the rated capacity hydraulically.

iii. Complete system of waste water draw off for collecting and disposing off waste water during cleaning of filter beds shall be provided as per above requirements.

iv. General Layout and Carpet Area

Full details should be indicated in general layout plan.

Bypass Arrangement

A) Design and Construction

Bypass arrangement shall be provided for clarifier and filters separately. The arrangement shall be designed for rated flow rate plus 20% overload. It shall also include construction of RCC chambers of suitable size wherever necessary.

It should be possible to bypass.

i. Flash mixer and clariflocculator.
ii. Filters totally and / or partially.
iii. Flash mixer and clariflocculator and filters.
iv. Clariflocculator shall be designed to take water to the chlorination point of pure water channel in the filter house proper.

The period of bypass will be minimum possible required of various units and repairs, whether panel or otherwise. During this period the hydraulic capability of various units will be utilized to the maximum but in any case no unit shall be over-flooded nor the quality of pure water be deteriorated beyond acceptable limits. The Concessionaire shall give trials of such hydraulic bypass and limits of end quality achieved.

i. Piping

Pipes and specials shall be of CI 'LA' class, below structure and in other places they may be RCC NP-3 class.

ii.C.I D/F sluice valves, sluice gates, penstocks, etc. at suitable points shall be provided with operating guide-rod and wheel etc. The CI sluice gates, penstocks, etc. should be of reputed make and must have ISI certification mark and should conform to the relevant latest ISS. Sluice valve shall be used exclusively when the difference of water pressure on both sides exceed 1.00 m.

Wash Water Tank

A)Design and Construction

The tank shall be of RCC with a suitable capacity sufficient for cleaning two filter beds at a time, at the rate of 600 litre /Sqm /minute for 10 minutes duration plus 10% extra for other usage and shall be provided at a suitable location. The tank shall be at such an elevation as would give an effective head of 8 M at the under drain of the filter beds.

B)Allied Items

i. Water Level Indicator

Water level indicators shall be installed at both ends of operating platform in the filter house.

ii. RCC spiral staircases for access to the top of the tank and Aluminium ladder inside the tank.

iii. 2 Nos. of CI heavy duty manhole covers with frames of size 1.2 M x 0.9 M with locking arrangements.

iv. Lightening Conductor

One No. as per relevant IS specifications.

v. Piping and Valves

CI/MS pipeline with specials, valves, etc. shall be provided from pump house to wash water tank and awsh water tank to filter for back wash and all sanitary blocks, etc. are to be connected as per requirements. Separate outlet pipe 150 mm dia upto G.L with sluice valve shall be provided for external distribution.

Chemical House and Store and Chemical Feeding Equipment

A)Design

The building shall be constructed in two floors as indicated. It shall be a RCC framed structure in columns and beams with brick paneling of minimum 23 cm. thickness.

B)Area and Locations

The chemical house shall be so located that the chemicals could be conveniently and easily fed and controlled between aeration fountain and flash mixer and fed by gravity.

C) Construction

a)Ground Floor

The ground floor shall accommodate alum store for 90 days', lime for 30 days' and TCI powder for 7 days' requirement and other miscellaneous store, platform type alum weighing machine of 1.00 M.T. capacity. The average height of the plinth of the chemical house shall be 0.6 m above ground level.

b)First Floor

The first floor shall accommodate 3 RCC alum solution tanks, each of adequate size and feeding equipment to suit a maximum dose of 50 mg / litre. Similarly it shall also accommodate laboratory, rest room and one TCI solution tank for pre-chlorination and post-chlorination. The height shall be 5.5 M. The entire construction should be a RCC structure in columns and beams as specified with panels of 23 cm thick walls.

All the civil works of building and brick work plastering, pointing, flooring, painting doors, aluminium windows etc. complete shall be as per standard specifications.

D)Mechanical and other Equipment

A dissolving tray of RCC trough with holes or slots shall be provided on each tank for placing the alum cakes. The alum solution tank shall be fed with pure water by means of GI piping and valves of adequate size from wash water tank. Each solution tank shall be provided with brass gauge plate level indicator. The top of the solution tank shall be covered with 50 mm thick wooden planks properly fixed with edge rounded and painted in 3 coats of oil paint. The alum mixing paddles shall be of stainless steel of enough section and size. Individual drive arrangement shall be provided. Necessary wash out arrangements shall be provided. An RCC operating platform at suitable level and of width 1.20 M and length covering all the tanks shall be provided. All the tanks shall have independent outlets, feeding the dosing tank. In addition, there shall also be adequate capacity for lime solution and TCI solution tank with allied equipment to work in emergency situation.

The solution dose shall be drawn into a constant head rubber lined RCC dosing tank of suitable size and fed to raw water just where it leaves the measuring flume. Automatic dose adjusting arrangement for proportionate dosing shall be provided at the dosing tank. The dosing tank shall be provided with MS rubber lined cover and PVC automatic ball valve etc.

All valves, pipes and fittings for dosing and washout shall be non-corrodible materials and should be adequate size. The gantry girder mechanical arrangement of 1.5 MT capacity shall be made by the Concessionaire to handle to chemicals on ground floor. Both side movement should be operated and controlled electrically and it should provide for manual operational facility also. In addition to the above 1 MT capacity simple chain pulley block fixed to a hook in the top slab of first floor shall be provided to lift the chemicals of top floor from chemical store. The chain pulley block should be of Morris / Elephanta make.

An opening of suitable size in first floor for lifting alum bags from ground floor to fist floor shall be provided. The opening of the floor shall be provided with 25 mm dia GI pipes railing in double row and 1.85 M high. The operating platform of solution tank shall be provided with GI pipe railing. The tank shall be provided with 1.20 M. wide access staircase with 15 cm wide MS plate – stringers of 10 mm thickness and 20 mm rise. The hand railing shall be 0.85 m high GI posts and two rows of 25 mm dia (internal) GI pipe (medium duty) on both sides. Precaution shall be taken to ensure continuity of feeding, alum solution by gravity and prevention of gas hazards, corrosion and dust nuisance. Accuracy of the dosing equipment shall be an essential requirement.

The solution tanks shall be given to coats of chloro rubber paint. The chemical house, platform, staircase, shall have flooring of corrosion – proof tiles.

Wash Water Pump Sets

A)Design

Two numbers of wash water pump sets as described under the statement of obligatory requirement shall be provided. One will work and another pump-set as standby. Hence, total two nos. of pumps shall be provided with 100% standby.

B)Allied Items

Piping and Valves

The piping shall be provided consisting of suction and delivery upto wash water tank inlet. It shall be of CI 'LA' class of suitable dia. All piping shall be double flanged pipes and specials.

Each pumpset shall be provided with CI foot valve and 1 No. of Cast Iron Double Flange (CIDF) sluice valve, one reflux valve, etc. on delivery side.

The test of the pumping machinery shall be given for a period of 100 hours non-stop. Performance of machinery will also be observed in the entire performance period.

A panel board of suitable capacity shall be provided with all fixtures thereon, suitable for these pumping sets.

Chlorine Room and Chlorinators

A)Design

Two numbers of vacuum type chlorinators having capacity to treat 192 MLD should be provided, one for pre-chlorination at a dose of 3 ppm and one for post-chlorination at a dose of 2 ppm. 100% standby chlorinators shall be provided.

B)Construction

Disinfection will be achieved through chlorine gas for this purpose. Not less than two numbers of vacuum type chlorinators of reputed make like Pennwalt with all accessories shall be provided and erected as per maker's specifications. Dosing capacity of each shall be as per design.

Chlorinators shall be housed in chlorine room. The chlorine cylinder room shall be located and designed for facility of removing and bringing in large chlorine cylinders. There should be provision of weighing machine of adequate capacity to weigh and keep the cylinder on top of cradles during use. The chlorination room shall be provided with additional ventilators at floor level also. Exhaust fans, at least 6 numbers, should also be provided at floor level of chlorination room. Chlorine cylinder store room should be designed to accommodate at least 4 numbers of tonners at a time, all on cradles. The arrangement of storing shall be conforming to provisions of bylaws prepared for gas storage by the Central Government 1981. The piping conveying gas to chlorination room shall be concealed below detachable false flooring. For movement of cylinders from truck to cradles and in between cradles shall be done with a 2.5 MT capacity gantry. The scope of work includes supply of tested chlorine tonners 4 Nos. (tonners of 900 kg) to be installed before commissioning.

C)Piping

This shall be provided from the chlorinators upto the point of application and shall be of PVC with suitable specials. Piping shall also be provided for supply of pure water to the chlorinator from a suitable tapping point.

D) The safety equipment for chlorine gas cylinder handling such as gas mask with artificial inhaling arrangement of a reputed Company in 3 sets to be provided. Chlorine leak detention and control equipment shall also be provided in 3 sets. Water tank with lime solution of required size shall be provided for safety.

Emergency Disinfection Arrangement

A)Design

This arrangement is proposed for disinfection of water by TCI. The capacity of each TCI solution tank shall not be less than 3 hours (1 kg TCI in 40 litres of water). There will be 3 nos. of tanks.

B)Construction

The emergency disinfection TCI tank shall be located suitably in the chlorination room. The chlorination room should have a separate entrance. Tank walls shall be lined from inside with bitumen rubber paint or any other suitable anticorrosive materials. Additional ventilators shall be provided at floor level.

C)Accessories

Approach ladder and walking platform 1.20 m wide with GI pipe railing as specified in the general specifications for mechanical, engineering works shall be provided if the tank top is more than 1 m above the floor level.

D)Piping

This includes alkathene piping encased in AC pipes for solution outlet and drawn upto the point of discharge and GI piping with valves for feeding pure water to tanks, right from tapping point.

Mechanical Equipments

The tanks shall be provided with electrically operated by suitable metal shaft fixed with wooden mixing paddles with suitable metal cover. A dosing arrangement consisting of constant head dosing box with stainless steel ball valve and polythene float and stainless steel orifice with stainless steel taper shall be provided to administer a dose 0.4 ppm of chlorine at each place. A solution level indicator shall be provided to each tank.

Electrification

The main distribution panel board should be connected to panels for flash mixer, clariflocculator, clarifier, chemical agitators, lighting purpose, etc. This item includes all power / control wiring, external, internal electrification, illuminaries, fixtures, switch fuse unit, circuit breakers, etc. The units shall be as per site requirement and test and trial shall be given upto the satisfaction of Engineer – in –charge.

Laboratory Equipment

The laboratory shall be suitably accommodated on the ground floor of chemical house.

The Concessionaire shall provide the laboratory equipment to the latest and upto-date design and shall consist of –

- **i)** Jar test apparatus to decide optimum alum dose including chemical / electrically operated stirrer.
- **ii)** One turbidity rod for measuring the turbidity of raw water.
- **iii)** a). Latest type optical turbidity meter for measuring the turbidity of filtered and settled water.
  b). A turbidity meter specially to measure turbidity of pure water with digital display along with 2 nos. of spare kits.
- **iv)** One electrically operated pH meter (Aquascope) with full range of comparator disks with necessary reagents.
- **v)** Two chloro-scopes for measurement of residual chlorine with necessary reagents.
- **vi)** One wash basin of large size laboratory use with inlet pipe connections from main and washout pipe arrangement upto manhole.
- **vii)** Plastic buckets of 10 litres capacity – 2 Nos.
- **viii)** One analytical chemical balance with glass case, having weighing capacity upto 200 gms and sensitivity upto 0.1 milligram along with a weight box. One mechanical balance of 1 kg capacity with dial display shall be provided with sensitivity of 1 gm.
- **ix)** Stainless steel tongs of 200 mm size2 Nos.
  a) Crucible silica with lid 2 Nos.
  b) Test tubes 15 cm and 20 cm size12 Nos.
  c) Volumetric pipettes range varying from 1 cc to 100 cc6 Nos.
  d) Measuring flask range varying 4 Nos.
  e) Beakers4 Nos.
  f) Weighing bottles2 Nos.
  g) Wash bottles 1000 cc. 2 Nos.
  h) Burettes 25 cc. 6 Nos.
  i) Reagent bottles of different capacity 4 Nos.
  j) Chemical flask 250 cc. 4 Nos.
  k) Porcelain crucible 25 cc. 4 Nos.
  l) Measuring cylinders 100 cc to 500 cc. 4 Nos.
  m) Distillation flask 1000 cc. 1 No.
  n) Pipette stand for 12 pipettes. 3 Nos.
  o) Test tube stand. 2 Nos.

x) One electrically operated 'Beaker' laboratory flocculator for stirring solution.

xi) One water-works model of minimum plan size 6.0 M x 4.0 M (in 3 dimensions) showing the different units and total plant site as per actual execution in a glass case mounted on a T.W. table to be located in the office room of filter house.

xii) Sampling Table

This shall be provided for collecting samples of raw water, settled water, filtered water and chlorinated water with necessary pumps if required, clarify bowls, glazed sink, piping and teak wood French – polish table size not less than 1 M x 2 M with glass cover and aluminum top for supporting the same on which the bowls are mounted. All fittings for the table shall be chromium – plated.

Individual supply lines of the sampling table shall be marked, (preferably on the push rod of the cocks) with distinctive letters such as raw settled, filtered, etc. The whole assembly shall form a pleasing central feature. Each arrangement in the background for clear vision. The equipment shall also include drain connecting the manhole outside the filter house.

xiii) Two sets of instruction manual for operation of flash mixer, clariflocculator, filters, venturi flume and the flow recording equipment and the chlorinator shall be provided by the Concessionaire.

xiv) The Concessionaire shall identify and provide all necessary reagents and chemicals so as to enable the chemist and his assistants to satisfactorily test the samples and analyze them.

xv) The Concessionaire shall provide 1 No. of Godrej medium size Almari and Godrej Book case and 1 No. of large size Godrej Table, 6 Nos. of chairs along with 3 Nos. of cushioned stools.

xvi) A Quartz type battery operated 30 cm. dia wall clocks.

Internal Roads

The item shall include designing the works to an attractive layout, leveling of the works site and construction of internal roads of 5.0 M (including 0.75 m wide side margin on each side) total width with asphalt topping 40 mm thick of 3.5 m width approachable to each unit of the plant with side gutters.

Pure Water Sump

a) Design and Construction

Capacity of sump shall be minimum 1 hour's storage. The construction shall be in RCC.

b) Allied Requirements

i. The water level indicators one no. mechanical and one no. electronic digital display shall be provided to each compartment. Mechanical and one no. electronic shall be fitted in wash water pump house and one no. of display in the office.
ii. Suitable decorative RCC ventilators shall be provided.
iii. Four Nos. 1.2 M x 0.9 MCI heavy duty manhole frames and covers with suitable locking arrangements shall be provided and fixed.
iv. Sufficient no. of access ladders / steps shall be provided.
v. Overflow from pure water sump is necessary upto 15 M length from sump.

Pure Water Pump House

Pure water pump house shall be accommodated on top of sump and shall have adequate area to accommodate pumps. Height of pump house shall be 6.5 m minimum. Ventilation shall be minimum 20%. The construction should be in RCC frame structure and brick panels of minimum thickness of 23 cm. Top slab thickness should be 12 cm minimum. Doors shall be in Country Cut Teak Wood (CCTW) and aluminium frame windows fully glazed shall be provided. Floor shall be provided of Kota stone with M-100 bedding. The arrangement of cable tray / trench, location of panel board, etc. shall be got approved from Engineer –in – Charge. The pump house columns shall be designed with corbels designed to take the weight of gantry.

Conveyance of Waste Water and Sludge Drain Arrangement

a)Design

The arrangement is to be provided for collecting and carrying the waste water and sludge from the aeration fountain, venture flume, flash mixer, clariflocculator, filter house, chemical house, overflow of wash water sump and pure water sump, etc. through a system of pipes and manholes upto point of discharge i.e. point of last manhole near to the boundary of plot. The pipe shall run 2/3rd full. The velocity at 1/3rd flow shall not be less than 1 M/sec. The conveyance system to drain effluent of septic tank shall be provided separately upto the disposal point using R.C.C. NP-3 pipes of minimum 400 mm dia and suitable manholes.

b)Construction

The pipe lines shall be of RCC NP-3 class with rubber jointed, the minimum cover over the sewers shall be 0.9 M. The pipe below 400 mm dia. shall not be used in the system. The system shall include all valves, specials, etc. as per requirements at site and as directed by the Engineer – in – charge.

c)Manhole

These manhole shall be in BB masonry and shall be in circular shape of 500 mm opening.
The diameters of manhole shall be as stated below:

1. Depth upto 1.0 M1.0 M dia.
2. Depth from 1.0 to 2.0 M1.2 M dia.
3. Depth from 2.0 to 3.0 M1.5 M dia.
4. Depth more than 3.0 M1.5 M dia.

The B.B. masonry shall be 23 cm. thick manholes upto 1.0 M depth, 35 cm thick for manholes between 1 M to 3 M depth and 45 cm thick for manholes more than 3 M depth. The bottom of each manhole shall be of 30 cm. M – 100 (1:3:6) cement concrete with a benching of M – 150 (C.C. 1:2:4). The bottom and inside and outside surfaces of the chambers shall be finished smooth with cement plaster in CM 1:3. Manhole shall be provided with heavy duty CI manhole frame and cover (560 mm dia as per ISS 1726 – 1967). CI steps shall be provided for manholes more than 1.0 M deep.

Sanitary Blocks

Sanitary blocks of carpet area 25 sqm. With septic tank arrangement should be constructed within the premises of WTP.

Trial Run

The period of this trial run shall start from the satisfactory testing and commissioning of the plant by the Concessionaire.
Similarly, 3 sets of colour photographs of major stages of construction shall be taken and furnished to the AURANGABAD MUNICIPAL CORPORATION for record.

APPENDIX 'A': SPECIFICATIONS FOR CIVIL ENGINEERING WORKS

1 GENERAL

The following specifications shall be applicable to all civil engineering works under this contract. Items, which are not covered under the following description, shall be carried out as per relevant specifications in ISS or book of Standard Specifications 1972 (Government of Maharashtra) Publication and National Building Code and as mentioned in the proceeding pages. Wherever IS specifications are referred, the same should be treated as latest edition.

2 MATERIAL

i. All the materials shall be of best and standard type as laid down in PWD Hand Books volume I and II. Red Book of B and C Department, IS specifications and shall have to be got approved by Engineer – in – charge.

ii. All skilled and unskilled labour, supervisors, site engineers, etc shall have to be provided as directed by Engineer – in – charge.

3 GENERAL REQUIREMENT

i. PCC Course

All structures shall be provided with a 15 cm. thick leveling course of PCC (M-150) the floors slabs or foundation slabs. This course shall have an offset of 15 cms on all sides and it shall rest on suitable strata of appropriate bearing capacity as per design.

ii. Refilling by Excavated Stuff

Sides of the structures below GL shall be refilled, wherever necessary, with selected murum from the excavated from the excavated stuff duly watered and rammed in 15 cm layers.

iii. Plinth Filling

The plinth shall be filled up with hard murum in 15 cm layers duly watered and rammed. Properly selected excavated murum obtained on the work is to be used.

iv. Superstructure

The walls shall be in 2nd class brick masonry in CM 1:6 in framed structure unless otherwise specifically, mentioned. Panel walls shall be 23 cm thick.

v. Plaster

All the inside faces of structure shall be provided with 20 mm thick cement plaster (1:3) with neeru finish from inside and sand faced from outside. Ceiling plaster shall be 12 mm thick in CM 1:3 with neeru finish.

vi. Flooring

All floors of building except chemical store and chlorine room shall be provided with 25 mm thick 1st quality marble mosaic tile floors of white cement with mosaic grains in different colours of approved quality and shade. Chequrred treads of all RCC staircase shall also be provided with identical marble mosaic chequerred tiles. Tiles shall rest on 12 cm. thick PCC. In M -100 grade for ground floor. At upper floors they may directly rest on RCC slabs with cement mortar base. Skirting of mosaic tiles of one tile height for all inside faces of walls of the building except alum store and chlorine room shall be provided.

The flooring of the chemical house, store and chlorine room, platform staircase etc. shall have 50 mm thick Shahabad stone laid on 10 cm. thick PCC M-100 bedding.

vii. Doors and Windows

All building shall be provided with adequate nos. of doors, windows and ventilators.

a) The total shutter area of all external doors, windows, ventilators shall not be less than 25% of the carpet area of the structure. All external doors shall be provided with c.c ramps / steps for access inside or exit outside of the building.

b) All the windows, ventilators of the filter house shall be of aluminium and as per IS specifications.
c) All doors shall be CCTW fully paneled 40 mm thick frame size 125 mm x 75 mm.
d) All fastenings and fixtures shall be strong and of heavy oxidized brass. Proper locking arrangement shall be provided for each unit.
e) All exterior doors, windows, ventilators shall be provided with RCC chajja in a box type or any other suitable architectural form.
f) The central main external teak wood door of the filter house and chemical house shall be fully paneled and having shutter thickness not less than 40 mm. and shall be of decorative type. The size and type should be provided suitably as would prove to be decorative. This door shall have a beautiful RCC porch. This shall be provided in best quality with three coats of French polish of approved shade.
g) All doors, windows and ventilators shall be painted with 2 coats of synthetic enamel paint of approved colour and shade as per standard specifications.

viii. Colour Snowcem Painting and Distempering

a) All internal plastered and finished faces of all the walls, columns etc. shall be given 3 coats of oil bound distemper of approved quality and shade. The ceiling shall be given 2 coats of white snowcem paint.
b) All external plastered and finished faces of walls, in RCC masonry, columns etc. shall be given 3 coats of snowcem paint of approved shade. The finish of exterior faces shall give aesthetic appearance to the building.
c) The colour scheme shall be got approved from the Engineer – in –charge.

APPENDIX "A-1"
ABSTRACT OF SPECIFICATIONS

Sr. No.	Item	Standard Specification No.	Page No	Reference
1	Excavation	B-1 & B-2 Bd. A-1 to A-13	24,25,26,27,28, 257 to 265	Vol I Vol II
2.	Materials Lime, Cement, Neeru water, Fine and coarse aggregate, Stone Bricks, HT steel wires, stainless steel, cast steel. CI:WI:MS wire timber, oil paints	A-1, A-2, A-4, A-5, A-6, A-7, A-8, A-9, A-10, a,b,c, A-11, A-12, A-13, A-14 A-15, A-16, A-17 a,b and C	5 to 18	Vol I
3	Structural Steel	Bd, C2, B, 19.1	273	Vol II and I
4	Plane cement concrete	Bd E1 to E7	287 to 291	Vol II
5	Reinforced cement concrete	Bd F2 to Bd F16	297 to 306	Vol II
6	Steel	Bd F17	306 to 307	Vol II
7	Brick Masonry	b 8(a), b 8 (b), Bd G1 Bd G2 G3, G4, G5 G6, G7	40 to 45, 313 to 317	Vol I, Vol II
8	Stone masonry	B9 (i)	57	Vol I
9	Cement plaster	B11 (i)	65 to 66	Vol I
10	Cement pointing	B13	67	Vol I
11	General wood work	B20	82,83,84	Vol I
12	Oil painting	B21	84,85,86 and 87	Vol I
13	Water proofing	Bd j(3)	355,356	Vol II
14	Paving	Bd M1, M2, M3, M4, M5, M6, M7	379 to 383	Vol II
15	Glazed tiles	Bd M12, Bd M13	385, 386	Vol II
16	Marble Mosaic	B4 M14, Bd M15	386, 387	Vol II
17	Chequerred tiles	Bd M33 (a) and (b)	392	Vol II
18	Wood finishes French polish	Bd N	399,400	Vol II
19	Wooden Door	Dn T1	477	Vol II
20	Glass & Glazing	Bd. S	465 to 467	Vol II
21	Iron Grill work	Bd U1	537	Vol II
22	Laying of CI pipes GI pipes	Bd V1 to V3 Bd V5	547 555	Vol II
23	Water meter	Bd V6 & V7	553,554	Vol II
24	Taps	Bd V8	555	Vol II
25	Gunmetal brass tap	Bd V10 and V11	555	Vol II
26	Rolling shutter	Bd T56	511	Vol II
27	MS ladder	Bd V19	559	Vol II
28	Water Closet	Bd V20	559 to 560	Vol II
29	Urinals	Bd V25	562 to 563	Vol II
30	Hand Basin	Bd V30	565 to 566	Vol II
31	Sink	Bd V31	566 to 567	Vol I
32	CI / AC rain water pipes	Bd V33 and V34	567 to 568	Vol II
33	CI soil pipes	Bd V35	570 to 571	Vol II
34	AC soil pipes	Bd V36	570 to 571	Vol II
35	Stone ware soil pipe	Bd V39	573	Vol II
36	Concrete soil	Bd V41	574	Vol II
37	Septic tank	Bd V45 2-3	575	Vol II
38	Colour washing, white washing & distemper	Bd P1 to Bd P6	411 to 414	Vol II
39	Welding	B 18	78 to 81	Vol II
40	Cement based paint	Bd 0.8.1	406	Vol II

APPENDIX 'B': SPECIFICATIONS FOR MECHANICAL ENGINEERING WORKS

1 PIPES AND SPECIALS

All pipes and specials except for sludge drainage arrangement shall be of CI 'LA" class upto 600 mm diameter. Pipes shall be of MS plate 12 mm thickness for diameter above 600 mm. For sludge drainage arrangement. RCC NP-3 class pipe shall be used. For diameter below 200 mm RCC. Pipes shall not be allowed to be used anywhere. All pipes and specials which shall be laid below the floors, walls, foundation etc. of plant structures shall be duly embedded in M250

2 VALVES / PEN STOCKS / SLUICE VALVE

All the valves shall be of CI/DF type. Valves shall bear the certification of ISI. All valves above 300 mm shall have spur gear arrangement and hand wheel for manual and electrical drive operation with necessary HP motor and its control. The actuator design, torque requirement, selection of gear ratio shall be got approved from the Engineer – in – charge.

All sluice gates shall be of approved make and with brass lining. It shall be provided with spur gear arrangement and hand wheel for easy manual operation.

All penstocks shall be brass-lined and provided with suitable arrangement for easy and smooth manual operation.

The list of approved makes enclosed.

3 GI PIPE RAILING

The railing shall consist of 25 mm inside diameter GI (medium) pipes in two rows. The vertical posts shall be of CI having attractive appearance placed at 1.5 m centre to centre and height of 1 mtr. It should be painted in 2 coats of anti-corrosive paint of approved quality and shade.

4 M.S. LADDER

The MS ladder shall be 0.50 m wide consisting of 65 x 12 mm flat stringers with 16 mm diameter MS bars in double row at 25 cm c/c. The item shall include all fixtures and painting with 2 coats of anti-corrosive paint.

For aeration fountain, flash mixer, clariflocculator etc. MS ladder shall be provided in 45 cm. wide, 6 mm thick chequerred plates for strings as well as steps at 20 cm. and shall be provided with GI pipe hand railing.

5 WATER LEVEL INDICATOR

The indicator shall be of 15 cm. wide brass plate mounted on CC teak wood frame with necessary graduation. All allied fixtures such as copper float, guide-chain, pulley counter weight, indicating arrow etc. shall be provided. The entire unit shall be got approved from the Engineer – in –charge before supply.

6 ROLLING SHUTTER

The rolling shutters shall be fabricated from 16 gauge steel lath with side guide; bottom rails brackets, door suspension shaft, housing box at top including mechanical gear operation arrangement. Locking arrangement shall be provided at bottom at both ends. The shutters shall be painted with 3 coats of anti-corrosive paint of approved quality and shade.

7 FINISHING

After entire completion of the plant, all the mechanical equipment fixtures, fastenings shall be first thoroughly scraped and cleaned and then shall be applied with 2 coats of anti-corrosive paint of approved quality and shade.

8 LIGHTNING CONDUCTOR

Lightning conductors shall be provided suitably for the entire plant area. The lightening conductors should be as per ISS. Item shall include excavation for the trench to the required depth, filling with

charcoal, salt and sand and excavated stuff and all the labour with necessary fixtures etc. as per instructions of the Engineer – in –charge.

9 FIRE Fighting Equipment

6 numbers of fire-extinguishers shall be provided suitably located. Each unit shall have a capacity of 10 kg.; it shall be of a reputed make and shall have to be approved by the Department. Three nos. out of six shall be designed to cope electric fire / chemical fire.

APPENDIX 'C': SPECIFICATIONS FOR ELECTRICAL INSTALLATION

GENERAL

i. All the electrical installation, both internal and external shall be carried out as per Indian Electricity Rules, 1956 and subsequent amendments from time to time.
ii. The work shall be carried out through a licensed electrical Concessionaire registered with the Government of Maharashtra.
iii. All the electrical installation shall be got approved, tested and certified from the Electrical Inspector of Government of Maharashtra by the Concessionaire in the presence of Engineer-In-Charge or the Engineer's representative.
iv. The damages caused to the civil structures etc. during electrical installation shall be made good by bringing such locations to their normal condition i.e. original finish.
v. All the materials used for electrical installation shall be of standard type and of reputed make specified at relevant places hereafter. All the materials shall be got approved from the Engineer – in – charge prior to the supply.
vi. All safety measures shall be adopted for all the installation as per Indian Electricity Rules i.e. providing adequate earthing, proper insulation, etc.
vii. The general layout of the internal and external electrification of entire plant shall be got approved from the Engineer – in –charge, well in advance. Necessary modifications shall have to be carried out as per instructions of the Department and as specified in the RFP document. The Concessionaire shall justify his layout with RFP document.
viii. All the external and internal electrical installations shall be properly screwed to poles and walls respectively to withstand storm, rain, etc.
ix. The electrical installations, internal and external, shall be adequate and should have decorative finish, keeping in view architectural beauty of the civil structure.
x. The entire electrical installations, both internal and external shall be commissioned to the satisfaction of the Engineer – in –charge and shall be covered with guarantee for its performance, designs, equipments and workmanship.

SCOPE OF WORK

The job involved, consists of providing, erecting and commissioning of electrification with necessary allied equipments, its fixtures and accessories for entire plant structures as per requirement both external and internal including yard premises of the treatment plant. Adequate electrical power at 400/440 volts 50 c/s shall be made available for such work to the Concessionaire, who will design and install the panel board for entire internal and external electrification and power requirement to the prime movers of all mechanical equipments of treatments plant i.e. flash mixer, clariflocculator including its flocculator mechanism and end carriage, alum solution tank equipment, wash water pumps and air blowers, sampling table, etc. The Concessionaire shall have to install his panel board in a separate room in the filter house to be constructed by him. Adequate illumination shall be provided both for internal and external areas. Sufficient number of plug points shall be provided. The external electrification will be done by laying underground cables as per Indian Electricity Rules. The scope also includes the essential items of work and material required but not specified anywhere in specifications.
The makes of all mechanical / electrical components shall be got approved.

ITEM-WISE REQUIREMENTS

i. Motors

All the prime movers required mechanical equipments of water treatment plant should be of suitable H.P 3 phase squirrel cage induction motors, working on 440 volts., 50 c/s., 1440 rpm, class of insulation "B" Motors shall be as per IS-325. The motors for outdoor installation shall be of degree of protection IP 54/55 and SI continuous duty.

Recommended Makes

Kirloskar, Siemens, Jyoti Crompton, GEC, NGEF, BHEL.

ii. Starters

Direct on-line starters for motors upto 5 HP shall be provided, above 5 HP and upto 20 HP star-delta starters shall be provided for motors above 20 HP auto-transformer starter shall be provided. These starters shall be fully automatic.

Recommended Makes (Obligatory on Part of Concessionaire)

LT / LK, Siemens, Kilburn, MEI, Jyoti.

iii. Panel Board

a) Main Distribution Board

A cubical sheet metal enclosed panel comprising 415 V switch gear and control gear shall be suitably designed for the functions as under:

Reception of power from power transformer.

Distribution of power to filter house, chemical house and lighting purpose, etc.

This switch gear and control gears components shall be as specifications below:

One no. M.C.C.B for reception of power.

Outgoing feeders for (a) air blower, (b) wash water pumps, (c) electrical circuits for flash mixer, Clarifier Bridge, chemical dosing arrangements, external illumination and internal illumination, etc (Separate feeder for each of the above).

Panel Construction

The 415 volts control gears shall housed in totally enclosed, sheet metal clad, vermin and dust proof cubicles suitable for floor mounting and of equal height. The panels shall incorporate the following:

3 ½ pole – A bus-bars housed in enclosed compartment in horizontal formation.

Inter-panel barriers in the bus-bar chambers shall be of epoxy. The panel shall be fabricated from MS sheets 2 mm thick. Hinged doors shall be provided at the front and rear with car type handles. Mechanical interlock shall be provided to prevent opening of the front alternatively arrangement shall be provided to trip supply in event of opening of the front door. Suitable stopper shall be provided to restrict opening of the door and scratching of paint with adjoining panel structure. Cable entries and exists shall be from bottom. The indicating and operating devices shall be preferably at uniform levels and shall not be above 1600 mm from floor level.

The drawing of the panel shall be submitted and got approved from the competent authority before fabrication.

The same shall be tested in the factory before brought to site.

The panel frame work shall have minimum ISMC 75 base channel.

Current Transformer

The CT for metering shall be wound coil type and shall be rated for 21 KA fault level.

Earthing

Ground bus of section not less than 50 x 4 mm GI flat extending throughout the length of panel shall be bolted to the frame work.

Positive earthing arrangement shall be provided inside each cubical to ensure that cubical tank is earthed in all positions of the tank.

Painting

The panel shall be painted as under:

Prime coatOne coat of red oxide

Intermediate coatEnamel paint of shade approved by the Engineer.

Final CoatAs above.

Labels and danger mark

Scheme of labeling shall be as under:

i. Each compartment door shall have title label. The component / control on each compartment shall have function label.

ii. Each internal component and fuse shall have identification label with fuse current capacity where applicable.

As external labels shall be clear painted black in English. All internal labels shall be multi-layered plastic. All labels shall be affixed with chrome plated nuts and bolts. Size of labels shall be 50 x 25 mm minimum with height of letters as 5 mm.
Compartment not interlocked to an insulator shall have an external danger mark as under:
'DANGER LIVE TERMINALS' with flash mark and volts in red letters on white background.

Mat
Electrical grade rubber mat 1000 mm wide extending full length of panel shall be provided. The requirement shall be applicable for all LT panels and starter panel.
Specifications of Components

1. MCCB of amp. Rating 2 shall be of (1) L & T (ii) E.E. (iii) Tele-mechanic.
2. Ammeter with 100 mm size with C.T. having suitable ratio and with selector switch.

Switch and Fuse Unit
The switch and fuse unit shall conform to IS-4047 and IS-4237. They shall be double break, quick break type designed to break under full load condition. All switches shall have ON and OFF indication. Mechanical interlock shall be provided to prevent inadvertent opening when ON. All fuses shall be HRC and of link type. Indication for state of fuse shall conform to IS-2208.

Indicating Lamps
All indicating lamps shall be of low voltage with series resistance. The lens shall be polycarbonate, oil and dust-proof, unbreakable and of suitable colour. The arrangement shall permit removal of lenses and bulbs from front. All lamps shall be protected with individual fused circuit.

Meters
The ammeters and voltmeters shall be dust and water-tight with plastic window and of accuracy class I as per IS-1248. They shall be flush mounted on panel. Size of the meter shall be 96 sq.mm.

Inspection
The panel shall be offered for inspection and tests to the Engineer at manufacturer's works as under:

i. Complete panel after assembling.
ii. HV tests on power and control circuits.
iii. Simulation test of check functioning of control.

Documents

i) Final dimensional, schematic and wiring drawing or panel board and test reports shall be submitted to the Engineer – in –charge in 5 copies.
ii) Constructional schematic and wiring drawings and operation and maintenance manual for OCB shall be submitted to Engineer in 3 copies.

Panel Board for Blower
The panel board shall be cubical type. The panel board designed for the blowers shall have bus bar chambers, phase indicator lamps with switches, ammeter, voltmeter of suitable range with rotary switch and suitable starter with single phase preventor unit and ICTP main switches of adequate capacity and fuses.

Panel Board for Clariflocculator
The panel board shall be of cubical type. This panel board shall be installed on the bridge of clariflocculator and should be water-proof and weather-proof. It shall consist of main switches of adequate capacity with HRC fuses, direct-on-line starters or star-delta starters as the case may be etc. including the switches for fluorescent light on bridge.

Panel Board for Flash Mixer
The panel board shall be of cubical type. This panel board for flash mixer shall consist of main switch of adequate capacity with HRC / fuses, star-delta starter and single phase preventor. The panel board should be water proof and weather proof. The canopy shall be fitted to panel box.

Panel Board for Alum – Mixing Mechanism
The panel board shall be of cubical type. The panel board shall also include main switch of adequate capacity with HRC fuses, star-delta starter and single phase preventor. The canopy shall be fitted to panel box.

Note
The location of all above panel boards shall be at places considering the operating convenience and shall be properly installed as per directions of the Engineer – in –charge. Suitable starters, DOL, star-delta or auto transformer starter as the case may be, shall be suitably installed in Panel Board.

CABLES
For connecting motor of various HP and panel board suitable 3 ½ core aluminium armoured cable of adequate capacity with regard to starting current of motor shall be provided and shall be of reputed make (IS mark) conforming to IS 1554 / 1964 and laid as per standard practice in a channel as per Indian Electricity Rules. All cables shall be sized considering duct rating and shall have minimum 10% current margin above duct rating. The voltage drop should be restricted to 10 volts.
The cable schedule should be submitted to the AMC and got approved before procurement and starting the cable work.

Recommended Makes
I.C.C, Siemens, Incab, Tropodur, Finolex, Asian.

WIRING
a) Internal
Point wiring with 2.5 sq.mm PVC sheathed aluminium wire shall be provided in a MS conduct of 16 gauge and 25 mm diameter with continuous GI earth wire of 14 SWG complete with shock-proof accessories erected on Formica topped TW block. MS conduit pipes and all necessary conduits specials e.g. bends, tees and cross, elbows, inspection and distribution covers, cutout etc. shall be provided.

Recommended Makes
i. PVC shathed wires:Aluminium conductor 250/440 volts, Henley, Gloster, Finolex.
ii. HGMS Conduit pipe:ISS Mark.

b) External
All the external wiring will be done by using cable of suitable section, 2 core, aluminium armoured cable suitably erected with earthing in ground below 60 cm. with necessary screened sand column of 15 x 15 cm and cable placed exactly at centre of the sand column as per Indian Electricity Rules, suitable cable and cable boxes, glands shall be provided.

Recommended Makes
I.C.C, Gloster, Tropodur, Incab, Finolex, Asian.

c) Poles
i. Poles for street light shall be of GI heavy duty swage welded ones and of 100 x 75 x 50 mm diameter, 5.5 m long with suitable bend at top as per standard practice.

The erection of pole shall include excavation with 0.6 m x 0.6 m x 1.5 m deep and embedded in cement concrete foundation in 1:3:6 with 40 cm plinth. The poles shall be spaced at a distance not more than 20 m centre to centre, along with road and in area requiring lightning.
ii. All necessary fixtures with GI light post, clamps, nuts, and bolts screws, insulators with kit-lat type fuse unit of suitable capacity shall be provided. Suitable earthing shall be provided to the poles.
iii. Painting : All the poles shall be nicely painted with one coat of red oxide and 2 coats of superior quality anti-corrosive Silver paint.
iv. For illumination on bridge of clariflocculator, 1.5 sq.mm 2 core aluminium armoured cable shall be used, with all necessary fixtures e.g. glands, clamps etc.

ILLUMINATION

a)Internal

White enamelied industrial type fluorescent fittings of 22 gauge MS sheet, open-ended reflector complete with 1.2 m (4 ft) x 40 watts, tube, starter and polyester heavy duty chokes, with decorative cover completely wired up with holders erected on TW block. It shall be mounted with two ball suspension places and flush with ceiling with all its accessories, i.e. ceiling rose, etc at places as directed. It shall be mounted in zig-zag pattern on walls, where suspension type is not possible but exclusively as per direction of the Engineer – in –charge. The rate of illumination shall be 40 watts / 10 Sqm.

b)External

Weather-proof and water-proof street light industrial type fluorescent for single 1.2 m (4ft.) tube consisting of cast aluminium body finished in silver gray enamel and MS sheet flat reflector in white stove enamel complete with one piece moulded plastic cover enclosed in metallic frame with rubber lining and complete polyester heavy duty chokes and lock type holders erected in a decorative manner on poles. The fluorescent lights on street shall be spaced not more than 20 m centre to centre.

c)Recommended Makes

Fluorescent fittings with tube rods of 40 watts and 1.2 M (4ft). long, polyester heavy duty chokes, lock type holders, starters etc. should be of same make e.g. Philips, G.E.C, Bajaj, Crompton.

d)Flood Light

General purpose flood light fittings of weather-proof and water proof construction, suitable for and with 500 watts bulbs, donflux type reflector with anodized aluminium sheet span and anodized with well-polished interior reflecting surface with holder of thread type, mounted on MS poles of 80 mm diameter 6 m long, suitably earthed and with necessary fixtures in an approved manner. 15 amps., 230 volts, ICDP switches shall be provided and housed in suitable water proof MS box at an operating level. There should be four flood lights located at each corner for the filter house and chemical house to illuminate the structures fully. One flood light should also be fixed suitably for the aeration fountain. The reflector for flood light shall be donflux type designed for a long and proper focus. In all four (4) nos. of flood lights shall be provided with donflux reflector and mounting clamps.

e)Recommended Makes

Philips, Mazda, Osram, Bajaj, Crompton of 500 watts suitable for 50 c/s. 230 volts supply.

f)Mercury Vapour (M.V) Lamps

Water tight mercury vapour lamp fittings complete with M.V. lamp of 125 watt of reputed make and 3 pin B.C. type 250 volts, with inner reflector and clear acrylic and decorative type cover and close type wired with 3 pin porcelain holder 125 watts, chokes, fuse condenser with fancy bracket of GI pipe suitably erected on 75 mm dia x 6 m MS poles (with suitable base plate and polycap) embedded in foundation, properly earthed and placed as per directions of Engineer –in –charge. (2 Nos.) M.V. lamps shall be provided.

g)Automatic Emergency Lighting

5 Nos. of automatic emergency light units comprising twin 20 W fluorescent tubes (complete fitting) chargeable batteries, auto battery charges, etc. complete.

The unit shall be provided with automatic ON-OFF arrangement during breakdown of electricity supply with flexible cord and 3 pin plug. The system shall be got approved before supply.

FANS

Ceiling Fans: Minimum 12 Nos.

Ceiling fans of approved type with condenser, AC 50 cycles / second, 230 volts and 1400 mm sweep complete with all fixtures e.g. fan champs, MS flat nuts and bolts and with regulator canopy and down rod of required length. The down rod shall be long enough so that a clear distance between the floor and the fan blades shall not exceed 2.6 m. The ceiling fans shall be provided to all

the buildings of the plant, stores and the portion of filter house. All ceiling fans should be of one make only.

Recommended Makes
G.E.C., Usha, Rallies, Crompton, Orient fans with regulators of same make.

Exhaust Fans: Minimum 12 Nos.
Exhaust fans of 45 cm. 230 volts, 50 c/s 1400 rpm with condenser unit and complete with all its accessories and necessary fixtures shall be provided and erected. The location of the exhaust fans shall be as per the directions of the Engineer – in –charge. Metal sheet cowl for exhaust fans recess 45 cm. dia fabricated from suitable frames of 25 x 25 x 3 mm angle, covered with 22 gauge GI sheet and opening covered by expanded metal, mech. Shall be provided. The cowl to be fixed to wall with grouted bolts of 9 mm diameter and 12 cm. long and nuts. Exhaust fans shall be provided in pump house, chlorine room, filter outlet, gallery, chemical house and store, toilet, sanitary block etc. Exhaust fans shall be ensure 10 air changes per hour.
The location of these shall be generally as below:

1. Chlorinator room – 4 nos.
2. nos. below filter gallery and above filter water chambers and channel in two pump house.
3. nos. in the filter house.

Approved Makes
G.E.C., Crompton, Rallies.

EARTHING
Earthing for electrical installation both internal and external, including panel boards and motors with adequate capacity of Aluminium wire of suitable gauge shall be provided at all places and all earthing stations shall be interconnected so as to ensure maximum safety and GI plate, charcoal, salt. Etc. shall be used as per Indian Electricity Rules and as per IS 3043/1966, the earthing wires will run along conduits upto plug points and as per the directions of the Engineer – in –charge.

SWITCH BOARDS WITH SWITCHES FOR BUILDING WIRING
Plate type switches and 3 pin plugs shall be provided and properly fixed in TW block of suitable size with Sunmica top. Sufficient number of such switch boards for operating convenience shall be provided with indication of fan lights etc. on it.

POWER WIRING
Power wiring with 6 Nos. of plug points and switches of 15 amps. Volts suitable for operation of electric power drilling machine and grinder shall be provided only in wash water pump house, and blower rooms 2 Nos. in each. This shall be in addition to the general plug points provided.

SPECIFICATION FOR INDUCTION MOTORS

CONSTRUCTIONAL FEATURES

All the motors shall be of TEFC below 20 HP.

The motors for wash water pump and blower if above 20 HP shall be SPDP type. However, all outdoor motors shall invariably of TEFC construction and with IP 55 protection.

PERFORMANCE

Motors shall be capable of satisfactory operation for the application and continuous duty as required by the drive equipment. All motors shall have 20% excess margin above maximum power required under operating conditions.

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuous under class II supply conditions.

Motors shall be suitable for the method of starting specified. Motors shall be capable of staring and accelerating the load with the applicable method of starting without exceeding acceptable winding temperature, when the supply voltage is 85% of the rated voltage.

The locked rotor current of squirrel cage motors shall not exceed 600% of rated current.

INSULATION

Any joints in the motor insulation such as at coil connections or between slot and end winding section shall have strength equivalent to that of the slot sections of coil.

The insulation shall be given tropical and fungicidal treatment for successful operation of motor in hot, humid and tropical climate as per the applicable standards.

PAINTING

External parts shall be finished and painted to produce a neat and durable surface which will prevent rusting and corrosion. The equipment shall be degreased and all rust, sharp edges, scales be removed and treated with one coat of primer and finished with two coats of final paint.

TESTS

All routine tests shall be conducted on motors and manufacturer’s test certificate should accompany the motor.

SPECIFICATIONS FOR ELECTRICAL INSTALLATION WORK

GENERAL CONDITIONS

SCOPE
This specification is intended to cover the general conditions for electrical installation work.

EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED
The Concessionaire shall furnish all labour, skilled and unskilled, supervisory and administrative personnel, erection tools and tackles, transport vehicles and mobile cranes, equipment for erection, testing and commissioning for timely and effective execution of the contract.

The installation work is inclusive of supply and erection of materials, hard-wares, consumables and sundry items to complete the installation.

The item of work to be performed by the Concessionaire for equipment and materials under this scope of work shall include but not limited to the following:

a) Taking delivery of equipment at shop and at the port of rail head including unloading port clearance from customs etc. and safe transportation to site storage arranging storage with suitable weather protection.

b) Complete assembly, erection and connection.

c) Pre-commissioning check up for correctness of erection.

d) Testing and commissioning in presence Engineer – in – charge or his representative, successful trial operation and obtaining approval.

METHOD OF WORKMANSHIP
All work shall be installed in a first class, neat and workman like manner by technical skilled personnel in the trade involved.
The erection work shall be supervised by competent supervisors holding supervisory license from the Government.
The installation shall be carried out in such a manner as to provide adequate access to other equipment installed.

PROTECTION OF WORK
The Concessionaire shall effectively protect his work, equipment and materials from theft, damage or tampering.
Concessionaire shall be held responsible for any loss or damage to equipment and material until the same is taken over by the purchaser according to the contract.

RESPONSIBILITY OF ERECTION
The Concessionaire shall be fully and finally responsible for proper erection and safe and satisfactory operation of the plant and equipment under his scope of work to the entire satisfaction of the Engineer – in - charge. Equipment and material which are wrongly installed shall be removed and re-installed to comply with the design requirement as directed by Engineer – in - charge.

EXCAVATION AND BACKFILLINGS
The Concessionaire shall perform all excavation and backfilling to the original level with good consolidation as required for buried cable.
The Concessionaire shall make his own arrangement for pumping out water that may accumulate in excavation.

STEEL

Concessionaire will arrange to provide steel for fabrication of all racks, trays, supports and fixtures. Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edges.

SAFETY MEASURES

The Concessionaire shall arrange to provide guards and prominently display caution notice of access to any equipment / area considered unsafe and hazardous.

The installation / erection work shall also include for the following works:

a) Damages / missing items, if any shall be immediately reported to the Engineer – in - charge and Supplier.

b) Mounting of all accessory items at proper position as per manufacturer's drawings.

c) All required adjustments in the equipments as per manufacturer's instructions.

d) For indoor equipment all bus bar internal power / control wire connections and for outdoor equipment any accessory which is integral part of the equipment shall be connected upto the equipment marshalling kiosk to make the equipment complete.

e) Physical and functional checking of complete internal wiring as per approved wiring drawings and schematics.

f) Grouting, chipping, making pockets in the foundation etc. to make the base suitable for mounting the equipment and making it good.

g) For the items, where only erection is included in the scope, the Engineer –in – charge may engage specialist engineers from the manufacturers to supervise the installation, testing and commissioning of their equipment. The Concessionaire shall extend full co-operation to these engineers and carry out the works as per their instructions.

No equipment shall be permanently bolted down to foundation structure until the alignment has been checked and found acceptable by Engineer – in – charge.

Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.

If any doubt / misunderstanding arises necessary clarifications shall be obtained from Engineer – in – charge / manufacturer.

The following incidental works shall be carried out by the Concessionaire :

a) Checking, attending and necessary cleaning of jammed motors.
b) Removing of rust, depression and similar flaws from panel enclosure followed by cleaning and painting of the damaged portion.
c) Replacement of damaged parts.

SPECIFICATIONS FOR ERECTION, TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENTS AND ACCESSORIES

SCOPE

This specification is intended to cover complete installation, testing and commissioning of electrical equipments i.e. motor control centres, power control centres, control panels, switch gears, motors, push button starters, transformers, etc.

CODE AND STANDARDS

The installation, testing and commissioning of all electrical equipments shall comply with all currently applicable states, regulations, fire insurance and safety codes in the locality where the work will be carried out. Nothing in this specification shall be constructed to relieve vendor of his responsibility.

Unless otherwise specified, the work, material and accessories shall conform to the latest applicable Indian British of IEC standard.

Good workmanship shall be in accordance with best engineering practices to ensure satisfactory performance and service life.

DETAILED REQUIREMENT OF INSTALLATION

Switch gear, Control panel, etc.

a) All alignment, leveling, grouting, anchoring, adjustments shall be carried out in accordance with manufacturer's instructions and or as directed by the purchaser.

b) All modules shall be taken out and shall be cleaned preferably with vacuum cleaner.

c) All connections of fixing of equipments in switch gear control panels etc. shall be completed, checked and adjusted to ensure safety and satisfactory operation of the equipment.

d) In some cases, minor modifications may have to be carried out at site in the wiring and mounting of the equipment to meet the requirements of the desired control scheme and the Concessionaire shall have to do the same.

Motors

a) The installation of motors shall be carried out in accordance with manufacturer's instructions and / or as directed by the Purchaser.

b) Checking and cleaning of bearings and charging / filling of lubricants whatever necessary.

c) Cleaning of core and winding, varnishing and drying but the windings and measurements of air gap for motor assembly at site if demanded.

d) Motors shall be run on un-coupled condition for few hours before coupling them with the drive equipment.

e) Motors shall be coupled with drive, adjusted and shall be tested on load.

Miscellaneous Items

a) The Concessionaire shall install miscellaneous items such as motors starters, local start / stop push button starters etc.

b) These equipments will be generally wall, column or stand mounting. The exact location will be as shown in the final drawing.

c) All supports or brackets needed for installation shall be fabricated and painted by the Concessionaire.

d) All welding, cutting, chipping and grinding as and when necessary shall be carried out by the Concessionaire.

CABLE TERMINATION

Cable Termination shall include the following

a) Making necessary holes in bottom / top plates for fixing cable gland / box.

b) Fixing cable gland / box, connecting armour clamp to cable armour.

c) Dressing cable, pouring, compound etc. wherever necessary to make termination complete.

d) Putting cable lugs, crimping them on to cores of cable, taping bare conductors upto lugs, wherever necessary.

e) Termination to equipment terminals.

f) Supply and fixing of cable and core identification ferrules.

Wherever purchaser has not provided MS plates for fixing cable tray supports, Concessionaire shall install approved concrete fasteners for fixing cable tray supports.

INSPECTION

a) After completion of the erection / installation, each equipment shall be thoroughly inspected in presence of purchaser for correctness and completeness of installation.

b) A check list may be furnished by the purchaser wherein all details to be checked and necessary instructions shall be listed. The inspection and checking shall strictly follow the check list.

c) On completion of the inspection two (2) copies of the check list duly filled in shall be jointly signed by Concessionaire and the purchaser, such endorsement, however, shall not relieve the Concessionaire of his obligation under the contract.

TESTING AND COMMISSIONING

a) After completion of erection work tests shall be conducted by the Concessionaire on each piece of the equipment as per list be supplied by the purchaser or his authorized representative.

b) The Concessionaire shall provide all tools, instruments; materials labour supervisory personnel for carrying out tests on the equipment and materials under his scope of work.

c) The Concessionaire shall record the test results on approved Proforma and furnish four (4) copies of the results to the purchaser for his approval within a week form the date of test completed.

d) Before commissioning of the equipment, the Concessionaire shall set the relays to their recommended values.

e) On successful inspection and testing, the equipment shall be commissioned and put on trial run along with other equipment in a manner mutually agreed upon.

RECTIFICATION

The Concessionaire shall carry out all rectifications, repairs or adjustment work found necessary during testing, commissioning and trial run.

Unless otherwise specified the work, material and accessories shall conform to the latest applicable Indian, British of IEC Standards, some of which are listed below:
IS 3043Code of Practice for earthing.

INSTALLATION OF CABLES

1. The Concessionaire's scope of work includes, unloading, laying, fixing, jointing, bending and terminating of cables. Concessionaire shall also supply all the necessary hard-wares for jointing and terminating of cables. Cables shall be laid directly buried in earth, on cable trays and support in conduits and ducts or bare on walls, ceiling etc as shown in the approved Drawings.
2. All cable work and the allied apparatus shall be designed and arranged to reduce the risk of fire and any damage that may cause in the event of fire. Wherever cables pass through any floor or wall opening suitable bushes shall be supplied. If required by the Engineer – in – charge,, the bushes shall be sealed using fire resisting materials to prevent fire spreading.
3. Standard cable installation tools shall be utilized for cable pulling. Maximum pull tension shall not exceed manufacturers recommended value. Cable grips, reels or pulleys used shall be properly lubricated. The lubricant shall not injure the overall covering and shall not set up undesirable conditions of electrostatic stress. Cables pulling shall permit performance of collateral work without obstruction.
4. Sharp bending and kinking of cables shall be avoided. The bending radius for various types of cables shall be more than those specified by manufacturer.
5. Power and control cables shall be laid in separate cable trays. The order of laying of various cable in trenches and overload trays shall be as specified below:
6. Cables of highest system voltage at the top most tier with second highest voltage on the second tier from top, third highest on the third tier from top etc. with control instrumentation and other service cables in bottom most cable tier.
7. Where groups of HV and LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be employed.
8. Where cables cross roads and water, oil gas or sewage pipes the cables shall be laid in reinforced spun concrete pipes of 15 mm minimum diameter, also 50% space shall be kept as space for future, if more than one cable is to be laid through pipe. For road crossing the pipe for the cable shall be buried at not less than one metre depth. Cable less than 15 mm unless otherwise approved by the Engineer. Cable shall be protected at all times from mechanical injury and from absorbing moisture.
9. Some extra length shall be kept in each cable run at a suitable point to enable one or two straight through joints to be made at a later date, if any fault occurs.
10. To facilitate visual tracing, cables in trays shall be laid only in single layers where design, permits. Cables shall be laid in proper sequence so as to avoid unnecessary crossing of other cables upon entering or leaving a run of tray. Cable splices shall not be permitted.
11. Cable jointing shall be in accordance with relevant Indian Standards Codes of Practice and Manufacturer's special instructions. Materials and tools required for cable jointing work shall be supplied by Concessionaire. Cable shall be firmly clamped on either sides of a straight joint at not more than 300 mm away from the joints. Identification tags shall be provided at each joint and at all cable terminations. Single core cable joints shall be marked so that phase identify at each joint can be determined easily. The joints shall be located at most suitable places. When two or more cables are laid together, joints shall be arranged to be staggered by about three meters. Before jointing insulation resistance of both sections of cables to be jointed shall be checked.
12. Concessionaire shall install and connect the power, control and heater supply cables, for motors. Concessionaire shall be responsible for correct phasing of the motor power connections and shall interchange connections at the motor terminal box if necessary after each motor is test run.
13. Metal sheath and armour of the cable shall be bonded to the earthing system of the station.
14. Cable clamps shall be minimum 3 mm thick and 25 mm wide galvanized MS flat spaced at every 1.0 m interval.

CABLE TRAYS, ACCESSORIES AND TRAY SUPPORTS

Cable trays shall either be run in concrete trenches or overload supported from building steel, floor slab etc.

Cables shall be clamped to the cable trays in both horizontal runs and vertical runs by suitable site fabricated clamps.

Cable trays supporting system shall be adequately designed so as to keep maximum deflection within permissible limit.

CONDUITS AND PIPES

Concessionaire shall supply and install conduits, pipes as specified and as shown in drawings all accessories / fittings required for making installation complete shall be supplied by Concessionaire.

Conduits and pipes shall be of GI and of heavy duty type.

Flexible metallic conduits shall be used for termination of connections to equipments to be disconnected at periodic intervals.

Conduits or pipes shall run along walls, floors and ceilings, on steel supports, embedded in soil, floor, wall or foundation, in accordance with relevant layout drawings. Under ground portions of conduit installation to be embedded in the foundation or structural concrete shall be installed in close co-ordination with collateral work. Exposed conduit shall be neatly run and evenly spaced.

Exposed conduit shall be adequately supported by racks, clamps, straps or by other approved means. These fittings shall be of same material as conduits.

Each conduit run shall be marked with its designation as indicated on the drawings. Identification shall be made where possible by means of brass ribbon. So located that each run of conduit is readily identified at each end.

When one or more cables are drawn through a conduit, cables shall fill not more than 50% of the internal cross sectional area of the conduit.

Entire system of conduit after installation shall be tested for mechanical and electrical continuity throughout and permanently connected to earth by means of special approved type earthing clamp efficient fastened to the conduit.

For jointing purpose, Concessionaire shall have available at site, dies for threading pipe or conduit. All such threaded ends shall be reamed after treading and anti-corrosive paint applied.

SWITCH GEAR CONTROL PANEL / DESKS

Base of outdoor type units shall be sealed in an approved manner to MS channel concrete to prevent ingress of moisture.

Concessionaire shall take utmost care in handling delicate equipments and mechanism like instruments, relays, dragging shall be avoided as far as possible. Proper pies shall be provided underneath when dragging for short distance. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panels / desks have been erected and aligned. Any damage to relays and instruments shall be immediately reported to the purchaser. Concessionaire shall also make all necessary adjustments as specified by the manufacturer for proper functioning of the equipment. The setting of relays shall be carried out.

Outgoing feeders and incoming feeders of cable or bus duct shall be connected at the switch gear panel and as explained in the installation procedures of cables and bus ducts.

After installation of all power and control wiring, Concessionaire shall carry out operating tests, manufacturer's installation tests. Meager tests for insulation, polarity checks on the instrument transformers.

The Concessionaire shall also carry out the drying of equipment in case of low insulation resistance.

TRANSFORMER

Sleepers shall be provided when unloading on bare ground. After placing on foundation alignment, leveling, etc. shall be carried out in neat workmanlike manner.

Dehydration of silica gel rather shall be carried out.

For the power / control cables projecting above the ground the termination of cable box / marshalling box / shall be run in GI conduits of suitable cross section. Ends shall be sealed with bitumen compound.

The cable end box of the transformer of detachable type shall be supported properly enabling the transformer to be taken out for repair without disturbing the cables.

SPECIFICATIONS FOR ERECTION, TESTING AND COMMISSIONING OF ILLUMINATION SYSTEM

SCOPE
This specification covers complete installation, testing and commissioning of indoor and outdoor illumination system.

SCOPE AND STANDARDS
The wiring, installation and commissioning of complete illumination system shall comply with all currently applicable statutes regulations. Fire insurance and safety codes in the locality where the work will be carried out. Nothing in this specification shall be construed to relieve vendor of this responsibility.

Unless otherwise specified, the work, material and accessories shall conform to the latest applicable Indian, British IEC Standards.

Good workmanship shall be in accordance with best engineering practices to ensure satisfactory performance and service life.

GENERAL REQUIREMENTS
Except as specifically approved by the site office installation of conduits and lighting fixtures shall be taken only after all major services such as piping, structural work etc. in that particular area have been completed.

Location of lighting fixtures, switches and receptacles shown on the drawings, are indicative and shall be relocated to suit site condition.

Except as noted mounting height of various lighting equipment from finish floor level shall be as follows:

i. Lighting Panels1200 mm
ii. Lighting control switches1000 mm
iii. Receptacle with switch
    a) For indoor500 mm
    b) For outdoor1000 mm

All cables and conduits from lighting panel upto first lighting fixture shall be identified with aluminium tags giving circuit reference number.

Lighting panel number shall be indicated when more than one panel for an area is to be provided.

A number of lighting panels shall be earmarked separately for supplying power to the space heater mounted in various switch gear panels and motors.

Steel surfaces exposed, to weather shall be thoroughly cleaned for removal of rust and shall be given a primary coat of zinc chromate and two finishing coat of paint. All metal parts not accessible for painting shall be made of corrosion resistant material.

Cable / Conduits separators shall be provided at an interval of 500 mm for horizontal runs and 750 mm for vertical runs.

Cable / Conduits shall be kept, wherever possible at least 300 mm away from pipes, heating devices and other equipments.

For the purpose of calculating connected loads of various circuits multiplying factor of 1.25 will be assured to the rated lump voltage for lamp fixtures to take into account the losses in the control gear.

Concessionaire shall supply junction boxes; pull boxes, terminal blocks, glands, conduits and accessories (elbows, tees, bends, etc). and supporting anchoring materials to make the installation complete.

Concessionaire shall work in co-ordination with the civil Concessionaire when openings, sleeves are required in walls and floors. Holes by Concessionaire shall necessarily be patches in a good and approved manner.

All types of wiring concealed or unconcealed shall be capable of easy inspection. In all types of wiring due consideration shall be given for neatness and good appearance.

In hazardous areas, the founding wire shall run along the conduits throughout the installation and all conduits and fixtures shall be effectively grounded. Conduits shall be grounded at the ends adjacent to switch boards at which they originate.

Wherever specified, DC lighting system shall be installed to provide necessary illumination in case of an emergency. Emergency lighting cables shall run in a separate conduit system.

For street lighting, steel tubular poles complete with fixing brackets shall be used. These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted.

Before a completed installation, or an extension to an existing installation is put into service, installation test stipulated IS: 2274 and other codes of practices shall be carried out by Concessionaire in the presence of Engineer-In-Charge's / Engineer's representative.

WIRING IN CONDUITS

Individual lighting circuits inside building shall be wired with 250/440 volts grade copper / aluminium conductor PVC insulated flexible wires cables. The circuit wire shall be colour coded as follows:
White-Phase or DC positive wire
Black-Neutral or DC negative wire

Pull wires in a conduit shall be drawn simultaneously. No subsequent drawings are permissible. Necessary, pull wires shall be provided by the Concessionaire.

The wires shall not be pulled through more than two equivalent 90^0 bends in a single conduit run.

Wiring shall not be spliced at any place other than junction boxes with approved type connectors of terminal strips, and for lighting fixtures, connection shall be T'd off through suitable round conduit or junction bars.

For vertical run of wires in conduit, wires shall be suitably supported by means of wooden plays at each pull junction bores.

OUTDOOR LIGHTING

Lighting for all outlying areas shall be carried out using 1.1 Kv grade. Aluminium conductor, PVC insulated steel wire armored cables between lighting panel an junction box near the lighting fixture.

All lighting poles shall be steeped tubular steel poles type ISTP 15 as per ID 2713 and shall be the painted type. length shall be as given in ES-5 c.

Except as noted cables for Road and outdoor lighting shall be directly buried in ground at a depth of 600 mm or routed in available cable trenches.

Lighting cables shall be taken through GI / Hume pipes buried in ground at 1000 mm below the Road / Rail track crossing.

EARTHING

For outdoor earthing of lighting poles, Masts etc. cut GI wire shall be used. The wire shall be run buried in ground at a depth of 600 mm.

Lighting fixtures, receptacles, junction boxes, switches conduits and handrails shall be earthed using GI wire of minimum size 12 SWG.

The earthing wire shall run over the entire length of the conduit between fixtures and the corresponding lighting panel where it shall be connected to earth grid. For 3 phase power socket, outlets, separate grounting wire shall be provided.

TESTING AND COMMISSIONING

After completion of the work complete illumination system shall be thoroughly checked and tested by Concessionaire in presence of purchaser or his representative as per the list.

The Concessionaire shall provide all tools, materials, labour and supervisory personnel for carrying out the tests.

The Concessionaire shall carry out all rectifications repairs or adjustments work found necessary during testing and commissioning.

The Concessionaire shall record the test results on approved Performa and furnish test report / results (4 copies) for approval.

On successful commissioning of the system and on carrying out necessary rectification work, the purchaser will take over the installation either wholly or in parts, as the case may be, where it shall be connected to earth grid, for 3 phase power.

SPECIFICATIONS FOR EARTHING AND LIGHTENING PROTECTION

SCOPE
This specification covers requirements of earthing and lighting protection system. The specifications in intended to cover complete supply, installation, testing and commissioning of the above system.

GENERAL INFORMATION
The design supply and performance of the system comply with all currently applicable statutes, regulations and safety codes in the locality where the systems will be erected and commissioned.

The earthing and lighting system shall be installed in conformity with the requirement of Indian Electricity Act 1910 as amended and the Indian Electricity Rules, formed there under Indian Standard Code and practice and other statutory regulations that may be relevant to the erection.

Unless otherwise specified, the equipments, materials and accessories provided by Concessionaire shall conform to the latest applicable Indian Standards or Indian Electricity Code standards, some of which are listed below:

IS:Code of practice for earthing.
IS:Code of practice for protection of building and allied structures against lighting.

EARTHING SYSTEM
Two separate and distinct earth leads shall be used for earthing each equipment / structures enclosing the power conductor and one earth lead for metallic structures adjacent to electrical installation.

Metallic frames of all electrical equipment rated above 250 volts, must be earthed by two distinct connections with earth system.

Earthing cables crossing other metallic structures such as conduits, pipe lines etc. shall be minimum 300 mm away from such structures.

All underground connections and joints in earthing system shall be blazed / welded. Connections with equipments / structures shall be bolted type.

Conducting petroleum jelly shall be applied to contact surface of all bolted joints and joints shall be covered with bituminous compound and taped.

When GI conductors are connected to aluminium conductors the contract surfaces of GI shall be covered with bituminous and taped.

Natural connections shall never be used for the equipment earthing.

Earthing conductors shall be protected against mechanical damage.

Earthing conductors running along the structures, wall etc shall be cleaned at every 750 mm interval.

Minimum size of earth conductor shall be in accordance with IS : 3043. However, sizes of earth conductors for equipments shall be at least half the size of power conductor, limited to maximum of 120 mm^2, of aluminium.

All earth lead connection shall be as short and direct as possible and shall be without kink.

EARTHING AND MAIN GRID

Adequate number of earthing pits and electrodes as shown in enclosed drawing shall be used in conjunction with earthing grid.

Minimum spacing between two adjacent earth pits shall not be less than size (6) meters and shall be kept sufficiently away from structures to clear footings.

Main grid loop for a building shall be installed outside boundary of the building, buried in backfill. It shall be installed at a minimum depth of 600 mm outside the building wall.

The main earth loop (MEL's) in plant areas shall be generally routed along cables when equipments are located away from MEL's suitable sub-loops may be run upto them for deriving connections for individual equipment.

LIGHTENING PROTECTION

Tall structures shall be protected from lighting strokes by suitable lighting protection system to be erected and installed.

Down-comer shall not be tapped in between for equipment earthing.

Cable sheaths, metal conduits, casing etc. shall not be connected to lighting protection system.

Down-comers shall be as short as possible. Each down comer shall be provided with a testing point located at a height of about 1000 mm from ground level.

A minimum 2 ,meter separation shall be maintained between any other electric conductor and lighting protection system.

Earthing and lighting protection system shall be bounded to each other to prevent side flash over. If adequate clearance between two system can not be maintained.

INDOOR EQUIPMENT EARTHING

Each floor of building shall have its own earth bus embedded in concrete.

Earthing grid embedded in the floor slab shall have a minimum concrete cover of 50 mm.

Earth buses on different floor and main grid shall be connected by at least two conductors of main grid conductor size.

Every alternate column (Steel or RCC) of the building housing electrical equipments shall be connected to main earthing grid.

Every conductor shall be welded at interval of 1000 mm along their run on steel structure and shall be at interval of 750 mm along the wall.

OUTDOOR EQUIPMENT EARTHING

Each transformer neutral shall be provided with two separate earth leads to two separate earth pits located near transformer.

Wherever earthing conductor crosses the trenches tunnels, railway track, etc., it shall be run below the trench etc.

Equipment structures shall be earthed at two diametrically opposite points.

Each pole of H.V. lighting arrestor and coupling capacitor shall be gounded with minimum one separate earth pit.

CTs secondary winding shall be connected to earthing grid by minimum two earthing conductors. CT and VT secondary neutral shall be earthed at the terminal block where they enter the control panel.

Every alternate post of switch yard fence shall be earthed and gate shall be earthed by flexible GI wire.

Any two diametrically opposite legs of each switch yard tower, without lightening protection shield wire, shall be earthed at the base of tower.

A well distributed earth mat shall be provided below ground on which operator would stand and operate the HV isolator or circuit breaker.

TESTING AND COMMISSIONING

Entire earthing system and lightening protection system shall be tested for continuity by ELV tester after installation.

For the earthing and lightening protection system, the connections shall be thoroughly checked.

The earth resistance shall be checked, recorded and resistance shall be improved in case it is higher than acceptable limits.

The Concessionaire shall carry out all rectifications, repairs or adjustment work found necessary during testing and commissioning.

EARTHING AND LIGHTENING PROTECTION SYSTEM

Sizes and number of earth leads for earthing various items and other technical particulars shall be as specified.

Earthing conductors are shown diagrammatically. Exact location of earthing conductors, earth electrodes and test pits and earthing connections may be changed to suit the site conditions.

Earthing conductors in the building, running parallel to walls and columns shall not be less than 150 mm away from the wall / columns.

Suitable earth risers shall be provided if the equipment is not available while carrying out earthing connections.

Wherever, earthing conductor passes through walls, galvanized iron sleeves shall be provided for the passage of earthing conductor. Water stop sleeves shall be provided. Water stops shall be provided wherever earthing conductor enters the building from outside.

Wherever the conductors are to be buried, Concessionaire shall co-ordinate with other civil Concessionaires to ensure that the conductors are installed before concreting.

All connection shall be low resistance. Contact resistance shall be minimum.

Steel conductors, above ground level shall be galvanized. All conductors shall be free from any defects.

Earthing conductors shall not run in direct contact with control and other cables. Single core cable armoured shall be earthed at one end. The cable trays shall be earthed to main grid at-least at two points and at every 25 meters intervals.

Testing of earthing system

Purchaser may ask to carry out earth continuity tests, earth resistance measurements and other tests in presence of him which in his opinion are necessary to prove that the system is in

accordance with design, specification, Indian Code or Practice and Indian Electricity Rules. Concessionaire shall have to carry out all such tests.

The lightening protection vertical air terminations and / or horizontal air termination conductors shall remain in their installed position even during severe weather conditions.

All joints in the down conductors shall be of welded / brazed type. All metallic structures in the vicinity of down conductors shall be bonded to the down conductors.

The rest joint for down conductors shall be directly connected to the earthing system.

SITE TESTING AND COMMISSIONING

STANDARDS

The testing and commissioning covered by this specification shall, unless otherwise stated, comply with the requirement of the latest editions of applicable Indian Standards and currently applicable regulations.

The manufacturer's recommendation for testing and commissioning shall be followed.

GENERAL

The following physical tests shall be carried out on all the equipments.

a)Check for physical damage.
b)Check name plates as per specification.
c)Check adequacy in tightness of nuts, bolts, clamps, and other connecting terminals.
d)Check leakage of oil or air if any, oil level, air pressure wherever applicable.
e)Check earth connectors.
f)Check cleanliness and glaze of insulator and bushing surfaces.
g)Check proper lubrication provided for moving parts.
h)Any other checks, specified in the relevant code of installation and manufacturer's drawings / catalogues.

The test to be carried out on various equipments shall be as follows:

Insulation Resistance Test

The insulation resistance test shall be carried out on the following equipments:

a) EHV installationby 5000 V megger
b) HV installation above 1 KVby 2500 V megger
c) Power circuit of voltage upto 1 KVby 1000 V megger
d) AC and DC auxiliary circuitsby 500 V megger

The results of all the above tests shall be submitted to the purchaser.

The purchaser may ask for some additional tests to be carried out which in his opinion are necessary to determine that the works comply with the specifications, manufacturer's recommendations or IS standards. The Concessionaire shall also carry out such additional tests.

APPENDIX 'D': ELECTRICAL APPARATUS AND SYSTEMS

Power Factor Improvement Capacitors

1. Number required — 1 No. per motor of suitable KVAR rating
2. Rating — 440 V, 3, 3 ph, 3 wires, 50 Hz. To improve power factor upto 0.95
3. Each capacitor unit of the bank shall be complete with:
   Internal HRC fuse
   Discharge resistor
   Bushing resistor
   Bushing, etc

4. Dielectric material shall be all polypropylene or mixed dielectric (paper and polypropylene).

   The guaranteed loss KW/KVAR including discharge resistor loss shall be indicated in the bid

5. Applicable Standard — IS : 2834.

Earthing for Electrical Installation excluding Incoming Transformer

Earthing

1.1 To be provided as perIS : 3043
1.2 Main earthing conductor50 x 6 mm GI.
1.3 Earth pits — 250 m long 50 mm dia GI pipe. Other details as per IS : 3043 for continues protection.
1.4 Overall earth resistance — Less than 1 ohm.
1.5 Number of pit should be minimum — 4 Nos.

Lightening Protection

For building and tanks 32 x 6 mm. copper tape shall be used upto copper earthing plate of size 50 cm x 50 cm x 3 mm placed 1.5 m below GL. The topmost bar conductor shall be of gunmetal. The Concessionaire should arrange for satisfactory continuity test.

2.1 To be provided per IS : 2309.

Power and Control Cable

650/1100 V power Cables

650/1100 V grade, standard / solid aluminium conductors, PVC insulated, inner sheath of PVC, copper wire flexible and extruded PVC sheathed conforming to IS : 1554.

650/1100 V Control Cables.

Similar to 650/1100 V power cables, except that the conductors shall be of copper.

For all circuits connected with CTs, 2.5 mm copper conductors shall be used. For other circuits 1.5 mm^2 copper conductors shall be used.

DETAILED SPECIFICATIONS FOR STAFF QUARTERS

The staff quarters of Cl. III and Cl. IV shall be constructed at the locations as per directions of Engineer in Charge. The structure shall have following specifications.

1) The working drawing shall be prepared by the Concessionaire suitable to the area for class III and class IV type quarters as mentioned. The drawings shall be got approved from the Engineer in charge.
2) The R. C.C. designs required for the R.C.C. components shall be prepared by the Concessionaire and got approved from the Engineering College.
3) The R.C.C. components such as columns, beams, lintels, slab, chajjas shall be designed and cast in M-20 grade concrete.
4) The room height shall be min 3.05m from finished floor level upto bottom of roof slab for all the floors.
5) Structure shall be either load bearing or R.C.C. frame.
6) Foundation depth shall be taken to rest the structure on hard foundation of adequate bearing capacity.
7) P.C.C. M-15 layer of 15 cm thick shall be laid as bedding course for the foundation wall or below column footing.
8) Foundation and plinth shall be in U.C.R. masonry in c.m.1:6 with pointing OR there shall be columns with plinth beams.
9) Superstructure shall be in B.B. masonry in C.M. 1:4 with 12 mm thick plaster in C.M. 1:4 with neeru finish from inside and 20 mm thick cement plaster in c. m. 1:4 from outside.
10) Column footings, columns, lintels, beams, slabs shall be in M-20 grade concrete.
11) Doors shall be of size 1.0 m X 2.4 m except for W.C. and Bath for which the door size shall be 0.8 m X 2.1 m. The No. shall be as per approved drawing.
12) The windows shall be aluminium windows with glass panels and MS grill (powder coated).
13) The No. and size of windows shall be as per approved drawing.
14) The doors and windows shall have approved quality fixtures and fastenings.
15) R.C.C. chajjas of 0.6 m projection shall be provided for all windows in external walls.
16) The lintel height shall be minimum 2.4m from finished floor level
17) Flooring shall be mosaic tiled flooring for all rooms.
18) For W.C. and Bath the flooring shall be Kota stone flooring 25 mm thick.
19) The walls of W.C. – Bath and kitchen platform shall have glazed tile dado of height 1.2 m from the floor for W.C.-Bath, 0.6 m height for Kitchen platform.
20) There shall be one kadappa stone platform in the kitchen, of width 0.75 m and length 2.5 m with stainless steel sink fitted at suitable location on one side of the platform.
21) The walls shall be painted with oil bound distemper of approved colour in two coats from inside. The roof from inside shall have white wash in two coats.
22) The external walls shall have water proof cement paint in two coats of approved colour and shade from outside.
23) The roof slab shall have water proof treatment of approved type in order to make the roof fully leak proof.
24) All the items of the work of staff quarter shall be carried out as per standard specifications of PWD, Govt. of Maharashtra.
25) The quarters should have complete water supply and drainage arrangements with approved quality G.I. –B class water pipes, chromium plated water frictures, approved quality W.C. pan and soil and drain pipes.
26) The Concessionaire will have to construct septic tank of adequate capacity with soak pit for disposal of sewage.
27) Suitable size B.B. masonry chambers with R.C.C. covers in adequate numbers will have to be constructed by Concessionaire for efficient working of the whole drainage system.

LIST OF SPECIFICATIONS FOR GENERAL CIVIL WORKS

Applicable Codes and Specifications.
The following codes and standards are included in this section.

IS:110 - Ready mixed paint, brushing, gray filler, for enamels for use over primers
IS:269 - Specification for 33 grade ordinary Portland cement
IS:280 - Specification for mild steel wire for general engineering purpose
IS:383 - Specification for coarse and fine aggregates from natural sources for concrete
IS:412 - Expanded metal steel sheets for general purposes
IS:419 - Specification for putty for use of window frames
IS:428 - Distemper, oil emulsion, color as required
IS:702 - Specification for industrial bitumen
IS:712 - Specification for building limes
IS:1003 - Specification for timber paneled and glazed shutters (Part 1 & 2)
IS:1038 - Specification for steel doors, windows and ventilators
IS:1077 - Specification for common burnt clay building bricks
IS:1081 - Code of practice for fixing and glazing of metal (steel & aluminum) doors, windows and ventilators
IS:1124 - Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS:1322 - Bitumen felts for water proofing and damp proofing
IS:1346 - Code of practice for water proofing of roofs with bitumen felts
IS:1361 - Specification for steel windows for industrial buildings
IS:1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
IS:1542 - Specification for sand for plaster
IS:1580 - Specification for bituminous compounds for water-proofing and caulking
IS:1597 - Code of practice for construction of stone masonry : Part 1 Rubble masonry
IS:1659 - Specification for block boards
IS:1661 - Code of practice for application of cement and cement-lime plaster finishes
IS:2074 - Ready mixed paint, air drying, red oxide-zinc chrome, priming
IS:2116 - Specification for sand for masonry mortars
IS:2185 - Specification for concrete masonry units (Parts 1, 2 & 3)
IS:2212 - Code of practice for brickwork
IS:2250 - Code of practice for preparation and use of masonry mortars
IS:2339 - Aluminum paint for general purposes, in dual container
IS:2395 - Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 &2)
IS:2571 - Code of practice for laying in-situ cement concrete flooring
IS:2645 - Specification of integral cement waterproofing compounds

IS:2690	-	Specification for burnt clay flat terracing titles : Part 1 Machine made
IS:2691	-	Specification for burnt clay facing bricks
IS:2932	-	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
IS:3036	-	Code of practice for laying lime concrete for a water-proofed roof finish
IS:3067	-	Code of practice of general design details and preparatory work for damp-proofing and water-proofing of buildings
IS:3068	-	Specification for broken brick (burnt clay) coarse aggregates - use in lime concrete
IS:3384	-	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3495	-	Method of test for burnt clay building bricks: Part 1 to 4
IS:3536	-	Specification for ready mixed paint, brushing, wood primer, pink
IS:4351	-	Specification for steel door frames
IS:4948	-	Specification for welded steel wire fabric for general use
IS:5318	-	Code of practice for laying of flexible PVC sheet and tile flooring
IS:5410	-	Cement paint, colour as required
IS:5411	-	Specification for plastic emulsion paint (Parts1 & 2)
IS:5491	-	Code of practice for laying of in-situ granolithic concrete floor topping
IS:6042	-	Code of practice for construction of light weight concrete block masonry
IS:6248	-	Specification for metal rolling shutters and rolling grilles
IS:7193	-	Specification for glass fiber base coal tar pitch and bitumen felts
IS:7452	-	Specification for hot rolled steel sections for doors, windows and ventilators
IS:12200	-	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams

Mandatory Project Requirements

(Refer Clause 1.1.13 (B) (ii) (b) of the RFP Volume 1-Instructions to Bidders)

Aurangabad Municipal Corporation

Build, Refurbish, Operate and Maintain the Water Supply System of Aurangabad City, Maharashtra State, India

Small Transmission Mains, Trunk Mains and Feeder Mains – Required Investment and Proposed Design

February, 2010

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CONTENTS

1 SMALL TRANSMISSION MAINS, TRUNK MAINS AND FEEDER MAINS – REQUIRED INVESTMENT AND PROPOSED DESIGN

The objective of this report is to estimate investment required for small transmission mains, trunk mains and feeder mains from MBR to service reservoirs. The report discusses the existing infrastructure in the Aurangabad city, design objectives, analysis of the existing system and cost estimation based on design suggestion.

1.1 Existing infrastructure

1.1.1 Small transmission mains

Currently there are two small transmission mains in the city for Harsool water supply scheme. These small transmission mains of 450 mm diameter RCC pipes had been designed to supply raw water of 10 MLD from Harsul dam to filter house and treated water from filter house to Delhi gate:

1. 450 mm diameter × 700 m long RCC from Harsul dam to filter house
2. 450 mm diameter × 2200 m long RCC from pumping station at filter house to Delhi gate GSR

These small transmission mains are in operation since 1954 and the capacity of these pipes has been reduced to about 50% of original capacity, as a result of encrustation inside the pipes. These pipelines are required to be replaced by 450 mm diameter DI K9.

The details of the existing system have been provided in Figure 1.

1.1.2 Trunk mains and feeder mains

It has been observed that there are large numbers of booster pumping stations in the city, putting pressure on energy as well as O&M cost. It is therefore considered desirable to reduce booster pumping stations and to examine whether few ESRs can be filled by gravity by relocating tapping points on trunk mains and redesigning feeder mains. At present there are three streams for trunk mains and feeder mains, covering entire service area:

1. **City area (excluding CIDCO and Kanchanwadi – Itkheda etc. on Paithan Road)**:
    a) The trunk mains of 700 mm diameter × 9360 m long PSC and feeder mains are in operation since 1972-74. The system experiences frequent failures and high leakages. It is therefore, proposed to abandon this pipeline. However, the 700 mm diameter PSC pipeline will be in use till the time 1400 mm diameter MS pipeline becomes operational.
    b) New trunk main to city area comprises of 1400 mm diameter × 6230 m long PSC in series with 1400 mm diameter × 1140 m long MS pipeline and further 1200 mm diameter × 2500 m long MS pipeline, total length of 9870 m. The line is in operation since 1992-93. The AMC has proposed to replace 1400 mm diameter PSC section of 6230 m length with 1400 mm diameter MS pipeline, as a result of frequent failures in PSC section and higher

leakages. Currently the work is under execution. In addition, AMC is also carrying out other minor pipeline works either as replacement of existing pipeline or providing parallel pipelines to existing mains.

c) The current feeder system is mainly of CI or AC pipes, branched from 700 mm diameter and 1400 mm diameter trunk mains to various service reservoirs (GSR / ESRs) in the city. To tackle low pressure problem booster pumping stations have been installed at ESRs at following places:

i. Kranti Chowk
ii. Jubilee Park
iii. Shahganj
iv. Jinsi
v. Hanuman Tekdi

It is possible to eliminate 3 - 4 booster pumping stations by designing trunk mains appropriately.

2. **CIDCO area**:

The express feeder comprising 1118 mm diameter × 9250 m MS pipeline in series with 914 mm diameter × 2580 m MS pipeline is in operation since 2003. The line terminates in N5 sump, which is a major installation for further pumping and supply to the CIDCO area. The condition of the present trunk main is considered to be good and therefore proposed to continue with it. Feeder mains are generally of CI or AC types. To tackle low pressure problem booster pumping stations have been installed at ESRs at following places:

1. **N5 Sump**:
   a) Booster pumping station for 3 ESRs at N5
   b) Booster pumping station to pump water to N5 sump and ESRs which can be served by the pumping mains i.e. Naregaon, Brijwadi, Mukundwadi, Sanjaynagar, Masnatpur and Chikhalthana
2. **N7 Sump**:
   a) Booster pumping station for 3 ESRs at N7
   b) Booster pumping station for N8
   c) Booster pumping station for Harsiddhi and Harsool ESRs
3. **Girijadevi Sump:** Booster pumping station to fill Pundliknagar ESR
4. **Shivajinagar (Old) Sump:** Booster pumping station to fill Shivajinagar (Old) ESR

It has been observed that a very long booster pumping mains are provided for ESRs on Jalna road i.e. Mukundwadi, Sanjaynagar, Masnatpur, Chikhalthana. At one point, the pumping main is barely 500 m away from express feeder. It may be possible to feed these ESRs by tapping on express feeder. Also the filling of N7 sump by gravity needs to be examined. If feasible, pumping from N5 sump to N7 sump and to Naregaon and Brijwadi ESRs can be avoided.

3. **Paithan Road service area (Nakshatrawadi, Kanchanwadi, Banewadi etc.)**:

The feeder main of 300 mm diameter × 1800 m long, is serving Kanchanwadi, Itkheda, Banewadi and Silk Mill ESRs. The feeder main is in operation since 1992. There has been no failure observed and thus, proposed for continuation.

1.2 Design objectives

The proposed design for trunk mains and feeder mains has following objectives:

1. To meet water supply demand of 2026 and 2041 of the Aurangabad city;
2. Proper connectivity between ESRs;
3. Reduce number of booster pumping stations; and
4. Avoidance of long pumping mains

1.2.1 Design Methodology

To achieve above stated design objectives, following design methodology has been adopted:

1. Retain the pipe with good condition but of inadequate diameter, and provide another parallel pipe line to pass the required flow;
2. The diameter of pipe should be able to manage flow for 2041, however the length for parallel pipelines would be to manage flow requirement of 2026;
3. Selection of pipe diameter to avoid booster pumping to the extent possible and economical;
4. All AC pipes are discarded and replaced

1.2.2 Design criteria

STC used the WaterCAD for the hydraulic analysis of the system and adopted following design criteria:

Design	Criteria
Design horizon	Suitable for 2041, but length proposed for the year 2026
Pipe Material	100-500 mm diameter - DI K9 >500 mm diameter - MS (Grade Fe 410)
Hazen William's Coefficient	C **Pipe Material - C Value** CI (Unlined) – 90 DI (lined – old / new) – 135 MS (factory lined) - 140
Velocity	Minimum velocity - 0.6 m/s except for cross-connection Maximum velocity - 2.5 m/s (for flowrate in the ultimate stage)

1.3 Analysis of the system

STC analyzed three system streams in the city with the help of WaterCAD for the system requirement for 2026 and 2041. The highlights of the analysis are discussed below:

1.3.1 City area

1. The pipeline diameters for existing and under execution trunk mains and feeder mains are found adequate, even for 2041 demand. However diameter of DI pipeline from Medical ESR tapping to Hanuman Tekdi, 500 mm as proposed by AMC can be reduced to 350 mm, resulting in saving of Rs.83 Lacs;

2. A separate subtrunk main of 500 mm diameter × DI k9 × 300 m length can be provided from Jubilee Park junction to 7 ESRs in Mitmita-Pethenagar-Padegaon area, resulting all ESRs to be filled by gravity;

3. Following five booster pumping can be eliminated as ESRs can be filled by gravity:
   a) Kranti Chowk-1
   b) Kranti Chowk-2
   c) Jubilee Park
   d) Shahganj
   e) Jinci

4. The booster pump is considered required only at Hanuman Tekdi sump

1.3.2 CIDCO area

1. The existing pipelines are considered inadequate to meet the flow rate demand of 2026 and 2041. Hence, parallel pipelines to express feeder and other trunk mains are necessary.

2. ESRs on Jalna road i.e. Masnatpur, Chikhalthana, Sanjaynagar, Mukundwadi etc. are being fed by pumping from N5 booster pumps. These reservoirs can be connected to express feeder as gap between nearest points on express feeder and existing pumping main is as low as 500 meters.

3. As discussed earlier, the pumping is done from N5 sump to N7 sump. The distance is 2200 m and FSL of N7 sump (607.0 m RL) is lower than FSL of N5 sump (611.0 m RL). Thus N7 level is lower than N5 level. Considering this, the flow can be diverted directly to N7 by gravity avoiding pumping from N5.

Considering above objectives following major trunk mains proposed:

I. 1422 mm ϕ × 12.5 mm thick × 7750 m length in parallel with 1118 mm ϕ existing express feeder from Nakshatrawadi MBR;

II. 1219 mm ϕ × 10 mm thick × 5050 m length in series with 1422 mm diameter main and in parallel with existing express feeder upto N5 sump;
III. For 2026, a length of 1219 mm ϕ pipeline can be laid for 3105 m which can be extended by another 1945 m in future meeting demand for 2041;
IV. 1016 mm ϕ × 8.8 mm thick × 2200 m length pipeline from upstream point of 1219 mm ϕ pipeline to N5 sump and terminating into N7 sump. With above pipelines, the flow can be taken by gravity to N7 sump instead of present pumping from N5 sump;
V. 813 mm ϕ × 7.1 mm thick × 3450 m length pipeline from tapping on 1118 mm ϕ express feeder to Sanjaynagar – Mukundwadi – Chikhalthana – Masnatpur existing subtrunk main out of which 500 m length is gap make up pipeline and remaining is in parallel to existing 300 mm ϕ CI main;
VI. With above system, all reservoirs on Jalna road can be filled by gravity. Presently these reservoirs are being filled by pumping from N5 booster station;
VII. Provision of 25% has been considered in Jalna road subtrunk main to meet requirement for undeveloped area on Jalna road;
VIII. Provision of 75% has been considered in N7 sump to meet requirement for undeveloped area on N5-N7 side;
IX. The main aspect of the design is that even if the entire 75% of demand is required to be fulfilled, hydraulic network can be robustly workable. Flexibility is available in the design to meet part demand from N5 and part demand of N7 or entire demand from N7 depending on development and economical solution;
X. Pumping from N5 to N7 sump and two ESRs i.e. Brijwadi and Naregaon has been eliminated;
XI. It is possible to reduce 300 mm ϕ pipeline of length 540 m proposed by AMC for execution to Girijadevi sump to 250 mm ϕ, resulting into cost savings;
XII. Two ESRs at Shivajinagar which are presently being filled by pumping, can be filled by gravity, eliminating booster pumping;
XIII. Booster pumping is considered required only for Girijadevi sump and from N7 sump to N8 ESR, Harsool and Harsiddh reservoirs and for future ESRs in undeveloped area

1.3.3 Paithan road area

All four reservoirs as mentioned below on this stream can be filled by gravity:

1. Nakshatrawadi - Kanchanwadi
2. Banewadi (Rahulnagar)
3. Itkheda
4. Silk Mill

In addition, there is a provision for meeting demand of Indian Railways.

AMC has proposed 450 mm ϕ DI pipeline from Itkheda Junction to Rahulnagar Junction, a length of 1.7 kms. The same can be reduced to 400 mm, resulting into significant cost savings.

1.4 Appurtenances

Following appurtenances have also been considered for estimating cost:
Air Valve – Double orifice kinetic PN 1.0

Diameter of Pipeline	Diameter of Air Valve
Upto 250 mm	80 mm
300-500 mm	100 mm
600-900 mm	150 mm
> 900 mm	200 mm

The air valves are proposed at 750 m interval. If length of main is less than 750 m, at least one air valve should be considered.

Isolating Valve
Isolating valve has been provided at upstream end and downstream end to isolate the pipeline for maintenance. The size and type of proposed isolation valve are as follows:

Diameter of Pipeline	Diameter of Isolating Valve	Type
Upto 500 mm	Full size	Sluice valve
600-1200 mm	3/4th size	Butterfly valve
> 1200 mm	2/3rd size	Butterfly valve

Washout, to be considered at dip points, with sizes:

Pipe Diameter	Diameter of Washout
Upto 500 mm	100 mm
600-900 mm	150 mm
1000-1200 mm	200 mm
> 1200	250 mm

1.5 Cost estimation

Following is the cost estimation for the proposed system of small transmission mains, trunk mains and feeder mains:

	Area	**Cost**, Rs Crores
1	Group A - Harsool Scheme Area	2.94
2	Group B - City Area	5.37
3	Group C - CIDCO Area	55.45
4	Group D - Paithan Road Area	1.50
	Sub-Total	**65.26**
	Add 5% contingency	3.26
	Add 1% insurance	0.65
	Grand Total	**69.17**

2 ANNEXURE

2.1 Service reservoirs and demand

Sr No	Service Reservoir			Demand (l/s)		Remarks
	Name	Type	Existing / Proposed for year 2026	Year 2026	Year 2041	
A	**CITY AREA**					
1	MES	-	-	51.74	73.96	Bulk supply to ESR
2	Cantonment	-	-	34.49	49.31	Bulk supply to ESR
3	Garampani	ESR	Existing	7.13	10.20	-
4	University	ESR	Existing	36.77	52.58	-
5	Jubilee Park	(i) Sump & ESR (O)	Existing	90.63	129.66	(i) ESR can be filled by gravity for 2026 & 2041
		(ii) ESR (N)	Proposed for 2026			(ii) Additional ESR for 2041 proposed
6	Medical	-	-	25.81	37.04	Bulk supply to sump
7	Hanuman Tekdi	(i) Sump & ESR (O)	Existing sump & ESR	79.63	113.92	(i) Booster pump at sump is required to fill ESR
		(ii) ESR (N)	Proposed for 2026			(ii) Additional ESR proposed for 2041
8	Vedant	ESR	Existing	118.41	169.40	-
9	Jyotinagar	ESR	Existing	17.55	25.11	
10	Jaivishvabharati	ESR	Existing	74.53	106.63	
11	Kranti Chowk	Sump & ESR	Existing	211.09	301.99	(i) ESRs can be filled by for 2026 and 2041
12	Kranti Chowk	Sump & ESR	Existing			(ii) Additional ESR proposed for 2041
13	Kranti Chowk	Sump & ESR	Existing			
14	Kotla	ESR	Existing	105.9	151.51	-
15	Shahganj	Sump & ESR	Existing	80.55	115.24	ESR can be filled by gravity for 2026 &

Sr No	Service Reservoir			Demand (l/s)		Remarks
	Name	Type	Existing / Proposed for year 2026	Year 2026	Year 2041	
						2041
16	Delhi gate	(i) GSR 1	Existing	115.50	165.24	Additional ESR proposed for 2041
		(ii) GSR 2	Existing			
17	Jinci	Sump & ESR	Existing	66.94	95.77	ESR can be filled by gravity for 2026 & 2041
18	Hattesinghpura	ESR	Existing	147.01	210.32	-
19	Hotel Meadows	ESR	Existing	4.44	6.37	-
20	Rana Petrol pump	(i) ESR (O)	Existing	52.89	75.67	Additional ESR proposed for 2041
		(ii) ESR (N)	Proposed for 2026			
21	Padegaon	ESR	Existing	2.17	3.11	-
22	Pethenagar	ESR	Existing	111.65	159.73	Additional ESR proposed for 2041
23	Mitmita	(i) ESR (O)	Existing	17.34	24.81	Additional ESR proposed for 2041
		(ii) ESR (N)	Proposed for 2026			
			Total A	**1452.17**	**2077.57**	
B	**CIDCO AREA**					
1	SFS(Garkheda)	ESR	Existing	210.67	301.67	Additional ESR proposed for 2041
2	Girijadevi & Pundliknagar	Sump & ESR	Existing	125.49	179.54	Booster pumps at sump to fill Pundliknagar ESR required
3	Shivajinagar (O)	Sump & ESR	Existing	82.08	117.43	ESR can be filled by gravity for 2026 & 2041
4	Shivajinagar (N)	ESR	Existing			
5	Marimata	(i) GSR (O)	Existing	114.91	164.40	-
		(ii) GSR (N)				
6	Mukundwadi	ESR	Existing	95.95	137.27	Additional one ESR proposed for 2041
7	Sanjaynagar	(i) ESR (O)	Existing	41.55	59.44	
		(ii) ESR (N)	Proposed for 2026			
8	Chikalthana	(i) ESR (O)	Existing	13.91	19.90	Additional one ESR proposed for 2041
		(ii) ESR (N)				
9	Masnatpur	(i) ESR (O)	Existing	7.30	10.45	
		(ii) ESR (N)	Proposed for 2026			

Sr No	Service Reservoir			Demand (l/s)		Remarks
	Name	Type	Existing / Proposed for year 2026	Year 2026	Year 2041	
10	Undevelpoed area on Jalna Road side	ESR	Proposed, but to be constructed in future after development	104.78	149.66	-
11	N7 (Sump)	Sump	Existing	See Subtotal (a)		Booster pumps at N7 to fill N8 ESR, ESRs at N7, Harsiddhi ESR and ESRs at Harsul
12	N7(3 ESRs)	ESRs	Existing	458.94	656.57	-
13	N8	ESR	Existing	20.61	29.49	-
14	Harsiddhi	ESR	Existing	89.29	127.74	-
15	Harsul (including Central jail)	Three ESRs	Existing	50.34	72.03	-
16	Undevelpoed area beyond N7	ESR (one or two)	Proposed, but to be constructed in future after development	314.34	449.72	-
			Subtotal - a (Sr No 12 to 16)	933.52	1335.55	
17	N5 (Sump)	Sump	Existing	See Subtotal (b)		Booster pumps at N5 to fill ESRs at N5 and N7 sump and Naregaon & Brijwadi ESRs (Further modified)
18	N5 (3 ESRs) R1,R2,R3	ESRs	Existing	190.44	272.45	-
19	Naregaon	(i) ESR (O)	Existing	12.52	17.92	Additional ESR proposed for 2041
		(ii) ESR (N)	Proposed for 2026			
20	Brijwadi	(i) ESR (O)	Existing	9.05	12.94	Additional ESR proposed for 2041
		(ii) ESR (N)	Proposed for 2026			
			Subtotal - b (Sr No 18 to 20 + Subtotal - a)	1145.53	1638.16	
			Total B (Full CIDCO area)	**1942.17**	**2778.17**	

Sr No	Service Reservoir			Demand (l/s)		Remarks
	Name	Type	Existing / Proposed for year 2026	Year 2026	Year 2041	
C	Area along Paithan Road (Nakshatrawadi - Kanchanwadi - Itkheda etc)					
1	Nakshatrawdi - Kanchanwadi	ESR	Existing	57.54	82.32	-
2	Itkheda	ESR	Existing	28.13	40.25	-
3	Banewadi (Rahulnagar)	ESR	Existing	2.99	4.28	-
4	Silk Mill	ESR	Proposed for 2026	59.32	84.87	Additional ESR proposed for 2041
5	Additional demand for railway station area	-	-	2.99	4.28	-
			Total C	**150.97**	**216.00**	
			Grand Total (A+B+C)	**3545.31**	**5071.74**	
			Demand (ML/day)	**293.55**	**419.94**	

2.2 Figure 1: Small transmission mains – Harsool dam to WTP and WTP to Delhi gate

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2.3.1 Figure 2.1: City area

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Mandatory Project Requirements

(Refer Clause 1.1.13 (B) (ii) (c) of the RFP Volume 1-Instructions to Bidders)

Aurangabad Municipal Corporation

Build, Refurbish, Operate and Maintain the Water Supply System of Aurangabad City, Maharashtra State, India

Distribution Network – Investment Required and Technical Specifications

February, 2010

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1 DISTRIBUTION NETWORK – INVESTMENT REQUIRED AND TECHNICAL SPECIFICATIONS

The objective of this report is to estimate investment required for the distribution network. The report discusses the existing distribution system in the Aurangabad city, issues with the existing system, proposed design and estimation of the required investment. The proposed design is based on following objectives:

- Water supply system fulfilling demand of 2026 and 2041;
- Provide maximum coverage; and
- Equitable distribution of water with adequate pressure

1.1 Existing distribution system

1.1.1 Water supply distribution network

At present the distribution system has a pipeline network, including feeder mains of about 970 kms, serving six water districts (zones). Following are the details of pipe material / length (km) / diameter (mm) currently used in the distribution network:

Table 1: Details of Pipe Material / Length (km) / Diameter (mm)

Sr. No.	Pipe Material	Length (km)	Diameter (mm)
1	AC	570.54	80 to 400
2	CI	269.45	80 to 750
3	RCC	52.92	80 to 450
4	MS	46.61	200 to 1400
5	GI	7.52	50 to 100
6	DI	17.20	150 to 600
7	PVC	3.08	63 to 250
8	HPCL	0.28	300

Source - DPR of Parallel water supply scheme prepared by AMC

Figure 1 Provides base map layout
Figure 2 Provides Contour map of Aurangabad City
Figure 3 Provides map of the existing distribution network in Aurangabad City.

1.1.2 Service reservoirs

Currently there are 63 service reservoirs having total capacity of 800.55 lacs litres. Details of service reservoirs are shown in Table-2 below:

Table 2: Details of Service Reservoirs

Sr. No.	Location of Reservoir	ESR/GSR	Capacity, Lacs ltrs
1	NAKSHATRAWADI MBR	GSR	7.50
2	NAKSHATRAWADI MBR	GSR	48.00
3	NAKSHATRAWADI MBR	GSR	23.50
4	NAKSHATRAWADI MBR	GSR	43.75
5	NAKSHATRAWADI VILLAGE	ESR	1.50
6	KANCHANWADI	ESR	1.50
7	ITKHEDA	ESR	1.50
8	VEDANT NAGAR	ESR	15.00
9	POLYTECHNIC COLLEGE	ESR	15.00
10	KOTLA	ESR	18.00
11	KRANTI CHOWK	ESR	15.00
12	KRANTI CHOWK	GSR	11.00
13	KRANTI CHOWK	GSR	5.00
14	KRANTI CHOWK	ESR	3.00
15	KRANTI CHOWK	ESR	20.00
16	SFS	ESR	32.00
17	JAI VISHWA BHARATI	ESR	15.00
18	SHIVAJI NAGAR - CIDCO	ESR	15.00
19	MUKUNDWADI	ESR	2.00
20	SANJAY NAGAR	ESR	3.50
21	CHIKAL THANA (R-1)	ESR	4.00
22	CHIKAL THANA (R-2)	ESR	4.50
23	MASNATPUR	ESR	2.00
24	BRIJWADI	ESR	2.00
25	NAREGAON	ESR	2.00
26	N-5 (R-1)	ESR	11.25
27	N-5 (R-2)	ESR	18.00
28	N-5 (R-3)	ESR	20.00
29	N-5 SUMP	SUMP	22.00
30	MARIMATA NEW	GSR	22.00
31	MARIMATA OLD	GSR	15.00
32	N-7 (R-1)	ESR	11.25
33	N-7 (R-2)	ESR	18.00
34	N-7 (R-3)	ESR	20.00
35	N-7 SUMP	SUMP	20.00
36	HARSIDDHI	ESR	26.00
37	HARSOOL OLD	ESR	2.50
38	HARSOOL NEW	ESR	3.00
39	HARSOOL JAIL	ESR	10.00
40	DELHI GATE NEW	GSR	18.00
41	DELHI GATE OLD	GSR	13.50
42	HATTESINGH PURA	ESR	15.00
43	JINCI	ESR	15.00
44	JINCI SUMP	SUMP	5.00
45	SHAHA GANJ	ESR	24.00

Sr. No.	Location of Reservoir	ESR/GSR	Capacity, Lacs ltrs
46	SHAHA GANJ SUMP	SUMP	4.50
47	JUBILLE PARK	ESR	10.50
48	JUBILLE PARK SUMP	SUMP	3.50
49	MEDICAL	ESR	15.00
50	UNIVERSITY	ESR	21.30
51	HANUMAN TEKDI	GSR	15.00
52	PETHE NAGAR	ESR	1.50
53	SLAUGHTER HOUSE-PADEGAON	ESR	2.00
54	PADEGAON	ESR	1.50
55	RANA PETROL PUMP PADEGAON	ESR	2.00
56	HOTEL MEDOWS	ESR	2.00
57	MITMITA	ESR	2.00
58	GARAMPANI	ESR	1.50
59	SHIVAJI NAGAR NEW	ESR	26.00
60	PUNDALIK NAGAR	ESR	40.00
61	JYOTI NAGAR	ESR	15.00
62	BANEWADI Z1-1	ESR	1.50
63	N-8	ESR	15.00
	Total		**800.55**

Source – AMC

The existing distribution network serves a population of about 10 Lacs and is a combination of gravity and pumped system.

1.1.3 Existing water distribution system – issues

Following are the issues identified with the existing water distribution system in Aurangabad:

- System losses are greater than acceptable limit of 10%;
- Unequal distribution of water;
- Estimated rate of water supply, at around 80 lpcd, lower than CPHEEO norm of 135 lpcd;
- Inadequacy of water supply;
- Use of AC pipes in distribution network, causing water losses;
- Higher energy cost, as a result of booster pumping; and
- Number of parallel lines on the same road

1.2 Proposed design of the distribution system

The proposed distribution system network has been designed with at most care and foresight considering the capital investment impact on overall project. The design of the proposed system is based on following aspects:

- Overall project economy; and
- Adequate and equitable water distribution with desired pressure at peak demand period

1.2.1 Distribution system – design parameters

Followings are the design parameters for the proposed distribution system:

Sr. No.	System Design	Parameter
i)	Design Period	30 years
ii)	Design Year	2041 (considering 2011 as base year)
iii)	Water requirement of the city at the rate of 160 lpcd at source, with system losses as 15% considering water supply at consumer end as 135 lpcd	As per DPR prepared by AMC
iv)	Net demand at consumer end	135 lpcd
v)	Distribution losses	10%
	Peak factor	Based on population
	• For population less than 50,000	3.0
	• For population range of 50,000 to 2,00,000	2.5
	• For population above 2,00,000	2.0
vi)	Fire demand	1800-l/min for every 50,000 population or part there of for towns up to 3 lacks population and an additional 1800-l/min for every 1 lack population of more than 3 lacks. The requirement should be on the basis of 2 hrs duration
vii)	Floating Population	1% of total population @ 45 lpcd rate of water supply
viii)	System of Supply	Continuous
ix)	System Pattern	Loop / Grid
x)	Zoning	If there is an average elevation difference of 15 m to 25 m between zones, each zone shall be served by a separate system.

Followings are the design specifications for the proposed distribution network:

Sr. No	Distribution Network	Specifications
i)	Minimum diameter of pipe	100 mm
	PE 10	110-315mm
	DI K9	350-600mm
	DI K7	700-1000mm
	For dead ends PE 10	75mm
ii)	Min. residual pressure at ferrule point	12 m
iii)	Max. residual pressure	25 m
iv)	Max. velocity of water	2.5 m/s

Sr. No	Distribution Network	Specifications
v)	Min. velocity of water	0.6 m/s
vi)	No house connections from lines dia.	= 300 mm.
vii)	Cover depth	
	• Under traffic	= 1.0 m
	• Outside traffic	= 0.8 m
viii)	Headloss in pipeline	1 – 4m per 1000 m at peak flow
ix)	Hazen William formula shall be used for pipeline design	
x)	'C' Value for proposed pipe	
	• PE 10	140
	• DI	135
xi)	'C' value for existing pipeline	
	• CI	90
	• DI	120
xii)	Sluice Valves	Underground installation with spindle & surface box when diameter is < 200 mm In a chamber when dia. is = 200 mm Sluice valve- up to 300mm same as pipe dia, above 300mm 2/3 of pipe dia When diameter is = 300 mm butterfly valve Scour valve – Low points in pipeline and all dead ends Size – For main pipe line half of pipe dia, minor lines equal to pipe dia
xiii)	Fire Hydrants	Near commercial areas connections from the main lines (= 100 mm) Every 1 sq. km area – 1 fire hydrant
xiv)	Thrust block	
	DI pipes	90°, 45°, 22.5° bends
	PE and DI pipes	Tee, Cross and dead ends

1.2.2 Improvement in the existing distribution system

STC has proposed an improvement in the existing distribution system based on following procedure:

- Preparation of layout of the existing system;
- Calculation of future nodal demand based on land use;
- Hydraulic analysis of the system for future demand using WaterGEM Software
  - Evaluation of the existing distribution system;
  - Recommendation on improvement in the existing system;
  - Check on system performance under critical condition after improvement;
  - Check on system pressure under fire flow conditions; and
  - Report final result with improvement

- Replacement of AC, RCC, GI, PVC pipes;
- Possibility of elimination of booster pumping station;
- For house connections replacement of GI pipes with MDPE pipe;
- Improvement in the ESR system
  - Capacity worked out as per CPHEEO manual norms;
  - If capacity of existing ESR found inadequate additional ESR has been proposed for 15 years design period; and
  - ESR in bad condition and / or more than 50 years old have been suggested to discontinue
- Expansion of the current distribution system
  - Preparation of layout of distribution system on proposed roads;
  - Calculation of future nodal demand based on land use;
  - Hydraulic analysis by water distribution modelling software;
  - New ESR as per CPHEEO Manual norms; and
  - Block estimate based on MJP Schedule of Rates for the year 2008-09

1.3 Rehabilitation and expansion of existing water distribution network

Considering year 2011 as base year and year 2041 as a target year, future water demand has been calculated for target year. The proposed distribution network has been designed considering population of about 25 lakhs in 2041, divided into following six water districts:

Table 3: Water District, Area and Population

Water District	Area	Population
1	Kranti, Kotla, Vedant Nagar, Banewadi, Silkmill, Jyoti Nagar, Jai Vishwabharati, Jubille Park, Garampani, DelhiGate, Sahaganj, Hattesingpura	7,77,849
2	SFS, Mukundawadi, Shivaji Nagar, Pundlik Nagar, Jinci, N5, Marimata	7,01,119
3	N7, N8, Harsiddhi, Harsool, Harsool jail	2,83,980
4	University, Hanuman Tekdi, Pethe Nagar, Padegaon, Rana Petrol Pump, Hotel Midos, Mitmita	2,41,132
5	Nakshatrawadi, Kanchanwadi, Itkheda	67,725
6	Sanjay Nagar, Chikhalthana, Mansatpur, Brijwadi, Naregaon	67,150
3 & 6	Distribution network in undeveloped area of 3000 ha	3,33,112
	Total	**24,72,067**

The proposed design is based on following methodology adopted:

- **Nodal demand**: It is a common practice in the analysis and design of water distribution network to presume that the demand will be concentrated at nodes. Forecasted domestic demand together with public, commercial and industrial (small scale) have been calculated on each nodes based on land use, population density and the average per capita water consumption;
- **Design demand**: Considering the total daily demand and the peak factor, the design demand at the nodes of water distribution network has been estimated;

- **Input data for hydraulic modelling**: Nodal data which consists of node number, nodal demand, elevation and pipe data which consists of pipe number, starting node, ending node, pipe length, 'C' value and proposed diameter has been prepared for each zone for hydraulic modelling; and
- **Hydraulic analysis**: Zone wise hydraulic analysis has been carried out by using Water GEMS Software to work out the economic diameter of proposed network and rehabilitation of existing network. For undeveloped area of zone 3 & 6, development plans are not available hence hydraulic analysis has not been carried out but considered in the cost estimation

1.3.1 Proposed distribution pipelines

Based on above methodology, following network of the distribution pipelines has been proposed for the project:

Table 4: Proposed Diameter, Total Length, and Pipe Diameter

Water District	Material	Proposed Diameter (mm)	Length of Network (m)
1	PE 10	75 – 315	305
	DI	350 – 750	9.0
2	PE 10	75 – 315	215
	DI	350 – 600	5.0
3	PE 10	75 – 315	195
	DI	350 – 600	2.0
4	PE 10	75 – 315	185
	DI	350 – 500	12
5	PE 10	75 – 315	93
	DI	350	0.78
6	PE 10	75 - 315	68
	DI	350	0.22
3 & 6	-	-	200
Total			**1290**

1.3.2 Proposed service reservoirs

Storage capacity of the service reservoir is estimated taking into account the storage capacity of existing service reservoirs, daily demand and fire demand of each zone. Considering the design period of 15 years, storage capacity is worked out for stage one i. e. for year 2026 and stage two i. e. for year 2041. Table-6 below gives zone wise storage capacity of proposed reservoirs. (For the year 2026 and year 2041)

Table 6: Storage Capacity for Year 2026 and 2041

Water District	Location of ESR	Existing Capacity (lacs liter)		2026 Capacity (lacs liter)	2041 Capacity (lacs liter)
		ESR	GSR		
1	kranti Chowk	15, 3, 20	11, 5	-	15

Water District	Location of ESR	Existing Capacity (lacs liter)		2026 Capacity (lacs liter)	2041 Capacity (lacs liter)
		ESR	GSR		
	Silk mill	-	-	15	14
	Jubli park	10.5	3.5	4.5	12
	Delhi Gate	-	18, 3.5	-	4
2	SFS	32	-	-	10.5
4	PetheNagar	1.5	-	-	2
	Rana PetrolPump	2	-	5.6	4
	Hanuman tekdi ESR(new)	-	15	12	4.2
	Mitmita ESR(new)	2	-	4.7	1.1
6	Sanjay Nagar	3.5	-	4.89	2.7
	Masnatpura	2	-	1.3	0.5
	Brijwadi	2	-	1.5	0.6
	Naregaon	2	-	2	0.8
3&6	New -ESR in Undeveloped Area (2nos)	-	-	37	14.5
	Total			**88.49**	**85.9**

1.3.3 House service connections

For house service connections MDPE pipes have been proposed.

1.4 Proposed investment requirement

Broad estimate of the required investment has been worked out for the Water Distribution Network, Service Reservoirs and House Connection, given below in table-7, 8, 9 and 10 respectively:

Table 7: Cost Estimation for Proposed Water Distribution Network

Water District	Length of Network (m)	Immediate Cost (Rs. in Cr) for 2026	Total Cost (Rs. in Cr) for 2041
1	314	48.92	48.92
2	220	32.44	32.44
3	197	28.58	28.58
4	197	18.52	34.67
5	94	7.37	14.46
6	68	8.62	8.62

Water District	Length of Network (m)	Immediate Cost (Rs. in Cr) for 2026	Total Cost (Rs. in Cr) for 2041
3 & 6	200	-	31.50
Total	**1290**	**144.45**	**199.19**

Table 8: Cost Estimation for Service Reservoirs

Water District	Location of ESR	Cost 2026 (Rs. in Cr)	Cost 2041 (Rs. in Cr)
1	kranti Chowk	-	0.53
	Silk mill	0.50	0.48
	Jubli park	0.24	0.43
	Delhi Gate	-	0.23
2	SFS	-	0.42
4	PetheNagar	-	0.17
	Rana PetrolPump	0.29	0.23
	Hanuman tekdi ESR(new)	0.43	0.23
	Mitmita ESR(new)	0.24	0.10
6	Sanjay Nagar	0.25	0.20
	Masnatpura	0.11	0.07
	Brijwadi	0.12	0.07
	Naregaon	0.14	0.09
3&6	New -ESR in Undeveloped Area (2nos)	2.15	1.07
	Total	**4.47**	**4.31**
	Contingency 5%	0.22	0.22
	Total Cost	**4.69**	**4.53**
	Total Cost, for 2041	**9.22**	

Table 9: Cost Estimation for House Service Domestic Connection from HDPE Pipe Distribution Line with Regulating Ferrule

Pipe Dia	Connections (No)	Rate (Rs)	Amount (Rs)
1/2 " - 20 mm	113864	1419	16,15,37,718
3/4 " - 25 mm	3226	1592	51,34,598
1" - 32 mm	762	1917	14,60,419
1.5 " - 40 mm	50	2841	1,42,070
2"- 50 mm	82	3603	2,95,467
* 3" - 75 mm	28	8178	2,28,976
* 4" - 110 mm	18	17183	3,09,291
* 6" - 160 mm	9	30174	2,71,566
* 8" - 200 mm	3	44901	1,34,702
	Total Cost		**16,95,14,808**
	Total Cost in Cr		**16.95**

Table 10: Cost Estimation for House Service Commercial Connection from HDPE Pipe Distribution Line with Regulating Ferrule

Pipe Dia	Connections (No)	Rate (Rs)	Amount (Rs)
½ " - 20 mm	822	1500	12,32,918
¾ " - 25 mm	234	1704	3,98,759
1" - 32 mm	185	2104	3,89,240
1.5 " - 40 mm	22	3129	68,834
2"- 50 mm	18	4041	72,731
* 3" - 75 mm	3	8178	24,533
* 4" - 110 mm	6	17183	1,03,097
* 6" - 160 mm	8	30174	2,41,392
* 8" - 200 mm	3	44901	1,34,702
	Total Cost		**26,66,206**
	Total Cost in Cr		**0.27**

* without ferrule, Branch connection

The required investment for the distribution system is as follows:

Sr. No.	System component	Investment required, Rs. Crores
1	Water Distribution Network	144.45
2	Service Reservoirs	4.69
3	House Service Domestic Connection	16.95
4	House Service Commercial Connection	0.27
	Total	**166.36**

Generally the O&M cost of water distribution system would be about 2% of the total capital cost.

2 ANNEXURE 1 – WATER DISTRIBUTION NETWORK USING ALL DI PIPES

The objective of this section is to estimate investment required for the distribution network using DI pipes instead of a mix of DI and PE pipes. While designing the distribution system total eleven different diameters PE pipes have been used, in case of DI pipes only five different diameters are available. Following table depicts the pipes of different diameters available in PE and DI category:

Category of pipe	Diameter (mm)
PE	75, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315
DI	100, 150, 200, 250, 300

The suitable methodology has been adopted by STC to work out equivalent DI sizes among five categories matching the performance of eleven PE pipes.

2.1 Methodology for selection of DI pipes

A methodology based on nearly equal friction loss has been adopted to select diameters of DI pipe equivalent to diameter of PE pipes based on the following relationship for friction loss (H_f) as per Hazen William's equation:

$$\frac{H_{f\,DI}}{H_{f\,PE}} = \left(\frac{D_{PE}}{D_{DI}}\right)^{4.87}$$

The diameters of PE and equivalent DI pipes with ratio of friction losses are shown in table below:

Comparison of Internal Diameters and H_f

PE Pipes			DI Pipes			H_{fDI} / H_{fPE}
Nominal Dia	Thickness (Mean)	Internal Diameter	Nominal Dia	Lining Thickness	Internal Diameter	
In mm	In mm	In mm	In mm	In mm	In mm	
75	3.80	67.4	100	3	94	0.20
110	5.35	99.3	100	3	94	1.31
125	6.10	112.8	150	3	144	0.30
140	6.85	126.3	150	3	144	0.53
160	7.80	144.4	150	3	144	1.01
180	8.75	162.5	200	3	194	0.42

PE Pipes			DI Pipes			H_{fDI} / H_{fPE}
Nominal Dia	Thickness (Mean)	Internal Diameter	Nominal Dia	Lining Thickness	Internal Diameter	
In mm	In mm	In mm	In mm	In mm	In mm	
200	9.70	180.6	200	3	194	0.71
225	10.95	203.1	200	3	194	1.25
250	12.10	225.8	250	3	244	0.69
280	13.55	252.9	250	3	244	1.19
315	15.25	284.5	300	3	294	0.85

It is seen from values of H_{fDI} / H_{fPE} that equal friction losses cannot be achieved as a result of different diameters of DI and PE pipes. In order to ensure that solution is workable, equivalent DI diameters have been selected such that friction losses in DI would not exceed + 30%. No limit could be specified on minus (-) side as next higher diameter of DI only need to be followed. The equivalent diameters in above are based on above approach. The equivalent diameters are therefore adopted and summarized in table below:

Equivalent Diameter of DI for PE Pipes

Diameter of PE (in mm)	Equivalent Diameter of DI (in mm)
75	
110	100
125	
140	
160	150
180	
200	
225	200
250	
280	250
315	300

Annexure 2 provides the comparison of investment required for the distribution network using DI + PE pipes as against all DI pipes.

3 COMPARISON OF INVESTMENT REQUIRED FOR THE DISTRIBUTION NETWORK USING DI + PE PIPES AND ALL DI PIPES

Water District	Existing Length (m)	Alternative - I Proposed Distribution Pipeline - (PE 10 + DI)						Alternative - II Proposed Distribution Pipeline - All DI		
	Retained	Diameter	Length (m)	Total Length (m)	Total Cost, Rs Cr	Length for 2026	Cost, Rs. Cr	Diameter (all DI)	Total Cost, Rs Cr	Cost, Rs Cr
1.0	38565	75 - 315 (PE) 350 - 750 (DI)	3048588989	313847	48.92	313847	48.92	100-750	99.09	99.09
2.0	25496	75 - 315 (PE) 350 - 600 (DI)	2150045102	220106	32.44	220106	32.44	100-600	68.18	68.18
3.0	28962	75 - 315 (PE) 350 - 600 (DI)	1943832385	196768	28.58	196768	28.58	100-600	60.81	60.81
4.0	3810	75 - 315 (PE) 350 - 500 (DI)	18505211529	196581	34.67	105000	18.52	100-500	65.83	35.16
5.0	0	75 - 315 (PE) 350 only (DI)	93372780	94152	14.46	48000	7.37	100-350	31.36	15.99
6.0	0	75 – 315 (PE) 350 only (DI)	68106219	68326	8.62	68326	8.62	100-350	19.04	19.04
3.0 & 6.0 (Proposed area for Development)	Nil	75 - 315 (PE) =350 (DI)	200000	200000	31.5	-	-	= 100	30.78	-
Total					**199.19**	**-**	**144.45**	-	**375.09**	**298.27**

Mandatory Project Requirements

(Refer Clause 1.1.13 (B) (ii) (d) of the RFP Volume 1-Instructions to Bidders)

Aurangabad Municipal Corporation

Build, Refurbish, Operate and Maintain the Water Supply System of Aurangabad City, Maharashtra State, India

Water and Flow Meter – Required Investment and Proposed Technical Specifications

February, 2010

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CONTENTS

1 WATER AND FLOW METERS – REQUIRED INVESTMENT AND TECHNICAL SPECIFICATIONS

The objective of this report is to estimate investment required for metering, water & flow metering of all sizes within AMC's jurisdiction.

At present Aurangabad Municipal Corporation (AMC) does not have flow monitoring for its water supply system, considered crucial to control the flow of water with equitable distribution. Similarly the domestic as well as commercial water connections have not been metered, except in few cases of industrial and gram panchayat consumers.

Shah Technical Consultants (STC) conducted thorough site visits to get acquainted with the site conditions including parameters of water, flooding, ambient temperatures, possibility of theft, damages to the installations etc. The data and discussion with AMC officials have helped in the formalizing final recommendation. Observations on the Aurangabad's water supply system through data collected are enclosed as Annexure 1 – Observations of the System. This report discusses merit and demerits of various types of water meters to arrive at final recommendation.

1.1 Number of Water Connections in Aurangabad

There are about 1,44,000 properties in the city while only 99,451 water connections have been registered with AMC, domestic 98,371 and commercial 1,080:

Sr. No.	Size mm (in)	Qty		Total	Add 35%	Grand Total
		Domestic	Commercial			
1	15 (1/2)	94886	685	95571	33449	129020
2	20 (3/4)	2688	195	2883	1009	3892
3	25 (1)	636	154	790	276	1066
4	40 (1 1/2)	41	18	59	20	79
5	50 (2)	68	15	83	29	112
6	80 (3)	23	5	28	9	37
7	100 (4)	16	6	22	7	29
8	150 (6)	8	2	10	3	13
9	200 (8)	5		5	2	7
		98371	**1080**	**99451**	**34804**	**134255**

1.2 Selection of water meters

The different water meters, their merits / demerits and meter reading techniques are discussed in Appendix A and B respectively. Taking into account the present Indian conditions following water meters are considered most appropriate:

1. **Sizes 15 mm to 40 mm** – Should be inferential, multi-jet, Dry Dial, Magnetic Drive, screwed ends conforming to ISO:4064, Class B; and

2. **Size 50 mm and above** - Should be WOLTMANN Type Removable mechanism, flanged ends conforming to ISO:4064 Class B.

Other general specifications for the recommended water meters have been provided in the Appendix-D.

1.3 Selection of flow meters

In order to efficient monitoring water flow, AMC proposes to provide flow meters at:

1. Every rising main at the pumping station
2. Inlet to water treatment plant
3. Outlets of MBR at Nakshatrawadi
4. Inlets of MBR at Nakshatrawadi
5. Inlet to every ESR / GSR
6. Rising main of booster pumping station
7. Rising main of distribution pumping station

Annexure 2 shows different locations of flow meters and type selected.

1.3.1 Selection of flow meters

Considering the site constraint, performance expected by the flow meters and the cost, it is recommended to use electromagnetic flow meters on the pipeline ranging from 80 mm to 250 mm diameter. For the pipeline of diameter 300 mm and above, ultrasonic flow meters, transit time, insertion multi-path type are recommended on the following basis.

1. 300 mm to 600 mm, single path
2. 700 mm to 1200 mm, two path
3. 1300 mm and above, four path

Following aspects have been considered while recommending flow meters:

1. Electromagnetic flow meter, the duration for isolation required for pipeline at the time of installation
2. Ultrasonic flow meter
    a. The isolation of pipeline may not be required;

b. The cost for higher diameter should not vary considerably, as compared to electromagnetic;
c. However, the cost of ultrasonic flow meter for smaller diameter would be higher than that of electromagnetic and hence considered not suitable for smaller diameter pipeline; and
d. Inter-changeability in ultrasonic flow meter devices for various sizes of pipeline

It is recommended to conduct the flow reading with the help of GSM modem which should be installed at every flow meter. The readings can be transmitted to a central location or the respective zonal centre periodically.

The types of flow meters, their merits and demerits are discussed in Appendix C. The general specifications for electromagnetic and ultrasonic flow meters are provided in Appendix-E.

1.4 Estimated investment of metering

1.4.1 Water meter

The detailed cost break-up for water meters has been provided in Annexure 3, while this section provides required investment with three options, including contingency cost of 5%:

1. Single jet of sizes 15 mm to 25 mm, excluding automatic meter reading facility – Rs 44.42 Crores
2. Multi jet and woltmann, excluding cost of automatic meter reading facility – Rs 52.33 Crores
3. Multi jet and woltmann, including cost of automatic meter reading facility – Rs 96.13 Crores

1.4.2 Flow meter

The detailed cost break-up for flow meters has been provided in Annexure 4, while this section provides required investment for the number of flow meters suggested at places in section 1.3. The investment includes contingency of 5%. It is expected that the Concessionaire would be installing 73 flow meters of which 20 would be electromagnetic while 53 ultrasonic ones. The total investment required would be about Rs 4.30 Crores.

1.4.3 Total metering investment

The single jet water meters have not been recommended, particularly in hostile flow conditions. The Concessionaire could consider either of two options provided as below at the time of metering connections, while the option 1 has been considered to arrive at the estimated project cost:

1. Flow meters and multi jet and woltmann, excluding cost of automatic meter reading facility – Rs 56.63 Crores
2. Flow meters and multi jet and woltmann, including cost of automatic meter reading facility – Rs 100.43 Crores

3. ANNEXURE 1: OBSERVATIONS OF THE SYSTEM

Following are the STC's observations of the Aurangabad's water supply system:

1. Eight erstwhile administrative zones have been restructured into six zones;
2. Raw water turbidity - Maximum 150 NTU;
3. Water temperature - From 10° C to 50° C
4. Bulk consumers are provided connection with GI / CI pipes
5. Chlorination is carried out in such a way as to get residual chlorine of 1 ppm at ESR
6. Mode of communication - A group mobile system of 'Vodafone' is used as the communication media. At all ESR mobile phones are provided. Rupees 149 per month are charged for each mobile phone irrespective of duration of usage in the group system;
7. From Jayakwadi to city the following bulk consumers have been provided with water meters;

	Location	Size (mm)
i.	Allana	200
ii.	Globe Trotters	25
		50
iii.	Concept laboratories	25
		50
iv.	Videocon	50
v.	Veera Tanners	50
vi.	High-Tech	50
vii.	Gurunanak	25
viii.	Dhoot Transmission	25
ix.	Dhoot Compact	50
x.	MES	300
xi.	Agriculture School	80
xii.	WALMI	100
		25

8. Following bulk consumers are not provided with water meters

	Location	Size (mm)
i.	Bidkin	200
ii.	Dhorkin	150
iii.	Isarwadi	100
iv.	Dhangaon	25
v.	Cantonment	300

9. Charges of Irrigation department, Government of Maharashtra - Rs.150 / 1000 m3
10. Five ultrasonic flow meters of single path, picosonic make, insertion type, working on transit time have been installed at 1200 mm and 700 mm pumping mains at Jayakwadi and 700 mm, 1400 mm and 1200 mm outlets at Nakshatrawadi MBR;
11. Water meters each of size 200 mm should be provided at Siddharth garden and swimming pool;

12. Frequency of invoicing – Yearly;
13. Power supply situation - Current load shedding, daily about 3 hrs each in the morning and evening;
14. Time of ESRs filling – Night, at most of the places;
15. Quality of MS pipeline (trunk main) - Internally mortar and externally gunitted;
16. Water revenue, for the year 2007-08:

Diameter of Pipe	Domestic Rate Per Year	Domestic	Collection of Water Cess, Rs	Commercial Rate Per Year	Commercial	Collection of Water Cess, Rs
1/2"	1800.00	94886	170,794,800	6500	685	4,452,500
3/4"	2925.00	2688	7,862,400	12000	195	2,340,000
1"	6825.00	635	4,333,875	25000	154	3,850,000
1.5"	30000.00	41	1,230,000	70000	18	1,260,000
2"	50000.00	68	3,400,000	140000	15	2,100,000
3"	80000.00	23	1,840,000	200000	5	1,000,000
4"	120000.00	15	1,800,000	300000	6	1,800,000
6"	200000.00	7	1,400,000	400000	2	800,000
8"	300000.00	2	600,000	-	-	
		98365	**193,261,075**		**1080**	**17,602,500**

(Source: Water Supply Dept., AMC)

ANNEXURE 2: PROPOSED LOCATIONS FOR FLOWMETERS

Transmission mains from jayakwadi to nakshatrawadi MBR

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	Old Jayakwadi Pumping	700	2 U
2.	New Jayakwadi Pumping	1200	2 U
3.	Dhorkin Booster Pumping	700	2 U
4.	Inlet to Old Pharola WTP	700	2 U
5.	Old Pharola P.W. Pumping	700	2 U
6.	Inlet to New Pharola WTP	1200	2 U
7.	New Pharola P.W. Pumping	1200	2 U
8.	Inlet to MBR – Nakshatrawadi	700	2 U
9.	Inlet to MBR – Nakshatrawadi	1200	2 U
10.	Outlet of MBR – Nakshatrawadi	1400	4 U
11.	Outlet of MBR – Nakshatrawadi	1200	2 U
12.	Outlet of MBR-Nakshatrawadi	300	1 U

Pumping stations in cidco and harsool

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	CIDCO N-5 P.W. Booster	1000	2 U
2.	CIDCO N-7 P.W. Booster	500	1 U
3.	Harsool P.W. Pumping	450	1 U
4.	Branch on N-5, N-7 Pumping Main to Naregaon & Brijwadi	200	EM

GSR / SUMP in the City

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	Delhi Gate	450	1 U
2.	Delhi Gate-2	300	1 U
3.	Hanuman Tekdi (Bibikamakbara)	500	1 U

ESRs in the City

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	Vedant Nagar	300	1 U
2.	Kotala	700	2 U
3.	Kranti Chowk (15 Lacs)	300	1 U
4.	Kranti Chowk (3 Lacs)	100	EM
5.	Kranti Chowk (20 Lacs)	300	1 U
6.	Jaivishwa Bharathi	450	1 U
7.	Jyoti Nagar	300	1 U
8.	Shahganj	450	1 U
9.	Jinsi	300	1 U
10.	Hattesing Pura	300	1 U
11.	Jubliee Park	300	1 U
12.	University	500	1 U
13.	Medical	300	1 U
14.	Padegaon – Mitmita	150	EM
15.	Padegaon – Gaothan	200	EM
16.	Padegaon – Rana Petrol Pump	150	EM
17.	Padegaon – Hotel Medows	150	EM
18.	Padegaon – Slaughter House	100	EM
19.	Padegaon (Pethe Nagar)	150	EM
20.	Garampani	200	EM
21.	Itkheda	200	EM
22.	Kanchan Wadi	300	1 U
23.	Nakshatra Wadi	100	EM
24.	Rahul Nagar (Banewadi)	250	EM
25.	Silk Mill	350	1 U

GSR / SUMP in CIDCO

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	N-5	900	2 U
2.	N-7	1000	2 U
3.	Girija Devi (Pundlik Nagar)	300	1 U
4.	Marimata – Old	300	1 U
5.	Marimata – New	300	1 U

ESRs in CIDCO

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	N-5 (R1)	300	1 U
2.	N-5 (R2)	400	1 U
3.	N-5 (R3)	400	1 U
4.	N-7 (R1)	300	1 U
5.	N-7 (R2)	400	1 U
6.	N-7 (R3)	300	1 U
7.	Harsiddhi	500	1 U
8.	Shivaji Nagar (Old)	300	1 U
9.	Chikhalthana (R1)	150	EM
10.	Chikhalthana (R2)	300	1 U
11.	Naregaon	150	EM
12.	Brijwadi	150	EM
13.	Masanatpur	150	EM
14.	Sanjay Nagar	250	EM
15.	N-8	300	1 U
16.	Harsool Jail	250	EM
17.	Harsoolgaon (Old)	150	EM
18.	Harsoolgaon (New)	150	EM
19.	Mukund Wadi	500	1 U
20.	Shivaji Nagar (New)	450	1 U
21.	SFS (Garkheda)	300	1 U
22.	Pundlik Nagar	400	1 U

Extra

Sr. No.	Location	Size (mm)	Flowmeter Type
1.	MES	300	1 U
2.	Cantonment	300	1 U

EM - Electromagnetic flowmeter

1U - Single path ultrasonic flowmeter

2U - Two path ultrasonic flowmeter

4U - Four path ultrasonic flowmeter

ANNEXURE 3: COST OF WATER METERS

Proposed number of water meters

PROPOSED WATERMETERS						
Sr. No.	Size mm (in)	Quantity		Total	Add	Grand Total
		Domestic	Commercial		35%	
1	15 (1/2)	94886	685	95571	33449	129020
2	20 (3/4)	2688	195	2883	1009	3892
3	25 (1)	636	154	790	276	1066
4	40 (1 1/2)	41	18	59	20	79
5	50 (2)	68	15	83	29	112
6	80 (3)	23	5	28	9	37
7	100 (4)	16	6	22	7	29
8	150 (6)	8	2	10	3	13
9	200 (8)	5		5	2	7
		98371	1080	99451	34804	134255

*Additional quantity considered for the following

Siddharth Garden - 200 mm
Swimming Pool - 200 mm
Bidkin - 200 mm
Dhorkin - 150 mm
Isarwadi - 100 mm
Dhangaon - 25 mm

Cost of Multi Jet Water meter units

Size (mm)	Cost of Meter	Cost of Strainer	Cost of Gate Valve	Cost of Non-Return Valve	Cost of Labour, Nipple, Elbows	VAT 12.5%	Cost of Box / Chamber	Total (Rs.)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
15	1,200	245	215	170	50	291	1,000	3,621
20	1,500	385	295	255	600	379	1,000	4,414
25	2,400	660	455	395	750	583	1,000	6,243
40	5,700	1,370	850	765	1,500	1,273	1,200	12,658

Cost of Woltmann Water meter units

Size (mm)	Meter	Gate Valve / S.V.	N.R.V	Strainer	Flanges	Installation Nutbolts	VAT	Chamber	Total
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
50	10,000	1,325	1,170	1,500	250	5,000	2,406	3,175	24,826
80	12,500	2,675	2,450	2,000	300	5,000	3,116	3,121	31,161
100	15,000	3,625	3,300	3,000	350	7,500	4,097	3,111	39,983
150	22,000	5,250	5,250	5,000	600	10,000	6,013	3,081	57,193
200	27,000	9,725	9,125	11,000	900	10,000	8,469	3,033	79,252

Handheld Terminal: Rs.1,50,000 + VAT 18,750 = Rs.1,68,750

License Software: Rs.1,50,000 + VAT 18,750 = Rs.1,68,750

PC: approx Rs.50,000

RF pulse module: Rs.2,750 + VAT 343.75 = Rs.3,093.75

ANNEXURE 4: COST OF FLOW METERS

Cost of electromagnetic flow meter

Size	Flowmeter Cost	Assembly	Installation	Chamber+cabin	Battery backup	RTU	Electronic	Total
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
80	147,705	6,244	44,312	9,437	25,875	59,625	1,000	303,198
100	151,140	7,838	45,342	9,428	25,875	59,625	1,000	309,248
150	169,460	12,226	50,838	9,397	25,875	59,625	1,000	337,421
200	185,490	17,758	55,647	9,350	25,875	59,625	1,000	363,745
250	211,825	25,686	63,548	9,300	25,875	59,625	1,000	405,859

Cost of ultrasonic flow meter

Size	Flowmeter Cost	Assembly	Installation	Chamber+cabin	Battery backup	RTU	Electronic	Total
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
300	357,240	Nil	35,724	36,033	25,875	59,625	10,000	524,497
350	357,240	Nil	35,724	36,815	25,875	59,625	10,000	525,279
400	357,240	Nil	42,869	37,696	25,875	59,625	10,000	533,305
450	357,240	Nil	42,869	38,585	25,875	59,625	10,000	534,194
500	357,240	Nil	53,586	39,478	25,875	59,625	10,000	545,804
700		Nil		43,001			10,000	

Size	Flowmeter Cost	Assembly	Installation	Chamber+cabin	Battery backup	RTU	Electronic	Total
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
	460,290		69,044		25,875	59,625		667,835
900	460,290	Nil	69,044	48,012	25,875	59,625	10,000	672,846
1200	460,290	Nil	69,044	57,320	25,875	59,625	10,000	682,153
1400	643,490	Nil	96,524	82,569	25,875	59,625	10,000	918,082

Cost of SCADA software = Rs.2,953,125 approx
Installation & commissioning of RTU = Rs. 4,750
LPU: Lightning Protection Unit

APPENDIX A: WATER METER SELECTION

Mechanical Water Meters

Mechanical Water meters are classified according to the operating principle, type of end connections, the standard by which the same are covered, constructional features, method of coupling between the counter (register) and primary sensor, the metrological characteristics etc.

I. Classification as per the Operating Principle:

1. Semi positive / piston / volumetric Water Meter

A device fitted into a closed conduit which consists of chamber of known volume and a mechanism driven by the flow, whereby these chambers are successively filled with water and then emptied. By counting the number of these volumes passing through the device the indicating device totals the volume flow. These meters record practically down to zero flow of the water that has passed through with a small unavoidable leakage.

The sizes of the meter are from 15 mm to 100 mm as per ISO and from 15 mm to 150 mm as per BIS.

Advantages –

(i) Can measure almost down to zero flow i.e. most sensitive;
(ii) Available in class C and class D of ISO;
(iii) Useful as reference device;
(iv) Less sensitive to flow disturbances;
(v) No special installation conditions

Disadvantages –

(i) If the piston stops rotating, no water can pass through it;
(ii) Water need to be clear and free from solid dirt particles;
(iii) More number of component parts & difficult for maintenance once goes out of order;
(iv) Difficult to calibrate;
(v) Loss of pressure more than that of other types;
(vi) Cost is more than that of other type.

2 Inferential / velocity / Turbine Water meter

Meter which measures the velocity of flow from which the discharge is measured i.e. from the velocity of passing water the volume of flow is inferred.

These are further classified as:

A: Vane wheel or Fan type:

It is a device fitted into a closed conduit which consists of a moving set in motion directly by the velocity of the water flow. The movement of the moving element is transmitted by mechanical or other means to the indicating device, which totals the volume flow.

In this category, there are two types i.e. (a) single jet and (b) multi jet.

These are the devices consisting of a turbine rotors rotating about the axis perpendicular to flow of water in the meter.

The meter is called single jet, if the jet impinges at a single place on the rotor's periphery and a multi jet, if the jet impinges simultaneously at several points around the periphery of the rotor.

a) Single jet meters are manufactured in the seizes from 15 mm to 50 mm as per BIS and from 15 mm to 100 mm as per ISO.

Advantages:

i) Simple and less complicated mechanism;
ii) Low cost;
iii) Lesser number of component parts;
iv) Fairly good metrological characteristics;
v) Less loss of pressure

Disadvantages:

i) Sensitive to flow disturbance i.e. it needs sufficient upstream / downstream straight pipe length;
ii) No external regulator hence specialized calibration is necessary;
iii) Suitable for horizontal installation

b) Multi jet meters are manufactured in sizes from 15 mm to 300 mm as per BIS and from 15 mm to 100 mm as per ISO.

Advantages:

i) Fairly good metrological characteristic;
ii) Less sensitive to flow disturbances;
iii) Less stringent installation requirements i.e. horizontal and vertical installation are possible;
iv) Can sustain hostile flow condition without major damages;

v) Easy for maintenance;
vi) Easy calibration due to external regulator

Disadvantages:

i) More pressure loss than that of single jet type;
ii) More costlier than that of single jet

B: Woltmann or Helical Type Water Meter

It is a device consisting of Helical blades which rotate about the axis of flow in the meter, manufactured in the sizes ranging from 50 mm to 500 mm as per BIS and from 50 mm to 800 mm as per ISO.

These are classified into two types – (a) Horizontal helix type, (b) Vertical helix type

Advantages:

i) Good metrological characteristics;
ii) Low pressure loss than that of vane type;
iii) Robust construction;
iv) External and internal regulators for calibration;
v) Removable mechanism version is available;
vi) Easy maintenance;
vii) Suitable for large flows

Disadvantages:

i) Required sufficient approach length of pipe;
ii) Limited to higher flow measurement;
iii) These are not available in metrological classes in BIS

II. Classification according to constructional features

This classification is as follows:

1. Wet dial water meter

Complete counter unit in contact with water flowing through the meter.

Advantages:

i) Negligible friction due to absence of bush and hence more sensitive;
ii) Robust design;

iii) Always non magnetic and hence no chance of tampering by external magnetic field

Disadvantages:

i) Suitable for clear water only;
ii) Turbid water may damage the meter;
iii) High cost;
iv) Requires specialized repairs

2. Dry dial water meter

Counter mechanism isolated from the water flowing through the meter.

Advantages:

i) It can be used with slightly turbid water;
ii) Easy to read;
iii) Easy to maintain;
iv) Low cost

Disadvantages:

i) Moisture condensation, bush leakage etc. may have consequential problems in registers not sealed hermetically;
ii) Delicate and weak design possibility

3. Mechanically coupled water meter

Movement of the moving element transmitted to the indicating device by direct mechanical link.

Advantages:

i) Suitable performance over a period;
ii) Accuracy is not affected by external magnetic field.

Disadvantages:

i) Due to bush friction these are available in Class A only;
ii) Out of order meter has to be removed from the connection immediately to avoid further damage to component parts;
iii) Bush leak problems are likely to be encountered;
iv) Condensation of water inside the glass cover requires wiper to wipe the condensation. This arrangement increases the chances of tampering;

v) Air escape hole provided to cap / cover may allow ingress of dust and dirt during monsoon when the meter may be submerged in water

4. Magnetically coupled water meter

Meter in which the movement of the moving element is transmitted to the indicating device by magnetic coupling i.e. there is a physical isolation of the rotating element and the indicating device.

Advantages:

i) More sensitive and hence it is possible to manufacture in all classes of metrological characteristics;
ii) No bush leak problems;
iii) Less affected in flow rate if the meter goes out of order due to impeller problems;
iv) No cumulative damage to other parts if out of order meter remains on connection;
v) Less number of components;
vi) Hermetically sealed register can be used which prevents condensation in the register glass;
vii) No wiper

Disadvantages:

i) Can be tampered by external magnetic field;
ii) Magnetic particles flowing with water can get attached to lower magnet and obstruct it's movement;
iii) Excessive heating of stagnant water in the meter in intermittent water supply system may damage the property of the magnet

5. Straight reading cyclometer type water meter

In this meter the volume is given by a line of adjunct digits appearing in one or more apertures. The lowest value decoder may have a continuous movement. These indicating devices are of digital type.

6. Multi pointer type (Analogue recorder) water meter

The volume of water is given by continuous movement of a) one or more pointers moving relative to graduated scale b) one or more circular scales or drums each passing pointer.

These indicating devices are of analogue type

7. Combination of cyclometer and pointer type water meter (Digital and analogue recorder)

In this type the volume is given by a combination of analogue and digital indicating devices

III. Classification according to material construction of water meter body

These are classified as follows:

a. Domestic water meters

In the Indian context the domestic type water meters are covered under IS779. These water meters are with connections with body made up of brass / bronze or non metallic like plastic.

b. Bulk water meters

The water meters covered by IS2373 are usually called as Bulk water meters. These meters are with flanged end connections and body is made up of cast or steel.

IV. Classification according to Metrological Characteristic.

The water meters are classified into clases A to D in ISO and A & B in BIS on the basis of minimum measurable flow Qmin and transitional flow Qt.

The accuracy of water meter is divided into two zones i.e.

(1) Lower measurable limit in which ±5% accuracy from minimum flow to transitional flow (exclusive) and
(2) Upper measurable limit in which ±2% accuracy from transitional flow (inclusive) to maximum flow.

In short for any particular size or capacity water meter the maximum and nominal flow remains same for all classes of water meter but minimum flow and transitional flow are changed according to the classes i.e. minimum flow range and transitional flow range are lowered while going from class A to Class D. As a result of it only semi positive meters are manufactured in class C and class D.

Description: Electrical and Electronic Watermeters

Other than mechanical following type of water meters are common in the market
1) Fluidic oscillator; and
2) Ultrasonic

1. Fluidic oscillator:

Principle of operation of fluidic oscillator water meter

In the patented chamber profiled flow creates oscillations which are detected by way of electrical current introduced due to magnetic field. The current is sensed by electrodes and calculations deduce the rate of oscillations and hence flow rate. These type of water meters are available from ½" to 56".

Advantages:

1) Robust and highly reliable, as there is no moving part;
2) Sustainable accuracy;
3) Linear and high accuracy characteristic;
4) Maintains performance for longer time as compare to mechanical meters;
5) Tolerance for passage of solids;
6) Does not register air;
7) Lower maintenance cost;
8) Approximate life span of 15 years as against mechanical meters' 6 years;
9) These are available in visual read and AMR version

Disadvantages:

1) Cost approximately 2½ times that of mechanical meters.

In view of above these meters have not been taken into consideration for recommendation.

2. Ultrasonic water meters

Works on the principle of transit time technique i.e. ultrasonic waves if directed with and against the direction of water flow there exist the difference of time which is related to the flow. Ultrasonic water meters are available in sizes ranging from 50 mm to 500 mm.

Advantages:

1) No moving parts and hence long life;
2) Good accuracy;
3) High tolerance for passage of solids;
4) Does not register air;
5) No head loss;
6) Tamper proof;
7) No requirement of Strainer;
8) Available with / without AMR

Disadvantages:

1) Only one manufacturer in India;
2) Does not work with high turbid water;
3) Requires reasonable straight approach pipe run;
4) Not available below size 50 mm

The cost of the water meters without considering AMR, accessories, installation etc. is as follows.

Sr. No.	Size	Qty.	Rate	Taxes + Duties @ 14%	Total Amount
1	50 mm	112	54450	7623	62073
2	80 mm	37	65450	9163	74613
3	100 mm	28	69850	9779	79629
4	150 mm	12	79750	11165	90915
5	200 mm	3	101750	14245	115995
6	300 mm	2	142450	19943	162393

Ultrasonic water meters have not been considered as a result of higher cost.

The recommendation of mechanical water meters is based on ISO4064-1995, though ISO 4064 has been revised in the year 2005, for the following reasons.

1) The transition period was till 30th April, 2009.
2) In India the water manufacturers still offering the product conforming to ISO 4064-1995 and not ISO 4064-2005

Taking into account the availability of water meters, it is recommended to install mechanical water meters considering cost reasonability and availability in the market.

APPENDIX B – WATER METER READING TECHNIQUE

Normally and except in some Urban Local Bodies (ULBs) where electronic, remote, or Automated Meter Reading (AMR) systems are in place, the water meter reading is usually done by meter readers visiting customers' premises and directly taking readings. Meter data could be captured in one of the following ways:

1. Manual entry into meter books;
2. Manual entry onto consumer cards;
3. Manual entry into portable HDET (Hand-held Data Entry Terminal) or recorders;
4. Direct electronic entry from meter registers (generally via. remote receptacles) either into portable data entry terminals or display units from which readings are downloaded into a billing computer;
5. Telemetry link, such as radio or telephone line for Automatic Meter Reading (AMR)

Recommended Technique

Though the remote meter reading system is considered superior to the manual meter reading system, it has not been recommended as a result of high cost. AMC recommends water meters with manual meter reading system.

APPENDIX C – SELECTION OF FLOW METERS

Following flow meters are normally being used in the market:

A . Differential Pressure/Head Flow meters

These flow meters work on the principle that when the flow is constricted the velocity energy of liquid increases at the expense of pressure energy if friction is neglected keeping total energy constant.

Advantages:

i. Can be used for all fluids except some exceptions;
ii. No moving parts;
iii. Flow rate, indication, integration can be obtained easily;
iv. Can be fitted in any configuration of pipeline;
v. Signal can be transmitted to long distance;
vi. Moderate cost;
vii. Fairly accurate;
viii. Good linearity;
ix. Suitable for extreme temperatures and pressures;
x. Calculation possibilities for unusual situations

Disadvantages:

i. Rangeability 4:1 due to square root scale;
ii. Energy cost in terms of head-loss except in point velocity measurement;
iii. Ideal conditions required for good accuracy;
iv. Suitable for above particular Reynold number;
v. Accuracy is in terms of span;
vi. Slope for impulse piping wherever applicable should be minimum 1: 10;
vii. Very long conditioning sections;
viii. Intensive maintenance;
ix. Edge sharpness of orifice plates must be assured

B Linear Flow meters

These flow meters give the linear scale as against the square root scale, which is in the case of differential pressure flow meters. As a result of the linear scale, the rangeability of minimum 10:1 can be obtained.

APPENDIX D – GENERAL SPECIFICATIONS FOR WATER METER

Water meters of sizes 15 mm to 40 mm

Inferential Dry Dial, multi jet, Screwed ends, magnetic drive conforming to ISO: 4064, Class 'B', pre-equipped with pulse emitter and necessary battery of life minimum 5 years for remote reading by Automatic Meter Reading – Radio Frequency technique. The meter shall be suitable for potable water having temperature upto 45^{o}C.

The meter assembly should be complete with:

1. Brass forged "Y" type strainer, screwed ends with S.S. mesh inside.
2. G.M. gate valve ISI marked screwed ends.
3. G.M. non-return valve, ISI marked, screwed ends.

Installation shall be as per IS specification including necessary elbows, Barrel Nipples etc.

Water meters of sizes 50 mm to 300 mm

Shall be Woltmann type, removable Mechanism (RM) full flow water meter, flanged ends, conforming to ISO: 4064 Class "B", pre-equipped with pulse emitter for remote reading

The meter assembly should be complete with:

1. Cast Iron sluice valve, ISI marked
2. Cast Iron Non returned Valve, ISI marked
3. Cast Iron strainer "T", flanged ends, drilled to match water meters with S.S. mesh inside.
4. M.S. Slip-on flanges as per IS : 1538 to match all above items

Installation shall be as per IS specification complete with Labour, Bolts, Nuts, Washers + Gasket etc.

APPENDIX E – GENERAL SPECIFICATIONS FOR FLOW METERS

1. ELECTROMAGNETIC FLOWMETER

A) Flow Sensor

Type	Pulse DC excitation
Power supply	240V AC, 50 Hz
End connection	CS Flanges
Flange rating	CS ANSI 150
Electrode	SS 316
Meter tube	SS 304
Liner	Neoprene / Hard rubber
Protection category	IP 68
Accuracy	± 0.5% of reading for velocity 0.5 m/s and above; and velocity < 0.5 m/s accuracy $\pm\frac{0.25}{V}$

B) Flow Transmitter / Converter

Type	Microprocessor based remote monitoring
Display	Two line backlit LCD for indication of actual flow rate, forward, reverse and sum totaliser.
Output	One current output (4-20 mA) One scalable pulse output One status output
Protection Category	IP 65
Programming	From front facia through keypad / optical pin programming
Power supply	240V AC, 50 Hz
Backup power	For 6 hours
Required mounting	Wall mounting
Maximum separation	Upto 200 m
Flow indicator totalizer	Internal 5 mm high LED display with 6 digit LCD / Electromechanical totalizer
Password protection	Required
Data downloading to PC/Laptop	Via. HART or Profi buscommunication

C) Remote Terminal Unit : On the principle of GSM connectivity complete with SIM CARD

2. ULTRASONIC FLOWMETER

A) Flow Sensor

Mounting	Field
Measuring principle	Transit time
No. of tracks	1 track for upto 600 mm 2 track for 700 mm to 1200 mm 4 track for above 1200 mm
Accuracy	± 0.5% of reading for velocity of 0.5 m/s and above; and $\pm\frac{0.25}{V}$ / for velocity less than 0.5 m/s
Water protection	IP 68
Design pressure	40 bar
Probe material	SS 316
Provision for online removal	Yes

B) Flow Transmitter

Type	Multichannel, indicating type having LCD display
Display	LCD, 2 line with 16 character
Multi-display	2 freely selectable values are displayed flow, quantity, flow velocity, speed of sound, ultrasonic amplitude, each individual track shall display velocity.
Power supply	240 V with battery backup of 6 hrs.
Output	Analague - 4 to 20 mA Pulse output - Yes Relay output - NC or NO
Weather protection	IP 65
Password protection	Required
Facility for online diagnosis	Required
Programming and keypad	By remote hand held communicator
Data downloading to PC/Laptop	Via.HART or profibus communication

3. CENTRAL STATION

Licensed SCADA software at 7 Nos. of locations complete with workstation with two printers at each location. Pentium based PC for operator cum Engineering station with 20" TFT display unit

with DVD, CD writer Drive, keyboard and mouse, 230 VAC 50 Hz. Speakers for providing system alarms. Complete with battery backup for 6 hours.

4. REMOTE TERMINAL UNIT

GSM modem (RTU) shall be provided at each flowmeter end through RS232 interface. The RTU shall capture data coming from flowmeter through this RS232 port in the form of ASCII strings. It shall add the data received to calculate cumulative flow. Store this data, if required and communicate the flow information to centralized place at regular intervals using SMS. The communication interval shall also be settable using SMS commands. It shall work using normal GSM SIM card.