

Government of Rajasthan

Public Health Engineering Department

BID DOCUMENT FOR

Providing, Laying, Jointing, Testing & Commissioning of pipe line for distribution system and rising main, Construction and Commissioning of Reservoirs & pumping system, Up-gradation and Improvement of Source and ancillary works with operation and maintenance of the system for 5 years in Bhiwadi

CONTRACT PACKAGE NO. : PHED/BHI/WS

SECTION VI

EMPLOYER’S REQUIREMENT

Section VI – EMPLOYER’S REQUIREMENTS

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TECHNICAL SPECIFICATIONS

A. STANDARD SPECIFICATIONS

Standard Specifications

The "Standard Specifications (Civil Works)" issued by the PHED (Public Health Engineering Department)/PWD (Public Works Department) Rajasthan, set out the specifications that shall be followed for construction of general civil works under the PHED. Specifications for additional specialized items of civil works, and/or for mechanical and electrical works, shall be as set out in Part B, Particular Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Specifications and the Particular Specifications, then the provisions of the Particular Specifications will prevail.

B. PARTICULAR SPECIFICATIONS

1.0 General

1.1 Govt. of Rajasthan has applied for a loan from the National Capital Region Planning Board (NCRPB) & KFW (Kreditanstalt für Wiederaufbau, Germany) for Upgradation and improvement in water supply of Bhiwadi town of Alwar district. Proceeds of this loan will be used for payments under this contract.

1.2 The Technical clearance of integrated project of UWSS Bhiwadi of estimated cost of Rs. 47.00 crores was issued by Technical Committee in its 575th meeting held on 09.04.2013. Technical Sanction of augmentation of water supply scheme of Bhiwadi under NCR funding of amounting to Rs. 40.69 crores, has been issued by Technical Committee in its 604th meeting held on 24.09.2014. Also, Technical sanction of construction/augmentation of source and operation & maintenances of Bhiwadi under NCR State Plan of amounting to Rs 11.57 crores has been issued by Technical Committee in its 605th meeting held on 01.10.2014.

2.0 Information about Bhiwadi:

2.1 Bhiwadi is a census town in Tijara tehsil of Alwar district of the Indian state of Rajasthan. Bhiwadi comes under Delhi NCR region and it is an industrial hub. It lies on Rajasthan-Haryana border and is adjacent to Dharuhera town and Rewari city of Haryana. Dharuhera and Bhiwadi together form one urban sprawl. It is 70km from New Delhi. Distance from Gurgaon to Bhiwadi is 49 km (30.00 miles). Bhiwadi is situated at 28.21°N, 76.87°E. It is 55 km away from the Indira Gandhi International Airport, New Delhi. 200 km from Jaipur, 90 km from Alwar, 40 km from Gurgaon and 60 km from Faridabad. It is reached by National Highway NH8 (Delhi-Jaipur highway) via Dharuhera that is 5 km away. It can also be reached by Gurgaon-Sohna-Taoru-Dharuhera road. Nearest railway station is in Rewari approximately 26 km.

3.0 System Description:

3.1 Water supply to Bhiwadi is entirely from groundwater sources due to the lack of dependable surface water sources in the city vicinity. Presently the water supply

of Bhiwadi is being operated and maintained by RHB (Rajasthan Housing Board), RIICO (Rajasthan State Industrial Development and Investment Corporation), UIT (Urban Improvement Trust) and PHED in their respective areas.

The reorganization of water supply scheme Bhiwadi is being proposed in this package which includes the works of construction of new elevated reservoirs, clear water reservoirs, pumping stations, rejuvenation-strengthening and improvement of distribution pipelines, etc.

4.0 Description of Work:

- a. The city Bhiwadi is divided into 22 water supply zones. The source for water supply is tube wells located in the city and near by potential areas. Water is supplied to the public through OHSR & GLSR and by direct boosting from pump house and from tube wells. Distribution system present in Bhiwadi city in some part of the city is very old and of improper size which also results in low pressures at tail ends. There are some areas in Bhiwadi city which are facing repeated pollution problem because of leaking distribution pipe lines. Most zones receive 1-2 hours of water supply per day –however, dependent on the availability / yield of water from the localized production system.
- b. To augment the water supply system it is proposed to divide city in 22 distribution zones by constructing new OHSRs. To increase the storage capacity 18 new OHSRs (including two at hillock) and 16 new CWRs are also proposed. Rising mains to be laid under this project to fill new proposed OHSRs and for transfer of water. Laying of proper distribution system in zones is also proposed. It is also proposed to replace heavily leaking pipe lines causing pollution problem. Some interconnection between new pipe line and old pipe line is also proposed and some disconnection to isolate zones with each other is also proposed. Shifting of domestic connection is also proposed where old pipe line is replaced.

5.0 Scope of Work:

5.1 Volume of Work

The contractor shall carryout all works wholly in accordance with the terms and conditions of the contract to fulfill all the requirements of the project and the tender documents. All the material used, and the equipment installed shall be as per the specifications defined in the contract and the work shall be executed with good engineering practices.

Generally the following activities shall be carried out for each component of this contract but shall not be limited to:

- i. Submission of all documents required according to the Contract (security money/guarantee, etc.).
- ii. Submission of Action Plan/Execution Schedule in accordance with the provisions of bid document for approval of the Project Manager.
- iii. Conducting topographic survey for work of pumping main and distribution mains, internal distribution of the town and index map of town. No extra payment against this item shall be paid to the contractor as this work is part of the pipeline item.

- iv. Topographic survey for preparation of town plan should indicate details of mohallas, roads, locations of existing utilities i.e. GLR, Hand Pump, water pipelines, schools, temples, Govt. buildings, important land marks etc. and important levels with respect to pump houses. Survey of town shall be conducted by DGPS (or any other equivalent device) and KML/KMZ files shall be prepared and submitted for approval to the Project manager. The contractor shall then prepare and submit design of distribution system inside the town with the requirement of minimum terminal pressure of 12 m as per norms of CPHEEO manual, at the outlet of the highest point in the distribution system. The department may check the levels and distances submitted by the contractor and the contractor shall be fully responsible for the correctness of the levels and distances. The contractor shall lay the pipeline of diameter and lengths inside the town as per approved design by the department and directions of Project Manager.
- v. Submission of hydraulic calculations for the design of rising, distribution mains and internal distribution of the town. Although, Department has surveyed and designed the whole system, copy of which will be provided to the contractor but, the contractor must redesign the system under guidance of Project manager.
- vi. If, at any point of time, L-section with plan or without plan is required for getting approvals from various other agencies then, it is responsibility of the contractor to prepare the same at no extra cost.
- vii. To distribute the water received at various CWRs upto the consumer points. Contractor is to take care of outer colonies at the boundary of towns which will be developed in future.
- viii. Conducting required investigations to confirm that the provisions of system proposed are sufficient to fulfill the required objectives of the work so that the water, to fulfill the design demand of the town, can be delivered in an efficient manner with losses within permissible limits. For this, the contractor shall carry out the required designs to verify the design provisions given by the department. If, the provisions envisaged by the department are considered to be inadequate, the Contractor shall provide additional facilities / systems, and may change the hydraulic design i.e., staging and levels of reservoirs, pump heads, diameter of pipelines, etc. so that the objective of delivery of designed demand in respective villages and towns is achieved. No additional payment on account of providing such additional facilities / systems shall be made except for change in diameters and lengths of pipelines.
- ix. Conducting required soil/strata investigations and necessary soil treatment (if required) for the foundation of CWRs/Pump house/OHSRs and other civil works in all type of soil conditions. No additional payment will be given for this investigation work.
- x. The designs done by the department and the design data related to the pumping main and distribution main can be obtained from the office of Executive Engineer, NCR, PHED, Bhiwadi. The Contractor should make a note that all Data and designs available are Public Health Engineering Department's Concept, which are only for the purpose of information to the Contractor and will have no bearing on the contractual obligations. The Contractor will have a choice to make use of the data/designs etc. but the department does not take guarantee or responsibility of the data / designs/ drawings. The Contractor will be solely responsible for preparing and submitting

- required designs/drawings after carrying out appropriate field surveys, data collection, designs etc. for approval of Project Manager.
- xi. As the responsibility to supply the designed demand to the respective consumer of town is solely of the Contractor, the Contractor is required to review the design of the pipe network, the pumps etc. on his own and if required shall use the appropriate duty conditions of the pumps, use additional materials/equipment(s) so as to achieve the objectives of the work as defined in the above clauses.
 - xii. Getting approval of all QAPs, design and drawings, material to be used, equipment specifications and the samples prior to dispatching / installing /commissioning of work on site. Unless mentioned otherwise, if for any specific provision, references have been made in more than one specification, the provision more stringent and which complies with latest standards shall be applicable and the discrepancy shall be explained by the Project Manager whose decision shall be final.
 - xiii. Submission of the design/specifications, catalogs and the technical data sheets of all the equipment, electrical/ mechanical system, design of the electrical components, taking into account the interfaces to the other project components/packages and the future extensions of the project.
 - xiv. Preparation and submission of structural designs and reinforcement drawings for all civil structures of the work. The structural designs and drawings of SRs, CWRs and office building should be got checked from MNIT, Jaipur or BITS, Pilani or IIT, Delhi or any other institution approved by the Project Manager, prior to their submission. However, if there are more than one OHSRs of same capacity, and the SBC is same, then contractor may get checked and approved, design and drawing of only one OHSR of a particular capacity from above institutes. All expenses for this shall be borne by the contractor.
 - xv. All road cuttings and also their repair and restoration are in the scope of work of the contractor. The contractor is also to provide encasing of the pipeline in case of road crossing (WBM/tar/ concrete/stone slabs etc.) along with re-aligning, re-grading, strengthening and restoring damaged road section and associated lengths. For road crossings, the contractor himself shall contact the concerning department (PWD, etc) and obtain sanction to do the road cutting, crossing and repair of road-cutting. The repairing is to be done as per specifications of the concerning department, to their satisfaction. The maintenance of the repaired sections shall also be done by the contractor during one year defect liability period. The department may provide assistance, for obtaining road cutting permission, as demanded by the contractor, whenever required. All cost of cutting and repairing of all type of roads shall be born by the contractor. Department is only responsible for the permission fees of the concerning agency (capital works not included in the fees). The cost of shifting of electrical poles, transformers, etc., if any, shall be borne by the department. The contractor shall be solely responsible for any damage occurred to the telephone lines, OFC cables, cutting of trees, cables, distribution/rising water mains and gas pipes, drains while laying clear water pipeline, and shall be liable to pay the amount levied by respective department(s) for the repair and/ or damages so occurred.

- xvi. For maintaining the continuity of the laying, the contractor shall keep close liaison with the PWD, PHED & UIT or concern authorities for an early approval of crossing works.
- xvii. Preparation and submission of all detailed working drawings on the basis of conceptual designs and plans approved by the Project manager.
- xviii. To co-ordinate with the O&M staff and concerned officers of PHED, PWD, Forest, Mining, Railway, electric supply company, UIT and personnel of local water supply system (for carrying out the installation of new equipment), with the district administrative offices and other offices for necessary approvals and certificates.
- xix. Construction of new source (TW) and augmentation/development of existing Tube Wells.
- xx. Manufacturing, shop testing, pre-dispatch inspection, transportation to site, providing transit insurance, storage, handling at site, installation, sectional testing, pre-commissioning testing, commissioning and trial runs for all components of the system and the system as a whole, including the hydraulic, mechanical, electrical, Electro-Mechanical and instrumentation equipment.
- xxi. Various inter connections of the different dia pipelines at different locations in the town for which no additional payment shall be given as this item is included in the item of pipeline.
- xxii. It is responsibility of the contractor to provide consumer connections to existing consumers including supply and fixing of all materials including saddle piece, ferrule, various GI and MDPE specials, GI and MDPE pipes, water meters etc. The scope under this item shall be upto the GI pipe nipple after water meter.
- xxiii. It is responsibility of the contractor to take monthly reading of these consumer water meters in defect liability period as well as in O&M period.
- xxiv. To prepare the consumer water bills monthly (commercial) and bimonthly (domestic) as per different circulars of PHED and circulate these bills to the consumers upto 5th day of every billing month.
- xxv. Construction of all buildings and water retaining structures, chambers, thrust blocks, anchor blocks, saddle supports and other civil and engineering structures.
- xxvi. Ancillary Civil works, campus development and Buildings as defined herein after
- xxvii. Construction, testing & commissioning of all civil works as per scope of work, approved drawings & detailed specifications.
- xxviii. The submission of the as-built drawings of the works is the precondition for the final payment of execution part. The final drawings shall be submitted in 5 copies on linen bound in an album of an approved size. The contractor shall submit all the completion drawings and approved design calculations on CD ROM / DVD in two copies with proper directory structure. The maps of all villages and towns with details of pipeline network are supposed to be uploaded on the dept web site (GIS mapping).
- xxix. Marking of assets on GIS Platform - The contractor shall submit geo-referenced AUTOCAD drawings for the complete pipeline network laid under the contract.

Location of all valves and Tees, bends, junctions and joints of change in alignment of pipeline shall be determined using differential GPS of 0.6 m accuracy or better. Attributes of pipeline, like diameter, material, class etc shall be linked with GIS.

- xxx. Operation, routine & preventive maintenance, maintenance and repairs of the complete system for 5 years excluding defect liability period of 1 year, starting from the date as defined in Volume I of bid document, in Special Conditions of contract.

5.2 Major Components of the work

5.2.1 Over Head Service Reservoirs:

The work as described under this contract shall include:

- (i) Conducting the soil investigation for the sites.
- (ii) Preparation of layout plan for the site establishment and work program.
- (iii) Construction of 18 nos. Overhead Service Reservoirs (including two GLSR at hillocks) including related earthwork, construction of foundations, etc. as per design and construction drawings showing detailed reinforcement details and sizes. However, for information of Bidders, general arrangement drawings are included in the Tender documents and these drawings are only for tender purpose.
- (iv) Supply and installation of double flanged CI/DI pipes for inlet, outlet, and washout (scour) and overflow (upto bottom of OHSR) with specials.
- (v) Providing, Laying & jointing of all inter-connecting pipeline of inlet & out let CI/DI double flanged pipes, within the campus boundary of the head works for OHSRs. Payment of construction of boundary wall is not included in the item rate of construction of OHSR. The pipe sizes shall be corresponding to the incoming or outgoing pipes as the case may be.
- (vi) Providing & installation of two sluice valve on out let, one sluice valve each on inlet, washout pipe for each reservoir. The sizes of the valves shall be equal to that of the main on which they are to be installed.
- (vii) The overflow pipe shall be connected to the distribution pipeline.
- (viii) Providing scour / washout pipes including P/F of sluice valve as shown in drawing of GA of OHSR.
- (ix) Providing a bye-pass arrangement to connect the incoming rising main to the outgoing distribution line for town so as to enable supply to the town through direct pumping in case of shut down of OHSR.
- (x) Providing lightning arrester on the top of OHSR.
- (xi) Providing ventilation for the reservoir as per the specifications given in the chapter of "Specifications for Civil Works".
- (xii) Providing 25mm diameter GI pipe (Class B) in two rows in 50x50x6mm angle iron railing along the top of reservoir, on the sides of the staircase and balcony, and at other suitable points for the requirement of safety of maintenance and execution staff.

- (xiii) All the surfaces of the structure below ground level shall be painted with two coats of epoxy paint conforming to respective Indian Standards. The paint in contact with the stored water shall be conforming to the standards of non – toxic paint suitable to be used in potable water supply systems.
- (xiv) The inside bottom surface of the Top Dome shall be painted with two coats of suitable anti-corrosive food-grade epoxy coating (two build). Similarly the inside of the vertical wall shall also be painted with the same from its top to 1 m below FSL.
- (xv) The outer top surface of top dome shall be painted with suitable anti-carbonation paint.
- (xvi) Colour washing using cement paint of approved make & quality as per specifications.
- (xvii) Painting the metallic surface & putting slogan on tank as per specifications.
- (xviii) A store room shall be constructed below OHSR having floor level 15 cm above F.G.L & ceiling height not less than 2.75 mt. as shown in drawing & as per direction of Project Manager. This item is included in the item rate of the construction of OHSR.
- (xix) First landing of the stairs of the OHSR shall be from the inside of the store room so as to prevent unauthorised entry to the top of the OHSR. A man hole of minimum 800 mm X 800 mm size shall be provided on the roof of the store room to access to the top of the OHSR. 75X75X6 mm angle iron frame and 3 mm thick iron plate with locking arrangement shall be used for this purpose.
- (xx) Providing float valve with auxiliary float in each OSHR. The size of float valve shall be same as of Inlet pipe. The pressure rating of valve should be in accordance to the designed maximum pressure.
- (xxi) Providing and fixing PVC/ G.I. water bars at construction joints.
- (xxii) Providing and fixing of outlet, inlet, washout and overflow pipes (flanged) along with specials, puddle collars and other related work, etc. complete for all Service Reservoirs and testing of the same.
- (xxiii) Supplying and fixing of valves, dismantling joints, level indicator, strainer and other necessary fixtures as shown in drawing.
- (xxiv) Each Service Reservoir shall also be provided with staircase, ladders, ventilators, lightening arrester, G I railing, manhole cover with frame, etc. as required for completing the same in all respects.
- (xxv) Inlet pipe of Service Reservoirs will be connected to the Inlet main.
- (xxvi) Outlet pipe of Service Reservoir shall be connected to distribution main.
- (xxvii) After construction of each Service Reservoir, it shall be tested for its water tightness as per the procedure given in the specifications. In case leakages are observed, appropriate rectification measures should be carried out to arrest the same, as per specifications.
- (xxviii) The scope of work also includes Cleaning, washing and disinfection of inside of

Service Reservoir making it free from any foreign matter, loose particles, debris, etc. and making it suitable for storage of potable water, commissioning and handing over the Service Reservoirs and piping works with all other items included in the scope of work as described. Any statutory and other clearances and or approvals that may be required to complete the work are covered under the scope.

- (xxix) The Contractor shall arrange for electricity and water requirements at his own.
- (xxx) Construction of plinth protection.
- (xxxi) Shifting of existing pipe line, pole (RSJ/Concrete) carrying HT/LT lines with all accessories, shifting of existing telephone poles and cables, if any, for which no separate payment will be made to the contractor..
- (xxxii) Final clearance of site before handing over the work, including leveling of earth and disposal of surplus earth as per directions of the Project Manager.
- (xxxiii) Preparation and submission of structural designs and reinforcement drawings for all civil structures of the work. The structural designs and drawings of SRs, CWRs and Pump Houses shall be got checked from MNIT, Jaipur or BITS, Pilani or IIT, Delhi or any other institution approved by the Project Manager, prior to their submission. However, if there are more than one OHSRs of same capacity, and the SBC is same, then contractor may get checked and approved, design and drawing of only one OHSR of a particular capacity from above institutes. All expenses for this shall be borne by the contractor.
- (xxxiv) Submission of “As built drawings”
- (xxxv) Rectification of defects/ leakages observed during defect notice period.
- (xxxvi) No separate payment will be made for the reconnaissance survey, laboratory test, factory and performance tests, testing and commissioning, etc. unless they are specifically provided and quantified in the bills of quantities. This shall be included in the rates and prices of the physical works itemized and quantified in the bill of quantities.

Following Over Head Service Reservoirs are proposed to be constructed under this contract:-

S.N.	Location	Capacity & Staging
1	Mundana Meo	700 KL, 21 Mtr
2	Shahdod	400 KL, 21 Mtr
3	Santhalka	1300 KL, 24 Mtr
4	Harchandpur	950 KL, 21 Mtr
5	Khijarpur	120 KL, 21 Mtr

S.N.	Location	Capacity & Staging
6	Beelaheedi	300 KL, 21 Mtr
7	Godhan	220 KL, 21 Mtr
8	Kehrani	580 KL, 21 Mtr
9	Khijuriwas	740 KL, 21 Mtr
10	Udaipur	840 KL, 21 Mtr
11	Khanpur	400 KL, 21 Mtr
12	Milakpur Gurjar	1150 KL, 21 Mtr
13	Bhiwadi	1800 KL, 24 Mtr
14	Nangaliya	1660 KL, 21 Mtr
15	Saidpur	790 KL, 21 Mtr
16	Housing Board sector 1,2,3	560 KL, 21 Mtr

Following Hillock Service Reservoirs are proposed to be constructed under this contract:-

S.N.	Location	Capacity & Staging
1	Rampura	500 KL
2	Ghatal	1300 KL

5.2.2 Clear Water Reservoirs

1. Following Clear Water Reservoirs are proposed to be constructed under this contract as per drawings enclosed:-

S.No.	Location	Capacity (in KL)
1.	Santhalka	1000
2.	Harchandpur	710
3.	Khijuriwas	630

S.No.	Location	Capacity (in KL)
4.	Milakpur Gurjar	860
5.	Bhiwadi	1370
6.	Nangalia	1250
7.	Saidpur	600
8.	Bhagatsingh Colony	880
9.	Mundana Meo	530
10.	Rampura	380
11.	Beelahedi	230
12.	Kahrani	440
13.	Khanpur	400
14.	Ghatal	980
15.	Housing board 1,2,3	420
16.	Udaipur	630

2. The CWR bottom shall be kept at least 1.0 meters below finished ground level. Suitable ventilation shall be provided in the CWR roof at appropriate location and all opening of CWR shall be kept covered and lockable. The ventilators shall be provided with MS grill and stainless steel wire gauge net, to prevent dust entering in CWR.
3. At least one RCC stairs shall be provided for access to CWR floor. The CWR shall be provided with a float operated level indicator with gauge standing along the vertical wall. A wash out of minimum 100 mm and an overflow (size of overflow shall be one size higher than inlet dia.) shall be provided. The wash water pipe and the overflow pipe shall be taken up to a chamber through which it shall be connected to the campus drainage system as per site given by Project Manager.
4. The works detailed below includes providing and installation of material unless otherwise mentioned. MS pipes used for the works detailed below shall have minimum 6.3 mm thickness and shall be internally and externally coated as per specifications.
5. Providing puddle collar, 90 degree bend, duck foot bend, flanged CI/DI/MS pipes connecting bend and duck foot bend, pipe connecting duck foot bend and the collecting chamber suitably placed in campus of suitable size.

6. Providing puddle collar, sluice valves with necessary CI/DI/MS pipes for washout. The wash pipe shall be connected to the collecting chamber.
7. Construction of collecting chamber of suitable size with free fall from washout and overflow pipe, with ferro concrete covers and MS ladder for access to floor.
8. Providing puddle collar of adequate size at the bottom of the reservoirs in a sump of reservoir for out let. Connection of the outlet puddle flange to the MS suction headers of pump houses, with sluice valve. The main suction header size shall be designed as per requirements given in chapter "Specifications for pumping station".
9. The over flow pipe shall have bell mouth with stainless steel wire mesh at inlet.
10. For payment purpose, scope of work for this item of construction of CWR will be upto flange at a distance of 0.5 m from the outlet chamber.

5.2.3 Construction of Source and development of existing tubewells

The contractor is required to undertake following work for tube well:

The work of construction & commissioning of 75 nos tube wells along with suitable duty condition pumping machinery, electrical panels, piping, valves, meters, bulk water meter etc.

The work of augmentation and development of 54 nos. existing tube wells along with suitable duty condition pumping machinery, electrical panels, piping, valves, meters, bulk water meter etc.

The works proposed under this contract includes the following:

Drilling (for new TWs), lowering of pipe assembly, developing, testing with pump using generator, vertically test of tube well and commissioning of tube well.

Supply, installation, testing and commissioning of submersible pump sets including GI riser pipes 75 mm dia, valves, specials, pressure gauges, cable and flow meters of specified makes as per specifications and as indicated in the drawings and 'G' schedule.

Supply, installation, testing and commissioning of electrical system including providing & installing 40 mm dia GI pipe class-A from electrical pole to panel & panel to tube well cover plate. Power connection at the tube well shall be applied by department and the demand note shall also be deposited by department. The contractor shall, however, do the necessary liaisoning with the electricity department so as to get the connection released at the earliest. The power bills raised thereafter shall be deposited by the department.

Providing, laying and jointing of rising line included in 'H' schedule and commissioning of the system as a whole and joining the system with pipeline/rising main to enable delivery of water at CWRs/ SRs/ consumers. The work shall be treated as completed only when the tube well has been connected with the pipe network after laying required rising line.

In case of failure of tube well, the payment of drilling charges shall be made to the contractor. The decision of project manager with consultation of hydro-geologist shall be final regarding failure of tube well.

Though, the work has been defined in the detailed specifications, drawings and BOQ, the contractor shall prepare a list of all the materials for drilling of tube wells, mechanical and

electrical items pipelines along with a procurement plan well in advance and get approval from Project Manager.

The sequence and prorata progress to be achieved by the contractor in execution of each item of work have been defined earlier. The contractor shall incorporate all scheduling of work keeping in mind the progress required for all the items in the work plan.

The rig to be used for drilling will be of following types:

- Rotary rig suitable to drill bores up to 445 mm diameter in alluvial sediment of any formation
- Down the hole hammer (dth) rig capable of drilling 200 mm diameter bores in rock and repetitive strata upto 300 mts depth
- Or a combination rig of adequate capacity to drill bores of above sizes both in alluvium or rock and boulders up to depth of 300mtr

The following shall be submitted for approval to Project Manager -

- Drawings and data sheet of pumps, dual plate check valves and electrical panels to be procured for use in the contract
- Time schedule of execution for approval of Project Manager
- Strata chart, assembly chart, head discharge efficiency table / curve of pumping set, circuit diagram of electrical system shall be submitted by the contractor at the time of payment.
- Hidden erection item shall be witnessed by site in charge concerned.

5.2.4 Work of pipeline :

- a. All pipes and specials shall be provided by the Contractor. The work (for payment purpose also) includes approval of vendor and QAP, inspection & testing at manufacturer's works, packing, transportation, supply of pipes, as per specifications, along with all types of specials and other material to be used, Stacking and/or storage of material, re-handling, excavation of trenches, laying and jointing of the pipes as per approved L-section, construction of thrust blocks and pedestals/anchor blocks for pipe support to lay pipes above/below ground or by excavation, as per specifications, and carry out sectional testing, pre-commissioning checks, full commissioning tests and trial runs. For calculation of pipe length for payment purposes, the laying length of sluice valve & dismantling joints and any other length of pipe in scope of work of items other than pipeline shall be deducted from overall length, as the same are being paid separately.
- b. All specials like bends, tees, reducers, dismantling joints, rubber rings, flanges, gaskets, nuts & bolts, rubber sheets, etc to be used in the laying and jointing of all types of pipes shall be supplied by the contractor as per given specifications.
- c. The diameter of pipe, the approximate lengths for the distribution system can be seen from the drawings given with this section. The contractor has to re-design all pipelines based on survey conducted by his own team. Therefore, quantities of

various sizes of pipelines may vary. The contractor can propose changes in the design which the Project Manager would review and approve if found feasible.

- d. Pipe shall be laid along the roads, as far as possible on the outer edge of the road boundary. Expenses on account of any damages to private/govt. property during laying of pipes shall be borne by the contractor. The grade (i.e. L-section) in which the pipe shall be laid shall be got approved by the department.
- e. The slopes required shall be such that in normal conditions, the cover over the laid pipe is not being more than 2.0 meters. The clear cover should be minimum 0.9 meters.
- f. Submission of vendor credentials for approval of the department and submission of QAP thereafter.
- g. Procurement and supply of pipes after pre-dispatch inspection by Project Manager or his authorized engineer or Third Party.
- h. Procurement and supply of required specials after pre-dispatch inspection by Project Manager or his authorized engineer or Third Party
- i. Submission of L-section and plan (if required) for approval of Project Manager prior to commencement of work and after approval, take up the work and submit as-built drawings after final laying and testing of pipeline.
- j. Setting of works, laying and jointing of pipes and pipe appurtenances at required levels. The pipeline alignment in general shall be kept on the outer edge of the existing / proposed road boundaries. Wherever this is not possible, on approval of Project Manager, the pipe can be laid near the road or within the carriageway. No extra payment shall be made on account of additional excavation required for placing pipes further away from the road centres. No additional payment shall be made for excavation of road surface or any other strata for the approved pipe alignment. The alignment approved by the Project Manager shall be final and binding to the contractor.
- k. Cutting and repairing of roads during laying of pipelines. The item of cutting and repairing of roads is to be paid extra as per BOQ.
- l. Providing, installation and testing of on-line sluice valves, of the same diameter as that of pipeline, at all junction points or as per direction of Project Manager, on all branch pipes. All valves to be installed at a particular junction may be housed in one RCC chamber of appropriate size, the drawing of which shall be got approved by the Project Manager.
- m. The pressure rating of valves shall be as per the design pressure at the point of installation but not less than PN 1.0.
- n. Providing, Installation and testing of Kinetic Air Valves with Isolating sluice valves, on all rising mains, at an average spacing of 2000 meters, of adequate pressure rating. The air valves shall be provided at convexities of water mains as per L-section. Additional air valves shall have to be provided if there is any significant peak or change in gradient, in between two valves placed at above stipulated distance. Air Valves shall be placed in RCC chamber of suitable size, with CI rungs for access to the valve chamber, door with locking facility, and other facilities shown in tender

drawing. The wall, roof and other structural members of the chambers shall be constructed as per design, which shall be got approved from the Project Manager. The size of Kinetic Air valves shall be governed by the size of pipeline as under:

S. No	Nominal dia. of pipeline	Size of Air valve
1	Up to 200 mm	50 mm
2	Above 200 mm	80 mm

- o. Providing, testing and installing all materials such as bends, tees, reducers, dismantling joints, rubber rings, flanges, nuts & bolts, rubber sheets etc. of required specifications for the installations. All specials shall be of CI / DI/uPVC/Mild steel as per the requirements of site conditions desired at the point of installation as per hydraulic considerations.
- p. Construction of required structures to cross drains, nallah, ravines etc. Providing U/s and D/S cut-off walls with apron, retaining walls etc. for protection of foundation footings of pedestals from erosion due to flowing nallah or drains of ravines or in front of a road culvert etc., where the soil cover may erode due to flow.
- q. Providing anchor blocks where necessary.
- r. Providing support structures such as saddles, etc. for the pipe laid above ground.
- s. Providing thrust blocks at vertical and horizontal bends, for the combination of loads as per site conditions. Thrust blocks shall be provided at all locations for deflections exceeding 4 degrees in vertical/ horizontal alignment. The permissible deflection in each pipe length shall be as per the provisions of relevant standards. No reinforcement is required for thrust blocks to be provided for pipelines of diameters 150 mm and below.
- t. Providing gradient blocks for pipes laid in steep slopes as detailed in specifications/relevant IS code.
- u. Providing a dismantling pipe with flexible joints or dismantling joint with each sluice valve for easy maintenance.
- v. Providing sand cushion of 200 mm thickness below uPVC pipes as per given specifications. For sand cushion, excavated sand can be used after passing it through an adequate size sieve so as to make it free of stones, sharp-edged pebbles and kankars, etc.
- w. Any damage caused while laying, testing, and commissioning or during execution, to the roads; properties etc. shall be got repaired by the contractor at no additional cost to the department.
- x. For the length of pipe laid along nallah/river, a retaining wall up to scour depth or minimum 1 meter in area with rock formation & 2 meters in area of soil formations, below existing nallah/river bed, whichever is more, shall be provided by the contractor with no extra cost.

- y. Submission of Surge analysis (agency to be got approved from Project Manager) for pumping mains and providing required surge protection systems/additional equipment(s) as per the requirement of the design, in addition to the proposed kinetic air valves (the KAV shall not included in the analysis).
- a) Following rising mains to be laid under this project to fill new proposed OHSRs and transfer of water between pump houses. Details of rising pipe line to be laid are as follows:-

S.No.	Type of Pipe & Size	Length in Mtr
1	DI K-7 Dia 100mm	11259
2	DI K-7 Dia 150mm	6837
3	DI K-7 Dia 200mm	2457
4	DI K-7 Dia 250mm	623
5	DI K-7 Dia 300 mm	60

Distribution System:

The distribution system for Bhiwadi consists of laying of network of uPVC and D.I. pipes as per drawings provided in 22 zones each having its own OHSR/GLSRs. The network of pipelines has sizes varying from 90mm to 315mm pipes of uPVC class-3 and DI pipe line for road crossings or nallah crossings. The distribution system network includes excavation and refilling of trenches in all type of soil, providing, laying, jointing, testing and commissioning of pipelines with all required specials, fittings, shifting of consumer connections. Also, connect the existing useful pipelines with the new pipelines and disconnecting the existing pipelines wherever they are not required or zones to be separated. Also the cutting and reinstatement of roads to the original condition wherever new pipelines have been laid.

Total length of distribution system to be laid:

S.No.	Type of Pipe & Size	Length in Mtr
1	DI K-7 Dia 100mm	13951
2	DI K-7 Dia 150mm	1363
3	DI K-7 Dia 200mm	1279
4	DI K-7 Dia 250mm	345
5	DI K-7 Dia 300mm	495
6	Upvc class 3 Dia 90mm	44530

S.No.	Type of Pipe & Size	Length in Mtr
7	Upvc class 3 Dia 110mm	6050
8	Upvc class 3 Dia 125mm	3732
9	Upvc class 3 Dia 140mm	4405
10	Upvc class 3 Dia 160mm	3341
11	Upvc class 3 Dia 180mm	2560
12	Upvc class 3 Dia 200mm	1550
13	Upvc class 3 Dia 225mm	1686
14	Upvc class 3 Dia 250mm	603
15	Upvc class 3 Dia 280mm	2002
16	Upvc class 3 Dia 315mm	1231

5.2.5 Disconnection:

Disconnections are proposed to disconnecting the existing pipelines wherever they are not required or zones to be separated. For sizes equal to 200 mm or higher disconnection be done by installing sluice valve and for lower sizes disconnection be done by putting end plug in pipe line using CID joints.

5.2.6 Cutting and Restoration of roads:

It is responsibility of the contractor to :

- Identify the roads to be cut for laying of the pipeline.
- Apply to the concerning department for permission of road crossing/cutting and get permission letter for the road cutting/crossing after fulfilling the demand note/conditions of that department.
- Cutting of all type of roads, laying of pipeline, refilling of soil with ramming, sectional testing of the pipeline, repairing of the road to its original condition as per specification to the satisfaction of the Project Manager.
- Dispose of surplus material at suitable site as per direction of Project Manager.

5.2.7 Pump House:

The work of designing and constructing clear water pumping station, includes construction of the clear water pumping stations with providing and installing all mechanical, electrical and instrumentation plant and equipments, laying, jointing and

testing of the pipe systems within the limits of contract and commissioning of the pumping station.

Generally, the scope of work for construction of pump house & supply /installation of pumping machinery within the defined limits of contract is as listed below but not limited to:

- Construction of new pump houses as per the drawing enclosed.
- Preparation and submission of the layout plan, elevation and cross-sections for the buildings, structural design and drawings, foundations and associated civil and pipeline works.
- Verification of the proposed designs (pump discharge and head) according to the strategies and proposals of the department. Hydraulic system designs of the pumping stations and their equipment; electrical system design of the electrical components, taking into account the interfaces to the other project components, preparation and submission of layouts and cross sections of the proposed station, the equipment, the access roads, the cabling between the units etc. This design shall be approved by the Project Manager.
- Preparation of detailed designs and drawings of all civil works, mechanical, electrical, earthing, instrumentation and electro-mechanical equipment including architectural drawings on the basis of the approved system design, layout and arrangement. The Contractor shall be fully responsible for the technical suitability of the design based on the specifications, sound engineering practices, the relevant latest standard designs and IS provisions. These designs and drawings shall be submitted for approval to the Project Manager prior to commencement of the works.
- Structural design and reinforcement drawings for all structures of the Work shall be based on Geo-Tech investigation. The Contractor shall be fully responsible for the structural safety of the buildings.
- Preparation and submission of all detailed working drawings on the basis of designs and drawings approved by the Department.
- All types of excavation including cutting, grading and filling as required within the contract boundary up to the required levels, for foundation works and other ancillary works in all sorts of soil including back filling of trenches, reinstatement of works areas and disposal of surplus soil with in a lead specified by the Project Manager outside the campus etc.
- Construction of all buildings, chambers, boundary wall, internal roads, drains, plantation of trees in the headworks and other civil & electrical engineering structures.
- Manufacturing, shop testing, transportation to site, providing transit insurance, storage/handling at site installation and testing of all the hydraulic, mechanical, electrical, electro-mechanical equipment and instrumentation.
- Trial runs and testing of all the units and the complete plant, and commissioning as a whole working system. No separate payments will be made for the reconnaissance, survey, laboratory tests, design, drawings, factory and field

tests, inspections, testing, commissioning etc. They shall be included in the rates and prices of the physical works included in the Bill of quantities. The payments are to be made for all supplies and physical works described in these documents and according to the measured and agreed quantities executed.

- The clear water pumping stations shall consist of reinforced CC framed structures with plinth beam, housing the pumping sets and all the additional electrical and mechanical plant framed in the pump station system, including electrical power installation, as shown on the tender drawings. **While designing of the components of the pump house, the load due to mono rail hoist on the various components must be considered.** The details shown in the drawings are indicative only and shall be finalized based on the designs as per system requirement.
- Design and civil construction of 16 pumping stations along with other mandatory provisions at various pumping stations of following minimum plinth area (the area is the minimum requirement and may have to be increased to accommodate all pumps & equipment comfortably. No extra payment shall be made for increasing plinth area). Items executed will be paid as per BOQ.

SN	Name of PH	Minimum Plinth Area (SQM)
1.	Harchandpur (11.94 LPS, 32 m head)	40
2.	Santhalka (16.39 LPS, 35 m head)	40
3.	Udaipur (10.56 LPS, 32 m head)	24
4.	Khijuriwas (10.56 LPS, 32 m head)	24
5.	Milakpur Gujar (14.44 LPS, 32 m head)	40
6.	Bhagatsingh colony (14.72 LPS, 30 m head)	40
7.	Bhiwadi (22.50 LPS, 35 m head)	40
8.	Nagaliya (20.56 LPS, 32 m head)	40
9.	Saidpur (10.00 LPS, 32 m head)	24
10.	Rampura (6.39 LPS, 30 m head)	24
11.	Mundana meo (8.89 LPS, 35 m head)	24
12.	Beelahedi (3.89 LPS, 35 m head)	24
13.	Kehrani(7.50 LPS, 35 m head)	24

SN	Name of PH	Minimum Plinth Area (SQM)
14.	Khanpur (6.67 LPS, 35 m head)	24
15.	HB-1,2,3 (6.94 LPS, 30 m head)	40
16.	Ghatal (16.11 LPS, 30 m head)	24

- Supply & installation of Horizontal split casing pump sets / radially split multi-stage pump sets (pumps and motors) as detailed in bid document. The pumps selected should be as per latest circulars and directions of the department with regard to energy saving.
- Valves and operating mechanisms
- Interconnecting pipe work, specials and accessories
- Instruments and controls
- Flow metering equipment
- LT cables
- Earthing system for pump house
- Lifting/handling equipment and supporting structures
- Dewatering pump
- Ventilation systems for pump house.
- Internal and external lighting and small power installations
- All civil engineering works including plumbing up to termination points
- all covers and frames, railing, ladders, stairways, cable trays, supports and flooring etc
- The painting of all plant and equipment after erection

The pumping stations will pump water from the pumping stations to the elevated service reservoirs at different locations.

5.2.7.1 Installation of horizontal split casing centrifugal pumps using LT motors

The Pump sets (pumps and motors) of following duty conditions have been worked out by the department and shall be installed in a configuration given below:

SN	Particulars	Configuration (W+S)
(I)	At Pump House Santhalka H/W	
(i)	Providing 3 Centrifugal Pumps of 16.39 LPS/35m capacity	2+1

SN	Particulars	Configuration (W+S)
(II)	At Pump House Harchandpur H/W	
(i)	Providing 3 Centrifugal Pumps of 11.94 LPS/32 m capacity	2+1
(III)	At Pump House Khijuriwas H/W	
(i)	Providing 3 Centrifugal Pumps of 10.56 LPS/32 m capacity	2+1
(IV)	At Pump House Udaipur H/W	
(i)	Providing 3 Centrifugal Pumps of 10.56 LPS/32 m capacity	2+1
(V)	At Pump House Milakpur Gujar H/W	
(i)	Providing 3 Centrifugal Pumps of 14.44 LPS/32 m capacity	2+1
(VI)	At Pump House Bhiwadi H/W	
(i)	Providing 3 Centrifugal Pumps of 22.50 LPS/35 m capacity	2+1
(VII)	At Pump House Nagaliya H/W	
(i)	Providing 3 Centrifugal Pumps of 20.56 LPS/32 m capacity	2+1
(VIII)	At Pump House Saidpur H/W	
(i)	Providing 3 Centrifugal Pumps of 10.00 LPS/32 m capacity	2+1
(IX)	At Pump House UIT Sector 1 H/W	
(i)	Providing 3 Centrifugal Pumps of 9.72 LPS/30 m capacity	2+1
(X)	At Pump House UIT Sector 8 H/W	
(i)	Providing 3 Centrifugal Pumps of 15.83 LPS/30 m capacity	2+1
(XI)	At Pump House Bhagat singh coloni H/W	
(i)	Providing 3 Centrifugal Pumps of 14.72 LPS/30 m capacity	2+1
(XII)	At Pump House Rampura H/W	
(i)	Providing 3 Centrifugal Pumps of 6.39 LPS/30 m capacity	2+1
(XIII)	At Pump House Mundana Meo H/W	

SN	Particulars	Configuration (W+S)
(i)	Providing 3 Centrifugal Pumps of 8.89 LPS/35 m capacity	2+1
(XIV)	At Pump House Beelahedi H/W	
(i)	Providing 3 Centrifugal Pumps of 3.89 LPS/35 m capacity	2+1
(XV)	At Pump House Kehrani H/W	
(i)	Providing 3 Centrifugal Pumps of 7.50 LPS/35 m capacity	2+1
(XVI)	At Pump House Khanpur H/W	
(i)	Providing 3 Centrifugal Pumps of 6.67 LPS/35 m capacity	2+1
(XVII)	At Pump House HB 1, 2, 3 H/W	
(i)	Providing 3 Centrifugal Pumps of 6.94 LPS/30 m capacity	2+1
(XVIII)	At Pump House Ghatal H/W	
(i)	Providing 3 Centrifugal Pumps of 16.11 LPS/30 m capacity	2+1

The duty conditions given above are department's concept. The contractor shall verify them by his own survey and design and submit his own duty conditions for approval of the department. No extra payment shall be admissible for any change in duty conditions.

5.2.7.2 Pump Type

Single-stage / multi-stage, horizontal split casing centrifugal pumps or Radially Split Multi-stage pumps shall be installed. In case, HSC pumps are not available in the specific duty conditions, monoblock pumps may be approved by the Project Manager on the merit of the case. Preference shall be given to pumps of higher efficiency. For this purpose, please refer to clause no. 11.1.4 of CPHEEO's water supply manual for selection of pumps. The efficiency of pump should be as calculated from the Fig. 11.1 of the CPHEEO's water supply manual. Pump shall conform to specifications and standards furnished in specifications. **For pumps of 15 KW and below ratings, if synchronous speed of 1500 RPM is not available in approved makes then, synchronous speed of 3000 RPM may be considered.**

5.2.7.3 Pump Motor

All motors for pump shall be suitable for 0.415 kV, 3 phase, 50 Hz power supply. All motors shall be of suitable kW ratings and energy efficient. **The motors selected should be as per latest circulars and directions of the department with regard to energy saving.**

5.2.7.4 Suction and delivery system details

The suction and delivery piping systems in the pump house and from the clear water reservoirs shall be of MS pipes with welded bends and flanges for interconnections and

connections of the pumps and valves. The MS pipes (minimum thickness 6.3 mm) and specials used in the pump houses shall have food grade epoxy coating with primer on the inside surface and fibre-glass bituminous coating (Total thickness of 2.5 mm) on the outer surface, as per relevant standards. The size of the valves shall be same as that of piping and no reduction in the size of valves shall be allowed.

The suction lines of the pumps shall be connected to suction header. The suction header shall be connected to the flange of the sluice valve on the outlet of clear water reservoir. Each pump will have a manually operated sluice valve with a dismantling joint on suction side along with a compound gauge. On the delivery side, it will have a Dual plate check valve, one sluice valve, one butterfly valve with dismantling joints and a pressure gauge. On the common delivery header (of 2 pumps), a sluice valve with a dismantling joint, kinetic air valve, pressure sensor-transmitter and pressure switch, full bore electro-magnetic flow meter shall be provided. The flow meter and pressure sensor shall be provided inside the pump house, if feasible.

All delivery headers will be provided with adjustable pressure switch to switch off pumps near shut off head.

The sizes of the suction and delivery header pipes shall be designed by the contractor as per the prescribed velocity range and submit the same for approval of the department.

The reading of electromagnetic flow meters shall be required to be displayed in the control panel in addition to local display.

The diameter of pipe from CWR to main suction header, Main suction header, individual suction header, individual delivery header and common delivery header shall be designed on the basis of velocity as below:

SN	Section of pipeline	Maximum velocity allowed (m/sec)
1	Pipe from CWR to main suction header	1.6
2	Main suction header	0.5
3	Individual suction header	1.6
4	Delivery header	2.5

5.2.7.5 Chlorination System (For all pump houses)

At all PS, Electro-chlorinators, capable of chlorinating the water, in CWR, of full day demand, at required levels of liquid chlorine (2 PPM at Pumping Station), shall be provided. The system should be of continuous batch type. The system should be able to generate Sodium Hypochlorite from a solution of salt and water by electrolytic process using electrodes. For chlorination purpose, the contractor may suggest sodium hypochlorite dosing plant directly after the approval of the Project Manager. The system should include precision metering cum dosing pump to dose the Sodium Hypochlorite to meet the desired disinfection requirements. The system should be suitable to work on 3 phase, 410 V, 50Hz power supply. The system should also be protected for over-voltage and over-current.

For housing these chlorinators, chlorinator rooms of suitable size shall be constructed in the pump house building itself.

5.2.7.6 Fire Hydrant :

At all pumping stations, a 65 mm dia. Fire hydrant shall be provided. The connection of fire hydrant shall be done from the existing pumping main and also from distribution main (from OHSR). A sluice valve with dismantling joint and a 50 mm Bulk flow meter shall be installed at the connection point. A full way valve of 65 mm shall be installed at the outlet. The drawing of Fire Hydrant shall be got approved by the Project Manager.

5.2.7.7 Auxiliary equipment

a) Over Head traveling cranes/ mono rail hoist

Manually operated Mono-Rail Hoists of 1 MT capacity each shall be provided at all new constructed Pump Houses to handle the equipment including loading, unloading, installation and maintenance.

b) Drain sump pumps

Mono Submersible type dewatering pump (1 for each pumping station) with sump (1 cum per hour, 10 mt head) with level control switch to automatically switch-on the pump & all necessary electric accessories will be provided at all PS. The work also includes drainage piping up to nearest drain outside pump house building.

c) Ventilation

The ventilation system for the pump house and electrical switchgear panel room shall limit the temperature rise to a maximum of 5 Degrees Centigrade above the ambient temperature. The ambient temperature for the area is taken as 45 degrees Centigrade. Exhaust fans with G.I. cowls and bird screens will be provided for the exhaust of hot air.

5.2.7.8 Electrical system

The works component included are as defined below but shall not be limited to:

Providing & installation of main control panel for pumps with starter, required protection system such as motor protection relays and indicating meters such as voltmeter, ampere meter, multi-function meter, MCCB, cable & other accessories, etc complete.

The starters of motors of rating up to 22 KW shall be DOL starters. For motors above 22 KW to 50 KW, star delta starters shall be provided

Providing and installation of **APFC panels** in all PS.

Providing & installation of Energy Meters, to measure electrical power consumed, with each pump set.

Providing & installation of 0.44KV power cable. All cable shall be ISI marked and capable to take the starting current of motors.

Providing and installation of LV capacitor banks.

Panel for main lighting distribution board for pumping station building, outdoor lighting, building light and allied loads.

Providing exhaust fans for proper ventilation and maintenance of desired temperatures.

Cabling and ducting for entire electrical system.

Earthing and lightening protection system at relevant points.

Providing lighting fixtures along with cabling, distribution boards, switches and other accessories for indoor and outdoor areas of :

- All around the building outer area and the approaches from pump house.
- At respective pump/motor floor areas, switchgear rooms, control room, office areas, lobbies, staircase and other areas. The energy saving fixtures such as CFL shall be preferred to tube-lights, bulbs.

Providing Fire Extinguishers at places given in specifications.

Providing one first Aid kit for each PS.

Installation of lightening arrestor.

5.2.7.9 Lighting System

The lighting systems for the pump house shall be at normal 240 Volt A.C. Adequate lux levels shall be maintained as mentioned in the specifications.

5.2.8 Ancillary Civil Works

Following ancillary works are in the scope of this contract :

- (i) Construction of one office building of minimum plinth area of 280 SQM.
- (ii) Construction of one residence building for Executive Engineer of minimum plinth area of 150 SQM.
- (iii) Construction of three residence buildings for Assistant Engineer of minimum plinth area of 100 SQM.
- (iv) Campus development work at all pumping station sites.

The following works form the part of ancillary civil works at the headworks:

- Head works Development as detailed herein.
- Construction of boundary wall.
- Internal roads with drains at all pump houses.
- Electrification by providing poles and sodium / mercury lights along boundary wall, internal road and other important areas

The details of the works to be carried out are as following:

5.2.8.1 HEAD WORKS Development

The following works shall be taken up for all the head works :

- Preparatory works
- Survey of the Head Works campus at 0.5 m contour interval (vertical).
- Approval of developmental plans and landscaping and drawings
- Drainage plans & designs

- Other designs / plans required for campus area development

5.2.8.2 Work Components

The headworks site shall be suitably landscaped once the works are substantially completed. The landscaping scheme shall be submitted and got approved from Project Manager prior to start of actual work.

Landscaping shall include planting of suitable trees and development of grassed areas. Landscaping in general shall meet ecological and environmental conditions of site. Trees suitable for local conditions shall be selected.

For tree planting, pits dug a few days in advance of actual planting shall be allowed to weather and filled with top soil mixed with manure. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh shall be provided to protect the tree.

Construction of Boundary wall all along the acquired land with elevation, section and specifications as per drawing enclosed.

Leveling and grading of Head Works area

Providing minimum one main gate with guard hut.

Plantation of about 40 trees at each PS. These trees have to be developed for five years of O&M period and handed over to the department.

Providing internal roads with drains

Electrification of campus area - electric poles, etc

Pipe and piping work for potable water in campus area

Electrification all along the boundary, along internal roads, in gardens, at main gates with provision of ON-OFF switch operation, and in other operational & utility areas Providing drainage system.

Providing potable water supply facilities during execution and O&M period.

Providing sanitary arrangements including septic tank / soak pit and sewer with appurtenances for all the units within headworks.

5.2.8.3 Construction of Residential Buildings

Residential buildings as referred above shall be constructed at head works. The plan and elevation of the buildings to be constructed shall be as shown in drawing given in this document. The minimum plinth area of EE residence shall be 150 SQM and of AE residence shall be 100 SQM.

The contractor shall submit the detailed elevation & sectional drawings for the above buildings keeping the plan area not less than that shown above. The drawing shall also show all building details, details of materials, the electrical and sanitation drawing. The specifications of materials shall not be inferior to the minimum specifications defined in this bid document. The drawings shall be submitted for approval of Project Manager.

Public Health Engineering Department may allocate the existing buildings for use by the contractor as per possibilities only, but rent as per Government rule shall be charged during execution and O&M period.

Basic Amenities for office locations and residential quarters

The quarters to be constructed are also to be provided with basic facilities for:

- Providing safe drinking water facilities along with required pipe networking. The cost of providing water during execution period is to be borne by the contractor.
- Providing Electrical Connection from Electricity Company for individual unit. (cost of connection and power charges shall be paid by the respective user of the premises during O&M period). However, the contractor shall pay for electricity used by him during execution period.

5.2.8.3.1 TECHNICAL SPECIFICATION FOR RESEDENTIAL BUILDINGS

S. No.	Item	Office building	Staff Quarter
1	Base concrete for foundation	1:3:6, 10cm thick	1:3:6, 10cm thick
2	Masonry in foundation and plinth	RR stone masonry in CM 1:6	RR stone masonry in CM 1:6
3	Damp proof course	1:2:4 R.C.C.	1:2:4 R.C.C.
4	Superstructure	Brick Masonry in CM 1:6 23cm thick	Brick Masonry in CM 1:6 23cm thick
5	Lintels sun-shades etc.	R.C.C. lintels & sun shades as per approved drawing.	R.C.C. lintels & sun shades as per approved drawing.
6	Roofing	R.C.C. Roofing as per approved design with water proofing admixtures approved by Engg.-in-Charge.	R.C.C. Roofing as per approved design with water proofing admixtures approved by Engg.-in-Charge.
	Roof Treatment	As per approval of PROJECT MANAGER	As per approval of PROJECT MANAGER
7	Interior Finish (Cement Plaster)	20mm in cement plaster in CM 1:6	20mm in cement plaster in CM 1:6
8	Exterior Finish	20mm in cement plaster in CM 1:6	20mm in cement plaster in CM 1:6
9	Flooring		
A	With CC 1:3:6	Soling Stone or with 150 mm thick C.C. 1:3:6 base concrete	Soling Stone or with 150 mm thick C.C. 1:3:6 base concrete if not

S. No.	Item	Office building	Staff Quarter
	base	if not available	available
b	Finish	Kota Stone, Non-slippery ceramic tiles in toilets and kitchen	Kota Stone, Non-slippery ceramic tiles in toilets and kitchen
10	Skirting and dados	10 cm. Height of same material as used for floors & glazed ceramic tiles in toilets upto lintel level	10 cm. Height of same material as used for floors & glazed ceramic tiles in toilets upto lintel level
11	Windows (frame, panels, wiregauging, safety bars)	As decided by Project Manager	As decided by Project Manager
12	Doors (Frames and shutter)	Frame - pressed steel section Shutters - Flush door 35 mm as per specifications	Frame - pressed steel section Shutters - Flush door 35 mm as per specifications
13	White/ Colour/Cement lime/ Decorative Finish	As decided by Project Manager	As decided by Project Manager
14	Painting of doors, Windows and walls	Synthetic enamel paint	Synthetic enamel paint
15	Electrification (type of wiring, fittings and fixture)	PVC Conduit wiring as per approved drawing and specifications. 16 A and 6 A ampere switches shall be left as per requirements, in all room and main board with MCB's, kit-kat fuses, an electric meter, earthing protections and earthing system shall be installed for each unit.	PVC Conduit wiring as per approved drawing and specifications. 16 A and 6 A ampere switches shall be left as per requirements, in all room and main board with MCB's, kit-kat fuses, an electric meter, earthing protections and earthing system shall be installed for each unit.
16	Sanitary &		

S. No.	Item	Office building	Staff Quarter
	Water Supply		
	(I) European WC	In two toilets	In one toilet
	(I) Indian WC	In two toilets	In one toilet
	(A) Wash Basins	In every toilets and in launge	In every toilets and in launge
	(iv) Sinks	White glazed vitreous china	White glazed vitreous china
	(v) Other accessories	As per approved drawing	As per approved drawing
17	Other Specification	PVC frames & shutters in Bath rooms/Toilets	PVC frames & shutters in Bath rooms/Toilets
18	Special fitting and fixture		
A	Fans	In every Room	In every Room
B	Tubelight	In every Room	In every Room
C	Exhaust fans	Kitchen / Bathroom	Kitchen / Bathroom
D	Coolers	In bedRoom & drawing and lobby	In bedRoom & drawing and lobby

5.2.9 Providing and installation of Computers and printers :

- Providing 6 (six) nos. personal computers and 3 (three) nos. A-3 size colour printers is in the scope of this contract.
- Providing and installation of complete configuration computers with intel i7 processor, 8 GB RAM , 2TB HARD DISK (7200 RPM) , 23” LED monitor, 7.1 channel speaker & graphic card of 3 GB DDR-3 including HDMI support, Minimum 2 nos. USB 3.0 port, webcam etc having window-7 operating system with UPS (1 kva) including wi-fi modem, LAN card, antivirus with 3 years validity networking with other computers with wiring & data cable etc complete in all respect with 3 years maintenance.
- Providing and installation of A-3 size LaserJet, colour, internet compatible 3-in -one (Print, copy & scan) printer suitable for office work of standard make

(like HP, Samsung, canon etc.), minimum resolution of 1200x1200 dpi, minimum 20 colour PPM with A-3 paper, Compatible with windows, including connection with each computer complete job with 3 years maintenance.

5.2.10 Repairing of existing OHSRs and CWRs

Following existing OHSRs and CWRs are to be integrated with the new system therefore, some repairing work is required as detailed below :

SN	Name of ESR/CWR	Capacity (in KL)
1	ESR at UIT Sector no 1	1000 KL
2	ESR at UIT Sector no 8	1050 KL
3	ESR at Bhagat singh colony	900 KL
4	CWR at UIT Sector no 1	1000 KL
5	CWR at UIT Sector no 8	1050 KL

- Repairing of concrete works, wherever required.
- All concrete works shall be repaired by pressure grouting of rich cement mortar.
- Replacing of all valves and leaked pipes of ESRs.
- Providing of CI/DI pipes which are not there at the site but actually required as per GA of the ESR.
- The overflow pipe shall be connected to the distribution pipeline.
- Providing scour / washout pipes including P/F of sluice valve as shown in drawing of GA of ESR.
- Providing a bye-pass arrangement to connect the incoming rising main to the outgoing distribution line for town so as to enable supply to the town through direct pumping in case of shut down of SR.
- Providing lightning arrester on the top of OHSR, if required.
- Providing ventilation for the reservoir, if required.
- Providing 25mm diameter GI pipe (Class B) in two rows in 50x50x6mm angle iron railing along the top of reservoir, on the sides of the staircase and balcony, and at other suitable points for the requirement of safety of maintenance and execution staff, if required.
- The inside bottom surface of the Top Dome shall be painted with two coats of suitable anti-corrosive food-grade epoxy coating (two build). Similarly the

inside of the vertical wall shall also be painted with the same from its top to 1 m below FSL.

- The outer top surface of top dome shall be painted with suitable anti-carbonation paint.
- Colour washing using cement paint of approved make & quality as per specifications.
- Painting the metallic surface & putting slogan on tank as per specifications.
- Providing float valve with auxiliary float in each OSHR. The size of float valve shall be same as of Inlet pipe. The pressure rating of valve should be in accordance to the designed maximum pressure.
- Supplying and fixing of level indicator, strainer and other necessary fixtures, if required.
- Each Service Reservoir shall also be provided with staircase, ladders, ventilators, lightening arrester, G I railing, manhole cover with frame, etc., if required.
- It is responsibility of the contractor to test the ESR for water tightness as per specifications given in this bid document. The payment of repairing of ESR/CWR shall only be made to the contractor after completion of all repairing works and water tightness test.
- The scope of work also includes Cleaning, washing and disinfection of inside of Service Reservoir making it free from any foreign matter, loose particles, debris, etc. and making it suitable for storage of potable water.
- The Contractor shall arrange for electricity and water requirements at his own.
- Repairing of plinth protection, if required.
- Rectification of defects/ leakages observed during defect notice period.

5.2.11 Repairing of existing pumping stations

Two nos. pumping stations at UIT sector no. 1 and UIT sector no. 8 are existing pump houses which are at present not in running condition. It is responsibility of the contractor to repair these pump houses and get them in running conditions. All necessary repairs shall be done by the contractor.

5.2.12 IEC Activities

- Contractor is required to engage one NGO (credential of which are to be submitted to Project Manager for approval) for IEC activities. Minimum 4 trained and experienced persons are required to be engaged for this work.
- During the laying of pipeline, NGO persons must be present with the laying teams to handle the public grievances.
- During shifting of water connections, NGO persons are required to contact each consumer and literate them about the conjunctive use of drinking water as per norms and motivate them to construct rain water harvesting structure.

- Minimum 200 slogans (as per guidelines of CCDU) are to be written in the whole project area.
-

5.3 Activities During O&M period for 5 Years

5.3.1 General

The scope of O&M, for 1 year defect liability period and 5 years O&M period, shall include all works executed under this contract and some existing zones of UIT/RHB/RIICO. The contractor shall hand over town pipelines and infrastructure developed to the PHED, at the end of the O&M period and the PHED shall then carry out the O&M of the town of these works thereafter.

The O&M of the Facilities of the scheme shall be run with a well developed quality management system as per guidelines of ISO 9001:2008 revised up to date. The contractor, within 12 months of commencement of O&M, shall obtain ISO 9001:2008 certification from one of the following firms:

1. Bureau Veritas India
2. TUV India of TUV-Nord Group,
3. DNV (Det Norske Veritas)
4. Direct Assessment Services, Chennai
5. SGS India Pvt Ltd, Chennai,

The contractor shall update the O&M Systems and Procedures developed as per department's requirements and as per ISO guidelines. The same shall be submitted to the department for approval along with other O&M documents like O&M Manuals, Log sheets, Formats, etc. These shall be got audited annually throughout the O&M period.

Within the frame work of the contractors responsibilities given above, the contractor shall carry out the following activities, but these shall not limit requirement of other activities, which otherwise are required as per term and conditions of contract or to fulfill contractors responsibilities or are essential as per good industrial practices. The contractor shall be responsible for:

- a) Providing designed per day requirement of water to consumers of town. System shall be tested for design demand but shall be run as per actual demand based on population as per directions of the Project Manager.
- b) Chlorination of water in Pump House & maintenance of Chlorinators/ liquid hypochlorite system and associated system.
- c) Providing the minimum specified staff as specified in the relevant Clause during operation and maintenance period and additional staff as per requirement during periodic maintenance and in emergencies.
- d) Providing all required consumables required for functioning / operation & maintenance of equipment.
- e) Metering is of utmost importance in this contract. For flow measurements of meters at Pumping stations, reading shall be recorded every day and will be signed by

representatives of Department and Contractor. The monthly reading recorded from meters installed at consumers’ point shall be used for preparation of water bills.

- f) Preventive / breakdown maintenance of all pumps, electrical, mechanical & instrument equipment, pipeline installed under the contract. All costs including costs of all material, equipment, etc required for operation and / or maintenance (preventive and/or breakdown) to be borne by the contractor.
- g) Maintenance of the lighting fixtures and the lighting system of all areas and replacement of all non-functional lighting fixtures within 24 hours.
- h) After execution period (i.e. in defect liability and O&M period), If a new connection is issued to a consumer then the connection will be done by the contractor from the distribution line, however, all material shall be provided to the contractor by PHED/consumer. The work shall be done as per department’s norms.
- i) Maintaining;
 - Repair history of all mechanical, electrical and instrumentation control equipment Logbooks:
 - ~ Every day power availability, input voltages, kWh meter, power factor readings at pumping station.
 - ~ Daily Operation of submersible pumps of tube wells with every day readings for flow rate.
 - ~ Daily Operation of pumps with every hour readings for operating voltage, amperage and power factor, pressure on the manifold, pressure at outlet of pumps and flow rate in manifold.
 - ~ **Maintain record of net operating pressure, discharge and energy consumption of each pump so as to arrive at the operating efficiency.**
 - Last periodic maintenance done for all reservoirs of the system.
 - Observations made during patrolling of the pipeline.

In addition to maintenance of above logbooks the contractor is required to maintain one inspection book at pumping station. The complaints entered in the complaint register must be investigated and remedial measures must immediately be taken.

- i) Maintaining adequate additional inventory of spares/accessories or equipment itself for repair of system so that the electrical, mechanical, pipe and pipe appurtenances, can work efficiently as per the guarantees given or minimum required efficiencies asked for in the contract, without any additional costs to department.
- j) Providing manpower and materials for the required repairs of all facilities along with the manpower and materials for repair of the buildings, reservoirs and pipeline built under the contract.
- k) Maintenance of the stores for the electrical, mechanical and instrumentation equipment. The maintenance of stores will include but shall not be limited to:
 - Loading / unloading of materials received and issued for works.

- Proper arrangement of material in stores to ensure its safety and easy availability.
- Maintaining store area neat and tidy.
- Keeping records and Accounting the incoming materials
- Keeping records and Accounting the consumed materials

The contractor shall be solely responsible for the safety and security of the goods in the store and its accountability and will be responsible for any loss or damages in stores for any reason. He may opt for insurance cover against the value of the goods to be stored without any additional costs on the Department.

- l) Patrolling of the water mains laid in the contract, to identify and report the damages / defects pipe and pipe appurtenances, CD works, en-route structures.
- n) Emergency Maintenance / Periodic routine maintenance: Providing a fleet consisting of suitable hauling machine, sufficient inspection/patrolling vehicles and material hauling vehicles and any other vehicles / machinery / equipment for adequate and timely repairs and/or for routine/periodic maintenance /patrolling of the system.
- o) Periodic routine maintenance of buildings & reservoirs built in the contract. Such maintenance must ensure adequate cleanliness, ventilation, illumination and structural safety. In addition to this, the general hygienic standards must be maintained and adequate plantation should be done.
- p) Updating and periodic submissions of the operation and maintenance manual as defined in specifications for O&M works. The contractor shall take up all periodic maintenance works provided in the approved O&M manual.
- q) Maintenance of road-cut repairs carried out under the contract.
- r) Submission of monthly report.
- s) Co-ordination with other contractors and/ or agencies responsible for the Execution, operation and maintenance for regional schemes and Electric Supply Company.

5.3.2 Deployment of Minimum Staff

The minimum permanent staff to be deployed by the contractor for carrying out the O&M functions shall be as follows:

S.N.	Designation	Qualification	Experience	Nos. of staff
1.	Project supervisor	Diploma	5 years	1
2.	Electrician	ITI (Elect.)	3 years	2
3.	Pump Drivers for Pumping stations	8 th Pass	1 Year for pump operation	21

S.N.	Designation	Qualification	Experience	Nos. of staff
4.	Meter reader	10 th Pass	1 Year	2
5.	Fitters	ITI	5 years	1
6.	Helpers	8 th Pass	Skilled	8
7.	Computer Operator	Diploma	2 years	1
8.	Security Guard	8 th Pass	1 Year	1

Note:

- (1) The above requirement is minimum only. The contractor will arrange extra work force, as and when required, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.
- (2) The above staff strength is exclusive of leave/rest reserve required for different category of staff. The contractor shall ensure, the personnel given in the above table for all the seven days in a week.
- (3) The contractor shall make appropriate arrangements for maintenance of items like buildings, patrolling and maintenance of civil structures, vehicle operations and other activities defined to fulfill its obligations under O&M contract.

5.3.3 Pipeline Works – Contractor is to provide all labor and material for:

- a) Repair of leaks, damaged portion of road, embankment, pipe and pipe appurtenances, CD works and en-route structures identified during patrolling.
- b) Emergency Repair(s) of burst(s) for maintaining regular supplies.
- c) Operation of all valves quarterly to check its proper functioning. Maintenance of all valves in leak-less conditions. Quarterly inspection of, expansion joints and surge protection equipment/system, and to do repairs, if required. Contractor shall submit quarterly reports of all such activities done.
- d) Maintenance of inventory for repair of pipe leak(s) and burst(s), valves (air valve, sluice valves, butterfly valves), expansion joints, surge protection devices or any other pipe appurtenances or equipment(s) installed.
- e) To maintain the valve chambers along the pipeline in clean and dry conditions.
- f) To maintain the cover on the pipe damaged due to rains, runoff or any other reason.
- g) Cleaning of CD works along the pipeline alignment and to do required regarding works of area between road and pipe to ensure that water is not impounded near the pipe during rainy season.

5.3.4 Pumping Stations

The scope of maintenance shall be limited to the installations made under the contract. The Contractor shall provide all labor and material required and shall be responsible for:

- (i) To maintain power factor of 0.90, for the installed pumps failing which the contractor shall be liable of all type of penalties imposed by the respective power supply agency.
- (ii) To maintain the pumping station along with all instruments / chlorinator in working conditions. The down time of entire control system shall not exceed 12 hours.
- (iii) Routine maintenance of the entire control system and instruments as per recommendation of the manufacturer.
- (iv) Replacement of damaged control cables, and power supply cables.
- (v) Repair of all instruments such as flow meters, pressure gauges, float levels, loggers along with all other equipments. The down time of any individual instrument as referred above shall not exceed 12 hours.
- (vi) Periodic calibration of all measuring/metering equipment, every 6 month.
- (vii) To produce and submit monthly customized reports.
- (viii) Repair / replacement of damaged electrical equipments / parts for proper functioning of electrical system.
- (ix) Routine maintenance of the pumps as per recommendation of the manufacturer.
- (x) Replacement of bearings, damaged impellers and other damaged parts so that the operation of pumps ensures the guaranteed efficiencies with desired noise and vibration levels.
- (xi) Breakdown maintenance of all electrical, mechanical, instrumentation equipment.

5.3.5 Water Reservoirs

The Contractor shall provide all labor and materials required and shall carry out following maintenance work, during O & M period:

Repair of damaged portions of reservoirs.

To operate and check all valves, instruments once in 3 months and do the required maintenance work to ensure their smooth and proper functioning.

Cleaning and bleaching of the reservoir once in 6 months as per direction of Engineer in Charge. The date of cleaning and bleaching shall be painted on the signboard installed near the reservoir.

Repair of the damaged portions of the plinth protection works.

Repainting during every 3rd year of O&M period

To maintain the reservoir, its surrounding and the campus in a neat and tidy manner.

Other activities required for maintaining the tanks and their surroundings in neat conditions.

5.3.6 Source maintenance

- Wear and tear shall not be a ground for lowering of efficiency of the pump.
- Any replacement in the various equipments that become necessary with the change in discharge conditions without any additional payment during the whole defect liability period and 5 years O&M period. The contractor shall maintain adequate inventory of spare parts of the equipment so as to ensure that the defective part(s) of any equipment are replaced promptly and the equipment is restored in working condition in a maximum period of 2 days.
- During defect liability period and O&M period, in case of tube well becoming dry or giving unacceptably low discharge, the contractor has to submit his report to Project Manager and if he finds it suitable to declare the tube well dry/abandoned, in such cases, the contractor shall have to, without any extra cost, remove all equipment from the site and deposit all items to the Project Manager.
- All spare parts used for the equipment in the maintenance of the system must be from the manufacturer of the equipment or if the equipment itself has been made with parts of other manufacturer the parts must be of the same make as used in the equipment supplied and installed.
- All spare parts shall be packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be labelled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.
- Routine maintenance of the entire system and instruments as per recommendation of the manufacturer.
- Replacement of damaged power supply cables.
- Routine maintenance of the submersible pumping sets as per recommendation of the manufacturer and winding of motors if required.
- Replacement of bearings, damaged impellers and other damaged parts so that the operation of pumps ensures the guaranteed efficiencies with desired noise and vibration levels.
- Breakdown maintenance of all electrical, mechanical, instrumentation equipment.
- Efficiency test for pumps shall be conducted after an interval of every six months.
- Collecting the power bill from Electric Company and submit it to the Project Manager as the earliest for every billing cycle.

6.0 **Pre-Construction Inspection, Testing & Review of Data for Materials, Plant & Equipment**

The contractor shall place order for the material and the equipment only after the approval of the Project Manager. The Contractor shall submit the detailed drawings for the approved manufacturer and the procedure of submission, review and revision shall be specified herein below.

The Contractor shall inform the Project Manager about the likely dates of manufacturing, testing and dispatching. The Contractor shall notify the Project Manager for Inspection and Testing, at least twenty eight days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates. The Project Manager will decide whether he or his representative will inspect and test the material/ equipment or whether he will approve it on the basis of manufacturer's certificate.

The inspection and test categories shall be applied prior to delivery of the equipment, of various categories as indicated in the technical specifications for each type of the equipment.

Category A: - The Drawing has to be approved by the Project Manager before manufacturing and Testing. The material has to be inspected by the Project Manager or by an Inspecting agency approved by the Project Manager at the manufacturer's premise before packing and dispatching. The Inspection charges of the agency will be born by the Employer but the contractor has to pay the inspection charges. The Contractor shall include in their next bill the inspection charges and the same will be reimbursed by the Employer from the provisional Sum. The Contractor shall provide the necessary equipments and facilities for tests and the cost, thereof, shall be born by the Contractor. In case of failure of any item during third party inspection no charges shall be reimbursed to the contractor for the same.

Category B:- The drawings of the Equipment have to be submitted and to be approved by the Project Manager prior to manufacture. The material has to be tested by the manufacturer and the manufacturer's test certificates are to be submitted and approved by the Project Manager before dispatching of the Equipment. Not withstanding the above, the Project Manager, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of Contractor's representative.

Category C: The material may be manufactured as per standard and delivered to the site.

For material / Equipment under category "A" and "B", the Project Manager will provide an authorization for packing and shipping after inspection.

The testing, approval for dispatching shall not absolve of the Contractor's obligation for satisfactory performance of the plant."

Indicative list of Inspection Items with Category

Sr. No.	Item	Category of inspection
1.	uPVC, DI, CI pipes	Category A
2.	uPVC, DI, CI pipe fittings	Category A
3.	Rubber ring, Manhole cover, frame, CI footsteps, Other Fittings, Precast structures.	Category B
Mechanical and instrumentation work		
4.	Sluice Valves, Butterfly Valve and Air valves	Category A
5.	Non-Return Valves	Category A
6.	Dismantling Joints	Category B
7.	Ductile Iron Pipe Work	Category A
8.	Manually Operated Overhead Travelling Crane	Category B
9.	Exhaust Fans	Category C
10.	Float level switches	Category B
11.	Pressure Gauges	Category C
12.	Surge Protection Devices	Category B
13.	Instrumentation & Control Cables	Category B
14.	Instrument Control Panel comprising of PLC, digital indicator, alarm annunciator, mimic, pushbuttons etc.	Category A
15.	Battery & Battery Charger Panel	Category A
16.	Screen Control Panel	Category A
Electrical works		
17.	Transformer	Category A
18.	Disconnecter	Category A
19.	Diesel Generating set	Category A
20.	Lightning arrestors, drop-out fuses and insulators	Category B
21.	Capacitors and APFC Panel	Category A

Sr. No.	Item	Category of inspection
22.	LV switchboards and Control Cabinets	Category A
23.	Induction Motors	Category A
24.	Sub-Distribution Boards	Category B
25.	Power and Control Cables	Category B
26.	Earthing System	Category C
27.	Lighting system equipment	Category B
28.	Local Push Buttons	Category C

7.0 Sequence of Execution:

The works of laying of distribution system, laying of rising mains, gravity mains, installation of pumps and construction of OHSRs shall be executed simultaneously. However emphasis shall be given to commission the work completed in parts. The sequence however has been described as follows:

The work of distribution system should be taken up such that the water supply of any consumer is not disrupted for more than 12 hours in a day. The work should be planned in such a way that peak hour supply that is morning and evening hours supply is not affected at all.

C. GENERAL REQUIREMENTS

1.0 EMPLOYER’S DRAWINGS

1.1 The drawings listed in the Bid document are the Employer’s drawings and are provided by the Employer to enable satisfactory installation and also, to get acquainted with the system.

1.2 All data and information furnished in the drawings by the Employer is given in good faith but the Employer does not accept the responsibility for the completeness and accuracy thereof. The Contractor shall verify the same and promptly point out errors or discrepancies thereof to the Project Manager.

2.0 DRAWINGS FURNISHED BY THE EMPLOYER

2.1 The Contractor shall carefully check all drawings and/or instructions furnished by the Project Manager before commencing any Work. The Contractor shall inform the Project Manager in writing, within 14 days from the receipt of the same, of any errors or omissions discovered, or of the difficulty to execute any Works or part thereof in compliance with these drawings and/or the written instructions received from the Project Manager. Failing to do so the contractor shall be liable to make necessary alterations to works resulting from errors or omissions.

- 2.2 The Contractor will be furnished with 2 copies of any such drawings prepared by the Project Manager. The Contractor will also be furnished with two copies of all instructions as may be issued by the Project Manager. One copy of all such drawings and instructions issued to the Contractor shall be kept in his office at the site. No drawing or instruction shall be considered valid unless the Project Manager has signed it.

3.0 BID / CONTRACT DRAWINGS

- 3.1 Contractor is not required to submit any drawing or any detail of the equipment along with bid.

4.0 WORK PLAN

- 4.1 Work Plan should be submitted by contractor within 28 days after the Letter of Acceptance and/or prior to start of the construction activities at site. The Work Plan should be made with month-wise planning and include all the activities including shifting of utilities, procurement of major materials and deployment schedule of labour, T&P, machineries etc and CASH FLOW as well. The contractor shall also submit weekly/daily micro-plan for all the months separately as well, which shall be up-dated every month to have an effective monitoring tool.

- 4.2 As time is the essence of the Contract, on Mobilization, the Contractor shall submit the work program in an acceptable format. The Contractor shall submit 3 (three) hard copies of the said program for the approval of the Engineer. The Contractor shall update the said work program monthly to demonstrate the actual progress vis a vis planned so that necessary corrective measure can be taken up. Along with the said work program Contractor shall submit the following drawings for approval of the Engineer before proceeding with the work and during execution details of the work:

Lay out plan for site establishment showing therein all such details like site office, toilet blocks and sanitation system, store and storage area, fabrication yard, labor hutment, sanitation block for the labor hutment, boundary fencing details for the proposed site establishment and any other facilities contractor like to propose for approval of the Engineer. This is particularly required in case of execution of works of OHSRs.

The Contractor shall also submit his procurement plan for approval to Project Manager of pipes, specials, fittings, construction material for OHSRs, pump sets, panels, fittings & fixtures from approved manufactures, along with all resources as may require in line with his proposed program so that progress of work at no point get disturbed or delayed.

5.0 SITE POSSESSION

- a) The Engineer shall give possession of the whole Site or such parts of the Site as are sufficient to enable the Contractor to commence and proceed with the execution of the Works in accordance with the indicative Work Program. The Project Manager shall, from time to time, as the work proceeds, give to the Contractor possession of such further portions of the Site as may be required to enable the Contractor to proceed with the

execution of the Works with due diligence in accordance with the agreed program or proposals, as the case may be at the time of issue of NTP.

- b) Engineer or his representative shall undertake joint site visit to give possession of all sites before issuing Notice to Proceed (NTP). A “Handing over/Taking over of Sites” note shall be prepared after physically visiting the sites detailing out any hindrances / encroachments, if any.

In case of such hindrances / encroachments, probable dates of removal of hindrances / encroachments shall be given by the Engineer in this “Handing over/Taking over of Site’s note and such a Note shall be jointly signed by the Engineer as well as the Contractor.

Specifically following sites shall be jointly visited by the Project Manager and the Contractor for this Contract.

1. Sites of proposed OHSRs
2. Sites of Proposed CWRs.
3. Alignment of various rising mains and tapping points of existing rising mains.
4. Location of proposed pump house.
5. Location of proposed Pumps at various pumping stations.
6. Interconnections proposed.
7. Alignment of new Distribution proposed.

6.0 Preliminary Works

6.1 Immediately after the receipt of the letter to commence the works, the Contractor has to start with the preliminary works which generally shall include the following:

- Setting up of temporary office and mobilization of adequate manpower, after discussion with, and as approved by Engineer.
- **Study the existing system thoroughly and understand the methodology and necessity of temporary arrangements to avoid complete shut down of water supply to the various reservoirs at the time connections of rising main with pumps and OHSRs and bye pass arrangements of rising mains near the OHSRs, for longer durations** (maximum 12 hours shut down will be allowed that too during non peak hours in case of distribution system and 6 hours in case of rising mains) which will have considerable impact on supply of treated water to the city.
- Finalize the action plan in consultation with the Engineer.
- Preparation of feasible methodology for connecting the old pipelines with the new pipelines and transfer of consumer connections to the newly laid pipelines.
- Preparation, submission and obtaining approval of equipment design and drawings and placing of orders within specified time schedule.
- Preparation and obtaining approval of general arrangement and equipment layout drawing from Engineer as specified in time schedule.

- Laying of DI and uPVC pipe line includes all preliminary work such as site clearance in all types of conditions, marking of alignment etc. as described elsewhere in these specifications, for such work no extra payment shall be made to the Contractor. The Contractor is advised to inspect site before tendering to ascertain the quantum and cost of such work and include this cost in its offer.
 - Liaison with other agencies such as PWD, BSNL, JVVNL, PHED, local bodies for laying pipes on roads of the city and others as necessary.
- 6.2 The cost of all the above preliminary works shall be included in the tender cost spread over all the items of works. Contractor will not be paid any extra cost for carrying out preliminary works or any temporary arrangements.

D. MATERIALS AND WORKMANSHIP

1.0 INTRODUCTION

This part of the Specification sets out the general standards of materials to be supplied and the workmanship require to be ensured by the Contractor. All component parts of the Works shall, unless otherwise specified, comply with the provisions of this part or be subject to the approval of the Employer. Particular attention shall be paid to a neat, orderly and well-arranged installation carried out in a methodical competent manner.

2.0 REFERENCE SPECIFICATIONS AND STANDARDS

- 2.1 Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'BS') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi 110 002, or American Society for Testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American national Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Akasaka, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard at the Tender opening date.
- 2.2 The Contractor may propose, at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard and seek approval of the Engineer before adopting the same.
- 2.3 All details, materials and equipment supplied and workmanship performed shall comply with the specified Standards. If Bidder offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied and approval is sought from the Engineer.
- 2.4 In the event of conflict between this Specification and the Codes for equipment, provisions of this Specification shall govern. Certain specifications issued by national or other widely recognized bodies are referred to in this Specification. In referring to the Standard Specifications the following abbreviations are used:

- IS : Indian Standard
- ANSI : American National Standards Institute
- API : American Petroleum Institute
- ASME : American Society of Mechanical Engineers
- ASTM : American Society of Testing and Materials
- AWS : American Welding Society
- AWWA : American Water Works Association
- ISO : International Organisation for Standardisation
- DIN : Deutsche Institute fur Nuremburg
- BS : British Standard
- IEC : International Electro-technical Commission
- IEE : Institution of Electrical Engineers
- IEEE : Institute of Electrical and Electronic Engineers
- NEMA : National Electrical Manufacturers Association
- AGMA : American Gear Manufacturer’s Association

3.0 MATERIALS

- 3.1 All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passage of time, exposure to light or any other cause like workmanship, design life, lubrication etc.

E. DETAILED TECHNICAL SPECIFICATIONS

I. CIVIL WORKS

1 General Civil Engineering Works

General

This part of the specification covers the design loads to be considered, specifications of material and workmanship for the civil works. Material used and workmanship for the civil works of campus development, repair/new works of buildings, civil works associated with pipeline laying etc. to be done under the contract will adhere to the provisions laid down in this chapter.

For materials used other than those specified, the material must conform to the

requirement of respective Indian Standards/International Standard and/or good engineering practices. The contractor shall get prior approval of the materials proposed to be used under the contract as per the provisions of Special Conditions of Contract, from the Project Manager.

2 Design Considerations:

2.1 Design Submissions

The contractor shall be responsible for the safety of structures, correctness of design and drawings, even after the approval of the same by Project Manager.

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Project Manager. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Project Manager.

The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed.

2.2 Design Standards

All designs shall be based on the latest Indian Standard (I.S.) Specifications or Codes of Practice unless otherwise specified. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language is being supplied to and got approved by the Project Manager. In case of any variation or contradiction between the provisions of the I.S. Standards or Codes and the specifications given in the tender document, the provision given in this specification shall be followed.

2.3 Design Life

The design life of all structures and buildings shall be 60 years.

2.4 Design Loading

All buildings and structures shall be designed to resist the worst combination of the following loads/ stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads:

2.5 Dead Load

This shall comprises all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipments and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included.

2.6 Live Load

Live loads shall be in general as per I.S. 875. However, the following minimum loads shall be considered in the design of structures:

- i) Live load on roofs : 2.00 kN/m²
- ii) Live load on floors supporting equipment such as pumps, blowers, compressors, valves etc. : 10.00 kN/m²
- iii) Live load on all other floors walkways, stairways and platforms : 5.00 kN/m²

In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Project Manager prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection/ construction shall be considered and shall be partial or full whichever causes the most critical condition.

2.7 Wind Load

Wind loads shall be as per I.S. 875. Part 3

2.8 Earthquake Load

This shall be computed as per I.S. 1893 taking into consideration soil foundation system, importance factor appropriate to the type of structure, basic horizontal seismic coefficient/ seismic zone factor & average acceleration coefficient.

2.9 Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of structures

2.10 Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However contraction joints in buildings shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 40 m shall be provided in walls, floors and roof slabs of water retaining structures, as per IS-3370.

The positions of construction joints should be specified by the designer & indicated on the drawings. If there is a need on site to revise any specified position or to have additional joints, the proposed positions should be agreed with the designer.

The concrete at the joint should be bounded with that subsequently placed against it, without provision for relative movement between the two concrete should not be allowed to run to a feather edge & vertical joints should be formed against stop

edges.

Expansion joints for non liquid retaining structures shall be provided as per IS 3414.

2.11 Design Conditions for Underground or Partly Underground Liquid Retaining Structures

All underground or partly underground liquid containing structures shall be designed for the following conditions :

- a) liquid depth up to full height of wall : no relief due to soil pressure from outside to be considered;
- b) structure empty (i.e. empty of liquid, any material, etc.) : earth pressure and surcharge pressure wherever applicable, to be considered as per site conditions;
- c) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall;
- d) partition wall between two compartments : to be designed as one compartment empty and other full;
- e) structures shall be designed for uplift in empty conditions with the water table due care should be taken for seasonal variation on higher side. The possible flooding levels due to local drainage system shall be accounted while designing the structures.
- f) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
- g) underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The design shall be such that the minimum gravity weight exceeds the uplift pressure at least by 20%.

2.12 Foundations

- a) The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per IS 1904. However, for OHSR on sandy soil (other than rocky strata), minimum depth of foundation shall be 3 meters.
- b) Bearing capacity of soil shall be determined as per IS : 6403.
- c) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

- d) A structure subjected to groundwater pressure shall be designed to resist floatation. The dead weight of empty structure shall provide a factor of safety of 1.2 against uplift during construction and service.
- e) Where there is level difference between the natural ground level and the foundations of structure or floorslabs, this difference shall be filled up in the following ways.
- f) In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm) and the level difference shall be made up by compacted backfill as per specifications. However the thickness of each layer shall not exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction.
- g) In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete not weaker than M 10.
- h) If pile foundations are used, the contractor shall conduct the initial routine test as per IS 2911 at his own cost, to determine the safe load bearing capacity of piles.

3 Requirements For Construction of RCC Reservoirs

3.1 General

The RCC reservoirs are to be constructed as per the type and size detailed in the “Scope of Work” defined in this Volume II of tender document. The conceptual drawings of CWR / OHSR are given in the drawings in Volume III of the tender document which are for general understanding of department requirements but shall have no bearing on the submissions for approval, the requirements as given in this document are required to be fulfilled. The facilities and general arrangements of the reservoirs shall be as shown in the drawings in Volume III.

The contractor shall submit detailed general arrangement drawings, structural drawings and design of each structure for the approval of Project Manager. The designs shall adhere to the provisions given in this chapter. The design shall be got approved from the agencies defined in the contract before submission to the Project Manager.

The OHSRs shall be of Intze type shape, supported on raft foundation. The arrangements for lightening arrestor, conductors and earthing system shall be made by the contractor.

The construction of reservoirs shall be carried out in accordance with the specifications mentioned herein and relevant IS amended upto date. The general arrangement drawings of the piping system and other drawings like layout plan of site, structural drawings and designs, working drawings, etc shall be submitted by the contractor for approval of the department prior to start of work. In cases where

the specifications given below are silent about any aspects in respect of any item, the work shall be carried out as per the relevant IS code of practice in the latest version and/or as per sound engineering practice after approval of Project Manager.

3.2 Preparatory Works

The Contractor shall provide and maintain a benchmark with a level at a location approved by the Project Manager at each reservoir construction sites. All levels shall be deemed to refer to that benchmark. The Contractor may establish other secondary benchmarks on the site.

3.3 Soil & Geo Technical Investigation

SBC tests shall be got done through an approved agency wherever the strata on which foundation is to be laid is not rocky. For foundations to be laid on sandy strata, the structural design and reinforcement drawings shall be prepared assuming maximum SBC of soil as 10 T/Sqm even if the SBC testing is found to be 10 T/Sqm or more at foundation depth. If the SBC testing is found to be less than 10 T/Sqm at foundation depth, the structure shall be designed on the basis of actual SBC found on testing for which no extra payment will be made to contractor.

For foundations to be laid on rocky strata, with firm rocks the SBC shall be taken as 18 T/Sqm.

3.4 Material of Construction

The building/construction material to be used shall be as per the specifications given in this chapter. The pipes & specials to be used shall be as per the specifications given in Chapter 3 for Pipes. The valves and instruments shall be as per the specifications given in this volume II containing specifications for Valves and Instrumentation respectively.

3.5 Design Considerations for Reservoirs

GENERAL PRINCIPLES:

- Maximum height of live storage in water reservoirs shall be 4.0 meters.
- Height of dome shall be $1/5^{\text{th}}$ to $1/6^{\text{th}}$ of span of dome.
- Minimum Free board shall be kept as 0.3 meters.
- Staging in case of overhead reservoirs is defined as the difference of levels between the finished ground level and bottom of the water retaining structure (top of the bottom ring beam of bottom dome).

Considerations for CWR -

- All underground or partly underground liquid containing structures shall be designed for the following conditions :
- liquid depth up to full height of wall : no relief due to soil pressure from outside to be considered;

- Structure empty (i.e. empty of liquid, any material, etc.) : earth pressure and surcharge pressure wherever applicable, to be considered as per site conditions;
- Structures shall be designed for uplift in empty conditions with the water table as per site conditions considering due variation on higher side. The possible flooding levels due to local drainage system shall be accounted while designing the structures.
- walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
- Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The design shall be such that the minimum gravity weight exceeds the uplift pressure at least by 20%.

3.6 Design Requirements

The following are the design requirements for all reinforced or plain concrete structures.

- a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M10 unless otherwise specified.
- b) Liquid Retaining Structures:
 - i. All structural reinforced concrete shall be of a minimum M30 grade with a maximum 20 mm aggregate size.
- c) The reinforced concrete for water retaining structures shall have a minimum cement content of 320 kg/m³ with a maximum 20 mm size aggregate
- d) The minimum reinforcement in walls, floors and roofs in each of two directions of right angles within each surface zone shall be as per 7.1 of IS: 3370 part 2.
- e) The nominal cover of concrete for all steel, including stirrups, links, sheathing and spacers shall be as per 7.2 of IS : 3370 Part 2 for liquid retaining structures and as per IS:456 for other structures.
- f) Suitable admixtures may be used with the approval of Project Manager.
- g) Construction of floors and walls of Liquid Retaining structures shall be as per IS: 3370 Part 1.

Design requirement of RCC liquid retaining structures / grade of concrete / minimum cement content and for other provisions, these shall be governed by the provisions of IS 456 and IS 3370, whichever is more stringent.

3.7 Loads

All loads shall be considered as per the provisions of IS 875 and other references as defined in this chapter. The design shall be suitable for the worst possible conditions of loading during construction and operation.

3.8 Concrete Grade, cover, minimum cement content and thickness

Grade of concrete to be used for the reservoirs shall be as per the provisions of IS 456 for moderate environmental exposure conditions. The minimum cement content for reservoir members shall be 360 Kg/cum. For other works such as plinth protection etc., the minimum cement content shall be as per the respective codes. Minimum cover as prescribed in IS 456 shall be provided. The minimum thickness of reservoir members shall be in accordance to the provisions of IS 456 and IS 3370. However the following minimum thicknesses shall be provided for different reinforced concrete members, irrespective of design thicknesses as follows:

Walls for liquid retaining structures	150 mm
Spherical Dome/Flat roof slab of RCC reservoirs	100 mm
Bottom slabs of CWRs	150 mm
Floor slabs including roof slabs, walkways, canopy slabs	150 mm
Wall of cables/ pipe trenches, underground pits etc.	125 mm
Wall of cables/ pipe trenches, underground pits etc.	125 mm
Column footings	150 mm
Parapets, Chajja	75 mm
Pre-Cast trench cover	50 mm
Free board depth to be provided	300mm
Dead storage depth	100mm
Thickness of lean concrete below foundation	100mm
Depth of foundation for OHSR	3000mm or on solid rock.
Age factor shall not be more than	1(one)

3.9 Final Finishing

The contractor will ensure that the entire structure along with all its installations are in a finished and in new and fully operative condition when handed over, after the O & M period is over. He shall have repaired and removed all signs of damage that might have been done during the course of installation and fixing of equipment. He shall also see that all the exterior has been finished properly and the entire site is cleared of all extra construction material, debris and excavated soil. This shall have to be done to the satisfaction of the Project Manager.

4 Miscellaneous Items of Reservoirs

4.1 Puddle collars

Puddle collars shall be used for connecting the inlet, outlet, overflow & washout pipes to the reservoir. All puddles shall be fixed at right angle to the RCC wall during casting of wall. All puddle collars shall be of C.I. The minimum length shall be at least 100 mm more than the total finished thickness of the walls and size of the puddle collars shall be equal to the size of the respective pipe.

4.2 Float Valve System

The float valve system shall be installed at the end of inlet pipe in each OHSR

The float valves for OHSR shall comprises of two float valves i.e. main float valves and the auxiliary float valve. The different materials of construction for the components are as under.

Part no	Name of part	Material	Specification
1.	Body	Cast iron	IS 210,FG 200
2.	Valve	Cast iron	IS 210,FG 200
3.	Bottom plate	Cast iron	IS 210,FG 200
4.	Washer plate	Gun metal	IS 318
5.	Seat ring	Gun metal	IS 318
6.	Link	Gun metal	IS 318
7.	Liner	Brass	--
8.	Eye bolt for valve	Brass	--
9.	Lever fork	Mild steel	
10.	Valve face	Synthetic rubber	--

The float ball is to be suspended in a cylindrical vessel fabricated from 4mm MS sheet hot dip galvanized, So that free upward/ downward movement is available to the ball as the water level rises/falls in the cylindrical vessel. The valve shall ensure tight closing.

The auxiliary float valve shall be installed at the bottom of the vessel. It shall be of copper alloy, Croydon pattern with rough body and screwed male ends. The material

of ball shall be copper and shall be installed at the bottom of the vessel. The size of the float and the length of the lever must ensure a tight closing at a pressure of 6 kg/cm². The valve design must be made with view to a permanent withdrawal at pressures reaching 6 kg/cm². This relates to cavitation of the seat, the piston and the washers. The size of the valve is 25mm.

The different materials of construction for the components are as under:

Part no	Name of part	Material	Specification
1	Float Ball	Copper	-
2	Ball Cap	Gun metal	BS 1400 LG 2
3	Lever	Brass rod	BS 2872 or 2874 CZ 114
4	Split Pin	Brass	-
5	Piston	Gun metal	BS 1400 LG 2
6	Piston Cap	Gun metal	
7	Washer	Nitrile rubber	-
8	Body	Gun metal	BS 1400 LG 2

The above valves shall be tested for the following hydrostatic pressure. The lever and its connection to the ball must be designed for heavy duty conditions.

- Body of valve : 10 kg/cm²
- Seat of valve: 6 kg/cm²

4.3 Ladder

M.S. ladder 450 mm wide, made up of 50mm x 50mm x 6mm M.S. angle iron and 25mm M.S. bars welded at 300mm c/c shall be provided outside from the balcony to top dome in OHSR. MS cage shall also be provided on this ladder. Similarly MS ladder/RCC Staircase shall be provided at CWR for access to the top dome. M.S. ladder with all its components should be suitably painted as per approval of PROJECT MANAGER.

The ladders in all type of reservoirs (i.e. CWR & OHSR) from top dome roof to inside platform and from platform to bottom dome in the container shall be of aluminium. Its drawing shall be got approved from PROJECT MANAGER before dispatch.

4.4 Railing

Hand railing shall be provided along the stairs of OHSR and on the top dome of OHSR. Hand railing around the platforms, Balcony, stairs and landings shall be

consisting of 25 mm diameter medium B class GI pipes in two rows (one at the top and other at middle level) and 750mm high vertical post 50x50x6 mm angle iron @ > 750mm centre to centre properly embedded in the concrete (At least two vertical angles are to be provided wherever distance is less) with all accessories like elbows, tees etc. including welding, threading and embedding in cement concrete floor. Railing shall be protected against corrosion after welding. The pipe shall pass through hole in the vertical angle.

4.5 Water level indicator

Water level indicator shall be provided for each reservoir to be constructed in this contract. Water level indicator consisting of an approved float and an iron counter weight connected to a flexible stainless steel wire 4mm thick passing over pulley 70mm diameter. The pulleys shall be properly fixed with structure and should have a guide so that the wire does not slip from the pulley.

The scale shall be calibrated in centimeters and should consist of M.S. sheet 20 gauge fixed over wooden plank with an M.S. angle iron frame of 35mm x 35mm x 5mm and painted with white enamel base, letters in black and red. The scale shall be located and fixed with RCC vertical wall of OHSR/CWR/GLR.

4.6 Ventilator

Ventilators shall be provided for all reservoirs. The size of ventilator shall be approved by PROJECT MANAGER in consideration to the tank size and shall be of CI cowl and a bend of 300 mm high with mosquito proof jali of stainless steel shall be fixed at the opening. It shall be well painted and properly fixed in concrete. Thickness in case of MS shall be not less than 3 mm.

For smaller reservoirs CI vent pipes of dia as per approval of PROJECT MANAGER shall be provided.

4.7 Lightning arrester

Lightning arrester shall be of copper bar of 25mm dia and 2m long to be provided at the top of OHSR. This is to be connected by a GI strip 25 mm wide & 3mm thick. This conductor strip shall be connected to a 450 mm x 450mm x 3mm thick copper plate to be embedded below the average ground level by digging a pit. The earthing system shall comply with Indian Electricity Rules and shall conform to IS 3043. The pit shall be refilled by alternate layers of salt and coke and balance shall be filled with loose soil. The 40 mm dia GI watering pipe shall be provided in the pit. Care shall be taken that earth pit does not sink.

4.8 Plinth Protection

Plinth protection works for OHSR, CWR and GLR is to be provided all around each reservoir in a 1 m circular strip. It shall consist of laying lean concrete 100 mm thick in M10, over compacted soil. Over the lean concrete brick on edge flooring or RR stone flooring in 1:4 cement sand mortar shall be provided. Along this plinth protection provision of toe wall of M15 grade cement concrete 150 mm wide over the

base of lean concrete of M10 shall be provided. Side slope of plinth protection shall be 1 in 50 outward & peripheral slope should be 1 in 500.

Plinth protection works to be constructed below the OH Service Reservoir, shall be extended up to 1m from fall of balcony or edge of raft slab, whichever is more, all around service reservoir. It shall consist of laying lean concrete 100 mm thick in M10, over compacted soil.

The minimum free space between plinth protection and the first bracing of the OHSR shall be 1.60 meters.

4.9 Slogan and logo

The contractor shall paint on the vertical wall of the tank portion by using 3 coats of plastic emulsion paint of shade as approved by Project Manager to form a base for writing the slogan. The shade for painting the slogan will be approved and directed by Project Manager. The logo should indicate the name of the project, name of the village and the capacity of the reservoir. The slogan shall be as directed by the Project Manager.

4.10 Pipe Clamp

At least two clamp on one staging shall be provided of 6mm thick 50mm wide MS flat fixed on pipe & column.

4.11 Man Hole Cover

Square manhole cover 600X600 mm shall be provided. The cover shall be made of 5 mm thick MS flat. The frame shall be made of MS angle 50*50*6. The cover shall be connected to this frame by using two nos. strung hinges. Locking arrangement shall be provided.

4.12 Treatment of Joints in continuous portion

Two hours after pouring the concrete, the slurry would be washed with high pressure water jet & air jet. Before pouring the next layer of concrete the old surface shall be brushed, painted with approved joining compound.

Water bar of G.I. sheet 150 mm wide 20 gauge shall be provided as per IS 3370 Part-I 1965 as construction joints in vertical wall. Overlaps in sheets shall be 300 mm. Alternatively water stopper of PVC can be used.

5 Testing for water tightness

The contractor shall carry out a water tightness test as per IS: 3370 for the maximum water head condition i.e. with the water standing at full supply level. All cost of testing shall be borne by the contractor. This test shall be carried out in accordance with the procedure given below

- For water tightness test, before the filling operations are started, the reservoirs shall be jointly inspected by the Project Manager and the representative of

the Contractor and condition of surfaces of wall, construction joints etc. shall be inspected and noted and it shall be ensured that jointing material filled in the joints is in position and all openings are closed. The contractor shall make necessary arrangement for ventilation and lighting of reservoir by way of flood lights, circulators etc. for carrying out proper inspection of surfaces and internal conditions if so desired by the Project Manager.

- The water retaining structures shall be filled with water gradually at the rate not exceeding 30 cm. rise in water level per hour and shall extend for a period of 72 hours. Records of leakages starting at different level of water in the reservoirs, if any, shall be kept.

- The reservoirs once filled shall be allowed to remain filled for a period of 7 days before any readings or drop in water level is recorded again at 7 days. The total drop in surface level over a period of 7 days shall be taken as indication of the water tightness of the reservoir, which for all practical purposes shall not exceed 40mm. There shall be no indication of leakages around the puddle collars or on the wall and bottom of the reservoir.

- If the structure does not satisfy the test requirements, and the daily drop in water level is decreasing, the period of test may be extended for further seven days and if the specified limit is not exceeded, the structure may be considered as satisfactory.

- In case the drop in water level exceeds the permissible limit with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Project Manager to reduce the leakage in the permissible limit. The entire rectification work that shall be carried out in this connection shall be at Contractor's cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the water retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure will be condemned and the Contractor will dismantle and reconstruct the structure, to the original specification, at his own cost.

6 Materials & Standards

The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

Materials and workmanship shall comply with the relevant Indian Standards (with

amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Project Manager, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificates and forward it to the Project Manager.

The specifications, standards and codes listed below are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between two standards the provisions more stringent shall be followed. In case of discrepancy between the Bid Specification and the Standards referred to herein, the Bid Specification shall govern.

IS No.	Title
CONSTRUCTION PLANNING AND STORAGE OF MATERIALS	
4082 :	Recommendation on stacking and storage of construction materials at site (first revision)
IS No.	Title
7969 :	Safety code for handling and storage of building materials
EARTHWORK	
3764: 1992	Excavation work - Code of safety (first revision)
4081	Safety code for blasting and related drilling operations
FOUNDATIONS	
269 :	33 grade ordinary Portland cement.
432 (Part 1)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement : Part 1 Mild steel and medium tensile steel bars (third revision)
456	Code of practice for plain and reinforced concrete (Reaffirmed 1991)
2974 (Part 1)	Code of practice for design and construction of machine foundations : Part 1 Foundations for reciprocating type machines

- 2974 (Part 2) Code of practice for design and construction of machine foundations : Part 2 Foundations for impact type machines (hammer foundations)
- 2974 (Part 3) Design and construction of machine foundations - Code of practice : Part 3 Foundations for rotary type machines (medium and high frequency)
- 2974 (Part 4) Code of practice for design and construction of machine foundations : Part 4 Foundations for rotary type machines of low frequency
- 2974 (Part 5) Code of practice for design and construction of machine foundations :
Part 5 Foundation for impact machines other than hammers (forging and stamping press, pig breakers, drop crusher and jolter)
- 6403 Code of practice for determination of bearing capacity of shallow foundations.

PLAIN AND REINFORCED CONCRETE

- 269 33 grade ordinary Portland cement
- 383 Coarse and fine aggregates from natural resources for concrete
- 456 Code of practice for plain and reinforced concrete
- 516 Method of test for strength of concrete
- 875 (Part 1) Code of practice for design loads (other than earthquake) for buildings and structures : Part 1 Dead loads -Unit weights of building material and stored materials
- 875 (Part 2) Code of practice for design loads (other than earthquake) for buildings and structures : Part 2 Imposed loads
- 875 (Part 3) Code of practice for design loads (other than earthquake) for buildings and structures : Part 3 Wind loads
- 875 (Part 4) Code of practice for design loads (other than earthquake) for buildings and structures : Part 4 Snow loads
- 875 (Part 5) Code of practice for design loads (other than earthquake) for buildings and structures : Part 5 Special loads and load

	combinations
650	Standard sand for testing of cement
1199	Methods of sampling and analysis of concrete
1786	High strength deformed steel bars and wires for concrete reinforcement
2502	Code of practice for bending and fixing of bars for concrete reinforcement
2505	Concrete vibrators - Immersion type - General requirements
4926	Ready mixed concrete
8112	43 grade ordinary Portland cement
9012	Recommended practice for Concreting
9103	Admixtures for concrete
10262	Recommended guidelines for concrete mix design
12269	53 Grade ordinary Portland Cement

STEEL CONSTRUCTION

104	Ready mixed paint, brushing, zinc chrome, priming
123	Ready mixed paint, brushing, finishing, semi-gloss, for general purposes to Indian Standard Colours No.445, 446, 448, 449, 451, 473 and red oxide
800	Code of practice for general construction in steel
7205	Safety code for erection of structural steel work

FLOORS AND FLOOR COVERINGS

1237	Cement concrete flooring tiles
1443	Code of practice for laying and finishing of cement concrete flooring tiles
8042	White Portland cement

WHITE WASHING, COLOUR WASHING AND PAINTING OF MASONRY,

CONCRETE AND PLASTER SURFACES (CALCAREOUS SURFACES)

44	Iron oxide pigments for paints
109	Ready mixed paint, brushing, priming, plaster, to Indian Standard Colour No. 361 and 631 White and off white
133	Enamel, interior : (a) undercoating, (b) finishing
158	Ready mixed paint, brushing, bituminous, black lead-free, acid alkali and heat resisting
168	Ready mixed paint, air drying, for general purpose
427	Distemper, dry, colour as required
428	Distemper, oil emulsion, colour as required
2395 (Part 1)	Code of practice for painting concrete masonry and plaster surfaces : Part 1 Operation and workmanship
2395 (Part 2)	Code of practice for painting concrete masonry and plaster surfaces : Part 2 Schedule
5410	Cement paint
6278	Code of practice for whitewashing and colour washing
9862	Ready mixed paint, brushing, bituminous, black lead-free, acid alkali, water and chlorine resisting

6.1 Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by the Project Manager and shall carry out the specified tests directed by the Project Manager at the Site, at the supplier's premises or at a laboratory approved by the Project Manager.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Project Manager.

Approval by the Project Manager as to the placing of orders for materials or as to samples or tests shall not prejudice to any of the Employer's powers under the Contract.

6.2 Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments upto date).

Where the relevant standard provides for the furnishing of a certificate to the Project

Manager, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificates and forward it to the Project Manager.

The specifications, standards and codes listed in this chapter are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

7 Earthwork For Buildings/Reservoirs

7.1 General

The Contractor shall furnish all tools, plant instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Department's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8 m in case of buildings and 30 m in case of roads and pipe lines works intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Project Manager. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top.

Topsoil shall be stock piled separately for later re-use.

7.2 Clearing

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Project Manager. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter / materials before fill commences.

7.3 Excavation

Excavation for permanent work shall be taken out to such widths, lengths, depths

and profiles as are shown on the approved drawings or such other lines and grades as may be agreed with the Project Manager. Rough excavation shall be carried out to a depth of 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with material as approved by the Project Manager. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the approved drawings or as agreed with the Project Manager. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with material as approved by PROJECT MANAGER upto the required elevation at no cost to the department.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Project Manager shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

7.4 Rock

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Project Manager, to fall or otherwise endanger the workmen, equipment, the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe portion, which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Project Manager, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

8 Fill, Backfilling and Site Grading

8.1 General

All fill material shall be subject to the Project Manager's approval. If any material is rejected by Project Manager, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Project Manager after the fill work is completed.

8.2 Material

To the extent available, selected surplus soil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material.

All lumps of earth shall be broken or removed unless otherwise stated. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Project Manager. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Project Manager. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

8.3 Filling in pits and trenches around foundations of structures, walls, etc.

The spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated to the satisfaction of Project Manager. Earth shall be rammed with approved compaction mechanism. Usually no manual compaction shall be allowed unless the Project Manager is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Project Manager.

The filling shall be done after the concrete or masonry is fully set and done in such a manner as not to cause undue thrust on any part of the structure.

8.4 Plinth Filling

Plinth filling shall be carried out with approved material such as soil, sand or murum as in layers not exceeding 15 cm, watered and compacted with approved compaction mechanism. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of large areas be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Project Manager. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this be upto a maximum of 300 mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Project Manager obtained prior to commencing filling.

The process of filling in the plinth, watering and compaction shall be carried out by the contractor in such a way as not to endanger the foundation columns, plinth walls etc. already built up. Under no circumstances Black cotton soil shall be used for plinth in filling.

For mechanical compaction rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Project Manager, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

At some locations/ areas, it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

8.5 Sand Filling in Plinth and Other Places

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Project Manager has inspected and approved the fill.

8.6 General Site Grading

Site grading shall be carried out as indicated in the approved drawings. Excavation shall be carried out as specified in the Department's Requirements. Filling and compaction shall be carried out as specified elsewhere unless otherwise specifications indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 200 mm and levelled uniformly and compacted as indicated above before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip.

8.7 Fill Density

Unless otherwise specified the compaction, where so called for, shall comply with minimum 90% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

8.8 Timber Shoring

The provisions of relevant ISS shall apply.

8.9 Dewatering

The Contractor shall ensure at his cost that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/ rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/ trenches required for further work. The method of pumping shall be approved by Project Manager, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any test necessary at the site with the approval of the Project Manager to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Project Manager. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a build up of water in the opinion of the Project Manager obstructs the progress of the work, leads to unsanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Project Manager, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Project Manager, details of his well point system including the stages, the spacing number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

If any foundation pits are filled due to accumulation of surface flow during the progress of work or during rainy season, or due to any other cause all pumping required for dewatering the pits & removing silt shall be done without extra cost.

8.10 Rain Water Drainage

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Project Manager.

9 Concrete

9.1 General

The Project Manager 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 an inspection shall be arranged and the *Project Manager's* approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications 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 Project Manager and after establishing their performance suitability based on previous data, experience or tests.

9.2 Materials

(a) Cement

Unless otherwise called for by the Project Manager, cement shall be ordinary Portland cement (Grade 33, Grade 43, Grade 53) conforming to IS : 269, IS : 8112 or IS : 12269 or Super Sulphated cement conforming to IS 6909 or super resistant Portland cement conforming to IS 12330 or Pozzolana Portland Cement conforming to IS 1489(part 1)

Sulphate resistant cement conforming to IS 12330 shall be used for all cement concrete works below ground level if the soil resistivity is less.

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 Project Manager.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Project Manager and until the results of such tests are found satisfactory, it shall not be used in any work.

(b) Aggregates (General)

It shall comply with requirement of IS 383 and as specified in IS 456-2000. 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/slit/organic impurities/deleterious materials such as iron pyrites, cod, mica, slate, clay alkali, soft fragments, sea shells and conform to IS : 383. Aggregates such as slag, crushed over burnt bricks, bloated clay aggregates, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Project Manager.

Aggregates containing reactive silica shall not be used.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than $\frac{1}{4}$ 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 when specifically permitted. The plums shall be distributed evenly and shall not be closer than 160 mm from the surface. For heavily reinforced concrete members as in the case of ribs of main beams the nominal maximum size of aggregate shall be restricted to 5 mm less than minimum clear distance between the main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller. Coarse and fine aggregates shall preferably be batched separately, specially for design mix concrete.

The largest possible size, properly graded should be used in order to reduce water demand.

Graded aggregate shall conform to requirements in Table 1, 2, 3 & 4. All in aggregate shall conform to requirements in Table 5.

Table 1

Graded Aggregate

IS Sieve	1..1.1.1.1 Percentage Passing for Normal size of Aggregate			
Designation				
Mm	40 mm	20 mm	16 mm	12.5 mm
80	100	-	-	-
40	95-100	100	-	-
20	30-70	95-100	100	100
16	-	-	90-100	-

12.5	-	-	-	90-100
10	10-35	25-55	30-70	40-85
4.75	0-5	0-10	0-10	0-10
2.36	-	-	-	-

Table 2

Single Sized Aggregate (Ungraded)

IS Sieve 1..1.1.1.1.2 Percentage Passing for Normal size of Aggregate**Designation**

Mm	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
80	100	-	-	-	-	-
63	85-100	100	-	-	-	-
40	0-30	85-100	100	-	-	-
20	0-5	0-20	85-100	100	-	-
16	-	-	-	85-100	100	-
12.5	-	-	-	-	85-100	100
10	0-5	0-5	0-20	0-30	0-45	85-100
4.75	-	-	0-5	0-5	0-10	0-20
2.36	-	-	-	-	-	0-5

Table 3

Making Single Sized to Graded Aggregate

Cement Nominal Part of Single Size Aggregate to be Mixed to Get Graded

Concrete Mix	size of Graded Aggregate Required	Aggregate (by Volume)				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
1:6:12	63	9	-	3	-	-
	40	-	9	3	-	-
1:5:10	63	7.5	-	2.5	-	-
	40	-	7.5	2.5	-	-
1:4:8	63	6	-	2	-	-
	40	-	6	2	-	-
1:3:6	63	4.5	-	1.5	-	-
	40	-	4.5	1.5	-	-
	20	-	-	4.5	-	1.5
1:2:4	40	-	2.5	1	-	0.5
	20	-	-	3	-	1
	12.5	-	-	-	3	1
1:1.5:3	20	-	-	2	-	1

Note : Proportions indicated are by volume. If single sized aggregate specified is not available, the volume of single sized aggregates shall be varied with a view to obtain the graded aggregate.

Table 4
Grading of Fine Aggregates

IS Sieve	1..1.1.1.1.3 Percentage Passing for			
Designation				
	Grading Zone	Grading Zone II	Grading Zone	Grading Zone

	I		III	IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

Note : For crushed stone sands, the possible limit on 150 micron IS sieve is increased to 20 percent. This does not affect 5 percent allowance permitted to other sieves.

Table 5

All-in-Aggregate Grading

IS Sieve	1..1.1.1.1.4 Percentage Passing All-in-Aggregate Grading of	
Designation		
Mm	40 mm Nominal Size	16 mm Nominal Size
80	100	-
40	95-100	95-100
20	45-75	95-100
4.75 mm	25-45	30-50
600 micron	8-30	10-35
150 micron	0-6	0-6

Fine aggregates are divided into 4 zones. Typical good sand falls in Zone II grading,

however, finer or coarse sand may be used with suitable adjustment in the ratio of quantities of coarse to fine aggregates.

Very fine sands as included in Zone IV grading should not be used except when the concrete is closely controlled by design mixes.

(c) Water

Water used for both mixing and curing shall conform to IS : 456-2000 and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials that may be deleterious to concrete or steel. The pH value of water shall not be less than 6.

(d) Reinforcement

Reinforcement shall be any of the following :

High strength deformed bars and wires to IS 1786.

Rolled steel Grade A made from structural steel to IS 2062.

All reinforcement shall be free from loose mill scales, loose rust and coats of paints, oil, mud or other coatings which may destroy or reduce bond.

(e) 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 Project Manager. 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 trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedments.

Calcium chloride shall not be used for accelerating set 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.

9.3 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 /steel and when directed by the Engineer samples shall also be got tested by the Contractor in a laboratory approved by the Project Manager.

Sampling and testing shall be as per IS : 2386 under the supervision of the Project Manager.

Water to be used shall be tested to comply with requirements of IS : 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

9.4 Making of concrete

Concrete grade shall be as designated on approved drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq. mm as per IS: 456. 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. Grade M20 can be nominal or design mix as per the requirement whereas all other grades, above M20 necessarily be DESIGN MIX CONCRETE.

a) Design Mix Concrete

The mix design shall produce concrete having reduced workability (consistency) and strength not less than approximate values given in table below. Workability shall be controlled by direct measurement of water content and checking it at frequent intervals by method prescribed in IS 1199.

b) Mix Design and Testing

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall be 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 structures, the mix shall also result in watertight concrete. The Contractor 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 IS: 456.

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish mix design to the Project Manager well in advance of the 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 mixes ascertained on 150 mm cubes as per IS : 516

shall comply with the requirements of IS : 456.

1..1.1.1.1.5 Grade of Concrete	Minimum Compressive Strength N/sq.mm at 7 days	Specified Characteristic Compressive Strength N/sq. mm at 28 days
M15	10.0	15.0
M20	13.5	20.0
M25	17.0	25.0
M30	20.0	30.0
M35	23.5	35.0
M40	27.0	40.0

Grades lower than M20 shall not be used for reinforced concrete (general). Grading lower than M25 shall not be used for reinforced concrete in liquid retaining structures.

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Project Manager is given below:

Structure / Member	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	100	25
Slabs, Beams and reinforced walls	75	25
Pump & miscellaneous Equipment Foundations	100	25
Building columns	50	25

Pavements	50	25
Heavy mass construction	50	25

c) Batching & Mixing of Concrete

Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable 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 for use by the Project Manager 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 Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Project Manager. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS : 516 and IS : 456.

Nominal Mix Concrete

d) Mix Design & Testing

Mix Designing and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS : 456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 9 of IS : 456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

e) Batching & Mixing of Concrete

The Proportions of materials used for concrete of grades shall be as given below :

Proportions for Nominal Mix of Concrete

Grade of Concrete	Total Quantity for Dry Aggregate by Mass per 50 kg of Cement (as Sum of Fine and Coarse Aggregates), in kg, Max	Proportion of Fine Aggregate to Coarse Aggregate (by Mass)	Quantity of Water per 50 kg of Cement, Max in Litres
M 5	800	Generally 1:2 Subject to an upper limit of 1:1.5 and a	60

			lower limit of 1:2.5
M 7.5	625	-do-	45
M 10	480	-do-	34
M 15	350	-do-	32
M 20	250	-do-	30

NOTES

The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and maximum size of coarse aggregate becomes larger. Graded coarse aggregate (see Table 5.1) shall be used.

Example: For an average grading of fine aggregate (that is, Zone II of IS 383 :1970, Table 4) the proportions shall be 1:1.5, 1:2 and 1:2.5 for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

This table envisages batching by weight,. Volume batching when done the nominal mixes would roughly be 1:3:6, 1:2:4 and 1:1.5:3 for M 10, M 15 and M 20 respectively.

For underwater concreting the quantity of coarse aggregate, either by volume or mass, shall not be less than 1.5 times nor more than twice that of the fine aggregate.

f) Mixing

Concrete shall be mixed in a mechanical mixer conforming to IS 1791. The mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. If there is segregation after unloading, the concrete should be remixed.

10 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, falsework, wedges etc.

The design and engineering of the formwork as well as its construction shall the responsibility of the Contractor. However, if so desired by the Project Manager, the

drawings and calculations for the design of the formwork shall be submitted to the Project Manager for the approval.

Formwork shall be designed to fulfill the following requirements:

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.

Made of suitable materials.

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

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

Capable of easy striking out without shock, disturbance or damage to the concrete.

Soffit forms capable of imparting a camber if required

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

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 and 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 Project Manager. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints 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 at no extra cost.

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 Project Manager. The Contractor 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 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of the Project Manager, 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 Project Manager, than that required as per drawing to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

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 1.0 m or as approved by the Project Manager. The Contractor shall temporarily and securely fix items to be cast (embedments/ 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 Contractor's cost.

11 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 Project Manager. Contractor shall maintain separate Pour Card for each pour as per the approved format.

11.1 Check for Reinforcement and concreting

All reinforcement shall be checked and recorded prior to pouring of concrete by an authorised representative of the Project Manager. Similarly the entire concrete pouring work shall be done in the presence of authorised representative. The contractor shall therefore give a notice of a minimum three days to the Project Manager or his representative such that the works can be checked by him or his

authorised representative.

11.2 Transporting, Placing and Compacting Concrete

Concrete shall be transported from the 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. During hot or cold weather, concrete shall be transported in deep containers or by other suitable measures to reduce loss of water by evaporation and heat loss in cold weather may also be adopted.

In all cases concrete shall be deposited as nearly as practicable directly in its final position to avoid rehandling. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0 m. Care shall be taken to avoid displacement of reinforcement or formwork.

Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

Continuously between construction joints and pre-determined abutments.

Without disturbance to forms or reinforcement

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

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

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

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

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.

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

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

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. Over-vibration shall be avoided; under vibration is likewise harmful.

The vibrator should penetrate rapidly to the bottom of the layer and at least 15 cm into the preceding layer if there is any. It should be held generally 5 to 15 sec. until the compaction is considered adequate and then withdrawn slowly at thereof about 8 cm/s.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Project Manager. 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 Project Manager. Concrete shall be protected against damage until final acceptance.

11.3 Mass Concrete Works

Sequence of pouring for mass concrete works shall be as approved by the Project Manager. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

11.4 Curing

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

Premature drying out, particularly by solar radiation and wind;

- leaching out by rain and flowing water;
- rapid cooling during the first few days after placing;
- high internal thermal gradient;
- low temperature of frost;
- vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement

- After the concrete has begun to harden i.e. 1 to 2 hr. after laying curing shall be started.
- All concrete, unless approved otherwise by the Project Manager, 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 10 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 Project Manager, 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 Project Manager before use and shall be applied with spraying equipment capable of a smooth, even textured coat.
- When concrete is used as subgrade for flooring, the flooring may be commenced before the curing period of subgrade is over, but curing of subgrade shall be continued along with the top layer of flooring for a minimum period of 10 days.
- Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

11.5 Construction Joints and Keys

The position and arrangement of construction joints shall be as indicated by the contractor in his working drawings dually approved by the department. 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 Project Manager.

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 drawings or as approved by the Project Manager. Before resuming concreting on a surface which has hardened all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and horizontal layers. 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 of 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.

For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the concrete mix. This cement slurry or

mortar shall be freshly mixed and applied immediately before placing concrete.

11.6 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 filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Project Manager. 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 surface shall be kept wet for 2 to 4 hours before concreting.

Excavation, in clay or other soils that are likely to be affected by exposure to atmosphere, shall be concreted as soon as they are dry. Alternatively, unless otherwise mentioned the bottom of the excavation shall be protected immediately by 8 cm thick layer of cement concrete not leaner than M10 or in order to obtain a dry hard bottom, the last stretch of excavation of about 10 cm shall be removed just before concreting.

11.7 Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc, shall be inspected by the Project Manager 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 Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Project Manager.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Project Manager as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Project Manager.

11.8 Hot Weather Requirements

Concreting during hot weather shall be carried out as per IS 7861 (Part I).

Adequate provision shall be made to lower concrete temperatures which shall not exceed 40 deg C at time of placement of fresh concrete.

Where directed by the Project Manager, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

11.9 Cold Weather Requirements

Concreting during cold weather shall be carried out as per IS: 7861(Part II).

The ambient temperature during placement and upto final set shall not fall below 5 deg. C. Approved antifreeze/accelerating additives shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

11.10 Liquid Retaining Structures

The Contractor 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.

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

The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.

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 Project Manager. All such rectification shall be done by the contractor to the entire satisfaction of the Project Manager at no extra cost to the department.

11.11 Waterstops

Material

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS : 12200. Testing shall be in accordance with IS : 8543.

- a) Tensile strength : 3.6 N/mm² minimum
- b) Ultimate elongation : 300% minimum
- c) Tear resistance : 4.9 N/mm² minimum
- d) Stiffness in flexure : 2.46 N/mm² minimum
- e) Accelerated extraction
 - i) Tensile strength : 10.50 N/mm² minimum
 - ii) Ultimate elongation : 250% minimum

- f) Effect of Alkali : 7 days
 - i) Weight increase : 0.10% maximum
 - ii) Weight decrease : 0.10% maximum
 - iii) Hardness change : ± 5 points
- g) Effect of Alkali : 28 days
 - i) Weight increase : 0.40% maximum
 - ii) Weight decrease : 0.30% maximum
 - iii) Dimension change : $\pm 1\%$

PVC waterstops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

PVC waterstops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Project Manager before procurement for incorporation in the works.

11.12 Workmanship

Waterstops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion-welded type as per manufacturer’s instructions.

Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/ end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting waterstops shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

11.13 Preformed Fillers and Joint Sealing Compound

Materials

Preformed filler for expansion / isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS : 1838 Part I or IS 1838 Part 2.

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS:702. Bitumen primer shall conform to IS : 3384.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS:1834.

Other organic solvents such as polysulphate based joint sealants to IS:1433 Part 1 or IS 12118 Part 1 may be used with the approval of Project Manager.

12 Structural Steel Work

12.1 Fabrication

General

As much fabrication work as is reasonably practicable work shall be completed in shops, where steel work is fabricated.

All workmanship and finish shall be of the best quality and shall conform to the best-approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Tolerances for fabrication of steel structures conform IS 7215. Tolerances for erection of steel structures shall conform to IS 12843.

Minimum thickness of metal - Corrosion Protection

Unless, otherwise specified, the thickness of steel section shall be governed as below:

12.2 Steel work exposed to weather

Where steel work is directly exposed to weather and is fully accessible for clearing and repairing the thickness shall not be less than 6 mm; and where steel is exposed to weather and is not accessible for cleaning and painting, the thickness shall not be less than 8 mm. This shall not apply for hot rolled sections covered by Indian Standards.

12.3 Steel work not directly exposed to weather

The thickness of steel work not directly exposed to the weather shall be not less than 6 mm. The thickness of steel in secondary members shall be not less than 4.5 mm. For hot rolled sections to Indian Standards, the mean thickness of flange be considered and not the web thickness.

- a) The requirements (a) and (b) above does not apply to light structural work or sealed box section or to steel work in which special provision against corrosion has been made and also in case of steel work exposed to highly corrosive fumes or vapour in which case the thickness shall be as approved by the Project Manager.

Drawings prepared by the CONTRACTOR

The contractor shall prepare all fabrication working and erection drawings for the entire work. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

All fabrication drawings shall be submitted to the Project Manager for approval.

No fabrication drawings will be accepted for Project Manager's approval unless checked and approved by the contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the contractor only after Project Manager's approval of fabrication drawings. Approval by the Project Manager of any of the drawing shall not relieve the contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon.

The drawings prepared by the contractor and all subsequent revisions etc. shall be at the cost of the contractor for which no separate payment will be made.

12.4 Welding

Welding shall be in accordance with IS 816, IS 819, IS 1024, IS 1261, IS 1323 and IS 9595 as appropriate.

Welding procedure shall be submitted to the Project Manager for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS :7310 (Part 1) and IS :7318 (Part 1).

For welding any particular type of joints, welders shall give evidence acceptable to Project Manager of having satisfactorily completed appropriate tests as per IS 817 Part 1, IS 1393, IS 7307, IS 7310 Part 1 and IS 7318 Part 1 as appropriate.

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Project Manager shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during period of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately panned with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below -5 Deg. C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

All welds shall be inspected for flaws

The correction of defective welds shall be carried out in a manner approved by the Project Manager without damaging the parent metal.

12.5 Painting

All fabricated steel material, except those galvanised shall receive protective paint coating as prescribed in IS 1477 Parts 1 & 2.

All surfaces to be painted, oiled or otherwise treated shall be dry thoroughly cleaned to remove all loose scale and loose rust.

Shop contact surfaces need not be painted unless otherwise specified.

Surfaces not in contact but inaccessible after shop assembly shall receive full specified protective treatment before assembly. This does not apply to interior of hollow seatings.

Chequered plates shall be painted after the details of painting are approved by the Project Manager.

In case of surfaces to be welded, steel shall not be painted within a suitable distance of any edges to be welded if paint would be harmful to the welder or impair the quality of welds.

Welds and adjacent parent metal shall not be painted prior to slugging, inspection and approved.

Parts to be encased in concrete shall not be painted or oiled.

12.6 Surface Treatment

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The type of surface treatment shall be as specified in the respective item of work. The workmanship shall generally conform to the requirements of IS 1477- Part I.

12.7 Painting of Ferrous Surface

Unless and otherwise mentioned, all MS fabricated items used in the project shall be painted with any of the three options given for interior or external works. The specifications adopted for every component must be got approved from the Project Manager, before use.

Sr. No.	Final Finish Required	Primer	Undercoat	Finishing Coat	Number and Thickness of Coating
(1)	(2)	(3)	(4)	(5)	(6)
A. FOR INTERIORS					
(i)	Full gloss (enamel gloss)	IS 102:1962 (see Note) IS 207:1964	IS 133:1993 (B)1 IS 2933:1975 (B, S)1	IS 133:1993 (B)1 IS 2933:1975 (B, S)1	For optimum results, two coats of primer, one undercoat, and two finishing coats are recommended. The total film thickness shall be not less than 100 microns.
(ii)	Oil gloss	Same as for (i)	IS 133:1993 (B) OR IS 144:1950 (S)		Same as for (i)
(iii)	Metallic finishes	Same as for (i)	-	IS 2339:1963 (B) IS 2339:1963 (S) OR Bituminous aluminium paints	One coat of primer and two finishing coats; if bituminous aluminium paint is used, three coats will be necessary.
(iv)	Bitumen	Same as for (i)	-	IS 158:1981	Three coats of bitumen shall be used.
B. FOR EXTERIORS					
(v)	Full	IS 102:	IS 2933:19751	IS	For optimum results, two coats of primer,

Sr. No.	Final Finish Required	Primer	Undercoat	Finishing Coat	Number and Thickness of Coating
(1)	(2)	(3)	(4)	(5)	(6)
	gloss	1962 (see Note))	2933:19751)	one undercoat, and two finishing coats are recommended. The total film thickness shall be not less than 100 micron.
(vi)	Oil gloss	Same as for (v)	-	IS 117:1964 OR IS 128:1962	Same as for (vii)
(vii)	Metallic finishes	Same as for (v)	-	IS 2339:1963 OR Bituminous aluminium paint	One coat of primer and two finishing coats; if bituminous aluminium paint is used, three coats will be necessary.

NOTE – Paint primer conforming to IS 102:1962 may be used only where special precautions for drying of the primer coat taken and where satisfactory drying conditions is ensured before application of further coats.

1) Each of these Indian Standards cover both undercoating and finishing paints, and paints appropriate for the function shall be used.

12.8 Materials

- 1) *All the materials shall be of the best quality from an approved manufacturer. contractor shall obtain prior approval of the Project Manager for the brand of manufacturer and the colour/shade prior to procurement for usage in the works.*
- 2) *Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.*
- 3) *The colour and shade shall conform to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade/number from the alternatives available, contractor shall adopt*

trial painting in small patches in consultation with and as directed by the Project Manager.

- 4) *All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically directed by the Project Manager.*
- 5) *Paints shall be stirred thoroughly to keep the pigment in suspension.*
- 6) *Contractor shall at his own cost arrange for testing of paints as per relevant Indian Standard laboratory whenever Project Manager wants the tests to be carried out for each batch of paints. Test results shall be submitted to the Project Manager for obtaining approval.*

12.9 Workmanship

- 7) *The type and the number of coats of the primer paint and finish paint shall be as specified in the respective items of work.*
- 8) *Painting shall be carried out only on thoroughly dry surfaces.*
- 9) *No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 50⁰ C or lower.*
- 10) *Primers shall adhere to the surface firmly and offer a key to the subsequent coats.*
- 11) *The application of paint film serve the twin purpose of protecting the steel from corrosion and giving the decorative appearance. A paint which gives the steel adequate protection over a long period together with good appearance shall therefore be adopted.*
- 12) *Workmanship shall generally conform to requirements specified in IS 1477-Part-II.*
- 13) *It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film without "holidays". After the first coat becomes hard dry a second coat of primer shall be applied by brushing to obtain a film free from holidays.*
- 14) *Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces of the first coat during transport from shop to site and during erection shall be provided with a touch up coat of the primer.*
- 15) *The dry film thickness of each coat of primer shall be not less than 25 microns.*

- 16) *Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection to the steel surface over a long duration.*
- 17) *Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Filler prepared by whiting and linseed oil by craftsmen at site shall never be used as such fillers may be unbalanced and incompatible with primer and finishing coats. Application of filler shall be done with good putty knife and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, due as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.*
- 18) *Painting shall be carried out either by brushing or by spraying. contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.*
- 19) *After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.*
- 20) *The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.*
- 21) *At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Project Manager.*
- 22) *Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.*
- 23) *Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.*
- 24) *Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.*

- 25) Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.
- 26) Portion of steel members embedded to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50 mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall receive the painting as specified.
- 27) Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. The breakdown of a paint film is progressive from the top finish paint to the primer coat and the object of maintenance painting is to renovate periodically to effectively check the breakdown and protect the steel surfaces from corrosion. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause 7 of IS 1477 - Part II.
- 28) Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls etc.

13 Civil Works Details

13.1 Brickwork

13.1.1 Materials

Bricks used in the works shall conform to the requirements laid down in IS : 1077, IS 2180, IS 2222, IS 2691, IS 3952, IS 6165. The class of the bricks shall be as specifically indicated in the respective items of work prepared by the Contractor.

Bricks shall have following dimensions :

	Length	Width	Height
	Mm	mm	mm
Non Modular Bricks	230	110	70
	230	110	30

Common burnt clay bricks are classified on the basis of compressive strength as given below:

Class designation	10	7.5	5	3.5
Avg. compressive strength N/ mm ²	10	7.5	5	3.5

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/ machine moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be uniform in colour, tolerance of brick dimension shall be $\pm 3\%$ for designation 10 & above and $\pm 8\%$ for lower designation. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck.

The sample size for all the tests shall be as follows :

Brick	Lot size	Sample Size
Class 10	more than 50000 bricks	20 bricks
7.5, 5, 3.5	more than 100000 bricks	20 bricks

The sampling shall be at random & samples shall be stored in a dry place until tests are done.

13.1.2 Compressive strength :

Five bricks shall be tested. The average compressive strength shall be as per class designation. The compressive strength of individual brick shall not be less than 20 % of the specified value.

13.1.3 Water absorption :

Five bricks shall be tested for water absorption and shall not exceed 20 % by weight upto class 12.5 & 15% by weight for higher classes.

13.1.4 Efflorescence :

Five bricks shall be tested for efflorescence. The efflorescence shall be 'nil' to 'moderate'

Sample bricks shall be submitted to the Project Manager for approval and bricks supplied shall conform to approved samples. If demanded by Project Manager, brick samples shall be got tested as per IS : 3495 by Contractor. Bricks rejected by Project Manager shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand.

Mortar leaner than 1:5 and richer than 1:3 shall not be used.

13.1.5 Preparation of mortar

Materials

1) Water :

Water used shall be clean and reasonably free from injurious or deleterious materials such as oils, acids, alkalis, salts. The pH value of water shall not be less than 6.

2) Cement :

Cement shall conform to any of the following :

33 Grade	Ordinary	Portlan d	Cement	IS : 2697
43 Grade	Ordinary	Portlan d	Cement	IS : 8112
53 Grade	Ordinary	Portlan d	Cement	IS : 12269

3) Sand :

Sand for masonry mortars shall conform to IS 2116

13.1.6 Preparation of mortars :

Mortars shall be prepared and tested as per IS 2250. Mixing of cement mortar shall be done in a mechanical mixers.

13.1.7 Workmanship

Workmanship of brick work shall conform to IS : 2212. All bricks shall be thoroughly soaked in clear water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work prepared by the Contractor. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/ 115 mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast on e face should be kept

smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one meter. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10 mm/ 15 mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During harsh weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Project Manager.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS : 2750 and IS : 3696 (Part - I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Project Manager. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/ pointing.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/ floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top

with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS : 1397 or 2 layer of 50 micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 150 mm thickness, projecting 150mm on either sides of the beam, duly finished on top with 2 layer of Kraft paper Grade 1 as per IS : 1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to predeflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.

Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

13.2 Uncoursed Random Rubble Masonry, in Foundation Plinth and Superstructure

13.2.1 Materials

Stones for the works shall be of the specified variety which are hard, durable, fine grained and uniform in colour (for superstructure work) free from defects like cracks, sand holes, patterns of soft / loose materials veins, other defects. Quality and work shall conform to the requirements specified in IS : 1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Project Manager for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be as per IS 2250.

13.2.2 Scaffolding

Type of scaffolding to be used shall be as specified in the section of brick masonry.

13.2.3 Workmanship

For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dress stones for

the facing.

For all R.R. masonry in superstructure the masonry shall be well bounded, faced with hammer dressed stones with squared quoins at corners. The bushing on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depression more than 10mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in wall upto 600 mm thick and in case of wall above 600mm thickness, a set of two or more bond stones overlapping each other by at least 150mm shall be provided in a line from face to back. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45 deg. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

13.3 Damp - proof Course

13.3.1 Materials and Workmanship

All the walls in a building shall be provided with damp-proof course covering plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other opening. Damp-proof course shall consist of minimum 50mm thick cement concrete of 1:2:4

nominal mix with nominal reinforcement and approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10mm down graded coarse aggregates.

The surface of brick work/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster. Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

13.4 Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedments etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction Drawing to be prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the Project Manager. In the event, of any of the inserts are improperly installed, contractor shall make necessary arrangement to remove and reinstall at the correct locations/levels all as directed by the Project Manager.

13.5 Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in items of works prepared by the Contractor.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

13.6 Cement Plastering Work

13.6.1 Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Project Manager. If so desired by the Project Manager sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding

water as required restoring consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

13.6.2 Workmanship

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/ window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10 mm / 20mm for brick/ stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

a) Interior plain faced plaster

This plaster shall be laid in a single coat of 12 mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Project Manager.

b) Plain Faced Ceiling plaster

This shall be applied in a single coat of 6 mm thickness. Application of mortar shall be as stipulated in above paragraph.

a) Exterior plain faced plaster

This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14 mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20 mm thick if specified for uneven faces of brick walls or for random/ coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

For external plaster, the plastering operation shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/ windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 6.6.1.8.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2 m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/ thermal movement.

Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

13.7 Cement Pointing

13.7.1 Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS : 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Project Manager and if so directed it shall be washed/ screened to meet specification requirements.

13.7.2 Workmanship

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15 mm/ 20 mm deep in brick/ stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/ dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joint shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Wherever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Project Manager.

13.8 Water-Proofing Admixtures

Water-proofing admixtures shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer’s instructions and as directed by the Project Manager.

13.9 Pump House Civil Works

13.9.1 General

The pumping station building, construction of control cum administrative building etc., includes foundation works for pump/motor/transformer and other equipment & allied works, finishing works, lighting works etc. as detailed in scope of work.

The design considerations, material specifications, workmanship and testing of materials shall be as per Chapter for “Specifications for Civil Works”. The general requirement of pump house buildings shall be as follows:

S.No	PARTICULARS	SPECIFICATIONS
1.	Type of Structure	RCC frame Structure
2.	Plinth Level	Minimum 0.75 meters above finished ground level
3.	Minimum Height of building above finished floor Levels	
	i) at Pump/motor floor area	As per the requirement of installation of pumps and minimum height below crane.
	ii) Areas of Switchgear	4 meters
	iii) loading/ unloading/ maintenance bays	4 meters
	iv) other areas	4 meters
4.	External walls Below Ground Level	RR stone masonry in Cement Sand mortar 1:6

S.No	PARTICULARS	SPECIFICATIONS
5.	External walls above Ground Level	Brick masonry 23mm thick in Cement Sand mortar 1:6
6.	Internal load bearing walls	Brick masonry 23mm thick in Cement Sand mortar 1:6
7.	Partition walls	Half Brick masonry in Cement Sand mortar 1:4
8.	External finish	Either of water proofing cement paint, sand face plaster, Dholpur/Karauli stone facing as per approved architectural plan
9.	Plaster	
	Interior Plaster	20 mm thick in Cement Sand mortar 1:6
	Plaster on external Walls	20 mm thick in Cement Sand mortar 1:6
	Toilet	Glazed tiles upto lintel level and plaster 20 mm thick in Cement Sand mortar 1:4 above
10.	Flooring	
a)	Pump/motor Room	Floor Hardner (ironite) topping with CC base
b)	Switchgear Room	Floor Hardner (ironite) topping with CC base
c)	Battery room/ Battery Charger room/Operator office space/ duty room/ office space/toilets and other areas	Kota Stone/Marble
d)	Control room	PVC flooring with CC flooring base
e)	Walk ways	MS Chequered plates
f)	Corridors and stairs	Kota stone/Marble
11.	Painting	
a)	Outer building area	Cement based paint

S.No	PARTICULARS	SPECIFICATIONS
b)	Inner areas of pump/motor room, office area and lobbies	Dry Distemper
c)	Control room	Acrylic Plastic Emulsion Paint
12.	Doors	
a)	Control room	Glass paneled Aluminum Double door shutters with aluminum frame and single panel hinged shutters with door closures. The first gate shall be provided with air curtain of appropriate design to ensure dust proofing.
b)	Main Entrance Doors	Glass paneled Aluminum door shutters with aluminum frame and double panel hinged shutters with door closures.
c)	Switchgear room	Glass paneled Aluminum door shutters with aluminum frame and single panel hinged shutters with door closures.
d)	toilet and other areas	Pressed steel frame with 38mm thick flush doors shutter
13.	Windows	
a)	On Outer Front Walls and other windows opening in main entrances	Glass paneled Aluminum shutters with aluminum frame and double panel shutters. (All windows in Control room will be fixed without shutters of same specifications)
b)	Other Windows	steel section window with wire gauge and safety grill
14.	Cooling Arrangement	
a)	Entrance lobby	Fans
b)	Office rooms	Fans and Coolers
c)	Duty Room	Fan and coolers

S.No	PARTICULARS	SPECIFICATIONS
d)	Control room	Fan and Coolers /AC
15.	Drinking water arrangements	
a)	Treatment and cooling	Water cooler 40 liter per Hour and storage capacity 80 liters with Zero –B, to be installed

Miscellaneous requirements

13.9.2 Nameplates, signboards, nomenclature

Each item of the plant shall have permanently attached to it in a conspicuous position a nameplate, on which shall be engraved or stamped the manufacturer's name, type and serial number, year of manufacture, details of the design capacity etc. Such labels shall be of non-hygroscopic material to be approved by the Project Manager.

Near by or on each item of the plant, shall be fixed a plate with the name and nomenclature (code) of the item according to the project nomenclature. It shall be visible from a distance of several metres.

The Bidder shall also provide bilingual signboards and instruction tables of durable material, throughout the plant, for the purposes of operation, maintenance and security:

- Danger and caution signs (English and local language)
- Preventive maintenance schedules (local language)
- Operating instructions (local language)
- Unit names (English and local language)
- Nameplates at the doors to the units (English and local language)

Signboards and plates shall be appropriately sized in relation to the relevant item and its surroundings. Details of the proposed inscription, size, material and colours shall be submitted to the Project Manager for approval before any signboards or plates are manufactured. They shall be compatible with the instructions in the operation manual.

All cables shall be provided with clip-on identification numbers on both ends and at all terminations in between, for identification. The nomenclature shall correspond to the electrical as-built drawings.

The nomenclature and labelling of the plant shall be decided in close co-operation with the Project Manager.

13.9.3 Fire extinguishers

The Bidder shall provide 4 nos. dry powder type CO₂ fire extinguishers (10 kg) for the each pumping station and switchyards at the following locations after consultation with the Project Manager:

- at transformer site (1 nos. at each P.S.)
- indoor electrical room (1 Nos. at each P.S)
- pump rooms (maintenance bay) (1 Nos. at each P.S)
- control room (1 No at each P.S)

13.9.4 First aid kits

Complete first aid kits at all the sites shall be provided for the maintenance bays of the pump houses. The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns bad effects of inhalation of chlorine, bad effects on skin due to contact of chemicals acids etc. Following materials in general in sufficient quantities shall be provided.

- Medical cotton, sterile cotton pads
- Cotton Bandages, elastic bandages
- Pair of scissors, packet of new shaving blades
- Sticking plaster for medical use.
- Band aid stripes

Following chemicals/medicines shall be provided in sufficient quantities :

- Tinctures iodine and mercury chrome
- Burnol ointment
- Bottles of spirit and of Dettol
- Toilet soaps

To be procured under medical advice

- Skin lotions and ointments for burns, acid effects
- Eye drops for soothing effects

Fire extinguisher and first aid kits shall be provided for the end of the commissioning period only. They shall not be used before and shall be complete.

II. PIPELINE WORKS

1. Introduction

Clauses in this section shall apply to pipes, valves and fittings of all kinds (except as may be noted hereunder), whether required to be laid in, on , or above ground, or to be fixed on, or built into other parts of the works. The laying and testing of pipes shall conform to the latest available IS codes including all current Appendices and Amendments as and where applicable.

Excavation and backfilling of pipe trenches shall be carried out as specified in relevant section of specification.

For the purpose of proper interpretation of this specification, the following terms shall have the meanings hereby assigned to them:

Pipe(s) and Fitting(s) : means straight pipe(s) both for full and part length, fitting(s) which may be both standard and non-standard comprising bend(s), tee(s), collar(s), wye(s), reducer(s), enlarger(s), tail piece(s), end cap(s), plug(s) etc. and includes joint(s) and jointing materials(s).

Valve(s): means gate valve(s), air valve(s), sluice valve(s), washout or scour valve(s), and the like and include jointing material(s), operating gear(s) (as applicable) and associated fitting(s).

Pipeline: means those parts of the works comprising pipes, fittings and valves.

Specific Storage Area: means the area at which materials to be utilized for the works shall be stored and to be kept open for inspection by the Third Party.

Except as otherwise specified in this technical specification, the Indian Standards and Code of Practice in their latest version, National Building Code, PWD specification of the state of Rajasthan and Manual of water supply of GOI shall be adhered to for the supply, handling, laying, installation and site testing of all material and works.

2.2 Materials

2.2.1 UPVC PIPES

This section of the document specifies the required properties of the pipes made of unplasticized polyvinyl chloride (uPVC) with socket(s) suitable for elastomeric sealing ring type joints for conveyance of water under pressure for supply of drinking water. The pipes are intended to be used for buried water mains with ambient atmospheric temperature reaching up to 50°C and soil surface temperature rising more than 65°C. The stipulations given in this document for uPVC pipe which are not covered by any other code/standard, shall be governed by the provisions of IS 4985. The pipes will be supplied with one end plain with chamfer and other end socket suitable for elastomeric sealing ring type joints in accordance with IS: 4985. Each pipe shall be supplied along with one suitable elastomeric sealing ring with 5% extra rings on overall number of pipes. The pipes shall be ISI marked and of Finolex / Supreme /

Jain Irrigation / KASTA make or equivalent as approved by employer’s representative.

The material from which the pipes are made shall consist substantially of unplasticized polyvinyl chloride conforming to IS: 10151, to which may be added only those additives that are absolutely needed to facilitate the manufacture of the polymer, and the production of sound, durable pipes of good surface, finish, mechanical strength and opacity. The total quantity of additives like plasticizers, stabilisers, lubricants and fillers shall not exceed more than 7.0%. The bulk density of uPVC pipe shall be 1.39 to 1.44 g/ cm³. PVC resin of suspension grade K-66/K-67 shall be used for extrusion of uPVC pipe. The pressure rating of pipes shall be of class-3 and class-4 in accordance with IS: 4985 with a maximum continuous working pressure at 27 °C of 6 and 10 kg/cm².

2.2.1.1 DIMENSIONS OF THE PIPES AND THE SOCKETS

The dimensions and tolerances of pipes shall comply with IS: 4985. The tolerance on outside diameter and wall thickness of pipe shall be as per Table-1 given in IS: 4985. The dimensions of the socket for elastomeric sealing ring type joint shall be in accordance with Clause 7.2.1.2 and Tables 4 and 5 of the IS 4985. The pipe shall be supplied in straight lengths of 6 m with tolerance of + 20 mm and -0 mm. The effective length of socket pipe shall be considered as shown in Figure-3 of IS: 4985.

2.2.1.2 PHYSICAL & CHEMICAL PROPERTIES

The pipe shall conform to the Clause 10 of IS 4985-2000 for its physical and chemical properties except for the density and ash content provisions which shall be as per the stipulations made above. The colour of the pipes shall be dark grey. Influence on water intended for human consumption shall be governed by IS: 12235. All plastic and material for components of the uPVC piping system e. g. Elastomeric sealing ring, lubricants, when in permanent or in temporary contact with water which is intended for human consumption, shall not adversely affect the quality of the drinking water.

2.2.1.3 MECHANICAL PROPERTIES

The pipes and integral sealing ring will conform to internal hydrostatic pressure in accordance with Clause 11.1 and sampling as per annexure D of IS 4985.

2.2.1.4 TESTS AND CONFORMITY CRITERIA

The following in-house tests shall be carried out on the raw material by the manufacturer:

- grade (K-value)
- particle size distribution
- bulk density of resin
- bulk density of compound

The manufacturer will also have the following tests conducted from Standard Test Laboratory

- Effect on water quality
- Internal Hydrostatic Test (Type)

Acceptance Test

The pipes shall be inspected by Third party inspection agency for confirmation of the material to IS 4985 and the specifications given above.

2.2.1.5 MARKINGS

Each pipe shall be clearly marked as indicated below:

- Manufacturers name and trademark
- Outside diameter in mm.
- Class of pipe and pressure rating
- Year of manufacturing
- Marking of insert depth of spigot
- ‘PHED’

Each pipe shall also be marked in centre strip as circumference 1” wide at intervals not more than 3 meters to show the class of pipe.

- Class 3 – Green
- Class 4 – Brown

2.2.1.6 PACKING AND TRANSPORT

The socket and spigot end of all the pipes shall be provided with tightly fitted end caps, protecting the inside of the pipes effectively against dirt etc. The end caps shall be of suitable high density (HD) plastic material in any colour other than black. They shall be fitted to the pipes prior to packing and transportation.

The pipes shall be transported to the store and site by trucks in pre packed bundles to ensure adequate protection during transport. At the time of packing and stacking of pipes the sockets shall be alternated within the pile and shall project sufficiently for the pipes to be correctly supported along their whole length. The pipes shall rest uniformly on the vehicle bed over their whole length during transport, carefully placed and firmly secured against unwarranted movement during transportation to the satisfaction of Engineer Incharge.

2.2.1.7 Rubber Rings for PVC Pipes and Specials

Scope: To prescribes the requirements for materials used for vulcanised solid rubber sealing rings for water supply at ambient temperature. It covers rubber rings for uPVC pipes.

Material

The rubber shall be free from extractable substances which impart taste, odour or toxicity to water. The rubber or its compound shall not contain toxic materials, such as compounds of mercury, antimony, manganese, lead or copper.

The rubber rings shall be vulcanised from Ethylene propylene (EPDM). The colour of material shall be black.

The rubber ring shall be long term termite resistant.

The sealing ring shall have no detrimental effect on the properties of the pipe and shall not cause the test assembly to fail the functional requirements .

Appearance and homogeneity

The rings shall be homogeneous, free from porosity, grit, excessive blooms, blisters, or other visible surface imperfections. The fin or flash shall not exceed 0.4 mm and width 0.8 mm.

Rubber rings shall be made of a properly vulcanised virgin rubber compound containing no scrap or reclaim.

The surface of the rubber rings shall be smooth, free from pitting cracks, blisters, air marks, and any other imperfection that may affect its behavior in service. The body of the rubber ring shall be free from porosity and air pockets.

Dimensions and tolerances

The profile and dimensions of the rubber ring shall be such that under normal circumstances efficient sealing can be expected for the socket dimensions.

The nominal measurements and the tolerances shall be in accordance with the figures stated by the manufacturer and they shall be laid down in a drawing.

Physical requirements

The rubber ring shall have the ISI mark and will conform to IS: 5382 and comply with the following physical properties when tested in accordance with IS: 3400.

Properties	EPDM
Tensile Strength	11 MPa
Hardness	50, +5, -4 IRHD
Elongation at break	Min. 400%
Compression Set Test condition 27degree C., 72h, Max. permanent deformation	12%
Water absorption Test	Max. 10%

Accelerated ageing Test	
Hardness	-5 to +8 IRHD
Tensile Strength	± 20%
Elongation at break	-30% to +10%

Marking

Each sealing ring shall be permanently marked with:

- The Manufacturer’s name or trade mark.
- The month and year of manufacture
- Diameter of pipe for which the ring is suitable.
- Type of rubber material

Testing

The scale of sampling and criteria for conformity shall be in accordance with IS: 5382. The following tests shall be conducted for conformity.

- Hardness
- Tensile strength
- Elongation at break
- Compression set
- Accelerated ageing
- Water absorption
- Stress relaxation

The test pieces shall be cut from the finished product. Where this is not possible because the sample would be too small, the manufacturer shall provide test slabs from the same batch of rubber and vulcanised to the same degree and in the same manner as that of the rubber from which the rubber rings have been manufactured.

Wherever it is not possible to cut standard test piece from the rings, for determination of tensile strength and elongation at break, test piece in the shape of dumb bell as shown in Figure - 2 of IS: 5382 shall be used with the rate of traverse of moving grip as 15 cm/min.

Packing

Strength and elongation at break, test piece in the shape of dumb bell as shown in – 2 of IS 5382 shall be used with the rate of traverse of moving grip as 15 cm/min.

Maximum 10 pieces of rubber ring shall be packed in one polyethylene bag. The colour of the polyethylene bags shall be preferably black or dark grey. The rubber rings packed in polyethylene bags shall be supplied in bituminised polyethylene lined jute bags to protect them from undue exposure to light and heat.

The rubber rings should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

2.2.1.8 SPECIALS FOR UPVC PIPES

All the uPVC fittings shall be fabricated from class-4 uPVC pipes conforming to above specifications only and shall be all socketed & suitable for use with elastomeric sealing rings. The socket dimensions shall be in accordance with the pipe sockets. The rubber sealing rings for pipe/specials shall be in accordance with the specifications as stated in following clauses.

Double sockets:

The dimensions of the Double sockets shall be as given in Table below :

S No.	Suitable for pipe OD (mm)	Min. length of fitting (h) mm	Min. spacer (l) mm
1	63	235	20
2	90	266	20
3	110	288	20
4	140	314	20
5	160	334	20
6	225	404	30
7	280	460	30
8	315	485	30

DOUBLE SOCKET BENDS:

The fabricated bends shall be suitable for elastomeric sealing ring type joint. The dimensions of the double socket bends shall be as given below:

S. No.	Outside diameter in mm	Radius (r) mm	Angle of bend in degrees	L1 = L2
1	63	221	90	359

		221	45	230
2	90	315	90	469
		315	45	285
3	110	385	90	551
		385	45	326
4	140	490	90	674
		490	45	387
5	160	560	90	756
		560	45	428
6	225	788	90	1023
		788	45	562
7	280	980	90	1268
		980	45	674
8	315	1100	90	1410
		1100	45	746

QUALITY CONTROL TESTS

All the fitting shall be tested for socket dimension, workmanship/surface finish and leak tightness in accordance with those for uPVC pipes.

All the PVC fittings shall be supplied along with necessary rubber rings. The rubber rings shall be supplied in black coloured polyethylene bags. The fittings shall be packed and supplied in jute bags or in cardboard or wooden boxes according to their size.

The fittings should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under it's own supervision and have it tested at his/sub contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

2.2.2 DUCTILE IRON PIPES :

The pipes will be centrifugally cast (spun) Ductile Iron pipes for Water and Sewage confirming to the IS 8329: 2000. The pipes used will be either with push on joints (Rubber Gasket Joints) or Flanged joints. The class of pipe to be used shall be of the class K-7 & K-9.

The pipes shall be outside coated with zinc with a finishing layer of bituminous paint as per appendix A and have factory provided cement mortar lining in the inside as per the provisions of Appendix B of the IS 8329: 2000.

The pipes will be supplied in standard length of 4.00, 5.00, 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety will also be supplied with a rubber EPDM gasket. Any change in the stipulated lengths will be approved by the Engineer – in charge. The gaskets will confirm to the IS 5382:1985.

The gaskets should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under it’s own supervision and have it tested at his/sub contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products. The flanged joints will confirm to the Clause 6.2 of IS 8329. The pipe supply will also include one rubber gaskets for each flange.

2.2.2.1 CEMENT MORTAR LINING

All pipes and fittings shall be internally lined with cement mortar in accordance with ISO 4179 / IS:11906. Cement mortar lining shall be applied at the factory in conformance with the above mentioned standards. No admixtures in the mortar shall be used without the approval of the Employer’s Representative.

Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Employer’s Representative.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be 3 mm for pipes up to DN 300 mm.

2.2.2.2 COATINGS

a) Ductile iron pipes and fittings shall be zinc coated with bitumen over coating, all in accordance with the following Specifications. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Employer’s Representative.

b) Zinc Coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m² as described in Clause 5.2 of ISO 8179.

c) Bitumen Coating

Bitumen coating shall be of normal thickness 75 microns unless otherwise specified. It shall be a cold applied compound complying with the

requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

- Each lot of primer and paint used by manufacturer shall be accompanied by certified copies of the test results on hardness, impact and heat resistance and resistance to corrosion carried out by manufacturers in accordance with relevant Indian or International standards.
- Surface preparation shall be in accordance with manufacturer’s instructions, but as a minimum the pipes shall be abrasive blast cleaned to BS 7079 Grade Sa 2.5 or equivalent to achieve surface roughness profile of 40 – 50 microns. The primer shall be applied within 2 hours of surface preparation, before flash rusting can occur. Two coats of Zinc rich epoxy primer shall be applied by spray equipment on the pipes and fittings.
- The priming coat shall be uniform in thickness and free from floods, runs, sags, drips, and bare spots. Any bare spots or defects shall be recoated with an additional application of the primer. All defects shall be rectified as per the instructions of the Employer’s Representative.
- Though the priming coats become touch dry in 10 to 15 minutes, the finishing coats with epoxy paints shall be applied after allowing the film to cure at least for 48 hours. The final dry film thickness shall be a minimum of 300 microns. This may be achieved by applying in 2 to 4 coats.
- On completion of the work, the contractor shall remove any oil stains or paint spots, leaving the pipes and fittings in a clean and acceptable condition.

2.2.2.3 INSPECTION AND TESTING:

The pipes will be subjected to tests provided in IS:8329 including following tests for acceptance:

- Visual and dimensional check as per Clause 13 and 15 of IS 8329
- Mechanical Test as per Clause 10 of IS 8329
- Hydrostatic Test as per Clause 11 of IS 8329
- The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5832.

2.2.2.4 MARKING

- All pipes will be marked as per Clause 18 of IS 8329 and as below:
- Manufacturer name/ stamp
- Nominal diameter

- Class reference
- A white ring line showing length of insertion at spigot end
- ‘PHED’

2.2.2.5 PACKING AND TRANSPORT:

The pipes should preferably be transported by road from the factory and stored as per the manufacturer specifications to protect from damage.

2.2.2.6 SPECIALS FOR DUCTILE IRON PIPES

The following types of DI fittings shall be of class K-12, manufactured and tested in accordance with IS: 9523 or BS: 4772 and shall be suitable for use with DI pipes of titan jointing type confirming to IS8329..

- flanged socket
- flanged spigot
- double socket bends (90°, 45°, 22 1/2°, 11 1/4°)
- double socket branch flanged tee
- all socket tee
- double socket taper
- restrained joints

All the DI fittings shall be supplied with one rubber ring for each socket. The rubber ring shall conform to IS: 12820 and IS: 5382 as described in the following clauses. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts.

2.2.2.7 LUBRICANT FOR DUCTILE IRON PIPES AND SPECIALS

Lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-in rubber ring joints shall have the following characteristics:

- must have a paste like consistency and be ready for use
- has to adhere to wet and dry surfaces of DI pipes and rubber rings
- to be applied in hot and cold weather; ambient temperature 0 - 50 °C, temperature of exposed pipes up to 70 °C
- must be non toxic
- must be water soluble
- must not affect the properties of the drinking water carried in the pipes
- must not have an objectionable odour
- has to inhibit bacterial growth
- must not be harmful to the skin

- must have a shelf life not less than 2 years

2.2.2.8 ACCEPTANCE TESTS

- They shall be conducted in line with the provisions of the IS 9523

2.2.2.9 PACKING

All the DI fittings shall be properly packed with jute cloth. Rubber rings shall be packed in polyethylene bags. Nuts, bolts etc. shall be supplied in separate jute bags.

The fittings shall also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

2.3 LAYING, JOINTING AND TESTING OF PIPE LINE SYSTEM FOR WATER SUPPLY

2.3.1 PREPARATORY WORK

The contractor will inspect the route along which the pipe line is proposed to be laid. He should observe/ findout the existing underground utilities/ construction and propose an alignment along which the pipeline is to be laid. He should make all efforts to keep the pipe as straight as possible with the help of ranging rods. Where ever there is need for deviation, it should be done with the use of necessary specials or by deflection in pipe joints (limited to 75% of permissible deflection as per manufacturer). The alignment as proposed should be marked on ground with a line of white chalk and got approved from Project Manager. The Contractor will than prepare an L-Section along this alignment showing the location of proposed pipe line. The L-section should be got approved from the site Engineer. The position of fittings, valves, should be shown on the plan.

2.3.2 ALIGNMENT AND THE L-SECTIONS

The alignments, L-section (depth of laying) and location of specials, valves and chambers may be changed at site in co-operation with and after approval of the Project Manager.

2.3.3 STANDARDS

Except as otherwise specified in this technical specification, the Indian Standards and Codes of Practice in their latest version, National Building code, PWD specification of the state of Madhya Pradesh and Manual of water supply of GOI shall be adhered to for the supply, handling, laying, installation, and site testing of all material and works. The pipe laying work shall generally conform to IS: 12288.

2.3.4 TOOLS AND EQUIPMENT

The contractor has to provide all the tools and equipment required for the timely, efficient and professional implementation of the work as specified in the various

sections of the contract and as specified by the instructions of manufacturers of the pipes and other material to be handled under this contract. On demand he shall provide to the Project Manager a detailed list of tools and equipment available. If in the opinion of the Project Manager the progress or the quality of the work cannot be guaranteed by the available quantity and type of tools and equipment the contractor has to provide additional ones to the satisfaction of the Project Manager. The Contractor will always have a leveling instrument on site.

2.3.5 HANDLING AND LAYING OF PIPES

Transportation of pipes and specials

The Contractor has to transport the pipes and other materials from manufacturer to the site of laying as indicated by the Project Manager. Pipes should be handled with care to avoid damage to the surface and the socket and spigot ends, deformation or bending. Pipes shall not be dragged along the ground or the loading bed of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects. The pipes shall rest uniformly on the vehicle bed in their entire length during transportation. Pipes shall be loaded and un-loaded manually or by suitable mechanical means without causing any damage to the stacked pipes.

The transportation and handling of pipes shall be made as per IS 12288. Handling instructions of the manufacturers of the pipes shall be followed. All precautions set out shall be taken to prevent damage to the protective coating, damage of the jointing surfaces or the ends of the pipes.

Whatever method and means of transportation is used, it is essential that the pipes are carefully placed and firmly secured against uncontrolled movement during transportation to the satisfaction of Project Manager.

Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used. Where using crane hooks at sockets and spigot ends hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying according to the instructions of the pipe manufacturer. Pipes shall not be thrown directly on the ground.

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently with safety. The pipes should be lifted smoothly without any jerking motion and pipe movement should be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.

Rolling or dragging pipes along the ground or over other pipes already stacked shall be avoided too.

2.3.6 STRINGING OF PIPES ALONG THE ALIGNMENT

The pipes shall be laid out properly along the proposed alignment in a manner that they do not create any significant hindrance to the public and that they are not damaged.

Stringing of the pipes end to end along the working width should be done in such a manner that the least interference is caused in the land crossed. Gaps should be left at intervals to permit the passing of equipment across the working area. Pipes shall be laid out that they remain safe where placed and that no damage can occur to the pipes and the coating until incorporated in the pipeline. If necessary, pipes shall be wedged to prevent accidental movement. Precautions shall be made to prevent excessive soil, mud etc. entering the pipe.

Generally, the pipes shall be laid within two weeks from the date of their dispatch from the manufacturer/store.

The joint gaskets shall be kept in wooden boxes or their original packing and stored in cool conditions and not exposed to direct sunlight. Gaskets must not be deformed. They shall be taken out only shortly before they are needed. All PVC pipes when stored shall be protected from sunlight and heat at all stages.

2.3.7 TRENCH EXCAVATION

The trench excavation of pipe line shall be in accordance with IS 12288. Pipe trenches shall be excavated to the lines and levels shown on the drawings or as directed by the Project Manager. The depth of the excavated trench shall be as given in the drawings or as directed by the Project Manager. The width of the trench at bottom between the faces of sheeting shall be such as to provide 200/150 mm clearance on either side of the DI CI / PVC pipe except where rock excavation is involved. No pipe shall be laid in a trench until the section of trench in which the pipe is to be laid has been approved by the Project Manager.

In agricultural land the depth should be sufficient to provide a cover not less than 900 mm so that the pipe line will not interfere with the cultivation of land. It may be necessary to increase the depth of pipeline to avoid land drains or in the vicinity of roads, railways or other crossings. Care should be taken to avoid the spoil bank causing an accumulation of rainwater.

The bottom of the trench shall be trimmed and levelled to permit even bedding of the pipes. It should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation shall be made at the joints of the pipes, so that the pipe is supported along its entire length.

All excavated material shall be stacked in such a distance from the trench edge that it will not endanger the work or workmen and it will avoid obstructing footpaths, roads and drive ways. Hydrants under pressure, surface boxes, fire or other utility controls shall be left unobstructed and accessible during the construction work. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural water-courses shall not be obstructed.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards, as required, shall be placed and maintained during the progress of the work and until it is safe for traffic to use the roadways. All materials, piles equipment and pipes which

may serve as obstruction to traffic shall be enclosed by fences or barricades and shall be protected by illuminating proper lights when the visibility is poor.

As far as possible, the pipe line shall be laid below existing services, like water and gas pipes, cables, cable ducts and drains but not below sewers, which are usually laid at greater depth. Where it is unavoidable, pipe line should be suitably protected. A minimum clearance of 150 mm shall be provided between the pipe line and such other services.

Trees, shrubbery fences, poles, and all other property and surface structures shall be protected. Tree roots shall be cut within a distance of 50 cm from pipe joints in order to prevent roots from entering them. Temporary support, adequate protection and maintenance of all under ground and surface structures, drains, sewers and other obstructions encountered in the progress of the work shall be provided. The structures, which will be disturbed shall be restored after completion of the work.

Where water forms or accumulates in any trench the Contractor shall maintain the trench free of water during pipe laying.

Wherever necessary to prevent caving, trench excavations in soils such as sand, gravel and sandy soil shall be adequately sheeted and braced. Where sheeting and bracing are used, the net trench width after sheeting shall not be less than that specified above. The sides of the excavation shall be adequately supported at all times and, except where described as permitted under the Contract, shall be not battered.

The Project Manager in co-operation with the Contractor shall decide about the sheeting/ bracing of the trench according to the soil conditions in a particular stretch and taking into account the safety requirements of the Contractor’s and ENGINEER- IN- CHARGE’s staff. Generally, safety measures against caving have to be provided for trenches with vertical walls if they are deeper than 2.0 m.

2.3.8 TRENCH EXCAVATION TO COMMENSURATE WITH THE LAYING PROGRESS

The work of trench excavation should be commensurate with laying and jointing of the pipe line. It should not be dug in advance for a length greater than 500 m ahead of work of laying and jointing of pipeline unless otherwise defined by the Project Manager. The Contractor has to ensure the following:

- safety protections as mentioned above have to be incorporated in the work process
- hindrances to the public have to be minimized
- the trench must not be eroded before the pipes are laid
- the trench must not be filled with water when the pipes are laid
- the trench must not be refilled before laying of the pipes

The bed for the laying of the pipes has to be prepared according to the L-Section immediately before laying of the pipes.

2.3.9 BEDDING OF THE PIPES

The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may injure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continuous contact between the trench and the entire pipe barrel between socket holes.

2.3.10 LAYING AND JOINTING OF PIPES

2.3.10.1 General

The pipes will be cleaned in the whole length with special care of the spigot and sockets on the inside/ outside to ensure that they are free from dirt and unwarranted projections. The whole of the pipes shall be placed in position singly and shall be laid true to profile and direction of slope indicated on longitudinal sections. The pipes shall be laid without deflection in a straight alignment between bends and between high and low points. Vertical and horizontal deflections between individual pipes need the approval of the Project Manager. In no case the deflection shall be more than 75 % of those recommended by the manufacturer.

Before pipes are jointed they shall be thoroughly cleaned of all earth lumps, stones, or any other objects that may have entered the interior of the pipes, particularly the spigot end and the socket including the groove for the rubber ring. End caps are removed only just before laying and jointing

Pipes and the related specials shall be laid according to the instructions of the manufacturers and using the tools recommended by them.

Cutting of pipes shall be reduced to a minimum required to conform with the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer. The spigot end has to be chamfered again at the same angle as the original chamfered end. Cutting shall be perpendicular to the centre line of the pipe. In case of ductile iron pipes the cut and chamfered end shall be painted with two coats of epoxy paint. If there is no mark for the insertion depth on the spigot end of the (cut) pipe it shall be marked again according to the instructions of the manufacturer.

All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronisation with the pipes. The Contractor has to ensure that the specials and accessories are ready in time to be installed together with the pipes.

At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt or other foreign matter by means of approved plugs or end caps.

When pipe laying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water and dirt into the line.

No pipe shall be laid in wet trench conditions that preclude proper bedding, or when, in the opinion of the Project Manager, the trench conditions or the weather are unsuitable for proper installation.

The pipe line laid should be absolutely straight unless planned otherwise. The accuracy of alignment should be tested before starting refilling with the help of stretching a string between two ends of the straight stretch of pipes to rectify possible small kinks in laying.

Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered

On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position while the trench is back filled over the barrel of the pipe.

The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline.

The assembly of the pipes shall be made as recommended by the pipe manufacturer and using the suitable tools.

The socket and spigot ends of the pipes shall be brushed and cleaned. The chamfered surface and the end of the spigot end has to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material which may damage the rubber gasket shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.

The two pipes shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade

Deflection of the pipes -if any- shall be made only after they have fully been assembled. The deflection shall not exceed 75 % of the values indicated by the pipe manufacturer.

2.3.10.2 Anchoring of the pipeline

Thrust blocks shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per design of ENGINEER- IN- CHARGE according to the highest pressure during operation or testing of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

2.3.10.3 Backfilling of the pipe trench

For the purpose of back-filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top:

Zone A: Back-filling by hand with sand, fine gravel or other approved material placed in layers of 150 mm and compacted by tamping. From the bottom of the trench to the level of the centre line of the pipe The back-filling material shall be deposited in the trench for its full width of each side of the pipe, specials and appurtenances simultaneously. Special care shall be taken to avoid damage of the pipe and the coating or moving of the pipe.

Zone B: Back-filling and compaction shall be done by hand or approved mechanical methods in layers of 150 mm, special care shall be taken to avoid damage of the pipe and the coating or moving of the pipe. From the level of the centre line of the pipe to a level 300 mm above the top of the pipe

Zone C: Back-filling shall be done by hand or approved mechanical methods in 15 cm layers after compacting and carried to the level necessary to allow for the temporary restoration of road and path surfaces, and also for hard-core (if and where ordered) on roads or to such level as will leave the requisite space for the top soil, road surface etc. to be reinstated as directed by the Project Manager. From a level 300 mm above the top of the pipe to the top of the trench.

In case of agricultural or waste land and after approval by the Project Manager back-filling may be made in thicker layers and with less compaction up to 200 - 300 mm above the initial ground level.

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back-fill to the subgrade of the structures shall be made with sand in accordance with IS 12288.

The excavated material may be used for back-fill in the following cases, provided it complies with IS 12288 Clause 4.11.1:

- a) In Zone C: In cases where settlement is unimportant the back-fill shall be neatly rounded over the trench to a sufficient height to allow for settlement to the required level.
- b) In any zone, when the type of back-fill material is not indicated or specified, provided that such material consists of loam, clay, sand, fine gravel or other materials which are suitable for back-filling in the opinion of the Project Manager.

All excavations shall be backfilled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Project Manager, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof, and the manner of depositing and compacting shall be subject to the approval of the Project Manager, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

Trenches crossing a road shall be backfilled with selected material placed in layers not exceeding 15 cm in thickness after compacting, wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the Contractor at his expense.

The Contractor shall at his own expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.

On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The Contractor shall not use backfilling for disposal of refuse or unsuitable soil.

2.3.10.4 Sequence of Works for Ensuring Good Pipe Laying

- a) The required fittings, valves and jointing material should be carefully worked out in beginning. This material should be received in full first of all on site and stored as per directions of manufacturer or as directions given elsewhere in this manual on Standards. The pipes should be received on site only after the above fittings, valves and material for joints has been received and all necessary preparation for laying has been made. The material received should be checked for inspection certification as per contract and damage during transportation. All damaged material should be separated and not used. The pipes received should be stored strictly as per directions of the manufacturer or as mentioned elsewhere in this manual or standards. The pipes and other material should be again inspected for any damage before use in the trench. The fittings and valves should be installed in sequence with the laying of pipes without leaving any gaps. It is desirable to lay the pipe lines from the end from where it can be connected to the water source to enable regular flushing of laid pipes. The entry of dirt or any foreign material in the pipe should be religiously prevented. Each joint should be carefully checked for its completeness before covering up. There

should be a commensurate progress in trench excavation, laying and jointing of pipes, fittings, valves etc. and testing of laid pipes in sections so as to complete testing of all pipes laid in quick follow up of completing laying and jointing.

b) Installation of valves

The installation of valves shall be made between flanges and shall be according to the instructions of the manufacturer and the Engineer. Valves shall be placed on a support of concrete so that no shear stress occur in the flanges. In case of axial thrust due to closure of a valve against pressure, the valve shall be anchored in the support in a suitable manner to transfer the thrust into the floor slab of the chamber.

c) Other civil and related works

d) Crossing of existing Distribution Pipes, connecting pipes and other underground service components

Existing transmission and distribution pipes and connecting pipes of standpipes have to be protected during the laying of the pipes. In case of impossibility of deviation, the pipes have to be replaced according to the instructions of the Engineer and in co-operation with the local representative (e.g. Assistant Engineer of PHED). The Contractor shall be fully responsible in case of damage of pipes or any other item due to inattention of his staff. All costs for the reinstatement of the original status to the pipes or any other item in case of damage have to be borne by the Contractor at his cost. Similarly the contractor shall have to reinstate in the original status, other services damaged by him such as power or telephone cables etc.

e) Poles of electrical or telephone lines, if coming in the alignment, will be got shifted through the respective agencies, as per approval of the Engineer.

2.3.10.5 Testing of the pipelines

a) Sectional tests

After laying and jointing the pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections approved by the Project Manager. The length of the sections depends on the topographical conditions. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber). At the beginning, the Contractor shall test stretches not exceeding 2 km. After successful organization and execution of tests the length may be extended to more than 2 km after approval of the Project Manager.

The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases: preparation, pre-test/saturation and test, immediately following the pre-test. Generally, the following steps

are required which shall be monitored and recorded in a test protocol if required:

- complete setting of the thrust blocks.
- partial backfilling and compaction to hold the pipes in position while leaving the joints exposed for leakage control
- opening of all intermediate valves (if any)
- fixing the end pieces for tests and after temporarily anchoring them against the soil (not against the preceding pipe stretch)
 - at the lower end with a precision pressure gauge and the connection to the pump for establishing the test pressure
 - at the higher end with a valve for air outlet
- If the pressure gauge cannot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly
- slowly filling the pipe from the lowest point(s).
- the water for this purpose shall be reasonably clear and free of solids and suspended matter
- complete removal of air through air valves along the line.
- closing all air valves and scour valves.
- slowly rising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring.
- keeping the pipeline under pressure for the duration of the pre-test / saturation of the lining by adding make-up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.
- start the test by maintaining the test pressure at the desired level by adding more make-up water; record the water added and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.
- Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches.
- The testing conditions for the pipelines shall be as per the test conditions laid out in IS 8329 for DI pipes and IS 4985 for uPVC pipes.

The pipeline stretch will pass the test if the water added during the test period is not exceeding the admissible limits. No section of the pipework shall be accepted by the Project Manager until all requirements of the test have been obtained.

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline shall be completed.

b) Leakage Test

After the successful completion of the pressure test (i.e. pressure testing at factory/works), Leakage test at site after proper installation of pipeline shall be conducted at a pressure specified above for a duration as specified below :

- **Pre test and saturation period** with addition of make-up water

Pressure : Test Pressure

Duration : 24 hrs for pipes with cement mortar lining

- **Pressure test / Leakage Test** with addition of make-up water

Pressure : Test Pressure

Duration : 3 hrs

- Test **criteria** for DI/MS : Q = 1.0 litre per km per 10mm of pipe per 30 m Test Pressure per 24 hrs.
- Test **criteria** for **uPVC** pipes : Q = 1.5 litre per km per 10mm of pipe per 30 m Test Pressure per 24 hrs.

No pipe installation shall be accepted until the leakage is less than the amount 'Q', as determined by the above formula:

All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount 'Q', calculated by the above formula. Where any test of pipe laid indicates leakage greater than that specified as per the above formula, the defective pipe(s) or joints(s) shall be repaired/replaced as per the satisfaction of Project Manager until the leakage is within specified limits. The Contractor has to make his own arrangements for water of approved quality, required for testing pipeline

The table, hereunder, gives recommended test pressure for uPVC /DI pipes.

Maximum Continuous Working Pressures and Recommended Test Pressures		
Class of pipe	Working Pressure	Recommended Site/Field Test Pressure
	Kg/ sq cm	Kg/ sq cm
uPVC Class 3	6.0	9.0

uPVC Class 4	8.0	12.0
DI Class K-7	8.0	12.0

Due to the elastic characteristics and relatively high thermal expansion and contraction of uPVC, it is advisable to avoid prolonged pressure tests.

If it is required to test a section of a pipe line with a free end, it is necessary to provide temporary support against the considerable end thrust developed by the application of the test pressure. The end support can be provided by inserting a wooden beam or similar strong material in a short trench excavated at right angle to the main trench and inserting suitable packing between the support and pipe end.

c) Failure to pass the test

All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test shall have been obtained. Any work which fails or is proved by test to be unsatisfactory in any way shall be redone by the Contractor.

2.3.11 FLUSHING AND DISINFECTION OF PIPELINES

After testing and commissioning the contractor shall flush the pipes with a velocity not less than 1 m/s or as approved by the Project Manager.

The pipeline shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump.

In the case of pipeline of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'Slug' of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 300 mg/l. for at least 3 hours. As the chlorinated water flows past tees and crossings, related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid pipeline in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for at least 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until the chlorine concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or less 1 mg/l.

After final flushing and before the water pipeline is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory; the pipeline may be placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works including arrangement and cost of water and other relevant material till the main placed in service other wise specified.

2.3.12 COMMISSIONING

2.3.12.1 Commissioning general

After successful sectional tests and other pre-commissioning tests, flushing, disinfection etc. and after physical completion, the pipeline shall be commissioned by the Contractor. Dynamic commissioning shall be made in conjunction with or after the commissioning of the respective system.

During testing/commissioning, the Contractor shall supply all material and labour to supervise, adjust, test, repair and do all things necessary to maintain the testing/ commissioning. This shall include labour on a 24 hour-a-day basis during the test period and for such other period of continuous operation as the Engineer may consider necessary to establish the efficient operation of the cluster distribution system.

If any test result shows noticeable variation from the specification requirements for the system, the Contractor shall immediately take steps to rectify the deficiency without any extra cost to Engineer.

The Contractor shall test and commission the system for 7 days at a stretch, from the date of commissioning. On expiry of this period the system shall be taken over by the Engineer and a taking-over certificate shall be issued by the Engineer, provided all defects and/or deficiencies noticed are rectified to the satisfaction of the Engineer.

Should the supply of water from the pumping station fail or should any other event beyond the Contractor's control, the commissioning shall be during such a number of operational periods as the Engineer may consider equivalent. Any repairs or replacement required during this period shall be done by the Contractor at his own cost.

The main indicators for the successful commissioning are:

- no leaks in pipes, joints, specials and valves
- all valves are properly installed and operational
- execution of the entire work including finishing according to the drawings and the specifications

- submission of as built drawings

2.3.12.2 Dynamic commissioning

The dynamic commissioning shall commence after the work has been physically completed to the satisfaction of the Engineer. It shall simulate the design and operation conditions which are as follows:

- All branches into existing lines (if already in position) to be shut off.
- Pump in operation, pump discharging into the transmission main. This is for the commissioning of the transmission pipe only.
- Water being put into the system through overhead tank or direct pumping as the case maybe.
- Closing of the valves against full static or dynamic pressure.
- Operation of all valves including scour valves (open-close-open).
- Operation of all air valves.
- Operation of all locking arrangements of valve chambers

2.3.13 Dismantling Joints

Double flanged Dismantling joints shall be fabricated from MS sheets in such a manner that valves can be dismantled without stress to the joints. Dismantling joints shall be suitable for installation with all valves as shown in standard drawings. These shall be for working pressures of up to 10 kg/cm² and shall be completely leak proof with proper gasket arrangement. Flange dimensions of the joints shall conform to IS: 1538.

Flanged specials shall be supplied with required nuts, bolts and rubber gaskets. The nuts and bolts shall be of best quality carbon steel, machined on the shank and electro-galvanized. Rubber gasket shall be as per IS: 5382. Dimensions and drilling of flat gasket will be as per IS: 1538, suitable for making flanged joint. The dismantling pieces shall provide minimum clearance of ± 25 mm (total distance 50 mm). The dismantling joint shall be internally and externally coated with hot applied (dip) bituminous paint.

Other Items: Other materials to be supplied by the Contractor shall conform to the latest available Indian Standards or in accordance with DIN/BS specifications (in case IS specification for the material is not available).

2.3.14 Repair of Coating and Linings

Any pipe with lining that is broken, defective, or not adhering in all places to the metal interior of the pipe, or not otherwise in accordance with the specification shall be rejected. Remedial lining operations may be carried out by a method as recommended by the manufacturer and has been approved in writing by the Engineer. The standard of the remedial lining shall satisfy the requirements of the specification.

Damage to external coatings shall be made good equivalent to the original coatings applied by the manufacturer and to the satisfaction of the Engineer.

Exposed surfaces shall be finish painted according to the manufacturer’s instructions, and as directed by the Engineer, using a corrosion resistant paint.

2.3.15 Installation of Valves and Fittings

2.3.15.1 General

Valves, fittings, plugs, and caps shall be set and joined to pipes in the manner specified above for cleaning, laying and joining pipes. The Contractor shall furnish all components required for construction of valve chambers and valve control access to buried valves, including precast RCC covers. The valves shall be joined with dismantling pieces as shown in the drawing to facilitate future maintenance.

2.3.15.2 Sluice Valves

The valves shall be installed in accordance with IS:2685. While installing the contractor shall ensure that all grit and foreign matters are removed from inside of the valves and all the four faces are thoroughly cleaned and coated with a thin layer of mineral grease. The sluice valves shall be installed with spindle vertical. The location of valves shall be as per drawing. All sluice valves shall be installed on concrete bases. The length of the operating stem shall be properly adjusted depending upon the depth of the valve below operating level. This shall be done to the satisfaction of the Engineer.

2.3.15.3 Air Valves

Air valves shall be installed at high points using standard Tee fittings as shown in the drawings or as directed by the Engineer.

2.3.15.4 Washouts

Washouts or scour valves shall be installed at low points as shown in the drawings or as directed by the Engineer. Washouts shall be installed by a standard T-piece with the main.

The outlet of the drain must be directed to the lowest ground level, in such a way that no backflow to the main pipe can occur.

The drain pipe of washouts shall not be connected to any sewer, submerged in any stream, or be installed in any other manner that may permit back-siphoning into the system.

2.3.15.5 Easy Operation of Valves

All valves shall be provided with tee-key cap/hand lever/hand wheel (as required) within easy reach. Wherever necessary, operating platforms shall be provided. In general, valves installed underground shall have caps and those fitted above ground shall be operable by hand wheels.

2.3.15.6 Bends and Fittings

Pipelines shall be laid in straight lines with gradual changes being taken up at the joints as approved by the manufacturer. Where a sudden change of direction cannot be avoided, bends shall be used. The location of bends, tees, and other fittings shall be determined in the field in close cooperation with the Engineer.

1.13.7 Blind Ends

All pipe ends that shall be connected to future extensions, plugs, caps or blind flanges shall be installed and secured in place.

1.13.8 Fittings and Bends in Masonry and Concrete Works

All the puddle collars, double flanged pipes and fittings to suitable class as mentioned in the drawing or bill of quantities shall be supplied and fixed in position by the Contractor including testing of the fittings and cost of the materials. All joints shall be flanged joints and shall be as per Indian Standard Specification. All the pipes, fittings, valves etc. Shall be installed as per drawing and as directed by the Engineer. All the pipes and fittings required for above shall be fixed during concreting, fittings which are to be embedded in concrete shall have puddle collars at the centre of concrete thickness.

2.3.15.7 Valve Chambers

Valves on an underground pipeline shall be located in a masonry chamber with removable RCC roof and PVC encapsulated MS steps. The roof slabs shall be designed to suit for IRC Class ‘AA’ loading. The valve chambers shall be constructed as per the typical drawings enclosed.

The chambers shall be constructed after the laying of the pipes and the assembly of specials and valves. The size of the chambers shall be according to the following criteria as per direction of Engineer.

Minimum distance of flanges from walls	: 30 cm
Minimum distance of sockets from walls	: 30 cm
Minimum distance between highest point of equipment and roof slab	: 30 cm

In case of chambers deeper than 120 cm PVC encapsulated MS or rungs shall be provided at the inner side wall with a vertical spacing of 200 mm.

The work shall include excavation, consolidation, levelling, lean concrete as per drawing in foundations, finishing, refilling. It shall include all labour and material required for the complete chamber.

For sluice valves of sizes more than 250 mm, conventional type of chambers shall be provided. The chambers shall be constructed in masonry as shown in the standard drawing and as per specifications contained in the standard specifications for civil works.

Scour valve chambers shall be constructed according to the typical drawings enclosed suitable for the respective scour valve and special arrangement. The chambers for scour valves shall be off-line and placed on the scour pipe. There is a closed chamber containing the scour valve, specials, according to the details of chambers for sluice valves.

Scour valves of sizes 250 mm and below, “valve cap arrangement” will be made as shown in the drawing containing typical valve cap arrangement.

All specifications and constructional details for the sluice valve chambers shall also apply for the scour chambers accordingly.

2.3.15.8 Existing Road Crossing

The Contractor shall programme the work to reduce disruption to road traffic to a minimum, and before any work commences in existing roads shall:

- (i) obtain full permission and approval of all authorities concerned, serving notice of intent to start work as may be necessary and observing all the local rules and regulations;
- (ii) submit details of his proposals, and obtain approval from the Engineer;
- (iii) suitable signs indicating that a street is closed and suitable detour signs for proper maintenance of traffic shall be provided.

Wherever necessary, contractor shall make alternate routes for traffic diversion as directed by the concerned authority.

The bedding for the pipelines to be laid under the road crossing shall be in accordance with the relevant drawings.

The road way shall be reinstated using the form of construction and materials as ordered by the relevant authority and to the satisfaction of the authority.

2.3.15.9 Railway Crossings

Where the pipeline crosses any railway line, it shall be installed in accordance with the requirements of the railway authorities. Contractor shall take permission for railway crossing and coordinate with the authorities of the railways while working on this particular portion of the pipeline and shall consider all cost relevant to such typical work.

2.3.15.10 Miscellaneous Works

Crossing of Existing Distribution, Connecting pipes and other Underground Service Components

Contractor shall take the necessary precautions to avoid the damage to other service such as water supply lines, telephone cables, electrical cables, storm water drains etc. in case of any damages to any of the services, contractor shall be responsible for restoring the facilities in bare minimum time at his own cost. The other utility services and traffic shall be maintained as per clause 1.9 of Standard Specifications.

Existing transmission and distribution pipes and connecting pipes of standpipes have to be protected during the laying of the pipes. In case of impossibility of deviation, the pipes have to be replaced according to the instructions of the Engineer and in co-operation with line agency PHED. The Contractor has the full responsibility in case of destruction of pipes due to inattention of his staff. All costs for the reinstatement of the original status of the pipes in case of damage have to be borne by him. Similarly the contractor shall have to reinstate in the original status, other services damaged by him such as power or telephone cables etc.

Poles of Electrical or Telephone Lines

In case of impossibility of deviation of pipeline, poles of electricity lines (33, 11, 0.4 KV), telephone lines or anchor cables of poles have to be relocated. These works have to be executed by the respective department or according to its instructions. The Contractor has the full responsibility in case of destruction of lines or poles due to inattention of his staff. All costs for the reinstatement to the original status of the lines have to be borne by contractor.

Reinstating the Road Surface

The road surface shall be reinstated to its original level and slope. The reinstatement shall be done as advised by the Engineer and shall consist of the prevailing layers in the existing roads with similar compaction and moisture content. The road restoration shall be carried out immediately after completion of all the works.

Reinforced Cement Concrete covers

The Reinforced cement covers shall be designed for class AA loading duly marked on cover with adequate steel reinforcement having thickness 75 mm to 150 mm, anticorrosive bitumen painted MS plate, Rim and on M.S. lifting hooks, admixture like plasticizer bond-improving compound, shrinkage resistance compound abrasion resistant complete, as per approved design. The covers shall be provided in suitable nos. and with an insertion hole of minimum 50 mm or as required.

Public Inconvenience

Contractor shall also ensure that no public inconvenience is caused due to excavation, stacking of excavated material, storage of pipe at pipeline alignment. All safety measures mentioned in relevant Indian Standards and the rules and regulations of local authorities in regard to safety provision shall be observed by the Contractor. Any compensation, resulting from carelessness towards the safety requirements during all phases of work will be on the part of the Contractor.

2.3.16 Testing and Commissioning

After successful sectional tests after pipe laying and other pre-commissioning tests after physical completion, the pipeline shall be commissioned by the Contractor. Dynamic commissioning shall be made in conjunction with or after the commissioning of the respective system.

Complete supplying, laying, jointing, testing and commissioning of the pipeline works are included in the contract package and Contractor will make all necessary arrangement for complete commissioning of the transmission pipeline system when the pump sets feeding the pipelines are installed and yard piping works for respective CWR and OHSR complexes are complete and ready. Such coordination with the other Contractors and ensuring availability of required personnel and necessary equipment for such commissioning will have to be provided by the Contractor in consultation with and to the full satisfaction of the Engineer.

During testing/commissioning, the Contractor shall supply all material and labour to supervise, adjust, test, repair and do all things necessary to maintain the testing/commissioning. This shall include labour on a 24 hour-a-day basis during the test period and for such other period of continuous operation as the Engineer may

consider necessary to establish the efficient operation of the cluster distribution system.

If any test result shows noticeable variation from the specification requirements for the system the Contractor shall immediately take steps to rectify the deficiency without any extra cost to Engineer.

The Contractor shall test and commission the system for 7 days at a stretch, from the date of commissioning. On expiry of this period the system shall be taken over by the Engineer and a taking-over certificate shall be issued by the Engineer, provided all defects and/or deficiencies noticed are rectified to the satisfaction of the Engineer.

Generally, the timing of most of the commissioning tests will depend on the availability of the respective pumps, the water and power availability at the pumping station and the completion of the storage reservoir.

Should the supply of water from the pumping station fall or should any other event beyond the Contractor's control interfere, the commissioning shall be during such a number of operational periods, as the Engineer may consider equivalent. Any repairs or replacement required during this period shall be done by the Contractor at his own cost.

The Contractor shall allow for commissioning to be conducted at any time during the commissioning period without extra charges under the Contract.

The main indicators for the successful commissioning are:

No leaks in pipes, joints, locations of specials and valves,

All valves are properly installed and operational,

Execution of the entire work including finishing according to the drawings and specifications,

Submission of "As built" drawings both in soft copies and hard copies (two prints and one polyester film)

The dynamic commissioning shall commence after the work has been physically completed to the satisfaction of the Engineer. It shall simulate the design and operation conditions, which are as follows:

All branches into existing lines (if already in position) to be shut off.

Pump in operation, pump discharging into the transmission main.

Closing of the valves against full static or dynamic pressure.

Operation of all valves including scour valves (open-close-open).

Operation of all locking arrangements of valve chambers.

2.3.17 Cast iron specials

Scope

The IS 5531 : 1988 is applicable to cast iron specials for use with asbestos cement pressure pipes suitable for connection with cast iron detachable joints or asbestos cement couplings.

Supply of Material

The general requirements relating, to the supply of the materials shall be as laid down in IS : 1387-1967.

Manufacture

The metal used for the manufacture of the specials shall be of requisite quality conforming to any grade specified in IS 210 : 1978.

The castings shall be stripped with all precautions necessary to avoid warping or shrinking defects. The castings shall be free from defects other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the use of specials. The casting shall be such that they could be cut drilled or machined with tools normally used for installation. In case of dispute the castings may be accepted provided the hardness of the external unmachined surface does not exceed 215 HBS.

Mechanical tests

Mechanical tests shall be carried out during manufacture. Two tests per day of casting may be adequate. The results obtained are taken to represent all the castings of all sizes made during the day.

Tensile Test

Two tensile tests shall be made on bars cast from the same metal as specified in para 1.3.3.10.1. The results of the tests shall show a minimum tensile strength of 150 M Pa.

Brinell Hardness Test - For checking the Brinell hardness as specified in 1.3.2.2, tests shall be carried out on the test bars used for the tensile tests in accordance with IS 1500 : 1983.

Retest

If any test piece representing, a lot fails to pass the test in the first instance, two additional tests shall be made on test pieces made from the same metal used for the same lot. Should any of these additional test pieces fail to pass the test, the lot shall be deemed as not complying with the standard.

Hydrostatic test

For hydrostatic test, the specials shall be kept under required pressure for a period of minimum 15 seconds and may be struck moderately with a 700 gms hammer. They shall withstand the pressure test without showing any leakage, sweating or other defects of any kind. The hydrostatic test shall be conducted before coating the castings.

The specials shall withstand the test pressure specified in Table I of IS : 1592-1980 for the class of asbestos cement pressure pipes with which they are to be used.

Dimensions and mass

The dimensions and mass of the specials shall be as specified in attached drawings.

Note

1. Mass of specials has been worked out assuming density of cast iron as 7.15 kg/dm³.
2. Nominal diameter of a cast iron special shall refer to the corresponding nominal diameter of the AC pressure pipe.

3. Cast iron specials of nominal diameter more than 600 mm may also be manufactured. In such cases detailed dimensions may be as mutually agreed between the purchaser and the supplier.

Specials of a mass heavier than the maximum specified may be accepted provided they comply in every other respect with the requirements of this standard.

The outside diameter of the engagement end of a special shall match the corresponding outside diameter of the asbestos cement pressure pipe of different classes conforming to IS : 1592:1980.

The engagement length shall be not less than 90 mm.

Tolerances on dimensions and mass

Thickness - Tolerances on the wall thickness and flange thickness of the specials shall be as follows.

Dimensions	Tolerance
Wall thickness, e	$\pm (2.00 \text{ mm} + 0.05 e)$
Flange thickness b	$\pm (3.00 \text{ mm} + 0.05 b)$

Where, e = standard thickness of the wall in mm, and

b = standard thickness of the flange in mm.

Note : No limit for the plus tolerances is specified.

Other Dimensions -- Tolerances on other dimensions shall be as under.

Dimensions	Tolerance
Machined outside diameters	+1.5
(D ₂ and d ₂)	- 1.0
Length (l) and height (h)	+15 and -10

Mass -Tolerance on the mass of the specials shall be ± 8 percent except for bends and fittings with more than one branch and non-standard fittings, where it shall be ± 12 percent.

Coatings

After inspection and hydrostatic test, each casting shall be coated as specified below.

Coating shall not be applied to any castings, unless its surface is clean, dry and free from rust.

All castings shall be coated externally and internally with the same material, the casting being preheated prior to total immersion in a bath containing a uniformly heated composition having a bituminous tar or other suitable base.

Note: For specials used for carrying potable water, coal tar shall not be used.

Alternatively the coating on the castings may be done without preheating with two coats of black Japan conforming to type 3 IS 341:1973.

The coating material shall set rapidly with good adherence and shall not scale off.

In all instances, where the coating material has a bituminous or similar base, it shall be smooth and tenacious, and hard enough not to flow when exposed to a temperature of 65° C but not so brittle at a temperature of 0° C as to chip off when scribed lightly with a penknife.

Since the specials are to be used for conveying potable water, the inside coating shall not contain any constituents soluble in such water or any ingredient which could impart any taste or odour whatsoever to the potable water after sterilization and suitably washing of the mains.

Markings

Each special shall have cast stamped or indelibly painted on it the following.

- (a) Manufacturer’s name, initials or identification mark
- (b) Nominal diameter
- (c) Class reference
- (d) Last two digits of year of manufacture

Test bars for tensile test

The test bars for tensile tests shall be properly moulded free from defects as specified in Appendix A of IS 5531 : 1988. These may be either unmachined or machined to give a diameter of about 20 to 25 mm. The ends shall be selected by the manufacturer to fit the tensile testing machine.

2.3.17 SLUICE VALVES

The design and manufacture of the sluice valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the vendor of this responsibility. Valves shall be conforming to IS 14846:2000 for size 50 to 1200 mm and shall be ISI marked.

DESIGN REQUIREMENTS FOR SLUICE VALVES :

- a) Valves shall be provided with back seating arrangement.
- b) Renewable body and wedge rings shall be provided.
- c) Collared drain plugs of gunmetal shall be provided for all valves.
- d) Stuffing box gland shall be of bolted type.
- e) Valves shall be with non-rising spindle type.
- f) Valves shall be flanged and drilling shall conform to the standard as specified in data sheet.
- g) Face to face dimension shall be as per IS 14846:2000.

DATA SHEET FOR SLUICE VALVES IN PUMP HOUSE

1.0	Make	Given in the list of preferred makes	
2.0	Standard	IS 14846:2000. And ISI marked.	
3.0	Size range and quantity	As per Appendix to the data sheet	
4.0	Fluid	Water	
5.0	Rating	PN : 1.0 (10 Kg. / cm ²)	
6.0	Stem	Non rising	
7.0	Ends	Flanged, flat faced flanges as per IS-1538 Table IV & VI having off center bolt holes	
8.0	Bonnet	Bolted	
9.0	Disc.	Solid wedge	
10.0	Operation	Hand wheel	
11.0	Seat	Body Renewable	Disc Renewable
12.0	Other requirements	Valves shall close in clockwise rotation of the hand wheel.	

13.0	Body / bonnet	C.I. IS 210 GR 260
14.0	Disc	C.I. IS 210 GR 260
15.0	Stem	S.S. AISI – 410
16.0	Body seat	Bronze IS 318 GR LTB 2
17.0	Disc seat	Bronze IS 318 GR LTB 2
18.0	Stem nut	Bronze IS 318 GR LTB2
19.0	Stuffing box	C.I. IS 210 GR 260
20.0	Gland	C.I. IS 210 GR 260
21.0	Packing	Graphite Asbestos
22.0	Bolts, studs & nuts	Carbon Steel IS 1367 Class 4.6 / 4
23.0	Shell test	15 Kg / Cm ²
24.0	Seat test	10 Kg / Cm ²
25.0	Back seat test	10 Kg / Cm ²

2.3.18 DUAL PLATE NON RETURN VALVES

The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipments will be installed. Nothing in this specification shall relieve the contractor of his responsibility. The valves shall be confirming to API 594 and API 598. The distance across flanges shall be in accordance to IS:5312 for flanged valves.

DESIGN REQUIREMENTS

The non return valves shall be of dual plate type check valve and provided with soft seating for clear and cold water. The valves shall be suitable for mounting on horizontal/vertical pipeline. The valves shall be designed for minimum head loss. The valves shall have lugged ends or flat faced flanged ends as specified. The back side of the flanges shall be fully or spot faced. Hydraulic passage shall be designed to avoid cavitations. The valves shall have non slam characteristic during closing. This is to be achieved by suitably designed springs. Direction of flow shall coincide with the flow direction indicated by arrow cast on the valve body.

PAINTING

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface. The coating shall not contain any constituent soluble in water or any ingredient which could impart any taste or odor to the water.

TESTS AND INSPECTION

Valves shall be tested as per relevant Indian standards specification, API 594 and API 598 with latest revisions. Valves shall be offered for visual inspection and dimensional checks. The hydrostatic and water tightness testing shall be witnessed by the Engineer. Valve shall be offered for inspection and following tests will be conducted (before painting) :

Visual inspection with dimensional checks.

Hydrostatic test.

DATA SHEET FOR DUAL PLATE NON RETURN VALVES

1	Mfg. Standard	API 594 and 598
2	Size in mm	80 - 250 mm
3	Maximum working pressure	10 kg /cm ²
4	Ends	Flanged flat faced flanges as per IS 1538 Table IV and VI having off center bolt holes or lugged ends
5	Seat	Body - Renewable Plate - Renewable
MATERIAL OF CONSTRUCTION		
6.1	Body	C.I. IS 210 Grade 260
6.2	Plate	ASTM A21 GR WCB
6.3	Seat Rings	EPDM
6.4	Spring	S.S. AISC 31
6.5	Body Bearing / Plate Bearings	S.S. AISC 31
6.6	Hinge Pins	S.S. AISC 431
6.7	Bolts, Studs and Nuts	Carbons Steel IS : 137 Class 4./4
6.8	Shell Test	15 kg /cm ²
6.9	Seat Test	10 kg /cm ²

2.3.19 SUPPORTS FOR PIPE WORK & VALVES

All necessary supports, saddles, sling, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valve and other facilities mounted in the pipe work shall be supported independent of the pipes to which they connect.

2.3.20 House connections using Medium Duty Polyethylene (MDPE) pieces

Scope

The scope of part of work consisting of a house connection using Medium Duty Polyethylene pipes (MDPE) shall consist of the following.

1. A piece of MDPE pipe blue PE 80 / 100 and of the outer diameter which will be the same as that of the outer diameter of AC pipe to which it is to be connected, and inner diameter equal to or greater than that of the inner diameter of AC pipe to which it is to be connected. The diameters shall be as follows.

	Inner Diameter	Outer diameter
AC pressure pipe	80 mm	99.5 mm
Matching MDPE pipe	82.5 mm	99.5 mm
AC pressure pipe	100 mm	121 mm
Matching MDPE pipe	101 mm	121 mm
AC pressure pipe	125 mm	147 mm
Matching MDPE pipe	130 mm	147 mm

Similarly for higher sizes the ID and OD of MDPE pipes shall be same except that ID of MDPE pipe could be slightly bigger as above in each case.

2. Two sets of Detachable joints by which this MDPE pipe piece will be connected to the AC pipe.
3. Two Electrofusion Tapping Tees each of PE 80, along with fittings namely 4.7 mm pin terminal, each of diameter compatible to the diameter of MDPE pipe, 120 mm long with 32 mm outlets of varying lengths matching with the diameter of pipe. Each Electrofusion Tapping Tee will be provided with a Fusion joint in such a manner that the 32 mm outlets which are perpendicular to the axis of pipe line, will open in opposite directions.
4. From each 32 mm outlet, an Electrofusion reducer 32 mm x 20 mm will be provided at each end.
5. From each 20 mm end, a length of MDPE service line consisting of blue pipe shall be extended up a point 30 cms from the boundary wall of property. The average length of this service pipe is expected to be 5 metres.
6. At the end of this service pipe line a 20 mm blue compression equal Tee tested as per ISO 3458 / 3458 shall be provided.

7. Both the ends of the Tee will be provided with MDPE caps.
8. The entire assembly shall be as per the enclosed drawing.

The (MDPE) pipe pieces shall be made out of MDPE pipes conforming to ISO 4427 : 1996. This International Standard specifies the required properties of pipes made from polyethylene (PE) to be used for buried water mains and services and for water supply above ground both inside and outside buildings. In addition, it specifies some general properties of the material from which these pipes are made, including a classification scheme.

MATERIAL

Compounds

General : The pipes shall be manufactured from polyethylene containing only those antioxidants UV stabilizers and pigments necessary for the manufacture of pipes conforming to this specification and for its end use. The pipes for drinking water shall be either black or blue or black with blue stripes.

Blue pipes and stripes : The use of the colour blue or black with blue stripes shall be specified in accordance with national requirements. The material for the stripes shall be of the same type of resin as used in the base compound the pipe.

Dispersion of blue pigments : When determined in accordance with ISO 13949, the dispersion of blue pigment shall be equal to or less than grade 3.

Thermal stability : When determined in accordance with ISO/TR 10837, the induction time for materials PE 63, PE 80 and PE 100 shall be either at least 20 min when tested at 200° C, or an equivalent period when tested at 210° C, provided the equivalence is supported by a clear correlation between results obtained at 200° C or 210° C, respectively. In case of dispute, the test temperature shall be 200°C.

Reworked material : The reworked material generated from a manufacturer’s own production of pipe in accordance with this specification may be used if it is derived from the same resin as used for the relevant production.

Effects on Water quality of pipes intended for the conveyance of water for human consumption

When used under conditions for which they are designed, materials in contact with or likely to come into contact with drinking water shall not constitute a toxic hazard shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water.

The concentrations of substances, chemicals and biological agents leached from materials in contact with drinking water, and measurement of the relevant organoleptic / physical parameters shall not exceed the maximum recommended by the World Health Organization in its publication “Guidelines for drinking water quality volume 1 recommendations or as required by the ECE council directive of 15 July 1980 on the quality of water intended for human consumption, whichever is the more stringent in each case.

Designation and classification

The compound shall be designated by the material type (e.g. PE 80) conforming to the applicable level of minimum required strength (MRS) specified in table 1, when the lower confidence limit σ_{CL} for the compound is determined in accordance with ISO/TR 9080 and this σ_{CL} is classified in accordance with ISO 12162 to obtain the MRS.

The validity of the designation shall be certified by the compound manufacturer or, in the case of master-batch by the pipe manufacturer.

The design stress σ_s of a pipe shall be obtained by applying a design coefficient of not less than 1.25 to the M value for the material.

Designation of material

Designation of material	MRS at 50 years and 20° C	Maximum allowable hydrostatic design stress, σ_s
	MPa	MPa
PE 100	10	8
PE 80	8	6.3

The relationship between MRS and σ_s for various design coefficients is given in table 2.

Relationship between MRS, σ_s and design coefficient C at 20° C

Hydrostatic design stress of pipe, σ_s	Minimum required strength of material				
	MPa				
	10	8	6.3	4	3.2
MPa	Design coefficient, C				
8	1.25	-	-	-	-
6.3	1.6	1.25	-	-	-

Melt flow rate and density

The pipe manufacture shall provide evidence of the density and the melt flow rate of the raw compound.

When measured in accordance with ISO 1133, the melt flow rate shall conform to the following conditions.

- The melt flow of the compound shall not deviate by more than $\pm 30\%$ from the value specified by the manufacturer.

- b) The change in MFR caused by processing i.e. the difference between the measured value for material for the pipe and the measured value for the compound, shall not be more than 25%.

Geometrical characteristics

Dimensions of pipes: outside diameters, nominal pressure and wall thicknesses

The dimensions of pipes shall be measured in accordance with ISO 3126.

Nominal outside diameter shall conform to ISO 161.1. The selected nominal outside diameter and the thicknesses in accordance with the selected nominal pressure are given in table 3 ($\sigma_s = 8$ MPa), and table 4 ($\sigma_s = 6.3$ MPa).

The tolerance on the outside diameters shall be in accordance with ISO 11922-1, as follows:

Grade A for normal-tolerance (NT) pipes

Grade B for close-tolerance (CT) pipes

Polyethylene pipes with a design stress σ_s of 8 MPa

Nominal diameter	outside	Pipe series		
		S 8	S 6.3	S 5
		Standard dimension ratio		
		SDR 17	SDR 13.6	SDR 11
		Nominal pressure PN ² for $\sigma_s = 8$ MPa		
		PN 10	PN 12.5	PN 16
d_n	Nominal wall thickness, δ_n mm			
32	-	-	3.0	
40	-	-	3.7	
50	-	-	4.6	
63	-	4.7	5.8	
75	4.5	5.6	6.8	
90	5.4	6.7	8.2	
110	6.6	8.1	10.0	
125	7.4	9.2	11.4	
140	8.3	10.3	12.7	

160	9.5	11.8	14.6
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Polyethylene pipes with a design stress σ_s of 6.3 MPa

Nominal outside diameter	Pipe series				
	S 10	S 8	S 6.3	S 5	S 4
	Standard dimension ratio				
	SDR 17		SDR 13.6	SDR 11	
	Nominal pressure PN^2 for $\sigma_s = 8$ MPa				
	PN 10		PN 12.5	PN 16	
d_n	Nominal wall thickness, δ_n 1mm				
16					2.3
20					2.3
25					2.8
32	-		-	3.0	3.6
40	-		-	3.7	4.5
50	-		-	4.6	5.6
63	-		4.7	5.8	7.1
75	-	4.5	5.6	6.8	8.4
90	4.3	5.4	6.7	8.2	10.1
110	5.3	6.6	8.1	10.0	12.3
125	6.0	7.4	9.2	11.4	14.0
140	6.7	8.3	10.3	12.7	15.7
160	7.7	9.5	11.8	14.6	17.9

The nominal wall thicknesses δ_n in accordance with ISO 4065 (however for reasons of jointing techniques the smallest wall thickness is limited to 2.3 mm) correspond to the selected nominal pressure given in table 3 ($\sigma_s = 8$ MPa), and table 4 ($\sigma_s = 6.3$ MPa).

The tolerance on the minimum wall thickness permitted at any point $e_{y \min}$, corresponding to the nominal wall thickness δ_n shall conform to ISO 119221 as follows.

Grade T for $e_{y \min}$, less than or equal to 16 mm

Grade U for $e_{y \min}$, greater than 16 mm

Ovality

The ovality of pipes at the manufacture after extrusion but prior to coiling shall conform to ISO 11922-1, as follows

Grade K for PE 32 and PE 40

Grade N for PE 63, PE 80 and PE 100

The minimum diameter of a drum for coiled pipe shall be $18 \times d_n$ and in any case such that kinking of the pipe is prevented.

For coiled pipes rerounding equipment may be necessary.

Length of pipe

The length of pipe shall be such that pieces for MDPE house connections in required lengths could be cut without any wastages.

Hydrostatic strength

When tested in accordance with ISO 1167, the pipes shall conform to the requirement given in table 5 below.

Hydrostatic strength of pipes

Pipe material	Test stress		
	100 h at 20° C	165 h at 80° C	1000 h at 80° C
PE 100	12.4	5.5	5.0
PE 80	9.0	4.6	4.0
PE 63	8.0	3.5	3.2

Retest in cases of failure at 80° C

A brittle fracture in less than 165 h shall constitute a failure.

If, in the 165 h test, a test piece fails in a ductile mode in less than 165 h a retest shall be performed at a lower stress. The new test stress, and the new minimum failure time shall be selected from the through the stress/time points given in table 7.

Physical characteristics

Thermal stability of pipes manufactured from PE 63, PE 80 and PE 100

When determined in accordance with ISO/TR 10837, the induction time for test specimens taken from pipes manufactured from PE 63, PE 80 and PE 100 shall be either at least 20 min when tested at 200° C, or an equivalent period when tested at 210° C, provided the equivalent is supported by a clear correlation between results

obtained at 200° C 210° C, respectively. The test specimens shall be taken from the inside surface of the pipe.

Pressure reduction factor for PE pipelines systems for use at temperatures above 20° C

Table 6 shall be used for the derivation of reduction factors to apply to operating pressure for elevated temperature operation of PE pipes and fittings. Since these are related to the supply of water and other fluids which do not adversely affect the long-term properties of the PE materials at temperatures up to 40° C. In order to determine the category in which a material lies (i.e. type A, type B and type C).

Pressure reduction factors at temperatures up to 40° C, applicable to a 50 year lifetime

Material	Pressure reduction factors at				
	20° C	25° C	30° C	35° C	40° C
Type A	1	0.93	0.87	0.8	0.74
Type B	1	0.9	0.81	0.72	0.62
Type C	1	0.82	0.65	0.47	0.3

Hydrostatic strength at 80° C – Retest requirements

PE 63		PE 80	
Stress	Minimum Failure time	Stress	Minimum Failure time
MPa	h	MPa	h
3.5	165	4.6	165
3.4	285	4.5	219
3.3	538	4.4	283
3.2	1000	4.3	394
		4.2	533
		4.1	727
		4.0	1000

Longitudinal reversion

When determined in accordance with ISO 2505-1, method A or B, using one of the following temperatures, as cable:

110° C + 2 for PE 63, PE 80 and PE 100

or

100° C + 2° C for PE 32 and PE 40.

and the test times given in ISO 2505-2, the value of the longitudinal reversion shall be not greater than 3%.

For pipes with an outside diameter greater than 200 mm, longitudinally cut segments may be used.

Weathering of non-black pipes

To determine to a effect of weathering pipes shall be exposed to outdoor conditions in accordance with the procedure given in annex A.

After exposure to a total solar energy of at least 3.5 GJ/m², the pipe shall conform to the following requirements:

- (a) The hydrostatic strength, when determined in accordance with 5.1 at 80° C for at least 165 h, shall be the minimum required.
- (b) The elongation at break, when determined in accordance with ISO 6259-1 and ISO 6259-3, shall not be less than 350%.
- (c) The induction time, when measured in accordance with ISO/TR 10837 using a test specimen taken from the outside surface of the pipe shall be at least 10 mm at 200° C.

Fusion compatibility

Pipes manufactured from PE 63, PE 80 or PE 100 are to be joined by butt fusion or using electro fusion fittings mixing different pipe materials, the joints shall conform to the requirements specification in table 6 (80° C/165 h).

Compounds designated PE 63, PE 80 or PE 100 having an MFR (190° C/5 KG) within the range 0.2 g/10 min to 0.3 g/10 min shall be considered compatible for fusion to each other.

Marking

All pipes shall be indelibly marked at maximum intervals of 1 m.

The marking shall indicate at least the following information.

- The manufacture’s name and/or trade mark.
- The dimensions (nominal outside diameter x nominal wall thickness)
- The outside –diameter tolerance (A or B);
- The designation of the pipe material (PE 100, PE 80, PE 63, PE 40 or PE 32).
- The nominal pressure (PN)

- The production period (date or code)
- The number of this International Standard)

The word "Water" shall also be included as the pipe is intended for drinking water.

Procedure for exposure to outdoor weathering

A.1 Exposure aspects and site

Test racks and specimen fixtures shall be made from inert materials which will not affect the test results. Wood non-corrosive aluminum alloys stainless steel or ceramics have been found suitable brass steel or copper shall not be used in the vicinity of test specification. The test site shall be equipped with instruments to record the solar energy received and the ambient temperature.

The equipment shall be capable of supporting specimens of pipe such that exposed surface of the specimens is at 45° to the horizontal, facing towards the equator, Normally, the exposure site shall be on open ground well away from trees and buildings. For exposure in the northern hemisphere, no obstruction, including adjacent racks. Easterly southerly or westerly direction shall subtend a vertical angle greater than 20° or in a northerly direction greater than 45°. For exposure in the southern hemisphere, corresponding provisions apply.

A.2 Test specimens

The test specimens shall be approximately 1 m long. They shall be selected from the thinnest-wall pipes within a random range of diameters. The batch of pipes from which the specimens are selected shall conform to all the requirements of this International Standard.

A.3 Procedure

Mark each pipe specimens to identify it, and recode the mounting position of each.

Expose the specimens to a total solar energy of at least 3.5 GJ/m².

The specimens are to be tested in accordance with the provisions of 6.2.1.17. Where the specimen to be tested includes only part of the pipe cross-section e.g. a tensile dumb-bell or part of the surface layer, it shall be taken from the weathered crown of the exposed specimen.

A.4 Sectional testing

All the MDPE pipe pieces together with the fusion joints shall withstand the test pressures applied for the sectional testing of class 15 of AC pressure pipe lines as specified under their sectional testing.

III. MECHANICAL WORKS

3.1 HORIZONTAL SPLIT CASING/BACK PULL OUT TYPE CENTRIFUGAL PUMPS

Supply of centrifugal pumping sets shall be in accordance with IS:5210, IS:6595 & IS: 9137 except for the provisions made here under.

3.1.1 DESIGN FEATURES

- The bidder shall select suitable pumps Horizontal split casing pumps/radially split multi-stage pumps for operation of water pumping in the specified operating range. All the pumps for the particular pressure main shall be of similar characteristics.
- The bidder may opt for combination of fixed speed pumps and operation of pump for varying pumping hours. The pumping hours must not be more than 16 hours for all the pumps to be installed.
- All pumps shall be provided with suitable motors and accessories.
- For each main minimum 2 pumps each (1working, 1 stand by) shall be provided under this contract.
- All the pumps shall be capable of developing the required total head at rated capacity of design discharge for continuous operation. The Bidder shall match the performance curves of pumps to the operating range.
- The bidder shall guarantee a minimum overall efficiency for pumps as per reference given in scope of work or cl. 2.4 Scope of work-- under heading Pump Type for CPHEEO manual, whichever is high, corresponding to delivery of design discharge at duty point. The bidder shall specify the pump performance.
- All pumps shall be installed with positive suction head.
- The pump shall operate satisfactorily at any point or at the end of the pump performance curve with respect to the NPSH/positive head available at the lowest permissible suction water level. The pump characteristics should be selected on the basis of layout of pumping station, suction manifold and clear water reservoirs to ensure that the requirements are met.
- The pumps shall be capable of reverse rotation up to 125% rated full speed of the drive motor, due to back flow of water, without damage or loosening of threaded components.
- The specifications for flanges shall be as mentioned in the Chapter of "Specifications of pipeline work".
- Spare parts supplied with the pump shall be identical to respective pump components and shall be from original manufacturer.
- Pumps shall run smooth without undue noise or vibration. Noise levels and velocity of vibrations shall be within acceptable limits. Noise level shall be

limited to 85 dba at a distance of 2 m. Velocity of vibrations shall be within 4.5 mm/s as per relevant Hydraulic Institutes Standards and IS.

- Unless otherwise specified the drive unit power rating shall be the maximum of the following requirements:
 - 15 % margin over the pump shaft input power required for the flow and head as considered.
 - 10 % margin over the maximum shaft input power required within the "Range of Operation".
 - 30 % margin over the maximum shaft input power required within the "Range of Operation" for pumps of BHP less than 15 HP.
- The range of operation shall be +10% to -25% of duty point head.
- The bidder shall confirm that the pumps shall not be of a new design and a pump of at least the same design and same size has been supplied and tested satisfactorily at least at two locations. The details of locations shall be submitted in schedules.

3.1.2 FEATURES OF CONSTRUCTION

Casing

Pump casing shall be axially/vertically split type. The casing shall be of robust construction. Liquid passage in the casing shall be finished smooth. Casing drain and vent connection with valves and automatic vent shall be provided.

Impeller

The impeller shall be dynamically balanced so as not to cause any vibration during operation.

Impellers shall be made in one piece and securely keyed to the shaft. Means shall be provided to prevent loosening during operation including rotation in reverse direction. Impeller fastening nuts (if provided) shall be of cap type and shall tighten in the direction of normal rotation.

Impeller shall be of Bronze with smooth surface and without blowholes.

Wearing Rings

Wearing rings shall be of renewable type. These shall be held in place by screwing against rotation, press fit and locked with pins, flanged and screwed. Opposite wear surface of hard material shall have a hardness difference of at least 50 BHN.

Shaft

The shaft shall be of stainless steel AISI – 410 and finished to close tolerance at the impeller, coupling and bearing locations. The shaft design shall be on the basis of maximum combine shear stress. This shear stress shall not exceed 30% of the elastic limit in tension or 18% of ultimate tensile strength whichever is lower.

The design of the shaft shall also take into consideration the critical speed of the shaft, which shall be at least 30% above/ below the operating speed.

The shaft shall be statically and dynamically balanced so as not to cause any vibration during operation.

Shaft Sleeves

Replaceable shaft sleeves of Stainless Steel as specified in the data sheet shall be provided to protect the shaft where it passes through stuffing boxes. The shaft sleeves shall be securely locked or keyed to the shaft and shaft sleeves shall be machine finished and assembled for concentric rotation.

Bearings

The bearings shall be ball or roller type and provision shall be made for the axial and radial loads.

When there is a possibility of liquid entering the bearings, the pumps shall be provided with suitable preventive arrangements such as water deflectors.

Grease lubricated ball bearings are acceptable, if the pump is specifically designed for grease lubrication and if operating conditions meet the following:

- a) Shaft speed does not exceed the speed limit recommended by the bearing manufacturers
- b) Suction pressure is below 0.7 Kg./cm^2 and with no other source of high thrust.
- b) Whenever thrust bearings are fitted, suitable arrangement for adjusting clearance shall be provide. Bearing shall be easily accessible without disturbing the alignment of the pumps.

Couplings

Pumps shall be complete with flexible coupling. Both halves of the coupling shall be provided by the pump manufacturer. Coupling halves shall be keyed to fit shafts of the pump and the motor by the contractor. Both halves of the coupling shall be matched. Flexible rubber bushing with carbon steel coupling pins shall be provided with coupling.

Coupling guards, made of expanded metal bolted to the base plate, shall be provided.

Base Plates

The common base plate for pump and drive shall be in one piece and shall be made of welded steel construction. Suitable holes shall be provided for grouting and they shall be so located that the base can be grouted in place without disturbing the pump and motor. All pumps and drives shall be properly aligned, bolted and dowelled to the base plate by contractor. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 14 mm drain piping. Base plate shall be manufactured by pump manufacturer so that holes and spacers are as required for pump motor alignment perfectly.

Accessories

- a) All accessories required for proper and safe operation shall be furnished with the pumps.
- b) Each stage of the pump, unless self venting, shall be provided with a suitable vent connection, complete with valves.
- c) Drain connections shall be provided at low points, valve connections shall be provided for drains.

3.1.3 INSPECTION AND TESTING AT MANUFACTURER'S WORKS

Inspection and testing at manufacturers work shall be carried out as specified below:

All instruments and equipments required for such tests shall be provided by the manufacturer and the instruments shall be calibrated and certified by an approved independent testing authority not more than three months prior to the test.

Pump efficiency will be checked by the third party inspection agency and it shall not be less than the quoted efficiency.

All the tests shall be carried out as per the relevant standard and codes. Brief description of tests to be carried out are as follows:

Hydrostatic Test

A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or twice the rated head whichever is higher.

Unless otherwise stated in Data Sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.

Mechanical Balancing

Balancing: The rotating assembly comprising of impeller, shaft with shaft sleeve etc. shall be statically and dynamically balanced as per IS 11723(Part I).

Necessary test certificates shall be furnished by vendor for purchaser's approval before dispatch of material.

Performance Testing

All the tests shall be carried out by the third party inspection agency as per IS – 9137:1978 with its own motor for its entire working range.

Each pump shall be tested for its full operating range in accordance with the applicable standard.

Test shall be carried out with minimum NPSH as available at site for rated discharge and maximum discharge. Each pump shall be tested at its rated speed.

During pump testing, readings to the extent possible shall be taken to correspond to the net effective lift specified in the Data Sheet, and cover its full working range from its closed valve condition to when delivery valve is fully opened up. Head,

flow and overall efficiency shall be used to determine the capacity of pump sets to meet guaranteed performance at site.

Material Test Certificate

Material test certificates for the various pump components shall be furnished for purchaser’s approval as stated in the Data Sheet.

Visual Inspection

Pump body shall be painted only after the hydrostatic test has been witnessed by the third party inspection agency.

Field Testing

After installation pumps will be subjected to testing in field for its satisfactory and trouble free operation for 200 working hours. If the field testing, performance is found not to meet the requirement, the equipment shall be rectified and/ or replaced by the contractor.

3.1.4 DRAWINGS AND MANUALS

The following drawings shall be submitted by the Bidder along with his bid:

Preliminary out line dimensional drawing showing the details of pump, base plate and motor. Suction & discharge nozzle sizes and foundation details.

Performance curves for capacity v/s (a) total head, (b) efficiency, (c) NPSHR and (d) KW requirements ranging from run out to pump shut off duly signed by responsible engineer of the manufacturer.

Typical cross sectional drawing with material of construction of each pump offered shall be provided with the bid.

Installation manual of all types of pump offered shall be submitted at the time of approval of equipment.

3.1.5 NAME PLATE

Each pump shall be provided with a stainless steel name plate of the manufacturer, indicating following details.

- a) Rated capacity in m³/Hr
- b) Total head in meter
- c) Speed in RPM
- d) Make and Model number
- e) Manufacturer’s serial number
- f) Weight of equipment

3.1.6 TESTING & INSPECTION

The performance at duty point shall be checked and guaranteed at 415 + 6 % & - 15 % Volts as per clause 6.2.2 of IS 9283 and it shall be ensured that motor does not get overloaded.

Testing of the pump sets shall be carried out as per relevant IS codes.

The marking shall be as per relevant IS. Purchaser’s mark “PHED” & “Year of Supply” shall be mentioned on each pump & motor.

3.2 PRESSURE GAUGE

The Pressure Gauges shall conform to IS:3624. Casing for line mounted pressure gauges shall be black finished aluminium alloy with aluminium ring, and shall be weatherproof and dust proof suitable for outdoor service. It shall have nominal size of 150mm. A synthetic rubber blow-out disc shall be furnished on casing. Case drilling for disc shall be 25 mm diameter or larger.

Line mounted gauges shall have bottom connection with 1/2 inch male pipe thread. Thread shall be American Standard Taper Pipe Thread. The stainless steel socket and tip with welded stress relieved joints shall be provided.

Movement shall be the rotary geared type with bushed front and back plates. All parts except the hair spring shall be stainless steel. Set screw or similar device shall be provided to change effective length of sector arm.

Measuring system for line mounted gauges shall be constructed as a unit independent of the case.

Pointer shall be micro meter type. All the parts shall be aluminium or stainless steel.

Dial shall be of the laminated phenolic type with black figures on white background.

Pressure gauges shall be mounted on a board suitably supported on the side of a pipe. Pressure gauges shall be mounted using flexible wire braided tubing to avoid the effect of vibration on pressure gauges.

(i)	Process fluid	Pond Raw Water/ River Water
(ii)	Accuracy	+/- 1% of full scale
(iii)	Range	0 – 50 m (0 – 5 kg/sq.cm.)
(iv)	Dial size / Glass	150 mm / Shatterproof
(v)	Standard	IS : 3624
(vi)	Over range Protection	125% of maximum pressure
(vii)	Body Material	Die Cast Aluminium
(viii)	Material of sensor and other wetted parts (snubber, valves, fittings, tubings etc.)	SS 316
(ix)	Blow out disc	Required

(x)	Material of dial	Aluminium with white back ground and black numerals
(xi)	Accessories	2 valve manifold with drain cock Impulse tubing, fittings Snubber and all other installation hardware
(xii)	Make	Given in the list of preferred makes

3.3 Specifications of Mono block pumps

The mono block pumps shall conform to the requirements of the required head and flow as given above. The construction features of the pump shall conform to IS 9079.

Accessories and services required to be supplied by the Bidder with pump.

The bidder is supposed to provide at least the following accessories

- Base Plate
- Foundation Bolts
- Coupling
- Coupling guard

3.3.1 Drawings and information to be provided

During detailed engineering the Bidder shall submit the following:

- General arrangement, cross-sectional and dimensional drawings/data pertaining to selected model.
- Complete detailed drawing of the base plate
- Complete performance curve with (for pumps of BHP more than 50 HP)
 - (a) H - Q curves.
- Test reports, performance curves and other particulars, as required by the applicable clauses of this specification.

Instruction Manuals:

- Instruction manual for Erection
- Instruction for pre-commissioning check up, operation, abnormal conditions, maintenance and repair

3.4 MONO-RAIL HOISTS

Mono-rail hoists shall be provided over motor floor area of pumping stations of not less than capacity (of 1 ton) as mentioned in scope of work.

3.5 Ventilation & Cooling of Pump Room

The ventilation and cooling system of the pump room must be designed such as to limit the temperature rise to a maximum 5 ° Centigrade above the ambient temperature. The ambient temperature is to be taken as 45 ° Centigrade for design of ventilation and cooling system.

All the connected load shall be taken into account for design of ventilation and cooling system.

The bidder shall provide detailed calculations to determine the temperature of ambient air within the pump room with all pumps in operation.

3.6 Exhaust fans

General

Exhaust fans of appropriate rating, in general shall be provided for all openings and in suitable numbers as per layout of the building at clear water pumping station, switchgear rooms etc.. The air change ratio by the selected fan must be provided for the approval of the Engineer-in-Charge, before the selection of exhaust fans.

Technical particulars

Operating conditions

1	Fan designation	Exhaust duty
2	No. of fans and design capacity	<i>to meet stipulated temperature difference and air circulation levels for limiting temperature rise within specified limits.</i>
3	Type	Wall mounted, centrifugal/axial flow

Features of construction

1	Impeller	Mild steel or Cast aluminium
2	Hub	Cast Iron/Diecast aluminium
3	Casing	Mild steel
4	Wall cowl	Galvanised iron sheet - 22 gauge
5	Bird screen	14 gauge galvanised iron with 12 mm bird screen.
6	Motor	TEFC IP 54, with speed below 1500 rpm synchronous

Drawings and information to be provided

During detailed engineering the Bidder shall submit the following:

Leaflets on exhaust fan.

Instruction Manuals:

- Installation manual for erection

- Instruction for pre-commissioning check up, operation, abnormal conditions, maintenance and repair
- Recommended inspection points and periods of inspection
- Schedule of preventive maintenance
- Ordering information for all replaceable parts

3.7 Delivery & Suction Pipes – Design Considerations

The sizes of manifold pipes will not be less than that mentioned in the scope of work. The delivery pipes for centrifugal pumps shall be sized to limit the velocity of flow in respective pipes shall not exceed 2.5 m/s,. The velocity in the suction pipe shall not exceed 1.6 m/s. The lateral velocity in the main suction header pipe shall not exceed 0.5 m/s

3.8 Pipe Fittings

Pipe fittings of size 50 NB and below shall be forged conforming to IS-1239 Part-II. Fittings above 50 NB up to 200 NB shall be of welded/seamless conforming to ASTM A-234 Gr. WP or of DI /CI corresponding to the pressure ratings at the point of installation. Dimensional standard ANSI B.16.9. Fittings and specials of size 250 NB and above can be fabricated from MS pipes fabricated as per specifications detailed in the Chapter of “Specifications for pipes”.

All specials such as bends, tee’s, tapers, etc. must be either standard fittings of CI / DI or of fabricated from MS pipes made as per specifications given in the Chapter of “Specifications for Pipes”. Before fabrication the detailed drawings of fabrication of each special must be got approved from the Project Manager. All specials must be brought to site after inner and outer coating as specified in the Chapter for “Specifications for pipes”.

3.9 Cast iron pipes and specials

The puddle collars embedded in the wall will be of Cast Iron.

If flanged cast iron pipes and specials shall be used in the pump house and to the limit of both suction and delivery pipelines they shall be manufactured and tested according to IS 1536 and 1537 respectively. Flanges shall conform to IS 1538

3.10 Testing and inspection

Hydrostatic Test

The entire piping with valves and fittings will be site tested for the design pressure as per the provisions of the referred latest IS code. In case the piping is to be in a network, isolated portions with overlapping areas shall be tested. No pressure drop or leakage shall be evident.

3.11 Miscellaneous

3.11.1 Nuts, Bolts, Studs and Washers

Nuts and bolts shall be of the best quality bright steel, machined on the shank and under the head and nut. Studs, bolts and nuts shall be **galvanised**. Bolts shall be of accurate length so that only one thread shall show through the nut in the fully tightened conditions. Nuts and bolts shall conform to IS 1363 and IS 1367.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary.

Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel bearing stainless steel.

The Bidder shall supply all holding down, alignment levelling bolts complete with anchorages, nuts washers and packing required to fix the plant to its foundations, bed plates, frames and other structural parts.

The Bidder shall procure and keep at site, reasonable excess quantities to cover wastage of those materials which will be normally subject to waste during erection, commissioning and setting to work.

3.11.2 Gaskets

Gaskets shall be of Nitrile rubber and ready made ***machined cut gaskets for respective flange shall be used.*** Gaskets cut out from rubber sheet are not acceptable.

3.11.3 Support For Pipework & Valves

All necessary supports, saddles, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valves and other devices mounted in the pipe work shall be supported independent of the pipes to which they connect. Wherever necessary RCC supports shall also be provided

3.11.4 Galvanising

Wherever galvanising has been specified the hot dip process shall be used. The galvanised coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

(a) Fabricated steel

Thickness less than 2 mm but not less than 1.2 mm	340 gm/m ²
Thickness 2 mm and above	460 gm/m ² .

(b) Fasteners

Up to nominal size M10	270
Over M10	300

Galvanising shall be carried out after all drilling, punching, cutting bending and welding operations have been carried out. Burrs shall be removed before galvanising. Any site modification of galvanised parts should be covered well by zinc primer and aluminium Paint.

3.11.5 Painting

Painting of exposed ferrous surface of all items of plant shall be carried out by the Bidder in accordance with provision in the Chapter for "Specifications for Civil Works".

Immediately on arrival at the site all items of plant shall be examined for condition of the primer coat/finish paint applied at the Manufacturer's works and unsatisfactory portions shall

be cleaned down to the bare metal, all rust being removed, and the surface made good with similar primer/paint.

After erection, such items which are not finish painted shall be finish painted, items finish painted at the Manufacturer's works shall be touched up for any damaged paint work.

No painting shall be carried out unless the item has been inspected and accepted by Project Manager or the person authorised by him. Shades of finish painting of equipment shall be approved by Project Manager.

3.11.6 Lubrication

A complete schedule of recommended oils and other lubricants shall be furnished by the Bidder, in the operation and maintenance manuals. The number of types of lubricants shall be kept to a minimum. In case of grease lubricated bearings for electric motors, a lithium base grease is preferred.

The Bidder shall indicate the brand name of indigenously available equivalent lubricants with complete duty specification, to enable the department to arrange procurement in future. The Bidder shall furnish the schedule of quantities for each fill, frequency of filling and annual requirement.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose means more than once in a month.

Where more than one type of special grease is required, a grease gun for each special type shall be supplied.

All lubricant systems shall be designed so as not to cause a fire or pollution hazard.

The Bidder shall supply flushing oil for such lubrication system when an item of plant is ready for preliminary running.

3.11.7 Civil Works

3.11.7.1 Erection - General

The Bidder's staff shall include at least one competent erection engineer who should be at least a graduate with 3 years erection experience and who should be permanent employee of the Bidder, to supervise the erection of the works using sufficient skilled, semi-skilled and unskilled labour and to ensure completion of the Works on time. The Bidder shall not remove any representatives, erectors or skilled labour from the site without the prior approval of the Project Manager

The Bidder's erection staff shall arrive on the site on dates to be agreed by the Project Manager who will give to the Bidders advance notice in writing of the dates on which they will be required. Before they proceed to the site, however, the Bidder shall first satisfy himself, as necessary, that sufficient material of his supply has arrived on site so that there will be no delay on this account.

The Bidder shall be responsible for setting up and erecting the equipment to the line and level required.

3.11.7.2 Pump Foundation, Leveling And Grouting of Machinery

The pumps and motors shall be properly and accurately leveled and aligned on the concrete plinth by means of tapered metal wedges and metal packing pieces before any grout is poured. After correct alignment and leveling the foundation bolts shall be nipped up to hold the machine firmly in position and it shall be the Bidder's responsibility to check that the position is maintained after the grout has been poured but before it sets. The grout which will contain an approved expanding agent will be mixed and poured by the Bidder. ACC shrinkomph, grout mixer or equivalent as approved by Project Manager, is to be used for grouting.

The horizontality of base plate top shall be within 0.05 mm/metre. The base plate top surface and pump motor box are to be blue matched to get a contact area of at least 80%.

After the grouting mixture has set, the foundation bolts shall be pulled up hard and the alignment and level rechecked. The Project Manager shall be informed at all times of the progress of this work and when any checks on alignment and level are to be carried out so that he may witness the checks if he so requires. The approval of the Project Manager or his intimation that the alignment or level of the machines is to his satisfaction shall in no way relieve the Contract of his obligation under contract to properly install and align the machines and Pipe work and shall in no way prejudice the Project Manager's rights to order rectification of any installation work later found to be improperly carried out.

3.11.7.3 Name Plates

Each main and auxiliary item to the Plant shall have permanently attached to it, in a conspicuous position, a name plate and rating plate, each of weather-resistance and fire-resistance material. Upon these shall be engraved or stamped the manufacturer's name, type and serial number of Plant, details of the loading and duty at which designed to operate.

Details of proposed inscriptions shall be submitted to the Project Manager for approval before any labels are manufactured.

3.11.8 Miscellaneous requirements

3.11.8.1 Nameplates, signboards, nomenclature

Each item of the plant shall have permanently attached to it in a conspicuous position a nameplate, on which shall be engraved or stamped the manufacturer's name, type and serial number, year of manufacture, details of the design capacity etc. Such labels shall be of non-hygroscopic material to be approved by the Project Manager.

Near by or on each item of the plant, shall be fixed a plate with the name and nomenclature (code) of the item according to the project nomenclature. It shall be visible from a distance of several metres.

The Bidder shall also provide bilingual signboards and instruction tables of durable material, throughout the plant, for the purposes of operation, maintenance and security:

- Danger and caution signs (English and local language)
- Preventive maintenance schedules (local language)
- Operating instructions (local language)
- Unit names (English and local language)

- Nameplates at the doors to the units (English and local language)

Signboards and plates shall be appropriately sized in relation to the relevant item and its surroundings. Details of the proposed inscription, size, material and colours shall be submitted to the Project Manager for approval before any signboards or plates are manufactured. They shall be compatible with the instructions in the operation manual.

All cables shall be provided with clip-on identification numbers on both ends and at all terminations in between, for identification. The nomenclature shall correspond to the electrical as-built drawings.

The nomenclature and labeling of the plant shall be decided in close co-operation with the Project Manager.

4 ELECTRICAL WORKS

4.1 GENERAL

It is not the intent to specify herein all the details pertaining to the design, drawing, selection of equipment/materials, procurement, manufacture, installation, testing & commissioning, however, the same shall be of high standard of engineering and shall comply with all currently applicable standards, regulations & safety codes. These specifications cover the equipment to be installed in switchgear, cables etc. along with the specifications for workmanship, laying cables, earthing systems, lightning protection etc.

It shall be the responsibility of the Bidder to design the electrical system based on the selection of the mechanical equipment. The work will be executed as per the detailed designs and drawings approved during execution. At Ratangarh headworks, the equipment / material installed shall commensurate with those installed by the contractor constructing the pump house building in package I. Wherever the electrical equipment and system has to be connected with the Instrumentation system, the details of the connectivity of the electrical system/equipment with the Instrumentation system has to be worked out by the bidder to be commensurate with the requirement of the Instrumentation system to be provided, Irrespective of the provisions given in these specifications for electrical equipment/works, in this chapter. The bidder shall provide all necessary accessories with the equipment dealt herein or additional equipment required for effective functioning of the electrical and Instrumentation systems.

The pre-dispatch inspection and pre-commissioning testing and commissioning details are provided in the Chapters of Specifications for Pre-dispatch inspection and Specifications for Testing, Commissioning and Trial run respectively.

The brief technical specifications of the various electrical equipments are given in subsequent clauses comprising the following:

- Applicable Indian Standards
- Other considerations (if any)
- Technical parameters supplied by the department
- Drawings and documents for review/approval

The various systems covering the installation practices are described separately.

The scope of the Bidder shall cover design and drawing of electrical systems, selection of the equipment/materials, procurement, expediting, inspection, packing and forwarding, delivery at site, erection, testing, commissioning, obtaining the statutory approvals, handing over the complete plant etc.

4.2 Power SUPPLY Information

The proposed power supplies are as follows:

(i)	415V AC System	Voltage variation +10 to -15% Freq. Variation +3 to -5% Combined variation : +10% to -15%	Three Phase and neutral, 50 Hz, effectively earthed system, SC. rating of 50 kA
(ii)	240V AC System	Voltage variation + 10% to -15 % Freq. Variation + 3% to -5%	Single phase and neutral, 50 Hz, effectively earthed system

The ambient temperature for design of the electrical equipment shall be 50° C.

4.2.1 Fault Levels

The fault levels of the proposed units in the sub station / pump house shall be as per IS: 2026

4.3 Design Considerations

4.3.1 General

The electrical installations proposed under the contract are for the project requirement. Wherever found necessary, the installations shall be done considering the likely extension of the system/system component for integration with the future extensions.

4.3.2 Requirements Under This Contract

For the work under this contract, the Contractor shall install the following for operation of pumps installed under the contract:

1. Creation of GSS from the point where the JVVNL will provide 11 KV electricity.
2. 3.5 core, armoured aluminium cable of adequate size from transformers (2 nos.) to Main Panel. Contractor will lay cables separately from each transformer.
3. Main Panel shall be provided in the electrical control room.
4. A local push button station near the installed pumps.
5. Relay, Contactor, Capacitor banks for the installed pumps.
6. The motor panel shall have
 - Incoming – 2 MCCB 50 KA with 2 sets of metering having ammeter with selector, voltmeter with selector, multi-function meter, indicating lights.

- Outgoing – starter DOL up to 22 KW, star delta above 22 KW and upto 50 KW, Soft starter for above 50 KW motors; with motor protection relay having overload, phase loss, reverse phase, locked rotor, stalling, local remote push buttons, on-off trip indicating lights, CT for remote push button ammeter
- DOL starter will be provided for drain pumps
- Power factor improvement capacitors will be provided with fuse and contactors as per SLD. Power factor is to be maintained at 0.92. any penalty, if imposed , will be paid by the contractor.

All delivery headers will be provided with adjustable pressure switch to switch-off pumps near shut off head.

The Contractor shall provide and lay necessary cables for power connections/instrumentation/earthing of installed equipments.

4.3.3 Drawing and documents required

- GA drawing for operating mechanism.
- Schematic and wiring diagram.
- GA drawing of supporting structures with foundation details.

4.4 LT Motors for pumps, Dewatering Pumps, other motors not dealt in other sections of rating more than 2 kW)

4.4.1 Standards

No.	Standard	Description
1.	IS 325	Squirrel cage induction motors
2.	IS 4691	Type of enclosures
3.	IS 6362	Method of cooling
4.	IS 4029	Testing of induction motors
5	IS 12075	Mechanical vibrations of rotating electrical machines
6	IS 12065	Permissible limits of noise level

4.4.2 Other considerations

Bidder shall select the motor as per the required performance of the pumps and ascertain the required rating of the motor. **The motor selected shall be energy efficient.** Bidder shall also verify the starting characteristic and acceleration time for motor selection.

The number of permissible restarts (hot & cold) per hour for each motor shall be informed by the Bidder after obtaining the same from the motor manufacturer.

If cable termination box provided with the motor is inadequate to accept required no. of cables, then the Bidder shall provide an adopter box for the same. The cable termination box location shall be as per the layout drawings

4.4.3 Technical parameters

a)	Tentative motor details	As per System Requirement
b)	Type of motors	Totally enclosed fan cooled (TEFC) Squirrel cage induction motors
c)	Protection Class	min. IP 55
d)	Motor duty	Continuous, S1
e)	Supply voltage & frequency conditions	Voltage : 415 V +10% to -15% Frequency : 50 Hz +3% to -5% Combined variation : + 10% to -15%
f)	Insulation class	Class F
g)	Frame Size	Frame size should be selected keeping in view supply voltage and frequency conditions/hot and cold starts.
h)	Syn. speed	as per driven equipment
i)	Starting Method	a) Direct on line (DOL) for motors up to 20 kW b) beyond 20 KW, star delta.
j)	Starting Current	Starting current for the motor in DOL mode, should not be more than 600 % of the full load current.
k)	Cable termination details	Cable termination box protection class IP 52.
l)	Earthing conductor	GI strip as per the sizes specified
m)	Performance details	Efficiency at full load - 85 % min. P.F. at full load - 0.85 min.
n)	Painting details	Enamel paint of shade 631 as per IS 5.

4.4.4 Drawing and documents required

- GA drawing of the each motor showing dimensional details and terminal box details
- Motor selection details
- Motor Characteristics
- Instruction manual for installation, operation and maintenance for motors

4.5 Capacitors

LT Capacitors

Standards

Standard	Description
IS 2834	Power factor improvement capacitors

Other considerations

The Contractor shall check with manufacturer regarding providing of inductor coil.

The Contractor shall work out the automatic power factor control (APFC) scheme to achieve a power factor of 0.92. The power factor improving capacitor requirement shall be as per the power factor of the equipment selected by the Contractor.

Technical parameters

a)	Quantity and output	The figures indicated in SLD are tentative, the quantity and output must be designed as per the requirement of load to achieve the above-referred objective.
b)	Power factor control	Through APFC/capacitors as per SLD
c)	Capacitor type	APP
d)	Rated voltage and frequency	415 Volts 3 phase (line to line), 50 Hz
e)	Maximum over voltage the unit capacitor is capable of withstanding continuously	105 %

Drawing and documents required

- GA drawing of the capacitor unit, bank
- Instruction manual for installation, operation and maintenance for capacitor

4.6 Cables**LT Cables**

Standards

No.	Standard	Description
1.	IS 1554	PVC insulated electric Cables.
2.	IS 8130	Conductors for insulated electric cables.
3.	IS 5831	PVC insulation and sheath of electric cables.
4.	IS 3975	Mild steel wires, strips and tapes for armouring of cables.

5.	IS 1753	Aluminium conductors for insulated cables.
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Other Considerations

Power cable shall be of Al conductor, whereas control and lighting cables shall be of Cu conductor. The minimum size of Al conductor cable shall be 4 mm² and Cu conductor cable of 2.5 mm².

Power cable sizing shall be based on the various de-rating factors recommended by cable manufacturer, rated current, temperature rise of conductor and voltage drop.

Control cables of CTs shall be based on the VA burden of CT and relays, meters.

Technical parameters

LT Cables	PVC insulated, taped PVC inner sheath and outer sheath 650/1100 V grade, with multi-stranded aluminium/copper conductor, armoured
Cable selection	Cable shall be selected considering following points Current rating of the load De-rating due to grouping of cables. Voltage drop up to 3% in cable due to cable resistance De-rating factor due to ambient temperature. De-rating due to depth in case of buried cables
Spare cores for control cables	Up to 4 cores - nil 5 cores to 9 cores - 1 core 10 cores to 20 cores - 2 core 21 cores to 30 cores - 3 core More than 30 cores - 4 core

Drawing and documents required

- Cable catalogue

4.7 Cabling System

Installation

The cables shall be laid in trenches, trays or conduits or shall be buried in ground. Cable routings shall be checked at site to avoid interference with structures already provided in the pump house, piping and ducting. All cables shall be carefully measured and cut to the required length, leaving sufficient length for final connections to the equipment on both ends.

The Bidder shall ascertain the exact requirement of cable, for a particular feeder, by measuring at site along the actual finalised route.

Cables shall be laid in complete uncut lengths from one item of equipment to another.

Cables shall be neatly arranged in the trenches, trays in such a manner, that criss-crossing is avoided and final take off to the motor, switchgear is facilitated. LT Cables shall be laid a

maximum two layers in each tray for cables up to 3 ½ C x 95 mm². Arrangement of cables within the trench, tray shall be the responsibility of the Bidder.

Power and control cables shall be laid on different trays in one trench. 1.1 kV grade cable may be laid on one tray.

All cables shall be identified close to their termination point by cable numbers. Cable numbers will be punched on aluminium straps, (2 mm thick), securely fastened to the cable and wrapped around it.

Underground cables shall be provided with cable markers. These cable marker posts shall be located at every 50 metres and every corner or change of direction.

All temporary ends of cables shall be protected against dust and moisture to prevent damage to the insulation. While laying cables, the ends shall be taped with PVC tape.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with protective cover until the final termination to the equipment is completed.

Directly buried cable shall be laid underground in excavated cable trenches wherever required. The trenches shall be suitably designed for accommodating all the cables. Before cables are placed, the trench bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. The cable shall be covered with 150 mm of sand over the top of the largest dia. cable and sand shall be lightly pressed. A protective covering of RCC tiles shall then be laid on top in case of HT cable and ordinary brick in case of LT cables. The balance trench area shall then be back filled with soil, rammed and levelled.

As each cable is laid in the trench, it shall be subjected to an insulation test in the presence of the Project Manager before covering. Any cable which proves defective shall be replaced at no additional cost.

All wall openings shall be effectively sealed after installation of cables.

Where cables rise from trenches to motors, control stations, lighting panels etc., they shall be taken up in GI pipes (rigid, flexible) for mechanical protection up to a minimum of 600 mm above grade level. The diameter of the GI pipe shall be at least 3 times the diameter of the cable.

Cable shall be carefully pulled through conduits to prevent damage.

Wherever cables are taken in conduits, pipe, the Bidder shall ensure that the area of conduit, pipe is at least 100 % more than the cable area.

If pipe sleeves installed are inadequate due to a greater number of cables being laid, then additional pipe sleeves shall be laid. After the cables are installed and all testing is complete, conduit ends above grade level shall be plugged with suitable weatherproof plastic compound.

Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same.

At road crossings and other places where cables enter pipe sleeves an adequate bed of sand shall be given.

Cables installed above grade level shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel to, or at right angles to, beams, walls or columns. The cables shall be so routed that they will not be subjected to heat.

Cables running along with structures will be clamped by means of GI saddles and saddle bars at a spacing of 300 mm.

Cable carrier systems i.e. site fabricated ladder type cable trays and supporting steel shall be painted before laying of cables. Painting shall have two coats of red oxide and one coat of Aluminium paint.

For all outdoor buried cables a 3 metre diameter loop shall be provided at both ends before termination.

Termination

All XLPE insulated cables shall be terminated using HT termination kit only

All PVC cables shall be terminated at the equipment/panel by means of double compression type brass glands and tinned copper lugs.

Power cable cores shall be identified with red, yellow and blue PVC tapes.

In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per inter-connection diagrams, to be furnished to the Bidder.

The cable shall be taken through an adequate size gland inside the panel or any other electrical equipment.

Cable leads shall be terminated at the equipment terminals by means of crimped type solderless connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping.

Testing of cables

Before energizing, the insulation resistance shall be measured from phase to phase and phase to ground.

4.8 Earthing System

General

Earthing of all non-current carrying metal work of starters, motors etc. shall be earthed. The bidder shall integrate instrument earthing with the general earthing system of the pump house.

All the material required for making earthing stations, shall be supplied by the Bidder. Excavation and refilling for laying of earth strip and for earth pit shall also be in Bidders scope.

- The entire earthing system shall fully comply with Indian electricity act and rules. The Bidder shall carry out all changes desired by the electrical inspector, in order to make the installation conform to I.E. Rules.
- Conduits in which cables have been installed shall be bonded and earthed. Cable armours shall be earthed at both ends.

- All electrical equipment above 230 V shall be earthed at two points and equipment 230 V and below shall be earthed at one point.
- Minimum Conductor size for connections to various equipment shall be as per the table as follows:

Equipment		Conductor Size
Motors/Panel	Up to 11 kW 11 kW up to 22 kW 22 kW up to 37.5 kW 37.5 kW to 90 kW 90 kW to 200 kW Above 200 kW	8 SWG GI wire 4 SWG GI wire 25 x 3 mm GI flat 25 x 5 mm GI flat 40 x 5 mm GI flat 50 x 6 mm GI flat
Local control station, street light pole & its junction box		8 SWG GI wire
Lighting Panel		25 x 3 mm GI flat
Indoor fixtures		14 SWG GI wire

- All paint, scale etc. shall be removed before earthing connections are made.
- Anchor bolts or fixing bolts shall not be used for earthing connections.

4.9 Miscellaneous

Cable glands and lugs

All HT cables shall be terminated with HT cable termination kit of indoor or outdoor type depending on the application.

All LT cable glands shall be made out of brass and shall be of double compression type.

All LT cable lugs shall be of tinned copper, crimping type.

Cable trays

Cable carrier system shall comprise of site fabricated ladder type cable trays made out of structural steel and painted with two coats of red oxide primer and a final coat of enamel paint. The construction of the cable trays shall be as per the site requirement and generally in line with the tender drawings.

Rubber mats

Electrical grade rubber mats shall be provided in the switchgear room in front of all panels.

Civil Works

The civil works required for electrical installation will also be part of this package. The bidder shall also co-ordinate all inter-disciplinary interfaces between civil and electrical works.

Spare parts for Electrical Equipment

The compulsory spare parts shall be provided as per the list enclosed under scope of work.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be labelled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

5 INSTRUMENTATION SYSTEM

5.1 General

This section of specifications defines the general requirement of Instrumentation system & Automation system to be installed for the contract works for selection of field instruments and control system or anything related to instrumentation, the Contractor shall follow the specifications contained here in.

Irrespective of the detailed specifications of the respective items detailed in the chapters of pumping stations & scope of work, the contractor shall be required to provide all equipment, accessories, cabling, earthing etc.

General Requirement of Instrumentation & AUTOMATION system

The entire Instrumentation system is required to:

Receive & store the information from

a. Instrumentation Equipments

Flow data (instantaneous flow rates and total flow) from the pump house (through flow meter installed on clear water main). The reading of flow meter shall be displayed on the main panel in the pump house.

While selecting material/equipment, the following shall be considered:

1. Electronic instruments shall utilise solid-state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.
2. Unless otherwise stated, overall accuracy of all measurement systems shall be $\pm 1\%$ of measured value, and repeatability shall be $\pm 0.5\%$.
3. After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.
4. For equipments and machines wherever electricity is not available, it would be the responsibility of the contractor to consider for alternate option with sufficient battery backup, irrespective of the fact whether mentioned in this tender document or not.
5. The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.
6. The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.5 m above grade platform.
7. Unless otherwise stated, field mounted electrical and electronic instruments shall be weather proof to IP-68.

8. The instruments shall be designed to work at extremes of the ambient conditions of temperature, humidity, and chlorine contamination that may prevail. The instruments shall be given enough protection against corrosion.
9. Lockable enclosure shall be provided for the field-mounted instruments wherever required.
10. All field instruments, and cabinets/panel-mounted instruments shall have tag plates/name plates permanently attached to them.
11. The performance of all instruments shall be unaffected for the $\pm 10\%$ variation in supply voltage and $\pm 5\%$ variation in frequency simultaneously.
12. All wetted parts of sensors shall be made out of non-corrosive material capable of working with chlorine content of 5 ppm.
13. For all instruments (transmitting analogue signals) installed in the field (outside pump house), lightning protection units (LPU) shall be provided at both ends of the connecting cable for the protection against static discharges/lightning and electromagnetic interference.
14. Unless otherwise specified, double compression glands shall be used for glanding the cable in field instruments and instrument control panel.
15. Two wire transmitters shall be provided with on-line test terminals.

5.2 Specifications of equipment/system

General criteria

The design /selection criteria to be applied to instrumentation systems shall be as follows:

- (a) all instruments shall be suitable for continuous operation
- (b) all transmitting instruments shall have a 4 - 20 mA linear output
- (c) all digital outputs shall be volt free through a relay’s potential free contact
- (d) all instruments shall be designed for the ambient conditions of temperature and humidity
- (e) all wetted parts of instruments sensors shall be non-corrosive and suitable for use with potable water containing residual chlorine
- (f) all instrumentation systems for use out of doors shall be protected to IP 68
- (g) all analogue displays shall be of the digital type with no moving parts
- (h) instrumentation shall utilize solid state electronic microprocessor technology and avoid the use where practical of any moving parts
- (i) instruments shall resume operation automatically on application of power following a power failure.

5.3 Electromagnetic full bore type flow meter.

If not provided with the flow meter, the flow indicator and integrator as per clause 9.11 below shall be provided.

S.No	Details	Parameter
1.	Principal of working	Faradays law of electromagnetic induction
2.	Type	Full Bore Type with integral flow transmitter
3.	Size	As per requirements.
4.	Signal out put	4-20 mA DC
5.	Time contact	1 second to 20 second adjustable
6.	Pulse out put	10 – 18000 pulses per hour a) Out put to drive external electromagnetic counter of 12 V / 24 V DC directly
7.	Maximum load resistance	500 Ohm
8.	Local display	3.5 Dijet LCB
9.	Ingress Protection	IP 68
10.	Flow velocity	0.25 m/sec to 10 m/sec
11.	Accuracy	+/- 0.5 % of actual flow at reference condition
12.	Repeatability	+ or – 0.15% of span
13.	Power supply	Normal 240 Volt AC + or – 15 % 50 Hz
14.	Media pressure	As per requirement
15.	Power consumption	Maximum 20 W
16.	Materials	
a)	Liner	Neoprene /Polyurethane
b)	Pipe	SS304/carbon steel
c)	Flanges	Carbon steel
d)	Coil housing	SS 304/Carbon steel
e)	Transmitter	Cast Aluminium epoxy painted
f)	Electrode	SS316/Hastelloy

Flow Indicator and Integrator

1.	Type	:	Microprocessor based
2.	Display	:	Digital, seven segment back lit LCD/LED display
3.	Digit Height	:	14 mm or Higher
4.	No. of Digits for - Flow indicator - Flow integrator	:	5 Digits 6 Digits
5.	Input	:	4-20 mA DC (Isolated) from flow transmitter through analogue signal multiplier
6.	Zero and span adjustment	:	Required
7.	Manual Reset Facility for flow integrator	:	Required (shall be key operated)
8.	Engineering units for		
9.	- Flow rate indicator - Flow integrator	:	Cum/hr MI
10.	Battery backup for integrator	:	Required

Note: Digital flow indicator and flow integrator shall be a combined unit

5.4 SPECIFICATION FOR FLOW METERS

The specifications for flow meters, to be installed at the tube wells, are for following types of meters, as below:

- Woltmann/Multi-jet Type Flow Meters

The sizes of the meters selected should be such so as to register the minimum as well as the maximum flows of each tubewell.

5.5 SPECIFICATIONS OF WOLTMANN / MULTI-JET TYPE FLOW METERS**Meter**

- To be installed with strainer
- Flow straightner (for Woltmann type only)
- Protection class of IP 68
- As per ISO 4064

- Having EEC / MID marking
- The meter should have minimum and maximum flow rates so as to register minimum and maximum flows of each tubewell.
- Pre-equipped with arrangement to able to fix communication and remote reading device which will be done in another work package.
- Protection against corrosion with epoxy powder coating
- Hermetically sealed with copper can register

Meter Interface Unit

- The meter must be equipped with a digital output that reliably transmits data to the analyzer unit.

The flow meter shall comply with the following: -

- | | | |
|-----|-------------------------------|---|
| (a) | Nominal Diameter | : As per requirement |
| (b) | Accuracy | : $\pm 5\%$ at minimum flow |
| (c) | Accuracy | : $\pm 2\%$ at normal and Maximum flow |
| (d) | Maximum Working Pressure | : 16 bars |
| (e) | Temperature range | : $0^{\circ}\text{C}-50^{\circ}\text{C}$ |
| (f) | Minimum flow rate | : 70 litre per hour for 25 mm, 200 lph for 40 mm, 300 lph for 50 mm meters, 500 lph for 65 mm meters, 750 lph for 80 mm meters & 1200 lph for 100 mm meters |
| (g) | Maximum Flow rate | : $7\text{ m}^3/\text{hr}$ for 25 mm, $20\text{ m}^3/\text{hr}$ for 40 mm, $50\text{ m}^3/\text{hr}$ for 50 mm meters, $80\text{ m}^3/\text{hr}$ for 65 mm meters, $120\text{ m}^3/\text{hr}$ for 80 mm meters & $200\text{ m}^3/\text{hr}$ for 100 mm meters |
| (h) | Maximum permissible head loss | : Less than 0.15 bar
at peak flow of respective village |

5.6 Pressure Measuring System

5.6.2 Pressure Gauges

1. Pressure gauges shall comply with IS 3624/ BS 1780. Glycerine filled dial shall be provided where the gauge is subjected to pressure pulsation and / or vibrations. The internal parts of pressure gauge shall be stainless steel.
2. Pressure gauges shall be provided on discharge of each pump and compound pressure gauges shall be provided on suction of each pump. Pressure gauge shall be bourdon type with a dial size of 150 mm in diameter and calibrated for the required range. The gauge shall be supplied complete with impulse tubing, two valve manifold with drain cock/calibration valve, fittings etc. The pressure gauges shall have an accuracy of $\pm 1\%$ full scale and weather protection class IP 65. All wetted parts material shall be SS 316.

3. The minimum diameter for round pressure gauges shall be 150 mm unless specified otherwise or where the gauge forms part of a standard item of equipment.
4. The zero and span of pressure gauge shall not change by more than ± 0.1 % of the span per $^{\circ}\text{C}$ changes in ambient temperature.

5.6.3 Ultrasonic/Capacitance Type Level Measuring System

- (a) The Ultrasonic/capacitance type level measuring system shall consist of a sensing probe, a transmitter and a digital indicator.
- (b) The level-measuring probe shall be installed on a standpipe on a tank and shall be connected to level transmitter, which shall generate a DC analog signal for connecting it to the digital level indicator on the panel.

5.6.4 Level Sensors (LS)

Level sensors of ultrasonic/capacitance type, suspension mounted shall be provided for level measurement of water in tanks/ sump/ reservoir. Guide pipe shall be provided for probe support.

Technical parameters

No	Title	Description
1	Name of instrument	Level sensor
2	Location	Out door/indoor on tanks/ sump/ reservoir
3	Application	Measurement of water level
4	Mounting	Flange /socket mounting
4	Input	Level
5	Output	DPDT contact rated 5A at 230 V A.C.
6	Accuracy	2.0% FSR
7	Required Range	To suit the requirement
8	Power Supply	230 V AC or suitable
9	Connection Details	2x1.5 mm ² CYWY cable

5.6.5 Pressure Switch

- a) Electro-mechanical pressure switch shall be provided to detect high pressure in the common discharge header of the pumping station.

- b) The pressure switch shall have a manually adjustable set point and differential switching level. The switch shall be provided complete with impulse tubing, two valve manifold with drain cock/calibration valve, fittings etc.

i.	Type	:	Non-Indicating
ii.	Sensing Element	:	Bourden/Bellows
iii.	Switch type	:	Microswitch
iv.	Set pressure	:	Adjustable
v.	Accuracy	:	± 1% of span
vi.	Switch Contacts	:	2 NO + 2 NC
vii.	Switch Rating	:	24 V D.C., 2A
viii.	Wetted parts material	:	SS 316

5.6.6 Cabinets For Field Instruments

A Cabinet shall be provided for enclosing instruments and associated accessories which are mounted outside the control panel such as transmitter, LPU, terminal blocks etc. at all measurement locations.

It shall be fabricated from cold rolled steel with powder coating sheet of standard gauge and shall be suitable for wall mounting or pedestal mounting as required.

The cabinet shall conform to IP-65 protection and shall have built in locking facility. The cabinet shall be earthed properly. A steel plate/pipe, as per the requirement, shall be provided in the cabinet for mounting the instrument and accessories.

5.6.7 Instrument Power Supply Cables And Instrumentation Signal Cables

Cables shall be capable of satisfactorily withstanding without damage, transportation to site, installation at site, and operation under normal and short circuit conditions of the various systems to which the respective cables are connected when operating under the climatic conditions prevailing at the site as indicated in this specification.

Cable joints in instrument signals and power supply cables shall not be permitted.

Cables shall be capable of satisfactory performance when laid on trays, in trenches, conduits, ducts and when directly buried in the ground.

Cables shall be capable of operating satisfactorily under a power supply system voltage variation of ±15%, a frequency variation of ±5.0% .

5.6.7.1 Instrumentation Cables

Cables for Digital Signals and Power Supply to Instruments

660V/1100 V grade multicore cables, multistranded high conductivity annealed 1.0 sq.mm stranded tinned copper conductor, extruded PVC insulated, with aluminium mylar tape, ATC drain wire run continuously in contact with aluminium tape, inner sheathed with extruded

PVC, armoured with galvanised steel wire overall sheathed with extruded PVC conforming to IS:1554 & IEC:189 Part II.

Cables for Analog Signals and Signals from Temperature Sensors

660 V/1100 V annealed, tinned, high conductivity 1.0 sq.mm stranded copper conductor extruded PVC insulated two/three cores twisted into pair/traid, laid up collectively, individual pair/traid shielded and overall shielded with aluminium mylar tape, ATC drain wire run continuously in contact with aluminium side of the tape, inner sheathed with extruded PVC, armoured with galvanised steel wire, overall sheathed with extruded PVC conforming to IS:1554 & IEC:189 Part II.

5.6.7.2 Laying Of Cables

A distance of minimum 300mm shall be maintained between the cables carrying low voltage AC and DC signals and a distance of minimum 600mm shall be maintained between cables carrying HT and LT signals. In outdoor areas, the cables shall be directly buried. Each instrumentation and power supply cable shall be terminated to individual panel/ terminal box. Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.

Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for Project Manager approval.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. A loop of 1 meters shall be left near each field instrument before terminating the cable.

Cables shall be complete uncut lengths from one termination to the other.

All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules. Identification tags shall be securely fastened to the cables at both the ends.

Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

5.6.7.3 The general specifications for controller shall be as under:

Minimum Memory Size and Type	Minimum 10K words User program memory and 10K words User data memory
Data Logging	Minimum 128KB Data Logging and 64KB for Recipe
Battery Backup	Yes
Embedded I/O	Min. 32 Digital I/O & Min. 6 Analog I/O

I/O Expansion	More than 50 I/O's for actual requirement
Data Access Tool	Inbuilt / Embedded LCD Display Preferred
Communication Port	Required 2 number of ports of RS 232/485/ Modbus configurable. 1 No. Ethernet Port as minimum
Operating Power	24VDC
Operating temperatur	-20...+60 °C
Relative humidity	5...95% non-condensing
Certificate	UL, CE, C-Tick

6 Technical Specifications For Surge Protection Devices

6.1 Zero Velocity Valve

The valve shall have an outer fabricated casing ('Main Body') in which a 'Central Rod' is held by struts. The 'Stationary Central Dome' creating an annular streamlined passage for smooth flow of water shall be provided. Closing Disc shall be mounted on 'Central Rod'. Disc shall be held in closed position by number of 'Stainless Steel Springs' (as per AISI 304). Two 'Anti Rotation Guides' shall be provided on the edge of 'Central Disc' with minimum resistance to flow. 'Anti Rotation Guide' shall be clad with Stainless Steel Strip (as per AISI304) and 'Guide Fork' with brass liners. A 'Bypass' shall be provided with a 'Valve' connecting upstream and downstream sides of valve. A 'Man Hole' shall be provided on 'Outlet' cone of main body, for maintenance and replacement of spring (if required) without removing the valve from line. The 'Outer Shell', 'Dome' & 'Disc' shall be fabricated out of M.S. plates as per IS 2062. A stainless steel sleeve (as per AISI 304) shall be fitted on 'Central Shaft', which moves in brass bush in 'Disc' for free movement. The Valve shall be painted in Zinc Rich Epoxy Paint from inside and outside.

6.2 Air Cushion Valve

The valve shall have of a 'Main Body' and 'Top Housing'. On the side of main body, two 'Air Inlet Valves' loaded with a light spring shall be fitted. The 'Inlet' shall be protected by a cover. The 'Top Housing' shall have an opening for air escape. A spring loaded 'Poppet' with a brass seat and Neoprene 'Sealing Ring' shall be provided to covers the top of the opening. The spring pressure on the valve with adjustable screw (S. S. as per AISI-304) shall be provided. The 'Housing' shall have a tapered outlet, the opening of which shall be adjustable by a tapered plug and Screw (S. S. as per AISI-304). The outlet shall be protected by a cover. On its lower side a cage holding a ball float shall be fitted. 'Main Body', 'Top Flange', shall be fabricated from MS (as per I.S.2062/I.S.1239). The 'Top Housing' shall be made from high grade cast iron. Main body, float ball and air inlet flange shall be tested for hydraulically pressure. Stems of valves shall be are of stainless steel (as per AISI-304). Sealing rings shall be of good quality rubber and seats shall be of brass. The 'Valve' will be painted in Zinc Rich Epoxy Paint from 'Inside and outside'.

7 Technical Specifications For Electro Chlorinator

Capacity

- The plant should be designed for continuous production only.
- Brine is made of locally available common clean salt.
- For larger models Brine should be made separately in Preparation Tank made of PP/PVC/FRP and transferred to the service tank (PP/PVC made) by Pump. Each Tank should be fitted with level indicators raising Alarm at low level.
- Electrolyser made of PP/PVC should be attached with Brine Service Tank. Brine should be fed by Feed Controlled pump to the Electrolyser as Timer is Switched ON.

Control Panel

- Temp Controller / Level Controller / Electronic Controller, different alarms, Timer /Volt – Amp meters, auto Brine Controller etc should all be fitted in the Auto Brine Control Panel.

Rectifiers

Smaller Rectifiers should be 210 V operated units generating upto 100 Amps, 10 – 12 – 24 V. Air cooled in FRP housing with Timer Amp.mtr, etc. All larger Rectifiers should be 3 phase 415V, full wave, modular type which generates full value DC output current settings under fixed 10 – 12 – 24V within short time and continue functioning for days. All Rectifiers whether large or small should be housed in dust proof, moisture Controlled, air cooled, non corrosive materials. Each Rectifier routinely follows all measures as per IEC 146 and other protection norms in reducing over load, High Voltage, Leakages, Temperature in view of good safety measures against accidental losses of property and lives. Due to both Hydrogen gas, moist – salty surroundings and High Voltage in chlorinated room.

Hydrogen Safety Measures

Hydrogen is produced at Cathode during electrolysis of brine to make Hypo. Hydrogen is highly explosive therefore Hydrogen should be blown out with excess air of a blower. For larger unit, a blower should switch OFF a plant if air flow does not reach to the desired level – raising Alarm. Hydrogen Sensor Can also be used for in room Controlling, Exhaust Fan, natural ventilation help diluting stagnant Hydrogen.

F. INSPECTION REQUIREMENTS

1.0 GENERAL

1.1 All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification relevant Indian Standard or internationally approved equivalent standard.

The Employer shall be entitled to attend the aforesaid inspection and/or tests by his own duly authorized and designated representatives.

The Employer and his duly authorized representative shall have access to the Contractor's premises at all suitable times to inspect and examine the material and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain permission for the Employer or his duly authorized representative, to inspect as if the plant and equipment was manufactured

on the Contractors own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates submitted to the Engineer's Representative who will have the right to witness or inspect the above mentioned inspection / testing at any stage desired by him.

The procedure for the testing and inspection to be carried out during or following the manufacture of the materials to ensure the quality and workmanship of the materials and to further ensure that they conform to the Contract in whatever place they are specified shall be as described below.

The Contractor shall give the Employer at least 21 clear days notice in writing of the date and the place at which any plant or equipment will be ready for inspection / testing as provided in the Contract. The Employer or his duly authorized representative shall thereupon at his discretion notify the Contractor of his intention either to release such part of the plant and equipment upon receipt of works tests certificates or of his intention to inspect. The Employer shall then give notice in writing to the Contractor, and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As and when any plant shall have passed the tests referred to in this section, the Engineer's Representative shall issue to the Contractor a notification to that effect.

The Contractor shall forward to the Employer 3 duly certified copies of the test certificates and characteristics performance curves for all equipment.

If the Engineer's Representative fails to attend the inspection and/or test, or if it is agreed between the parties that the Employer's Representative(s) shall not do so, then the Contractor may proceed with the inspection and/or test in the absence of the Engineer's Representative and provide the Employer with a certified report of the results.

If any materials or any part of the works fails to pass any inspection / test, the Contractor shall either rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the maker's works.

Neither the execution of a inspection test of materials or any part of the works, nor the attendance by the Engineer's Representative(s), nor the issue of any test certificate shall relieve the Contractor from his responsibilities under the Contract.

The test equipment, meters, instruments etc., used for testing shall be calibrated at recognized test laboratories at regular intervals and valid certificates shall be made available to the Engineer's representatives at the time of testing. The calibrating instrument used as standards shall be traceable to National / International standards. Calibration certificates for test instruments shall be produced from a recognized Laboratory for the Engineer's consent in advance of testing and if necessary

instruments shall be recalibrated or substituted before the commencement of the test.

The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Employer or his authorized representative his written approval to the release of such part for shipment after any tests required by the Contract have been completed to the Employer's satisfaction.

The following Testing shall be carried out for all the equipment as applicable
Visual Inspection.

Material Certificates for all the specified material shall be furnished.

Welding Qualifications

Dimension Checking

Stage Inspections (in process inspection)

Dynamic balancing for all rotating parts

Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable

Operation check

Liquid penetration tests or magnetic particle tests for all machined surfaces of pressure parts.

Ultrasonic test for forging materials viz.,

Plates, flanges and bars of thickness / dia 40mm and above used for fabrication of pressure and load bearing members and rotating parts.

Radiographic testing for all but welded parts, as per applicable codes.

Hardness tests for all Hardened surfaces.

The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the data sheets / drawings / specifications.

2.0 INSPECTION REQUIREMENTS

The following inspection and test categories shall be applied prior to delivery of the equipment, of various categories as indicated in the technical specifications for each type of the equipment.

Category A : The drawing has to be approved by the Employer's Representative before manufacture and testing. The material has to be inspected by the Employer's Representative or a third party inspecting agency approved by the Employer's Representative at the manufacture's premise before packing and dispatching. The inspection charges of the agency shall be first borne by the Contractor which shall be reimbursed after production of actual receipt along with the first running bill of material from the item of provisional sums of BOQ.

Category B : The drawing of the equipment have to be submitted and approved by the Employer’s Representative prior to manufacture. The materials has to be tested by the manufacturer and the manufacturer’s test certificates are to be submitted and approved by the Employer’s Representative before dispatching of the equipment. Not withstanding the above, the Employer’s Representative, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of the Contractor’s representative.

Category C : Samples of the materials and / or equipment shall be submitted to the Employer’s Representative for pre-construction review and approval in accordance with the provisions of Section , Following approval by the Employer’s Representative, the material may be manufactured as per the approved standards and delivered to the Site.

For material / equipment under Category “A” and “B”, the Employer’s Representative will provide an authorization for packing and shipping after inspection.

The testing and approval for dispatching shall not absolve the Contractor form his obligations for satisfactory performance of the plant.

2.1 INSPECTION REQUIREMENT

Sr. No.	Item	Category of inspection
29.	uPVC, DI, CI pipes	Category A
30.	uPVC, DI, CI pipe fittings	Category A
31.	Rubber ring, Manhole cover, frame, CI footsteps, Other Fittings, Precast structures.	Category B
Mechanical and instrumentation work		
32.	Sluice Valves, Butterfly Valve and Air valves	Category A
33.	Non-Return Valves	Category A
34.	Dismantling Joints	Category B
35.	Ductile Iron Pipe Work	Category A
36.	Manually Operated Overhead Travelling Crane	Category B
37.	Exhaust Fans	Category C
38.	Float level switches	Category B
39.	Pressure Gauges	Category C

Sr. No.	Item	Category of inspection
40.	Surge Protection Devices	Category B
41.	Instrumentation & Control Cables	Category B
42.	Instrument Control Panel comprising of PLC, digital indicator, alarm annunciator, mimic, pushbuttons etc.	Category A
43.	Battery & Battery Charger Panel	Category A
44.	Screen Control Panel	Category A
Electrical works		
45.	Transformer	Category A
46.	Disconnecter	Category A
47.	Diesel Generating set	Category A
48.	Lightning arrestors, drop-out fuses and insulators	Category B
49.	Capacitors and APFC Panel	Category A
50.	LV switchboards and Control Cabinets	Category A
51.	Induction Motors	Category A
52.	Sub-Distribution Boards	Category B
53.	Power and Control Cables	Category B
54.	Earthing System	Category C
55.	Lighting system equipment	Category B
56.	Local Push Buttons	Category C

G. INSTALLATION, TESTING AND COMMISSIONING

1. ERECTION - GENERAL

The Contractor’s staff shall include adequate and competent erection engineers with proven, suitable, previous experience on similar contracts to supervise the erection of the Works and sufficient skilled, semi-skilled and unskilled labour to ensure completion of Works in time. The Contractor shall not remove any representative,

erector or skilled labour from the Site without prior approval of the Engineer's Representative.

The Contractor shall ensure that no installation or erection work shall commence until full and unconditionally approved working drawings, signed and stamped by the Employer are available at Site.

The Contractor's erection staff shall arrive on the Site on dates to be agreed by the Engineer. Before they proceed to the Site, however, the Contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractors) supply has arrived on Site so that there will be no delay on this account.

One erection engineer who shall be required to be the Contractor's representative shall be conversant with the erection and commissioning of the complete Works. Should there be more than one erector, one shall be in charge and the Contractor shall inform the Engineer's Representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.

The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference and of the positions, levels dimensions and alignment, appliances and labour in connection therewith. The checking of setting out of any line or level by the Engineer or Engineer's Representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the Contractor shall check the dimension of structures where the various items of Plants are to be installed and shall bring any deviations from the required position, lines or dimensions to the notice of the Engineer. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the Contractor during the course of erection to new or existing Plant or buildings or any part thereof, the Contractor shall, at no additional cost to the Employer, make good, repair or replace the damage, promptly and effectively as directed by the Engineer and to the Engineer's satisfaction.

The Contractor shall align all equipment and holding down bolts and shall inform the Employer before preceding with grouting-in the items concerned. The Contractor shall ensure that all equipment is securely held and remains in correct alignment before, during and after grouting-in.

The approval by the Employer of the Contractor's proposals for rigging and hoisting any items of the Plant into final positions shall not relieve the Contractor from his responsibility for damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items, whether structural, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Employer.

No Plants or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be

transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses and deflection, the beams and girders shall be provided with temporary supports.

During erection of the Plant the Engineer will inspect the installation from time to time in the presence of the Contractor’s Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be rectified as instructed by the Engineer.

2 GENERAL PREPARATIONS BEFORE COMPLETION OF THE PLANT

The following documents should be completed in accordance with the Contract schedule before completion of erection. The Employer and the Contractor shall preserve and control these documents in a safe and appropriate place on Site in order the both parties personnel can make use of them at any time.

Technical Documents

Operation and Maintenance manual

Design documents including the Contractor’s design data, drawings and Specifications.

Tools and test equipment list

Spare parts list

Lubricant list

Procedures

Mechanical testing procedure

Electrical testing procedure

Instrumentation testing procedure

Detailed Pre-commissioning and Commissioning procedure

Detailed Performance Test procedure

General and Coordination Documents

Detailed organization charts for Pre-commissioning and Commissioning showing lines of authorities and responsibility, and functions of all key personnel.

Job description of the members of the team.

Scheduled dates of assignment of each member to Pre-commissioning and Commissioning Organization.

Detailed schedule showing the time sequence, which Contractor anticipates to follow for the various steps in Completion of Erection, Pre-commissioning and Commissioning of each unit and equipment.

Regulations for safety, hygiene and discipline

Practical organization of the relationship (meetings, reports, etc.) between the Contractor and the Employer at the phases of Pre-commissioning and Commissioning

Emergency communication route

Manpower

Required manpower shall be provided as agreed between the Contractor and the Employer in a Manpower Mobilization Plan, which shall include the number and qualifications of the operator and maintenance personnel to be furnished by the Employer for the Plant.

3 COMPLETION OF ERECTION

The completion of Plant under erection by the Contractor shall be deemed to occur, if all the units of the Plant are structurally and mechanically complete and will include among other such responsibilities the following:

Plant in the Scope of the Contract has been erected, installed and grouted as per specifications.

Installation checks are completed and approved by the Engineer.

Erected Plants are totally ready for commissioning checks.

At the stage of completion of erection, the Contractor shall ensure that all physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo tests on completion and subsequent pre-commissioning checks.

Upon achieving the completion as described above, the Contractor shall notify the Engineer by a written notice intimating completion of erection and notify the Engineer for inspection. The Engineer / Engineer’s Representative shall proceed with the inspection of such units within 14 days of such a notice.

The Engineer shall certify completion when there are no defaults in the Works

or

The Engineer shall inform the Contractor list of deficiencies for rectification hereinafter referred as Punch list and the Contractor shall complete the rectification work within a jointly agreed period before pre-commissioning activities and obtain the Engineer’s acceptance or approval of the same before proceeding with the same.

The Engineer may inform the Contractor that the works are accepted with the ‘Punch’ list (items which do not hamper operability, safety or maintainability) and allow the Contractors to proceed with the pre-commissioning checks when the Contractor under-takes to complete such outstanding works within an agreed time during defects liability period. Taking over shall be based on rectification of all deficiencies as advised by Punch lists.

The erection period indicated by the Contractor would be deemed to cover all the activities up to Completion as stipulated in previous paragraphs, notice of completion by the Contractor, inspection by the Engineer for Completion, and Contractor rectification of all deficiencies as noticed by the deficiency/Punch list, and acceptance by the Engineer of such rectification’s, prior to Tests on Completion.

Minor defects, which in the opinion of Engineer, which do not hamper operability and maintainability will nor be taken into account for deciding Mechanical Completion. Such defects shall be rectified concurrent to commissioning checks before Tests on Completion. However, the Engineer’s decision in this regard is final.

The commissioning period as notified by the Contractor shall be deemed to occur beyond the date of Completion and shall include all periods of pre-commissioning, trials and Tests on completion.

It is in the Contractor’s interest to offer the section/units/systems, progressively under identified milestones within overall erection period, duly completed for rectification of any deficiencies pointed out by the Engineer and to achieve Mechanical Completion before undertaking the tests on Completion within the specified erection period. The Engineer also reserves the right to withhold the cost as estimated to be equivalent to the rectification of deficiencies pointed out to the Contractor until such a time such deficiencies are rectified to the satisfaction of the Engineer.

4 PRE-COMMISSIONING

After the Completion of erection, Pre-commissioning activities listed below shall be carried out to make the Plant ready for Commissioning. Instruments, materials and manpower necessary for conducting site tests shall be provided by the Contractor at his own cost.

Upon completion of erection of each piece of equipment, facility or discrete part of the plant, mechanical checks and tests shall be carried out according to the Contractor’s checklist. The mechanical checks and tests shall be to establish that:

The Plant is erected in accordance with the Contractor’s construction drawings, pipe work drawings, instrument diagrams, etc. issued for the Plant.

Materials are installed and mechanically function in accordance with the Contract and Applicable codes as listed in the Contract are followed for Materials and workmanship.

Items such as painting, thermal insulation and final clean up which do not materially affect the operation or safety of the Plant will be excluded. All these items shall be listed and completed after Pre-commissioning or Commissioning at the discretion of the Contractor, but before acceptance.

The Contractor shall prepare and maintain at Site test forms and records which shall include:

Description of type of test or check,

Date and times of test or check,

Identification of equipment and facilities,

Test pressure, test data and results, including remarks, if any,

Signature of the Contractor’s personnel attesting to data recorded, if any. The Contractors construction forces thereof shall carry out checks, tests and records.

Wherever the Employer's witness or attesting of the check or test is required, the Employer's personnel shall attend such check and test. For this purpose, the Contractor shall keep the Employer informed of a day-to-day test plan schedule. The test plan schedule may be revised from time to time to reflect the actual progress of the work and test.

Any items found incomplete or requiring repair or adjustment shall be marked as such on the test records and then reported by the Contractor to the Employer and the Contractor's personnel in charge of the relevant construction area.

Checking procedures shall be repeated until all the items on the checklist are cleared.

A complete set of test records shall be handed over to the Employer on completion.

The tests on the different Mechanical and Electrical equipment shall include but not limited to:

4.1 Pumps, Piping and Valves

Hydrotest pressure on the casing shall be 1.5 times maximum discharge head or twice duty point whichever is higher. Provision of the necessary pumps, gauges, blank flanges, and tapings etc. for carrying out these tests shall be included in the Contract. (*)

Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.

Operating tests shall be conducted on valves.

The pumps shall be tested for mechanical performance. The vibration and noise levels shall be checked to be within the specified.

4.2 Pump Motors

Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

5 INSTRUMENTATION TESTING REQUIREMENTS

Tests on cables

Check details are in accordance with the specification.

Check for physical damage.

Megger test between each core and armour/sheath.

Continuity check.

Connections.

Continuity of Signal/Control/Power Supply Cables

After laying of the field signal/control/power supply cables and prior to connection up to the control panels/instruments, the following procedures shall be adopted:

The signal/control/power supply cables shall be disconnected from each termination point in turn when the wires shall be 'rung-through' for identification and tagged.

The signal/control/power supply cables shall be reconnected to the termination points and again 'rung-through'.

Installation Inspection of Instruments

All instruments shall be checked at site for damage during transportation. Contractor shall submit list of such items to Engineers Representatives and shall arrange for new items.

Wherever necessary, instruments mounted on pre-assembled equipment or to be installed shall be calibrated in the field. Any instrument requiring changed calibration after initial calibration shall be recalibrated to Owner's satisfaction. The services of factory trained instrumentation technicians, tools and equipment for field calibration of each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration shall be provided.

Primary/impulse piping shall be tested hydraulically to 1.5 times the maximum operating pressure after thorough flushing. Flushing of the instrument lines can be carried out while the main line is pressurized after isolating the instrument. Lines shall be isolated from both instrument and vessel or piping ends before such tests. Contractor shall ensure that the instrument installation is as per the approved Installation sketches. Any change in installation arrangement shall be brought to the notice of the Owner.

Tests on electrical installation

Check all closing, tripping, supervision and interlocking of control devices.

Check operation of all alarm circuits.

6 COMMISSIONING

After the completion of Pre-commissioning activities the final checks and preparations necessary for start-up of the plant shall be carried out. The Contractor shall submit to the Employer a written Notice of Mechanical Completion, which shall include:

Identity of a part of the Plant considered mechanically complete,

Copy of all relevant completed test reports,

Date on which the completion of the tests was achieved,

Check list, and A request for issuance of a Mechanical Completion Certificate in respect of that part.

Within fourteen (14) days from the date of receipt of the Contractor's written Notice, the Employer shall:

In the case of acceptance, issue a Mechanical Completion Certificate.

In the case of Objection, submit a rejection Statement setting forth remaining items to be completed or defects or deficiencies to be corrected before Mechanical Completion status can be accepted. When the Employer rejects the Contractor's Notice the Contractor shall take any necessary action to complete or correct the items marked and give the Employer a second Notice of Mechanical Completion.

After the issuance by the Employer of a Mechanical Completion Certificate, Commissioning activities listed below shall be carried out to enable the start-up and operation of the Plant. Procedures are described as below:

Commissioning Procedure shall be carried out in a methodical sequence as follows

Warming up,

Start-up,

Initial running,

Operability adjustment,

Stable operation

Final adjustment

At all stages of commissioning sequence, the Plant shall be operated at optimum operating conditions. To ensure this, the Contractor may make minor adjustment to the conditions indicated in the Operation and Maintenance Manual as necessary.

The Contractor shall check the operating conditions of the Plant by constantly monitoring operating data.

The Contractor shall specify for each discrete part of the Plant the operational data to be recorded and the manner in which the data is to be taken.

The Employer on the forms to be mutually agreed shall record all the operating data. The Employer shall make a copy of the operating log and analytical data from initial operation through to the completion of Performance Test available to the Contractor for evaluation.

The Contractor shall carry out commissioning tests in the presence of the Engineer's representative. The evaluation of test results and decision passed by the Engineer's representative regarding the test results will be final and binding on the Contractor. Additional test or repetition of test to establish satisfactory operation of any equipment shall be carried out by the Contractor, if instructed by the Engineer's representative at no extra cost.

The Contractor shall carry out commissioning tests of the system in the presence of the Engineer's representative and run the equipment at its specified duties for the period of 15 successful days. These tests will be carried out after installation of all the new equipments in the pumping station. The evaluation of test results and decision passed by the Engineer regarding the test results will be final and binding on the Contractor. Additional test or repetition of test to establish satisfactory operation of any equipment shall be carried out by the Contractor at no extra cost, if instructed by the Engineer. During Commissions the contractor shall supply all labour to supervise, operate, test and do all things necessary to keep the plant running. This shall include for provision of such labour on a 24 hour a day basis during testing period of continuous operation as Engineer may consider necessary to establish the efficient operation of the plant.

The completion checks and commissioning tests to be carried out shall include, but not be limited to, those described in subsequent paragraphs, as applicable to the individual equipment/system.

All checks and tests shall be as per the Manufacturer’s drawing manuals, relevant codes of installation and commissioning checklists described in subsequent paragraphs.

General

In general, the following checks shall be carried out on all the equipment/systems, as applicable.

Name plate details according to approved drawings/ specifications

Any physical damage or defect and cleanliness

Tightness of all bolts, clamps and connections

Oil leakages and oil level

Condition of accessories and their completeness

Clearances

Earthing connections

Correctness of installation with respect to approved drawings/specifications

Lubrication of moving parts

Alignment

Correctness and condition of connections

7 SPARE PARTS

Spares during pre-commissioning trials, commissioning tests / maintenance, guarantee etc. shall be provided by the Contractor. The spares also include the consumable such as bulbs, fuses, wires, lubricating oil, gaskets, packing seals, etc. The necessary spares shall be brought by the Contractor prior to the pre-commissioning test so as to avoid the downtime of equipment due to non-availability of them. All these spares have to be provided as required, by Contractor free of cost.

All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements. Spares shall be packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed. All cases, containers and other packages shall be marked and numbered in an approved manner for the purpose of identification. Spares shall be delivered to Site after the completion of erection but before start of commissioning of Plant along with technical leaflets and details. Spare parts shall be indicated in the assembly drawing showing clearly the part numbers.

All cases, containers or other packages are liable to be opened for such examination as the Engineer’s Representative may require and packing shall be designed to facilitate opening and thereafter re-packing. In the event of the some specific spares offered in the Contract being withdrawn from manufacture owing to changes in design of equipment or similar reasons viz., model being obsolete etc.,

the Contractor shall inform the Employer before such withdrawal so that the Employer can take timely alternative steps.

8 SAFETY PROCEDURE AND PRACTICE

Following safety procedure and practice should be provided by Contractor in switchboard room/substation as per latest edition of I.S. 5216.

Rubber matting of 11kV test grade in front of LV switchboard and other panels in switchboard room

One shock treatment chart in LV switchboard room

Caution/Danger Board

415 V switchgear : 1 No.

Sub distribution board: 1 No.

Three sand bucket in switchboard room

Two fire extinguisher in switchboard room

One set of 11kV grade hand gloves in switchboard room

Fire Safety

The requirement of hand appliance in switchboard room, electrical equipment room shall be as per the latest edition of Fire Protection Manual by Regional Tariff Committee.

Contractor's Licence

The Contractor shall obtain the necessary Licence/Authorisation from the Licensing Board of the locality/State for carrying out the installation work. The persons deputed by the Contractor's firm should also hold valid permits issued/recognized by the Licensing Board of the locality/State in which the work is to be done.

The electrical installation work shall be carried out by licensed electricians only and approved by appropriate authorities. It is the responsibility of Contractor to get approval of complete electrical system from the appropriate authority such as JVVNL, CEIG etc which is relevant for electrical installation work.

9 SPECIFICATIONS FOR OPERATION AND MAINTENANCE

General

This section of specifications applies to the specifications of materials used for operation and maintenance, the workmanship, period for routine maintenance, specifications for the acceptable quality of treated water, maintenance of records, and responsibilities during operation and maintenance period.

The Contractor shall operate and maintain the entire system all buildings constructed in the project as per the scope of work, campus areas for the entire period specified in the Contract.

Specifications

The specification of materials used for repairs shall be the one used in the original work. If not used during execution, specifications for such materials, which were not used during construction, shall be got approved by the department, prior to commencement of operation and maintenance period and must be incorporated in the O&M manual. Without being limited by this clause, during O&M period, the contractor shall use appropriate material for repairs even if the material required for such repair is not approved earlier, and no delay in repairs shall be subjected to such limitation. But subsequent to such use of material, the contractor shall submit proposals for the approval of the specifications of such material. The submissions and approval of material shall be done in accordance to the conditions laid down in the special conditions of contract. The approved material, will subsequently form a part of the O&M manual.

Experience and Qualification of Staff

For all operation and maintenance works, the contractor shall provide skilled staff, who have adequate qualifications and sufficient experience of similar works. The minimum qualifications and experience required for minimum staff to be deployed by the contractor shall be as per scope of work for carrying out the O&M functions.

Lubrication

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor, in the operation and maintenance manuals. The number of types of lubricants shall be kept to a minimum. In case of grease lubricated bearings for electric motors, a lithium base grease is preferred.

The Contractor shall indicate the brand name of indigenously available equivalent lubricants with complete duty specification, in the O&M manual. The Contractor shall also furnish the schedule of quantities for each fill, frequency of filling and annual requirement in O&M manual.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose means more than once in a month.

Where more than one type of special grease is required, a grease gun for each special type shall be used.

All lubricant systems shall be designed so as not to cause a fire or pollution hazard.

The Contractor shall supply flushing oil for such lubrication system when an item of plant is ready for preliminary running.

Spare Parts

All spare parts used for the equipment in the maintenance of the system must be from the manufacturer of the equipment or if the equipment itself has been made with parts of other manufacturer the parts must be of the same make as used in the equipment supplied and installed.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be labelled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

Particular Requirements during O&M

The workmanship observed for all repair and maintenance work must be in accordance to "Good Engineering Practices".

Pipeline

The MS clamps, pipe sections used must have thickness as per design requirement at the point of installation and shall be coated internally and externally with suitable coatings.

The rubber gaskets/rings, nut & bolts etc. to be used shall be as per specifications given for respective items in this Chapter.

After each repair the damaged coating of pipes must be repaired and if in trench conditions, the trench must be filled with approved soil so as to provide minimum cover of 0.90 meters.

Stretches along pipe alignments where cover is washed out or removed due to other reasons must be rehabilitated so that the minimum cover required is always maintained.

All cracks in pipe supporting structures, valve chambers and their edges must be racked, filled and made good with cement sand mortar 1:2.

Operations and Maintenance Manual

The comprehensive manual to be submitted before the operation and maintenance period, i.e. during execution stage as defined in **PCC** containing the contents specified in scope of work given in this chapter, must be updated, not limited to, on principals listed below:

Up-dating any changes in the procedures existing in the O&M manual, deemed necessary to be changed due to limitation observed during the maintenance period and incorporating the procedures for maintenance of other repairs/break downs not incorporated in the maintenance but faced during O&M period.

Procedures for repair of leaks/burst in different types of pipes must be provided, with supporting drawings as provided in the O&M manual must be updated if any differences are observed during O&M contract.

Frequency of spares used in maintenance of valves (air-valve, sluice valves and butterfly valves), expansion joints, equipment installed for surge protection and protection against corrosion must be recorded for updating the contents of manual.

Record of trouble shooting points and details of events causing troubles (break down's) during maintenance of pumps / motors / measuring equipment(s), / electric panel and accessories there in must be maintained and used for updating the contents of manual.

The record of Inventory used must be maintained and the relevant portion of O&M manual must be updated to list out the requirement of Inventory for maintaining the system for 12 months.

The provisions in the manual must incorporate every aspect of good industrial practices even if not elaborated here or in other parts of the bid documents. The provisions in the approved operation and maintenance document shall only be valid and binding for both the parties during operation and maintenance along with the additions and deletions made.

The manual so prepared must be updated after the end of every year of operation and maintenance, giving effect to the experience gained and the observations made by the Department during the maintenance period.

II List of Drawings

Sl. No.	Name of Drawing	Drawing No.
1.	Zone 1 Beelahedi	BHI/WS/4-01
2.	Zone 2 Bhiwadi	BHI/WS/4-02
3.	Zone 3 Ghatal	BHI/WS/4-03
4.	Zone 4 Godhan	BHI/WS/4-04
5.	Zone 5 Harchandpur	BHI/WS/4-05
6.	Zone 6 Kahrani	BHI/WS/4-06
7.	Zone 7 Khanpur	BHI/WS/4-07
8.	Zone 8 Khijarpur	BHI/WS/4-08
9.	Zone 9 Khijuriwas	BHI/WS/4-09
10.	Zone 10 Milakpur Gujar	BHI/WS/4-10
11.	Zone 11 Mundana meo & Amlaki	BHI/WS/4-11
12.	Zone 12 Nagaliya & Alampur	BHI/WS/4-12
13.	Zone 13 Rampura	BHI/WS/4-13
14.	Zone 14 Saidpur	BHI/WS/4-14
15.	Zone 15 Santhalka	BHI/WS/4-15
16.	Zone 16 Shahdod	BHI/WS/4-16
17.	Zone 17 Udaipur	BHI/WS/4-17
18.	Zone 18 UIT Sector 1	BHI/WS/4-18
19.	Zone 19 UIT SECTOR 8	BHI/WS/4-19
20.	Zone 20 Bhagat singh Coloni	BHI/WS/4-20
21.	Zone 21 Housing Board Sector 4	BHI/WS/4-21
22.	Zone 22 Housing Board Sector 1,2 & 3	BHI/WS/4-22
23.	GA of OHSR	BHI/WS/5

Sl. No.	Name of Drawing	Drawing No.
24.	GA of CWR	BHI/WS/6
25.	GA of pump house	BHI/WS/7
26.	GA of EE Residence	BHI/WS/8
27.	GA of EE Office building	BHI/WS/9
28.	GA of A. En. Residence	BHI/WS/10
29.	GA of trench section	BHI/WS/11
30.	GA of Valve chamber	BHI/WS/12

III Supplementary Information

Information about Bhiwadi:

- 1.1 Bhiwadi is a census town in Tijara tehsil of Alwar district of the Indian state of Rajasthan. Bhiwadi comes under Delhi NCR region and it is an industrial hub. It lies on Rajasthan-Haryana border and is adjacent to Dharuhera town and Rewari city of Haryana. Dharuhera and Bhiwadi together form one urban sprawl. It is 70km from New Delhi. Distance from Gurgaon to Bhiwadi is 49 km (30.00 miles). Bhiwadi is situated at 28.21°N, 76.87°E. It is 55 km away from the Indira Gandhi International Airport, New Delhi. 200 km from Jaipur, 90 km from Alwar, 40 km from Gurgaon and 60 km from Faridabad. It is reached by National Highway NH8 (Delhi-Jaipur highway) via Dharuhera that is 5 km away. It can also be reached by Gurgaon-Sohna-Taoru-Dharuhera road. Nearest railway station is in Rewari approximately 26 km.
- 1.2 Generally, water table is below 20-25 m in Bhiwadi. Soil is mix of loose, hard soil and mixed with boulders. Temperature rises upto 45⁰ C in Summer and below 5⁰ C in Winter.

IV Personnel Requirements

The Contractor shall employ for the execution of work only such persons as are skilled and experienced in all activities required for the completion of the Works, from reconnaissance, design, manufacturing, execution and testing to commissioning. The Engineer in Charge shall be at liberty to object to and require the Contractor to remove from the Work any person who in the opinion of the Engineer in Charge misconducts himself or is incompetent or negligent in the proper performance of his duties. Such person shall not again be employed without permission of the Engineer in Charge.

The Contractor shall employ labour in sufficient number to maintain the required rate of progress and quality to ensure workmanship of the degree specified in the Contract.

Following minimum technical personnel are required for execution of this work and bio data of following key persons responsible for the execution of work shall be submitted along with the bid.

SN	Name of the post	Nos.	Minimum qualification	Minimum Experience Required in relevant field
1	Project Manager	1	B.E. (Civil/Mech.)	7 years
2	Site Engineer	1	B.E. (Civil)	5 years
3	Site Engineer	1	B.E. (Mech.)	5 years
4	Site Supervisors	5	Diploma (Civil/Mech.)	2 years

V Equipment Requirements

The Bidder should submit the details of following equipments along with the bid in the format given in Chapter-IV

No.	Equipment Type and Characteristics	Min. Number Required
1.	Rig (DTH) for 200 mm dia. With minimum capacity compressor of 900 CFM/250 psi	1
2.	Rig (Rotary) for 200 mm dia.	1
3.	Excavator	3
4.	Concrete batch mix plant	1
5.	Transit mixers	2
6.	Laboratory for testing fineness, consistency, setting time compressive & tensile strength of cement compressive & flexural strength of cement concrete and proof stress, elongation, tensile strength, bending & re-bending of reinforcement steel	1
7.	Concrete mixer with hopper	2
8.	Road roller (tandem/vibratory)	1
9.	Needle/ plate vibrator	5
10.	Trolley with tractors /Tipper lorries	3
11.	Total station survey equipment set	3
12.	Bituminous hot mix plant	1
13.	Road layer/ paver equipment	1
14.	Hydraulic testing equipment for pipes- set	2
15.	Water tanker (with sprinkling arrangements)	2
16.	Welding Set	1
17.	Crane/ Hydra of min. 8 ton capacity	1
18.	Dewatering Pumps (mud type, electricity and Diesel operated)	3

Note : In case of rigs machines, suitable for drilling in combination formation and of suitable capacity should be available with the bidder either in the name of firm or in the name of

partner or proprietor as the case may be, on ownership, proof of which shall be enclosed with the bid.

LIST OF SPECIFIED MAKES**LIST OF SPECIFIED MAKES**

(Updated up to 31.08.2013)

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
1.	H.T. MOTORS	KIRLOSKER ELCTRIC CO. LTD. (KEC.) / SIEMENS INDIA LTD. (SIEMENS) / CROMPTON GREAVES LTD. (CROMPTON) / BHARAT HEAVY ELECTRICAL LTD. (BHEL) /GENERAL ELECTRIC CO. LTD. (GEC) /NGEF (NGEF) / SCHNEIDER / JYOTI.
2.	L.T. MOTOR	KEC/GEC / CROMPTON /SIEMENS / ABB/NGEF/JYOTI/ SCHNEIDER / LUBI (upto 45 KW)
3	DEWATERING PUMP	KBL / M&P / KSB / SU
4.	BUTTER FLY VALVE	KIRLOSKER BROTHER LTD / INDIAN VALVE COMPANY/ FOURESS ENGINEERING / ADVANCE / DURGA ENGG./ MAYUR/ R&D / DALUI / JUPITER (UPTO 1600MM) / KARTAR (UPTO 250MM) / AVK / UPADHAYA / MARCK (UPTO 600MM)/ PATSONS/ VAG/CALSENS
4. (A)	DI Resilient (Soft) Seated BUTTERFLY VALVE	SIGMA FLOW (UPTO 300MM)/ AVK /VAG/JUPITER (UPTO 700MM) / IVC / DVPL
5.	ELECTRICAL ACTUATOR	ROTORK / LIMITORK / AUMA INDIA / MARSH / ENTROK
6.	SLUICE VALVE	KIRLOSKAR BROTHERS LTD., PUNE / INDIAN VALVE COMPANY/ FOURESS ENGINEERING / DURGA ENGINEERING / SHIV DURGA / KEYSTONE / MAYUR / DALUI / R&D / JUPITER (UPTO1200MM) / KARTAR (UPTO 600MM) / AVK / SHIVA (UPTO 600MM) / UPADHAYA / BEW (UPTO 300MM) / PATSONS/ VAG / SACHDEVA (UPTO 1200 MM)/ CALSENS/HARI (UPTO 250MM)
6.	DI Resilient (Soft) Seated SLUICE	SIGMA FLOW (UPTO 300MM)/ AVK / BEW (UPTO 300MM) /VAG/ JUPIETR (UPTO 450MM)/SACHDEVA (UPTO

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
(A)	VALVE	1000MM) / SHIVA (UPTO 300MM) / MAYUR (UPTO 300MM) / IVC / DVPL / KARTAR (UPTO 600MM)
7.	SLUICE GATE	JASH / BHARAT INDUSTRIAL CORP./ ORIENTAL / FLUID CONTROLS
8.	DOUBLE PLATE CHECK VALVE	ADVANCE / KBL / IVC / R&D /DURGA / MAYUR / DALUI / PATSONS / VAG
9.	NON RETURN VALVE	KIRLOSKAR BROTHERS LTD., PUNE / INDIAN VALVE COMPANY/ FOURESS ENGINEERING / DURGA ENGINEERING / SHIV DURGA / KEYSTONE / MAYUR / DALUI / R&D / JUPITER (UPTO1200MM) / KARTAR (UPTO 600MM) / AVK / SHIVA (UPTO 600MM) / UPADHAYA / BEW (UPTO 300MM) / PATSONS/ VAG / SACHDEVA (UPTO 1200 MM)/ CALSENS/HARI (UPTO 250MM)
9. (A)	DI Resilient (Soft) Seated NON RETURN VALVE	AVK / VAG / IVC / DVPL
10.	KINETIC AIR VALVE	KIRLOSKAR BROTHER LTD. / INDIAN VALVE COMPANY / ADVANCE VALVE / INTER VALVE / FOURESS / R&D / DURGA ENGINEERING / SHIV DURGA / MAYUR / DALUI / R&D / SHIVA / UPADHAYA / BEW/ AFT/ PATSONS/ AVK / VAG /CALSENS/JUPITER
10. (A)	DI Resilient (Soft) Seated KINETIC AIR VALVE	AVK / VAG / IVC / DVPL
11.	DISMANTLING JOINTS (TELESCOPIC)	ORIENTAL / SHIV DURGA / SUR INDUSTRIES / DWRENIND. / MANGALA / QUALITECH / SYSTEC FLEXO PRODUCT / DURGA / MAYUR / SHIVA / BEW / PRECISE
12	PAINTS	ASIAN / SHALIMAR / JENSON & NICHOLSON / GOODLAC NEROLAC/ ICL / BRITISH PAINT / CLEAN COATS
13.	COMPRESSOR FOR AIR VESSEL	ANGERSOL RAND / ELGI / CP
14	AIR VESSEL	L&T / SHRIDHARAN / SURESEAL

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
15.	EOT CRANES:	EDDY CRANES ENGINEERS PVT. LTD. (EEPL) / ACME MANUFACTURES ENGINEERS (ACME) / M/S ROCKWELL HOIST CRANES PVT LTD. NEW DELHI / REWA / WMI / VIDUT / WH BRADDDY/ JAPS
16.	WINDOW AIR CONDITIONERS:	VOLTAS LTD.(VOLTAS) / CARRIER AIRCON LTD (CARRIERS) / FEDDERS LLOYD./ AIRCON / BLUE STAR LTD. (BLUE STAR)
17.	EXHAUST FAN:	BAJAJ ELECTRICALS LTD. (BAJAJ) / CROMPTON GREAVES LTD. (CGL) / GENERAL ELECTRIC CO. LTD. (GEC) / KHAITAN LTD. (KHAITAN) / JAI ENGG. WORKS.
18.	MAKE OF HOIST. LIFTING SYSTEM	EDDY CRANES / ACME / INDEX / JAPS
19.	MECHANICAL FLOW MIXER AND INDICATOR	KENT. SCHLUMBERGER (ACTRIES) / CAPSTAN
20.	FLASH MIXURE	FABCO / PARAMOUNT / HDO / FIBRE & FIBRE / REMI
21.	CHLORINATORS	INDUSTRIAL DEVICES PVT. LTD./ BANACO / ISGECIES FABCAM / CHLOROCONTROL / AQUA / TUSCON JESCO
22.	BACK WASH PUMPS	KIRLOSKAR / M & P / JYOTI / BEACON WIER
23.	BACK WASH BLOWER MAKE & TYPE	FLAKT/ KAY INTERNATIONAL / SWAM / EVERST / ROOTS/ WEEPL
24.	DOSE METERING PUMPS	ASIALMI / SWELLORF / VK
25.	BRIDGE WEIGHGING DEVICE	AVERY
26.	CHLORINE LEAKAGE DETECTION SYSTEM	METIJO

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
27	SLUDGE PUMP	KIRLOSKAR / M&P / JYOTI / BEACON WIER
28.	RECTIFIER	CANARA ELECTRIC
29.	BATTERY	EXIDE / STANDARD / FUKUWA / AMCO
30.	OUTDOOR LIGHTENING ARRESSTOR	ALPRO / OBLUM / PACTIL / IGE/ SKIPPER SEIL
31	HV POTTENTIAL TRANSFORMER/(PT)	ABB / BHEL / CAPP / JYPTI / SKIPPER SEIL
32.	HV CURRENT TRANSFORMER/ (CT)	ABB / BHEL / CAPP / JYPTI / SKIPPER SEIL
33.	HIGH VOLTAGE DOUBLE BRAKE ISOLATOR WITH OR WITHOUT EARTH BRAKE	ATLAS / ABB / ELPRO / PRACTIL / SKIPPER SEIL
34.	VACCUM CIRCUIT BRAKER	ABB / BHEL / CGL / SCHNEIDER / JYPTI/
35.	33/6.6 KV POWER TRANSFORMER	ABB / CGL / ALSTOM / BHARAT BIJLEE / KIRLOSKAR / UTTAM (BHARAT) / VOLTAMP / VARDHMAN ELECTRO – MECH /SKIPPER
36.	33 OR 6.6/ .433 KV AUXILIARY TRANSFORMER	ABB / CGL / ALSTOM / BHARAT BIJLEE / KIRLOSKAR / UTTAM (BHARAT) / VOLTAMP / VARDHMAN ELECTRO – MECH/SKIPPER
37.	33KV SWITCHYARD CONTROL PANEL	GEC / L&T / SIEMENS / SCHNEIDER
38.	INDICATING METERS	AE / IMP / RISHAB/ E&H
39.	METERING	AE / IMP / RISHAB/ E&H
40.	ANNUCIATOR	MASIBUS / LETROTEK / APLAB / MINILEC / PEACON /

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
		ICA
41.	HT SWITCH GEAR PANEL	SCHNEIDER / ABB / SIEMENS / L&T/ C&S / CGL/ HT SWITCHGEARS/ SWATI SWITCHGEARS
42.	HRC FUSES	L&T / GEC / SIEMENS / ER / HAVELLS
43.	PROTECTION RELAYS	SCHNEIDER / ABB / SIEMENS / GEC / ER
44.	MOTOR PROTECTION RELAY	SCHNEIDER / ABB / SIEMENS / GEC/ ER
45.	PUSH BUTTON	L&T / BCH / SIEMENS / VAISHNO / TECHNIC / RASS / C&S
46.	INDICATING LAMPS	L&T / BCH / SIEMENS / VAISHNO / TECHNIC / RASS / C&S
47.	MULTI FUNCTION METERS	GEC / IMP/ SIEMENS / RISHAB / AE
48.	CURRENT TRANSFORMERS	ABB / BHEL / KAPPA / JYOTI / SKIPPER SEIL
49.	POTTENTIAL TRANSFORMERS	ABB/ BHEL/ KAPPA / JYOTI / SKIPPER SEIL
50.	LT SWITCH GEAR PANEL	GEC / CGL / SCHNEIDER / L&T / C&S / SIEMENS / HAVELLS/ DYNAMIC / GK MARKETING / DIVYA/ HT SWITCHGEARS/ SWATI SWITCHGEARS / ENGINEERS & ENGINEERS
51.	MOULDED CASE CIRCUIT BREAKER	GEC / CG L/ SCHNEIDER / L&T/ C&S / SIEMENS / HAVELLS / ABB
52.	TOR SWITCH	L&T / KAYEES / SCHNEIDER / SIEMENS / SALZER
53.	CONTROL FUSES	GEC / SCHNEIDER / L&T / C&S / SIEMENS / HAVELLS
54.	CONTACTORS	GEC / ABB / L&T / C&S / SIEMENS / BCH / HAVELLS / DIVYA

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
55.	EMERGENCY DG SYSTEM ENGINE	KIRLOSKAR / KIRLOSKAR-CUMMINS / GREAVES COTTON / CATER PILLAR / ASHOKA LEYLAND
56.	ALTERNATOR	KEC / JYOTI / NGEF / AVK / CROMPTON
57.	INDUCTION MOTOR	KEC/ NGEF/ CGL/ GEC/ BHEL/ SIEMENS / SCHNEIDER
58.	HT CABLE	CCI / INCAB / UNISTAR / RPG / NICCO / FORTGLOSTAR / SATELLITE / HAVELLS / KEI
59.	CONTROL CABLE	CCI / UNIVERSAL / TORRENT/ FINOFLEX / GEMSCAB / RPG / KEI / CORDS
60.	BATTERY CHARGER	SABNIFE POWER SYSTEM / CHHABIELECT/ UPTRON / AMCO / UNIVERSAL
61.	CAPACITOR	GEC / L&T/ YASH/ MADHAV / RPG / KHATAU JANKAR / UNISTAR
62.	PVC LIGHTING WIRES	FINOLEX / INCAB / RPG / FORTGLOSTER / GEMSCAB / KEI
63.	LIGHTING FIXTURES	PHILIPS / CGI / BAJAJ / MYSORE LAMPS / GE APAR / HAVELLS
64.	ELECTROMAGNETIC FULL BORE TYPE FLOW METER	FISHER ROSE MOUNT / KROHNE MARSHALL / NIVO CONTROL / E&H / SIEMENS / RLT / SBEM / ABB/ ELECTRONET
65.	ULTRA SONIC TYPE FLOW METER	FISHER ROSE MOUNT / E&H / KROHNE MARSHALL / SIEMENS / NIVO CONTROL / CHETAS / RLT
66.	MECHANICAL TURBINE TYPE FLOW METER	KENT / ITRON / CAPSTAN / NIVO CONTROL / AQUAMET / RLT
67.	PRESSURE LOGGERS	L&T / ABB / MASIBUS / LETROTEK

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
68.	PRESSURE GAUGE	BELLS CONTROLS/ JN MARSHAL / H GURU / MANOMETER INDIA
69.	PRESSURE INDICATOR	FISHER ROSE MOUNT/ BELLS CONTROLS / HONEYWELL / FOX BORO / E&H/ RLT
70.	PRESSURE TRANSMITER	FISHER ROSE MOUNT/ HONEY WELL / FOX BORO / BDO FORBES MARSHAL/ YOKO GAWA / BLUE STAR SEIMENS/ E&H / RLT
71.	LEVEL SWITCH	FISHER ROSE MOUNT / HONEY WELL / SIEMENS / VEGA INSTRUMENT / KROHNE MARSHALL/ SBEM/ E&H / RLT
72.	LEVEL SENSORS (ULTRA SONIC TYPE)	FISHER ROSE MOUNT / HONEY WELL / VEGA INSTRUMENT/ KROHNE MARSHALL / SIEMENS / SBEM / E&H / RLT
73.	LEVEL SENSORS (CAPACITANCE TYPE)	LEVCON / TOSHNIWAL / PUNE TECHTROL/ SBEM / E&H / RLT
74.	LEVEL TRANSMITTER	FISHER ROSE MOUNT / HONEY WELL / VEGA INSTRUMENT / KROHNE MARSHALL / SIEMENS / SBEM / E&H / RLT
75.	LEVEL INDICATOR	FORBES MARSHAL / YOKO GAWA / BLUE STAR / ELECTRO LUX / BELLS CONTROLS/ SBEM / E&H / RLT
76.	NOISE METER	CYGNET
77.	VT PUMPS	FLOWMORE / M&P / KBL / WPIL / JYOTI / AQUA
78.	HSCF PUMPS	FLOWMORE / M&P / KBL / WPIL /JYOTI / BEACONWEIR / LUBI (UPTO 45 KW) / MAXFLOW (UPTO 45KW)
79.	TAPE COATING ON MS PIPE	LLOYD INSULATION/ IWL / BITU-TECH / TYCO
80.	ZVV	SURESEAL / MANNEMANN MEER / MEGHA

SN	PARTICULARS OF EQUIPMENT	SPECIFIED MAKES
		ENGINEERING / FLOWNIX
81.	PLC SCADA	ABB / ALLEN BRADLY / HONEY WELL / SCHENIDGER / L&T / SIEMENS/ E&H/GE /PHOENIX CONTACT
82.	SUBMERSIBLE CENTRIFUGAL PUMP	AQUA

NOTE : Any other make approved by the Technical Committee of the PHED will also be considered.